Chapter

3

Basic Engineering Shapes

In this chapter, you will learn the following to World Class standards:

- **What are Basic Engineering Shapes**
- **Why use Basic Engineering Shapes**
- **Selecting a Basic Engineering Shape**
- **Using a Basic Engineering Shape Catalog**

What are Basic Engineering Shapes

What our basic engineering shapes? Simply, in the earliest days of manufacturing, let us say we are making doors and windows for residential housing and commercial buildings. If our manufacturer is old enough, then the designations residential and commercial would not even apply, so we would just be making doors and windows for any building. So at our manufacturer, we would start building common sized products that our customers would want to purchase. We might even be making a unique product that our competitors do not sell.

In most cases, the sides of the window would be similar even though the height of the window may vary. The tops and bottoms of the window would also have similar characteristics. Immediately, the window designer would notice the common parts and categorize the components of the assembly as basic engineering shapes. After designing several windows and doors, an entire series of basic shapes would be identified that would be used to quickly manufacture, assemble and deliver a functioning window or door. The production manager would maintain a minimum quantity of these parts in stock and when that number would fall below minimum stock, and then a machinist would manufacture the standard shape, which could be cut to length and used for production.

As the industrial revolution developed, individuals who specialize in machining or manufacturing parts that were not the end product formed companies to support larger industries. These companies could support all of the door and window manufacturers and supply them with their standard shapes. At the beginning, the custom shapes would belong to the particular manufacture that our parts factory supported. Eventually, the parts manufacturer would discover more economical ways to support their clients, and develop standard door and window components.

In other instances, architects, designers and engineers would join societies supporting their particular large industries, such as automotive, aerospace, architectural, radio, and naval. In almost every case, the society or association developing guidelines for basic engineering shapes and parts comes after the initial development of the industry. We will observe that although new guidelines governing products and basic components are released, many years go by before the older shapes, parts and devices are removed from application.

For the first 200 years of the industrial revolution, consumers would have to purchase spare parts and basic engineering shapes from the manufacturer who sold them product, because their component was unique to that single manufacturer. The industry did not have standard shapes or parts. Government agencies and particularly the united states military added specifications to their requirements which made certain shapes mandatory. Also, companies that would sell standard engineering shapes would release engineering information, which made it very easy to engineer standard engineering shapes into a product.

Why use Basic Engineering Shapes

Why use basic engineering shapes? Speed and economy are two of the main reasons we want

to incorporate basic engineering shapes into an engineering design. When we walk up the set of stairs, the three stringers supporting both ends and the middle of the tread are made from a standard engineering shape. The tread maybe a smaller shape, but is also readily available from any supplier, since the material is also the standard. The brackets that hold the stringers to a joist are also standard and made specifically for the standard shape of board it is holding. The nails are also a model which meet an industry specification. Whether we are walking on the stairs or on a bridge, we can observe the standard industry shapes that surround us.

The building industry uses pre engineered shapes. The shapes are available in almost every area of the world that has a good hardware store. The shapes include a multitude of lumber products that have the 2x prefix, like a 2x4, 2x6, or 2x12. Other lumber products are in the 0.5x, 1x, or 4x families. There are number of sheets that are in the 4 foot by 8 foot category, such as drywall, plywood and floor joists. Plastic and metal pipe and tube are extruded to standard shapes which are necessary when assembling them to faucets, sinks and other plumbing devices. Electrical wires are solid extrusion or are a bundle of smaller extruded wires twisted together to meet an electrical code called gage. Fasteners use standard threads and sizes so every manufacturer throughout the world can have the confidence that an off the shelf part cab be used to assemble their product.

Civil engineering projects use pre engineered shapes like I beams, channels and angles. Drive under any bridge and we will see basic engineering shapes holding the concrete. Engineering handbooks contain information which allows engineers to select engineering shapes used in structures, by using the published formulas for beams supported at both ends and assorted other configurations. If we know the maximum load which the designed needs to hold and the safety factor for the application, then the engineer can start applying different sized basic structural shapes and beam lengths, finally narrowing in on a certain sized beam. Architects perform the same procedure for selecting beams in the basement along with the lolly columns that hold that beam. The information and the method to calculate the size of the beam are all pre engineered. The designer, architect or engineer need to reference the set of engineering tables and provide their calculation to the building inspector or project engineer for approval.

In some cases, companies continue to ignore standards shapes. These companies make the products that we purchase for the inside of the buildings and that we ride on the road. Automotive companies rarely use pre engineered shapes. Nearly 99% of the components that are in a car are designed and manufactured specifically for that brand of automobile. Car manufacturers typically manufacture their components using high rate production machines, so they already are efficiently manufacturing their individual parts. They also maximize this effort by building different car models using the same chassis, power system and controls. In some cases, the only difference between two models of manufactured automobiles is in the car interior and exterior appearance. Even though the automotive industry uses custom parts for their product, when those numbers reach into the millions, they also become standard parts in themselves. An engineer can select an automotive intended lamp for another design application, because they are so readily available and may meet another specification.

We can see this affect on the industry from the aerospace industry, where they use the lightest materials available. During the last half of the twentieth century, an entire series of aluminum extrusions are available, since lightweight aluminum is used in the aerospace industry.

Selecting a Basic Engineering Shapes

Let us say the part we need uses four 1/16 walled, 0.75 by 1.50 aluminum extruded angle that are 24 inches long. What steps do we take to add the 1/16 walled, 0.75 by 1.50 aluminum extruded angle material to the company inventory?

Like we said previously, using basic engineering shapes is both economical and fast, so there are two tasks that a junior designer of mechanical apparatus would like to accomplish early in your career. The first task is to locate and inventory list of standard materials that our company or contractor is using presently. We can achieve this initial goal by visiting the production manager or purchasing agent with our organization. The second mission is to obtain a catalog, whether online or in print for the materials suppliers that our organization is presently using. Whenever possible, plan to visit the material supplier or when their sales engineer visits the office, ask the purchasing agent to make the introduction. Through questions and observation, try to get guidance about their capability for future material support when using basic engineering shapes.

The following are some suggestions for the questions we will want to ask our senior designer, the production manager, the purchasing agent and the supplier.

1. **What is the procedure when we need to select a new raw material (basic engineering shape) for a product and add it to the company raw material inventory?**
2. **Do we use more than one supplier for basic engineering shapes?**
3. **Who is the inside sales person assigned to give our company price and delivery for basic engineering shapes?**
4. **When asked how much material we will use annually, how do we compute the total amount of products we plan to sell this year?**
5. **Are there indications in the materials catalog that show whether the material is available immediately upon order?**

As a new designer in an Engineering department, we may feel awkward the first time we add a new basic engineering shape to the raw material inventory. In some cases, the individuals with whom we have to coordinate may respond with a statement like “we never use that material before” or they may suggest that we change the design or use a combination of materials to arrive at the same result. Our guidance to new designers is to keep an eye open mind and a good control on the facts.

First of all, in the design process, we should have considered using existing materials to solve the problem, because they are on hand and ready for fabrication. Even our supplier and their delivery driver should not have the capability to respond quicker than our own machinist using as our own onsite raw material inventory. Another advantage of using common materials is this will generally reduce the overall cost of that material when we are purchasing higher quantities of the engineering shape annually. After reviewing all of these considerations, we definitely should have convinced our engineering supervisor and the senior designer that we need the new engineering shape in the raw material inventory. If the purchasing agent and the manufacturing manager are on a project to reduce the many stock raw materials, hopefully our engineering

supervisors and the designers are aware of company goals when selecting a new material.

We have seen designers successfully bring in new materials to a facility to meet new production and have sales, purchasing and manufacturing support the expansion when the engineering designer does the proper research, follows the design process and works with the entire facilities team to bring a new product to manufacturing. Designers who have no respect for the company's overall mission can have a devastating affect on the organization. When an engineering manager has designers who would do not research the company inventory, we can walk onto the production floor and we will see a large amount of part boxes in each work area that support the many different designs in progress. When there is an effort to control the inventory, then we continue to use common parts and shapes to solve problems. In companies that do not work together on this part of manufacturing, we find duplicate parts and shapes that are only slightly different as we walk through the facility.

Using a Basic Engineering Shape Catalog

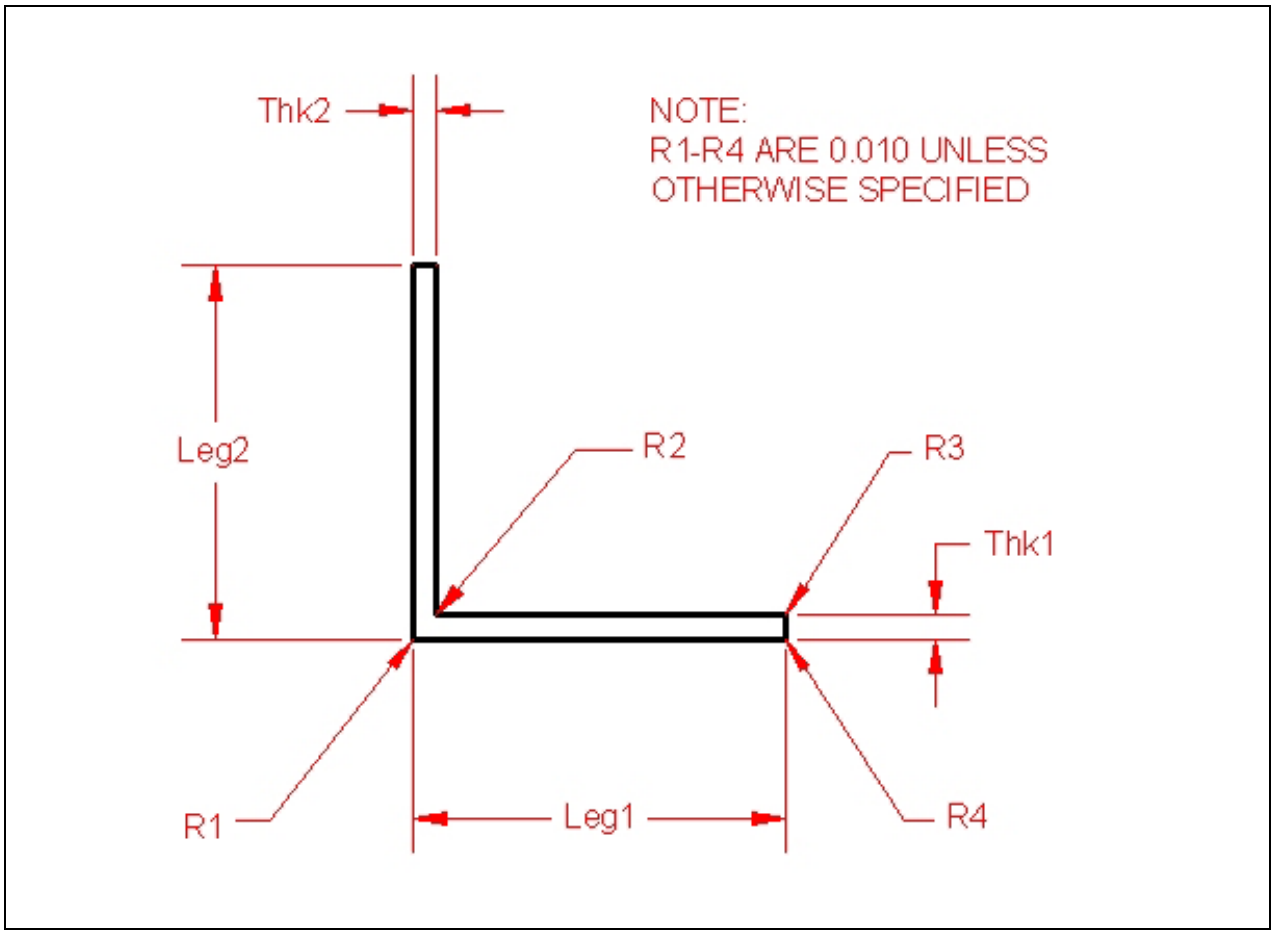

Figure 3.1 – Extruded Angle Diagram

After we know we will need a basic engineering shape like an aluminum extruded angle as seen in Figure 3.1. We will search a supplier catalog and ascertain whether the standard shape is in

stock or whether we need to extend our search to other suppliers. In many cases, an extruded aluminum angle is in stock somewhere and can be shipped to our facility.

A Basic Engineering Shape catalog will have a diagram as we see in Figure 3.1 and the diagram will have variable names that represent a dimension on the shape and the table of data shown in Figure 3.2 has a row or record representing a unique part. As we observe in the table, we can see that a 1/16 walled, 0.75 by 1.50 aluminum extruded angle is available for production.

Leg1	Leg2	Thk1	Thk2
0.500	0.500	0.094	0.094
0.500	0.500	0.125	0.125
0.500	0.500	0.063	0.063
0.500	1.000	0.094	0.063
0.750	0.500	0.094	0.094
0.750	0.750	0.063	0.063
0.750	1.000	0.063	0.063
0.750	1.250	0.063	0.063
0.750	1.250	0.094	0.094
0.750	1.500	0.063	0.063
0.750	1.750	0.125	0.125
0.875	1.500	0.125	0.125
1.000	1.000	0.063	0.063
1.000	1.000	0.094	0.094
1.000	1.000	0.125	0.125
1.250	1.250	0.187	0.187
1.250	1.250	0.125	0.125
1.500	1.125	0.125	0.125
1.500	1.250	0.188	0.188
1.500	1.500	0.125	0.125
1.500	1.500	0.188	0.188
2.000	1.500	0.250	0.250
2.000	2.000	0.125	0.125
2.000	2.000	0.250	0.250
2.500	1.500	0.250	0.250
3.000	2.000	0.125	0.125
3.000	2.000	0.188	0.188
3.500	2.000	0.125	0.125
3.500	2.000	0.125	0.125
4.000	2.500	0.125	0.125
4.000	3.000	0.250	0.250

Figure 3.2 – Extruded Angle Data Table

We would make a part drawing for the 1/16 walled, 0.75 by 1.50 aluminum extruded angle. In Figure 3.3, we make a drawing that is very similar to the catalog on our organization's border. We will add a table in the upper right hand corner showing the dimensions for the basic engineering shape entering our raw material stock. For our organization, the part number 106234-1 will represent our first aluminum extruded angle. If we desire a second angle, the part number would be 106234-2.

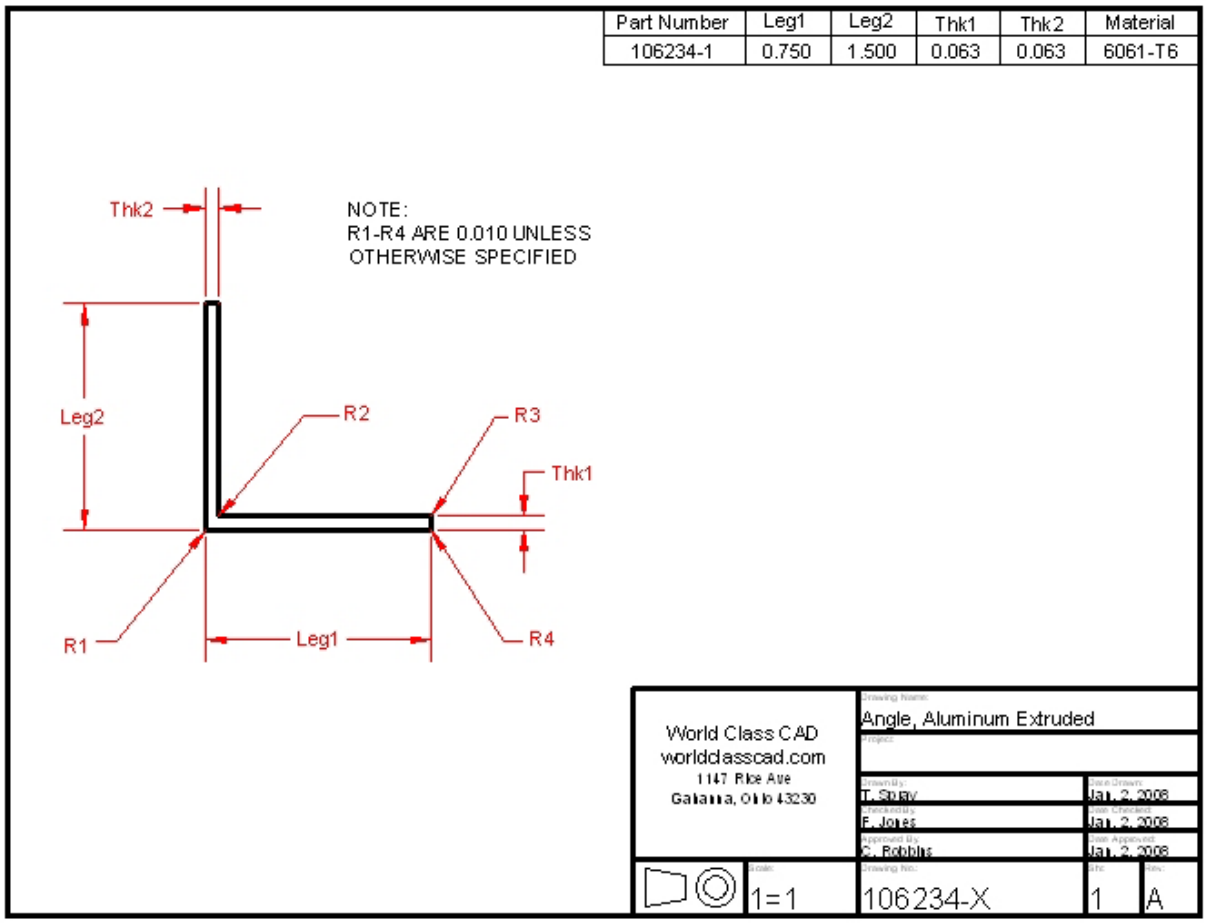

Figure 3.3 – Table Drawing for the Aluminum Extruded Angle

The senior designer asks us to add a second aluminum extruded angle that is ¼ walled and is 1.50 by 2.00. Instead of having multiple drawing sheets for similar parts meeting a standard engineering shape, we have a single drawing. See Figure 3.4 for the addition to the drawing.

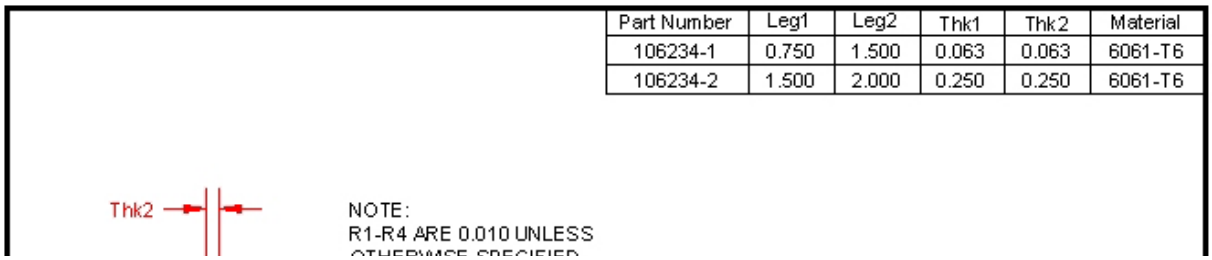

Figure 3.4 – Expanding the Table Drawing for the Second Aluminum Extruded Angle

*** World Class CAD Challenge 04-2 * - Save and close the extruded aluminum angle drawing file. Create a new file and make a part drawing for a 1/8 thick wall by 1.50 leg by 2.50 wide channel, dimension, and place the border and notes in less than 30 minutes. Continue this drill three more times, for a round tube, t-shape extrusion and a rectangular tube, each time completing the drawing under 30 minutes to maintain your World Class ranking.**

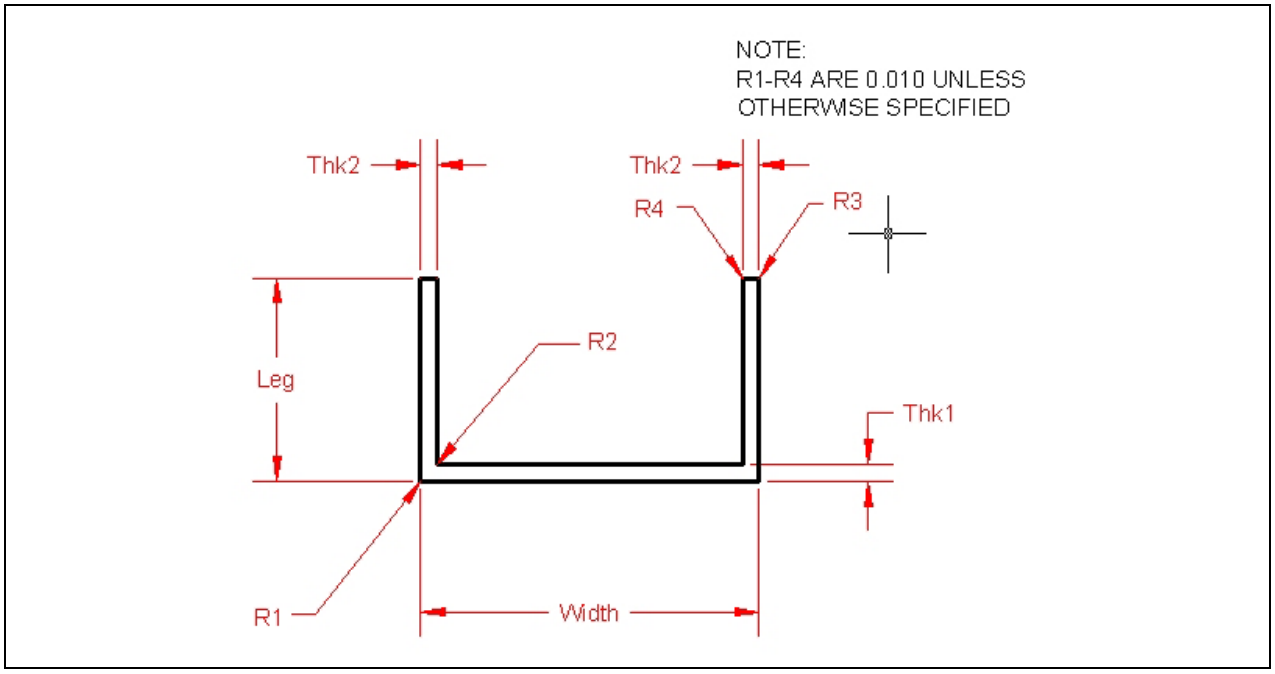

Figure 3.5 – Extruded Channel Diagram

Leg	Width	Thk1	Thk2
0.188	0.500	0.080	0.063
0.250	1.750	0.063	0.063
0.312	0.875	0.063	0.063
0.500	1.000	0.125	0.125
0.500	1.250	0.125	0.125
0.500	2.000	0.125	0.125
0.563	0.625	0.063	0.063
0.625	1.625	0.060	0.060
0.625	2.000	0.125	0.125
0.750	3.000	0.125	0.125
0.875	3.000	0.125	0.125
0.875	3.250	0.125	0.125
1.000	1.250	0.063	0.063
1.000	3.000	0.125	0.125
1.250	0.750	0.125	0.125
1.250	1.250	0.125	0.125
1.250	1.375	0.125	0.125
1.500	1.000	0.125	0.125
1.500	2.500	0.125	0.125
1.500	3.250	0.125	0.125
1.500	3.500	0.125	0.125
1.500	4.000	0.250	0.250
2.000	4.000	0.250	0.250

Figure 3.6 – Extruded Angle Data Table