

## HERC Funding – Final Report 2017

**Project Title: Environmental Engineering Curriculum Materials for ENGR 2270 – Computer Engineering Drafting.**

**Project Period:** August 2016 to July 2017

**Project Overview:** Curriculum materials development for **ENGR 2270 – Computer Engineering Drafting**.

**ENGR 2270-Computer Engineering Drafting** is required by all students in the biological engineering, environmental engineering and civil engineering programs. In the past, course assignments and activities used in the course were geared towards civil engineering students as those students made up a majority in the course. In recent years', environmental engineering and biological engineering student enrollments have been on the rise and it is important that the biological and environmental students see a need for the use of AutoCAD software in the course. To address this issue, in the fall of 2014, we started developing activities, assignments and other materials related to **green energy, environmental systems and biological systems** for use in the course. These activities, assignment and other materials were developed during the fall semester of 2016 and spring semester 2017. The assignments developed are included in the Assignments Developed section below.

**Assignments Developed:** Five new assignments were developed and include the topic areas of:

- Amber Vial
- Erlenmeyer Flask
- 96 Well Plate
- Meeting Room
- Flash Drive Rendering
- Concrete Block

Each of the new assignments is included below.

**Student Support:** Utah State University students were used to develop the materials for the course. **Murad Mahamud** (engineering education graduate student) and **Diane Wiley** (undergraduate engineering student) assisted in the development of the assignments and materials. They worked 10 hours per week during the fall and spring semesters to complete the assignments. During the summer 2017, these assignments were pilot tested by three undergraduate students, two from environmental engineering and one from biological engineering (**Celeste Hancock, Emily Jesgarz and Josh Fallon**). These students had been Teaching Assistants (TA) in the course. These two students worked 4 hours per week during the summer to pilot test the assignments and make modifications.

***Assignments Completed:***

**Amber Vial  
Erlenmeyer Flask  
96 Well Plate  
Meeting Room  
Flash Drive Rendering  
Concrete Block**

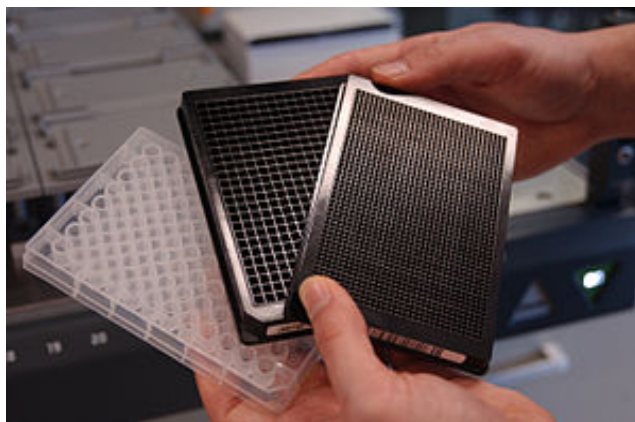
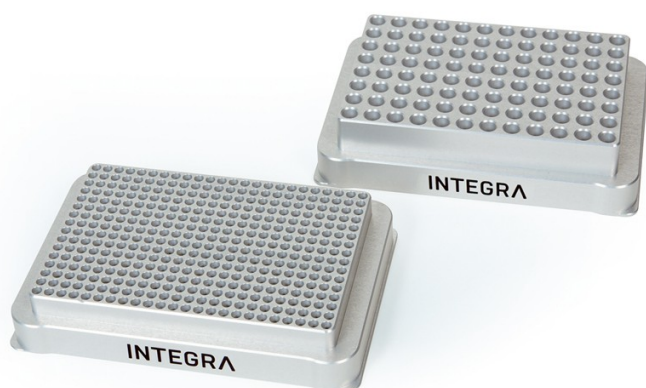
**Title: 96-Well Plate****Plot Scale:** 1" = 1"**Objectives:**

Students will be able to:

1. Use 3D commands in AutoCAD create a 3D model.
2. Print the assignment in 3D representation.

**Background:**

Plate readers, also known as microplate readers or microplate photometers, are instruments which are used to detect biological, chemical or physical events of samples in microtiter plates. A microtiter (also known as a microplate, a microwell plate, or a multiwall) is a flat plate with multiple "wells" used as small test tubes. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed from 6 to 1536 well microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is a 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200  $\mu\text{L}$  per well. Higher density microplates are typically used for screening applications, when throughput and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50  $\mu\text{L}$  per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization.



Various sizes and well count of micro plates commonly used.

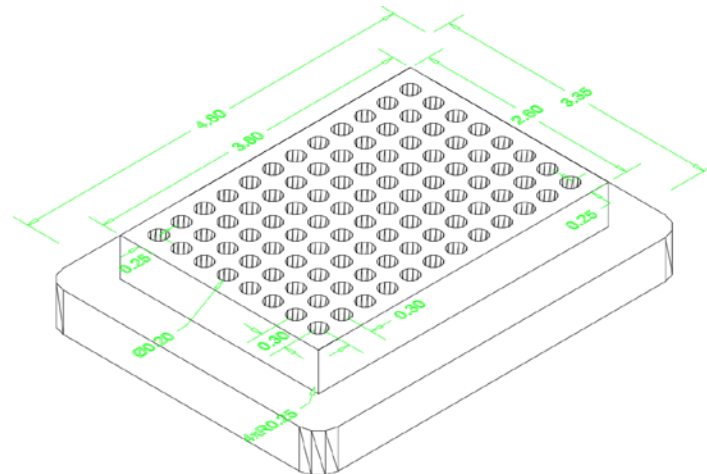
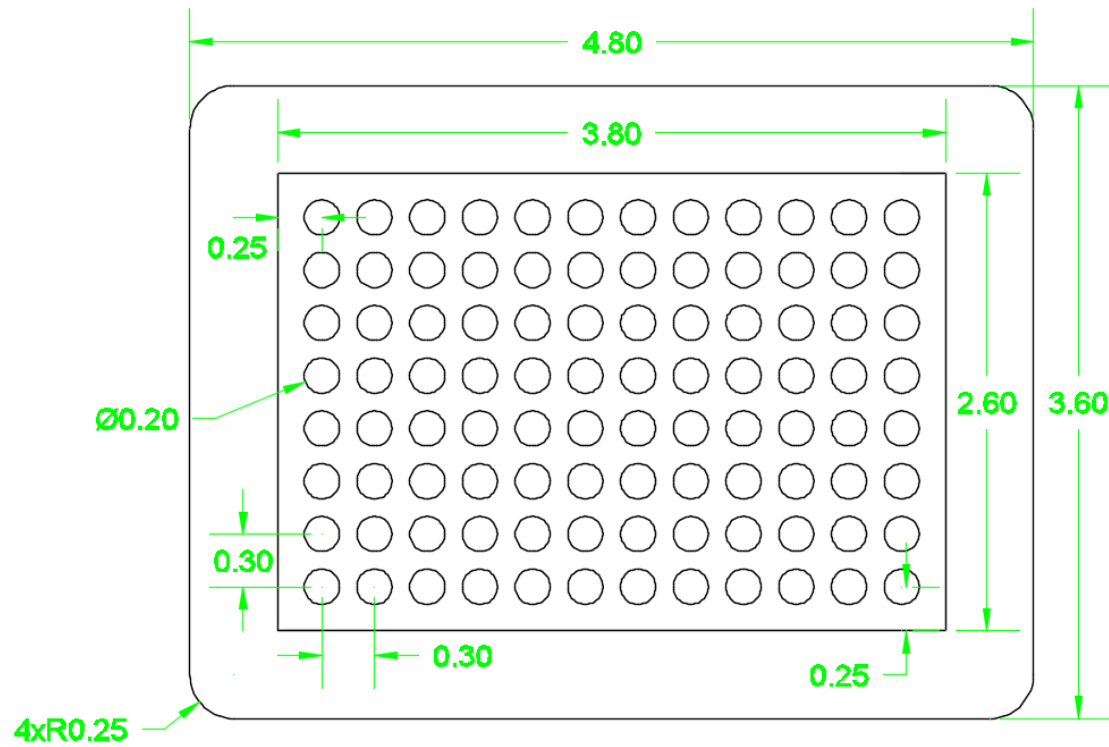


A plate reader used for a 96 well plate

**Problem:**

Analytical Solutions is a company that specializes in the production of analytical equipment and related parts. One of their top selling products is a 3-D printed 64-well plate that is used in conjunction with their micro plate reader. This plate is printed in 3-D to allow for accuracy and reproducibility with this equipment that is very sensitive to minute changes in shape or size. This is printed from a model that has been designed *in silica*. As the lead engineer in charge, your team is tasked with creating this model in AutoCAD. This model will be full size with the dimensions as shown below. Your final drawing should appear similar to what is shown below.

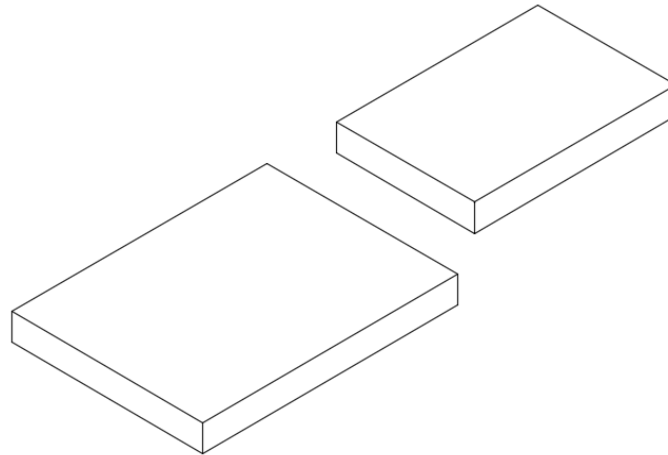
Top View



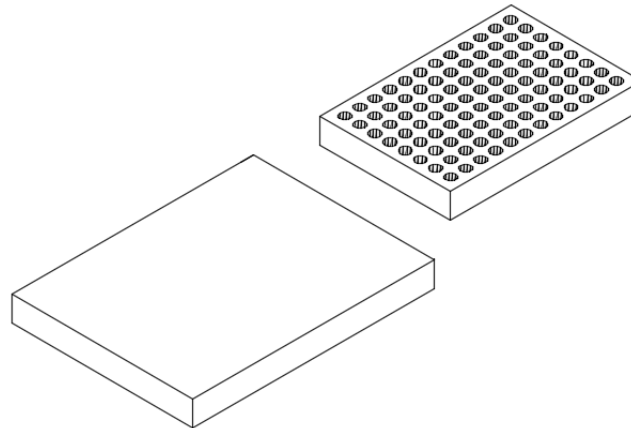
Isometric View

**Step-by-Step Instructions:****96 Well-Plate**

1. Draw a **3D solid** of the 4.8" × 3.6" × 0.5" base.
2. Draw upper part of the Well-Plate (as a 3D solid) without the cylindrical openings as shown in the picture below with a thickness of 0.5".

**Step 2: the two pieces of the well-plate.**

3. Draw the first cylinder with a diameter of 0.2" and height of 0.4" and place it on the top (smaller) piece at a distance of 0.25" from either side.
4. Use the **array** command to duplicate the wells (Cylinders) in an array of 12×8 with a spacing of 0.3" in both directions.
5. **Subtract** the array (wells) from the frame. *Hint:* Explode the array before you subtract.

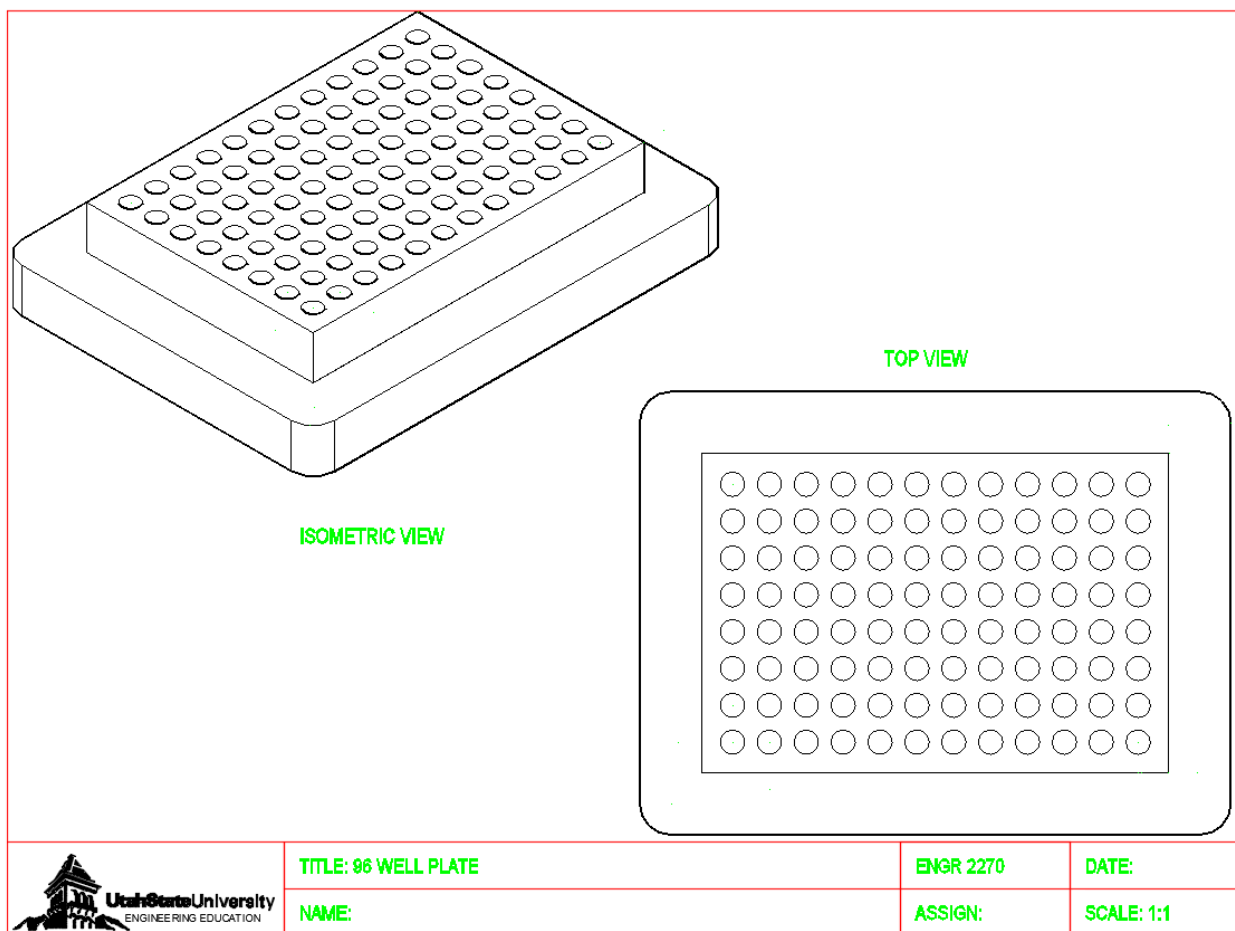


**Step 5.** This is what the box should look like after subtracting

6. Move the smaller box to the middle of the larger box. This should place it at 0.5" from the edges of the larger box
7. Fillet the edges of the larger box with a radius of 0.25".
8. Plot on A-Size sheet to show top view and 3D isometric view (side by side).

## Printing as a hidden model (PaperSpace)

1. Using template file (A-Size titleblock,) draw the 3D part in modelspace.
2. Create two views of the part (using two viewports and display as a **Hidden View**).



**Title: Meeting Room**

**Plot Scale: 1/2" = 1'-0"**

**Precision: .00"**

### Objective:

Students will be able to:

1. demonstrate an understanding of model/paper space and how to alter and plot from each.
2. recognize how to scale a drawing in AutoCAD through paper-space.
3. Follow appropriate dimension guidelines to FULLY describe this object.
4. Create and Use Blocks

### Problem:

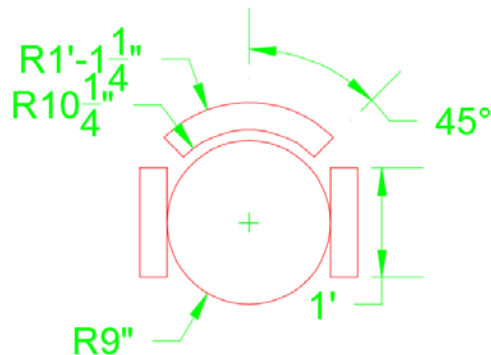
In this assignment, you will be required to draw the top view of

### Commands:

Text	Line	Layers	Undo
Layer	OSNAP	Grid	Limits
Units	Offset	Circle	Trim
Leader	LTSCALE	Dimension	Radius
Diameter	Aligned	Linear	Angular
Baseline	Center Mark	Baseline	Precision
Block			

### Procedure:

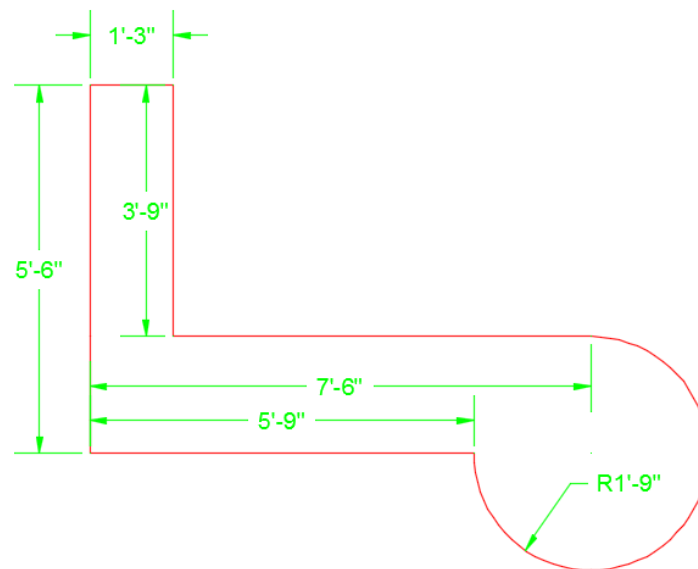
- 1) Start by drawing the chair according to the dimensions shown below.



### Step1: The meeting room chair

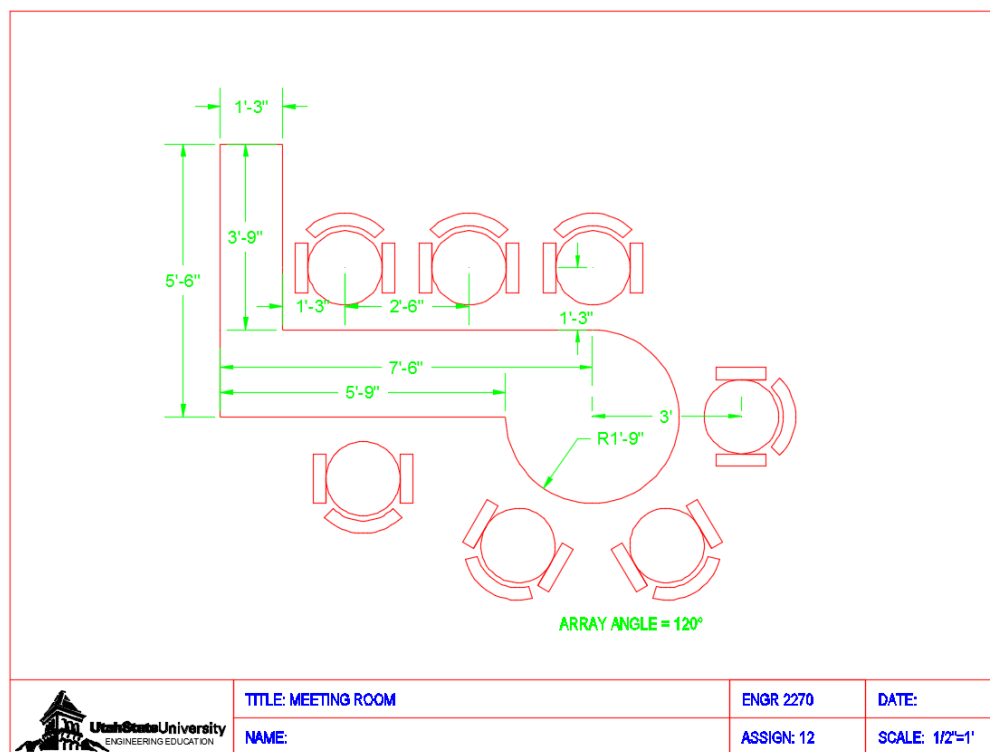
- 2) Convert the chair into a block using the 'Block' command.
- 3) Draw the layout of the top view of the meeting room table as shown in the figure below.





Step3: The meeting room table

- 4) Insert the block into multiple locations as shown in the final product and add dimensions. Note that the chairs around the circular part of the table are done using the array command.



Final Product

**Title:** Amber Vial

**Plot Scale:** 1:1

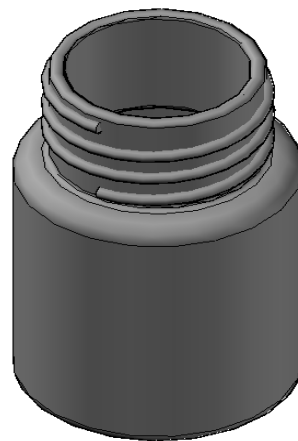
**Objective:**

Learn how to use the Revolve and Sweep Commands

**Problem:**



Amber Vial drawn in AutoCAD and then rendered



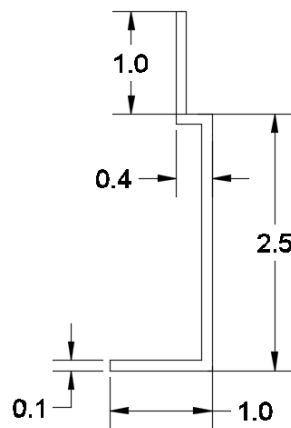
Amber Vial Drawn Using AutoCAD

**Commands:**

Text	Line	Layers	Undo
Layer	OSNAP	Grid	Limits
Units	Offset	Circle	Trim
Region	Fillet	Revolve	Sweep

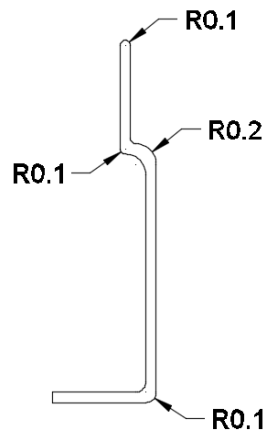
**Hints:**

1. Start by drawing the 2D cross section of the Amber Vial as shown in the figure below:



Step 1

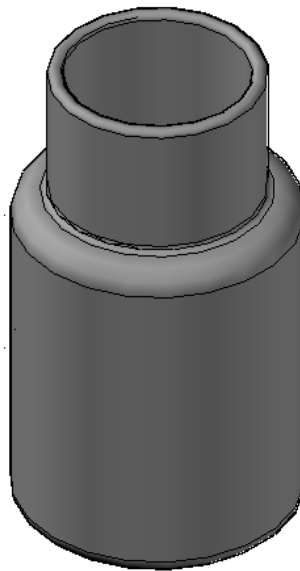
2. Add the fillets according to the figure below



Step 2

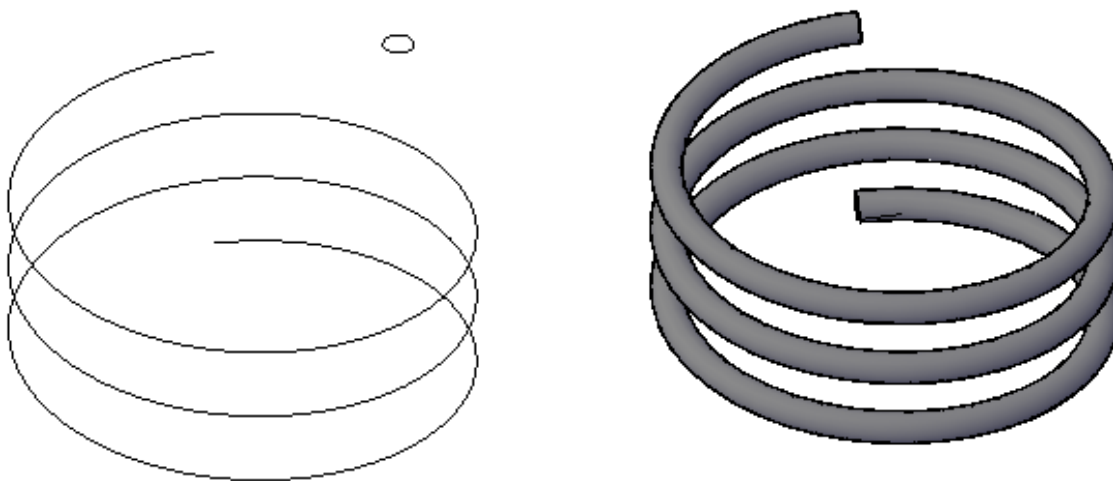
3. Join all the lines and fillets using the region command.

4. Create a copy of all the lines after doing the fillet (The cross section for the revolve) according to step 3. You will have two exact copies of what the picture in step 2 shows.
5. Revolve the drawing around the line with the 0.1 length at the bottom left corner of the drawing, you should end up with a drawing that looks like the figure below: (One copy will be used for the revolve and the other will be left to create the final product)



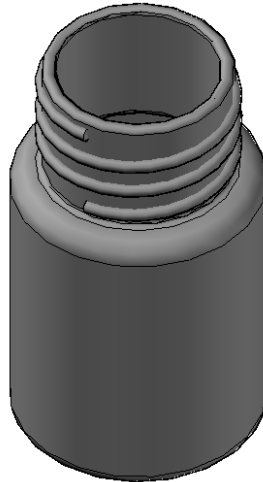
Step 4: Amber Vial after the revolve step

6. Draw a helix starting at the top center of the drawing with a radius of 0.75 at the top and bottom and with 3 turns and 0.75 height.
7. Draw a circle anywhere in model space with a radius of 0.05.


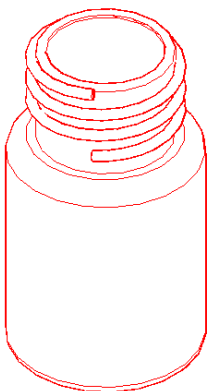



Step 6+7: Helix sweep

8. Sweep the circle on the helix path and you will end up with the drawing shown below in the final product.
9. Using the usual template, print the final product using the one of the Isometric view to show it the beginning and ending of the sweep (hidden visual style) for both the finished object and the cross section as shown in the picture below.



Step 7: Final Product

<b>AMBER VIAL</b>			
<b>ISOMETRIC VIEW FINISHED PRODUCT</b>			
			
<b>FRONT VIEW PRE REVOLVE</b>			
	TITLE: AMBER VIAL		ENGR 2270
	NAME:		DATE:
	ASSIGN:		SCALE: 1:1

Final Product

**Title:** Concrete block

**Plot Scale:** 1:3      **Precision:** .00"

**Objective:**

Students will be able to:

1. Use 3D commands in AutoCAD create a 3D model.
2. Print the assignment in 3D representation.

**Background:**

A concrete masonry unit, also called hollow block, concrete brick, concrete block, cement block, besser block, breeze block and cinder block, is a large rectangular block used in building construction. Concrete blocks are made from cast concrete, Portland cement and aggregate, usually sand and fine gravel for high-density blocks. Lower density blocks may use industrial wastes as an aggregate. Lightweight blocks can also be produced using aerated concrete. Those that use cinders (fly ash or bottom ash) are called cinder blocks in Canada, the US and New Zealand, breeze blocks in the UK and New Zealand, and hollow blocks in the Philippines. In Australia they are also known as besser blocks or besser bricks, because the American-based Besser Company is a major supplier of concrete-block-making machinery. Clinker blocks use clinker as aggregate. In non-technical usage, the terms cinder block and breeze block are often generalized to cover all of these varieties. These concrete blocks can come in a variety of shapes and sizes for different uses.



Examples of different types of concrete masonry units

**Problem:**

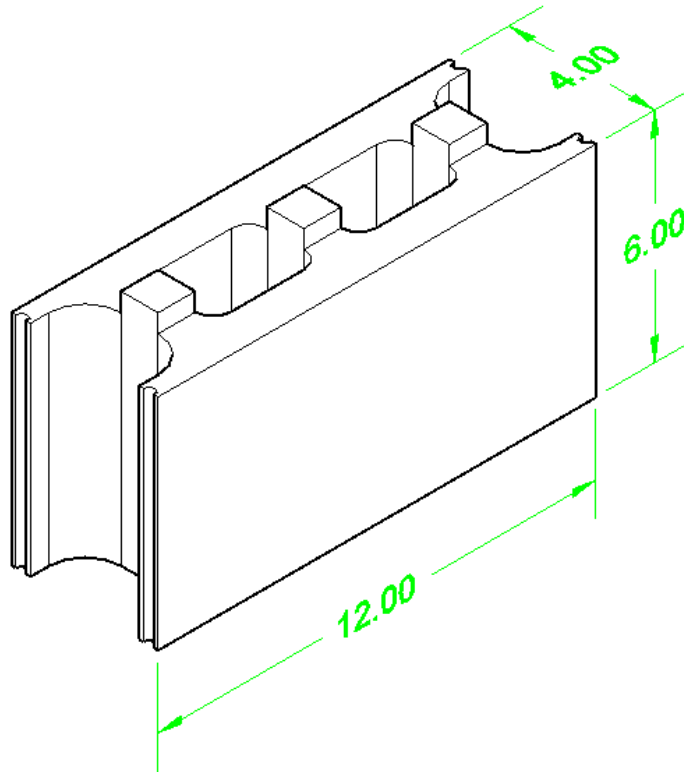
You are the head engineer for Concrete International. This company recently released a new style of concrete block. The company wants a 3D model of said block accompanied with a top view to show more details.



Rendered Concrete Block



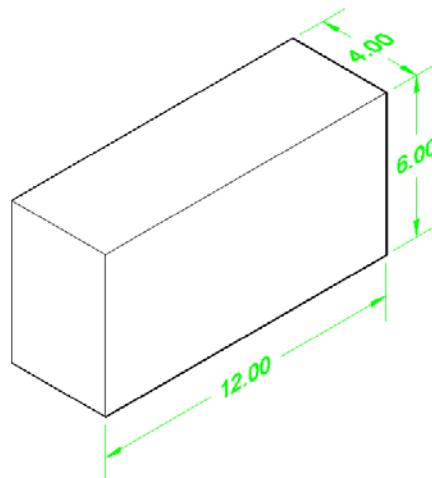
Sample Concrete Block used in this assignment



3D model with some dimensions

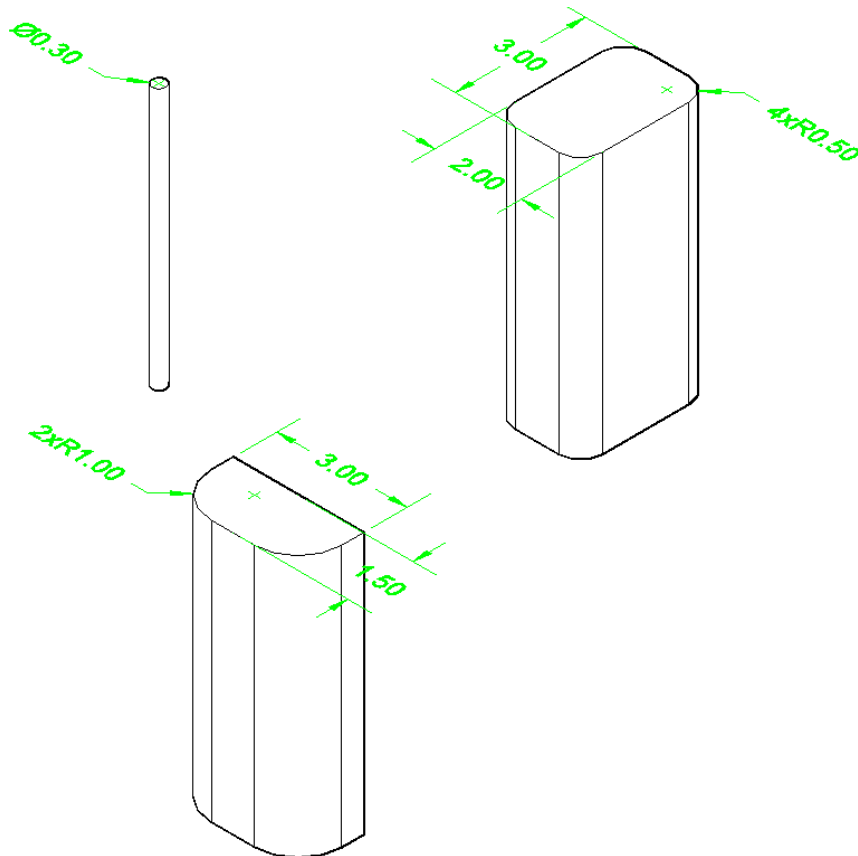
**Step-by-Step Instructions:****Concrete Block**

1. Draw a **3D solid** of the 12"x6"x4" block.

**Step 1: The concrete block.**

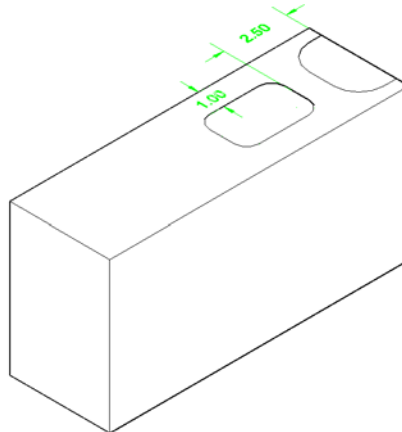


2. Draw the parts shown in the Step 2 figure with the dimensions shown, all parts have a height of 6":



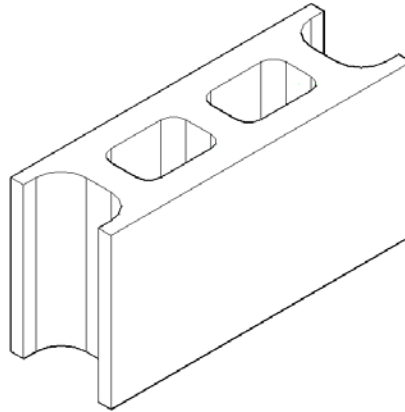
**Step 2: Parts to subtract.**

3. Move those parts to the main block according to the Step 3 figure.



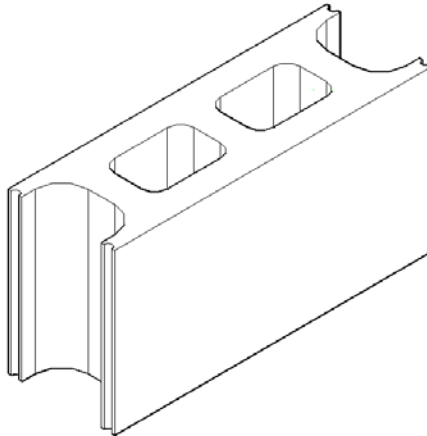
**Step 3: Moving the parts to the main block.**

4. From the top view, mirror the two parts to the other half of the object and then subtract those parts from the main block as shown in the Step 4 figure:



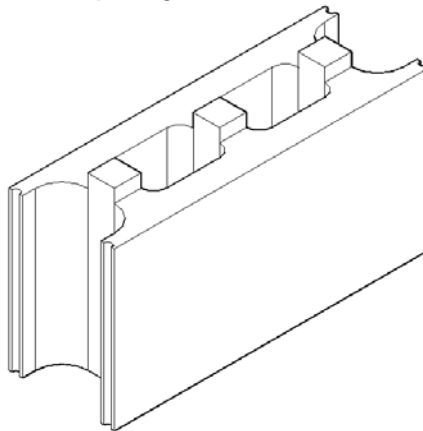
**Step 4: Mirror and subtract.**

5. Copy the cylinder into the four corners and subtract as shown in the Step 5 figure:



**Step 5: Adding the cylinders and subtracting.**

6. Draw the small blocks to be placed on top of the concrete block. They have a bases of 1"x1" with a height of 0.5". Draw the small block and then copy it three times on top of the concrete block as shown in the Step 6 figure.

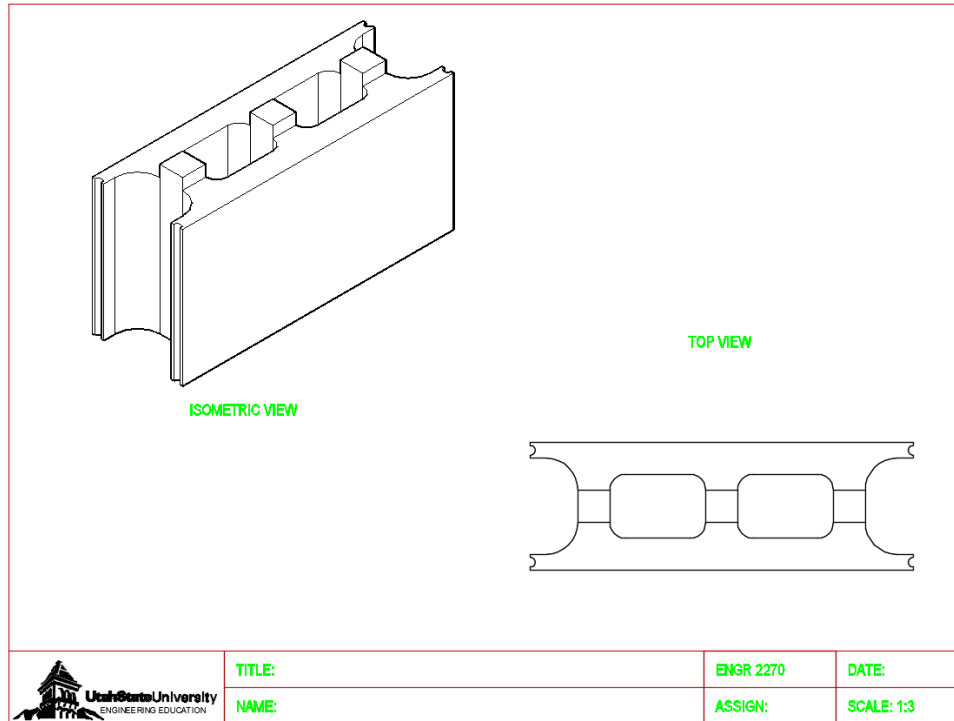


**Step 6: Adding the small blocks.**

7. Union the three small blocks with the main block and then go to the layout and print as shown in the final product below.

## Printing as a hidden model (PaperSpace)

1. Using template file (A-Size titleblock,) draw the 3D part in modelspace.
2. Create two views of the part (using two viewports and display as a **Hidden View**).



**Final Product**

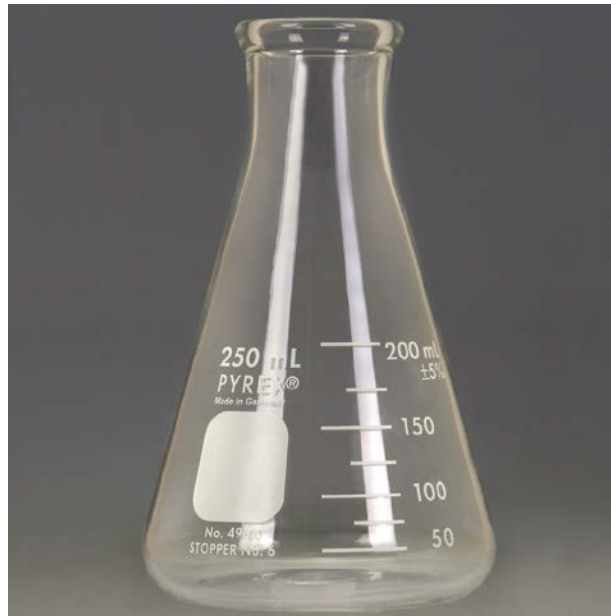
**Title:** Erlenmeyer Flask

**Plot Scale:** 1:1

**Objective:**

Learn how to use the Loft, Shell and Slice Commands

**Background:**



Erlenmeyer Flask that the design was based on

**Problem:**

You work for a laboratory supply manufacturer that is developing a new line of glassware using less materials for more efficient design. Your project is to implement the design ideas discussed with your project team in a conceptual design of an Erlenmeyer flask. Erlenmeyer flasks have a cone-shaped bottom and cylindrical neck. Their flat, thin bottoms are ideal for heating any materials inside and a narrow neck protects from spill-over during mixing or boiling.

The simplest approach to this design will be to loft and shell based on the design parameters discussed in your team meeting.



Erlenmeyer Flask Rendered Using AutoCAD

**Commands:**

Text  
Layer  
Units  
Slice

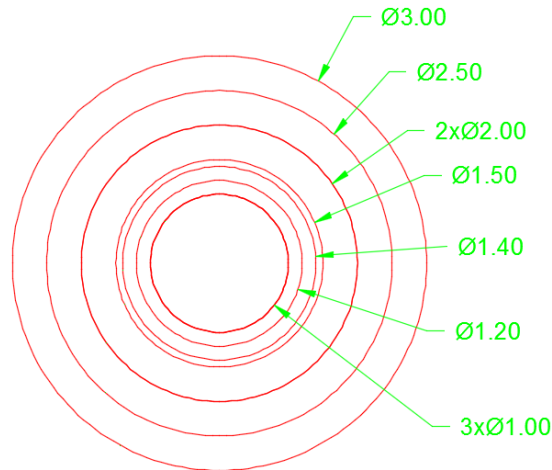
Line  
OSNAP  
Offset  
Fillet

Layers  
Grid  
Circle  
Loft

Undo  
Limits  
Trim  
Shell

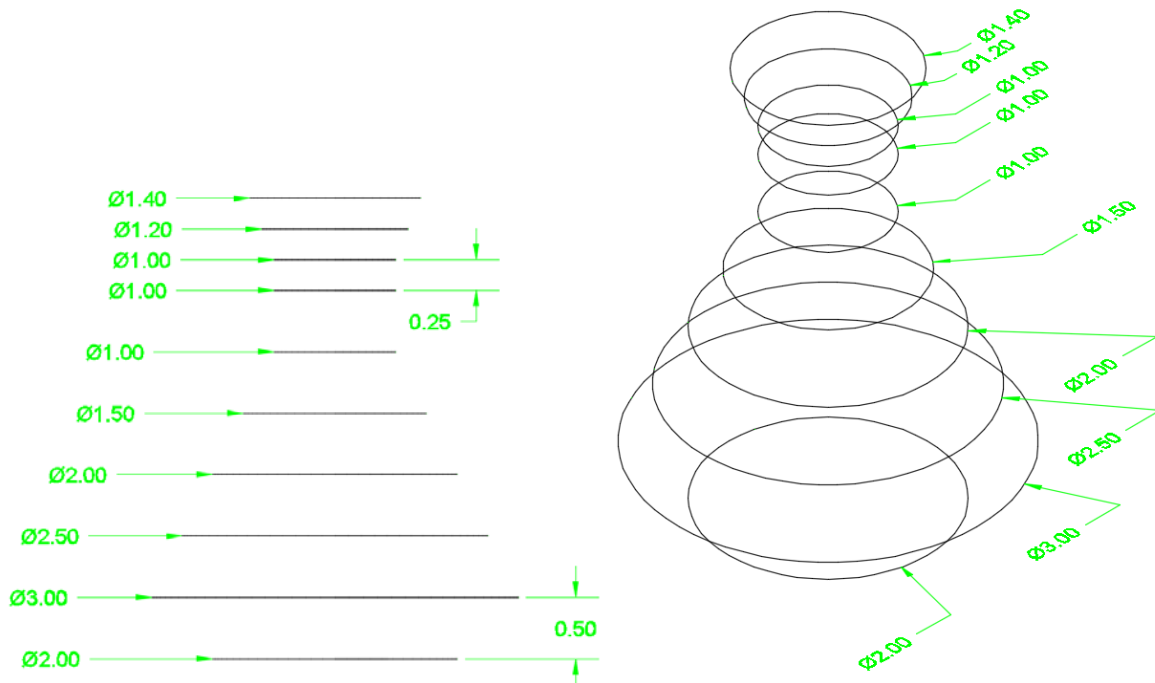
**Procedure:**

1. Start from the top view by drawing the circles shown. Note that there are 2 circles with a diameter of 2 and 3 circles with diameter of 1:



Step 1

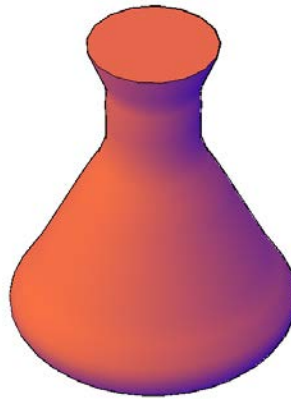
2. From one of the Isometric views, move the circles according to the dimensions shown, all the unlabeled distances are 0.5 except the top three are 0.25.



Step 2: Front View (Left) and Isometric View (Right)

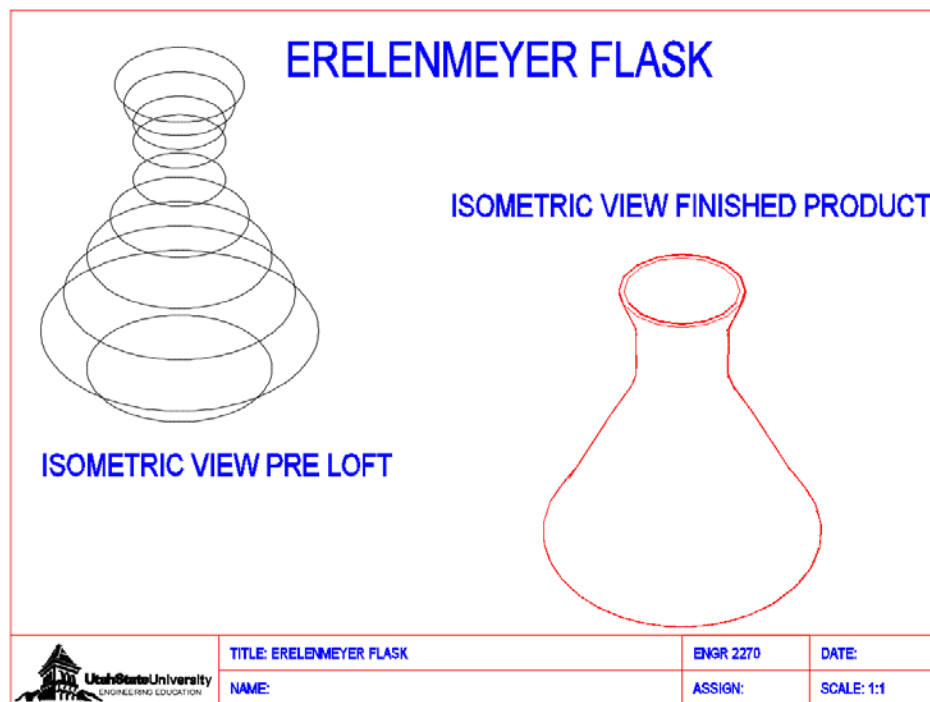
3. Create a copy of all the circles after moving them according to step 2. You will have two exact copies of what the right picture in step 2 shows.

4. Use the loft command to create the flask shape out of the drawn circles, start at the bottom and click on the circles one by one till you get to the top.(One copy will be used for the loft and the other will be left to create the final product)



Step 3

5. Use the shell command to convert the solid object created by the loft command into a shell. Use a shell thickness of 0.05.
6. Use the slice command to get the final shape. Make sure to select the appropriate slicing plane based on the current UCS on your drawing. Note: Switch to wireframe to be able to see the inside details and the effect of the shell command and to be able to select the proper point for slicing.
7. Delete the top part created after slicing to get the final product. Note: Realistic Visual Style was used in the final product below.
8. Using the usual template, print the final product using the SE Isometric view (hidden visual style) for both the finished object and the circles as shown in the picture below..



Final Product

**Title:** Flash Drive Rendering**Objectives:**

Students will be able to:

1. Use rendering commands in AutoCAD to create a fully rendered object out of their flash drive model.
2. Use AutoCAD textures to realistically represent a 3D model
3. Use AutoCAD lighting to properly light a 3D model
4. Use a background in AutoCAD to enhance a 3D environment

**Problem:**

Having completed and printed your flash drive 3D model, present your 3D model by placing the model in a 3D environment, add textures, and incorporate a background. Be Creative!!! Requirements and tips are listed below:

**Requirements:**

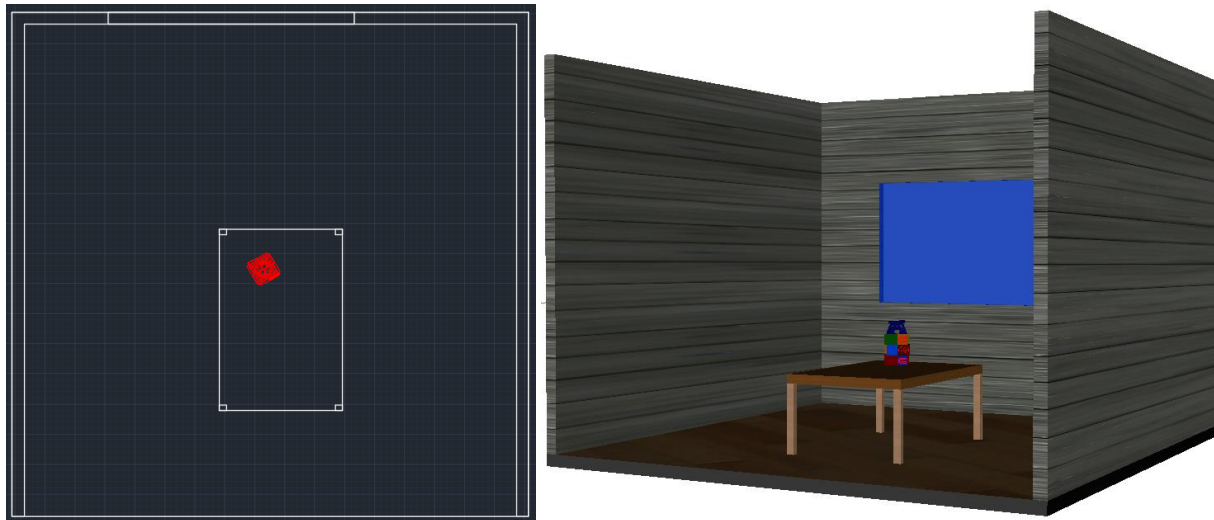
- Create an environment for your flash drive model. For example, if it is a desk piece, create a desk and some items around it like an actual desk. If it is a fish, create a pool with a water texture and render the fish inside. If it is a building, create some other less detailed buildings around the model (see examples). Remember to focus the rendering on your own model.
- Add lighting.
- Add a background.
- Create and upload in Canvas **two (2)** different rendered image files with coffee break quality and 1920x1080 resolution (just as with the solar water heater assignment #17).

**Tips:**

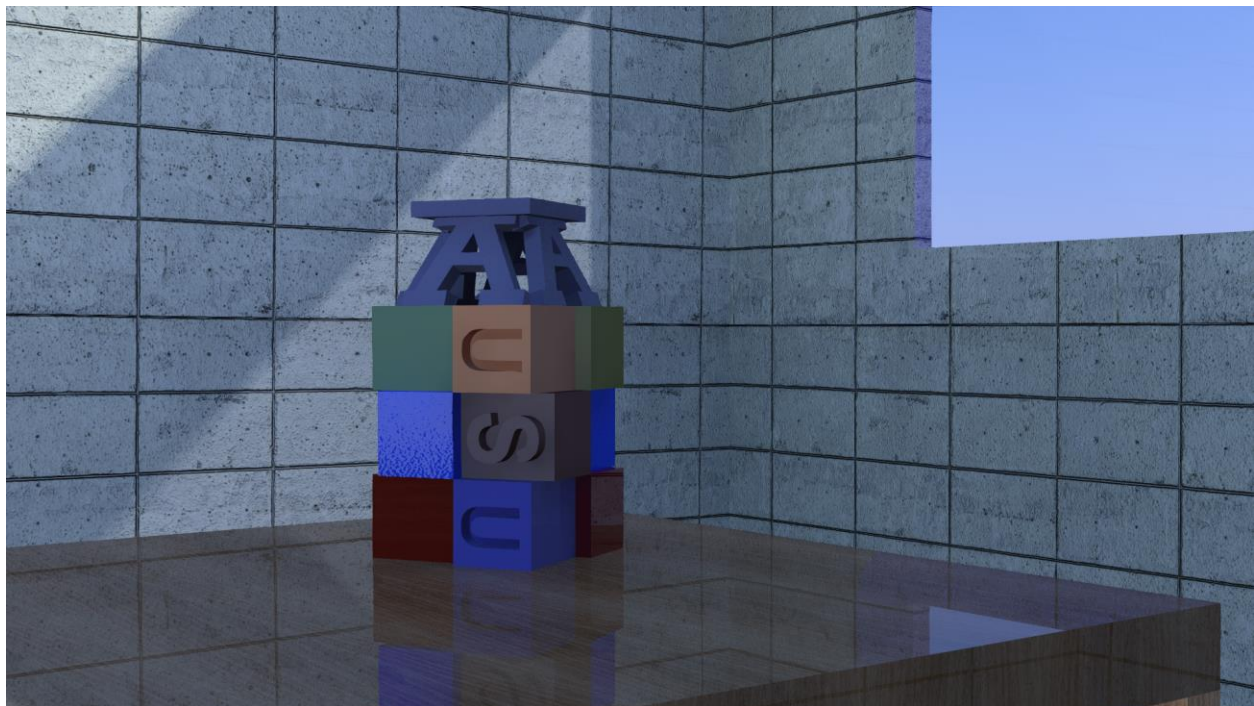
- Join the two parts of the flash drive.
- If you want to keep the two parts split, you have to draw the actual metal piece sticking out of the flash drive as shown in one of the pictures below.
- You can download ready-made .dwg files from the internet and incorporate them in the environment. This may include furniture, trees, cars or any overly complicated object that could enhance the environment.
- You can also use or download any image to use as background as shown in the instructions in the presentation from this week.

Below are sample flash drives from previous semesters rendered in a suitable environment to give you an ideas of what is expected.

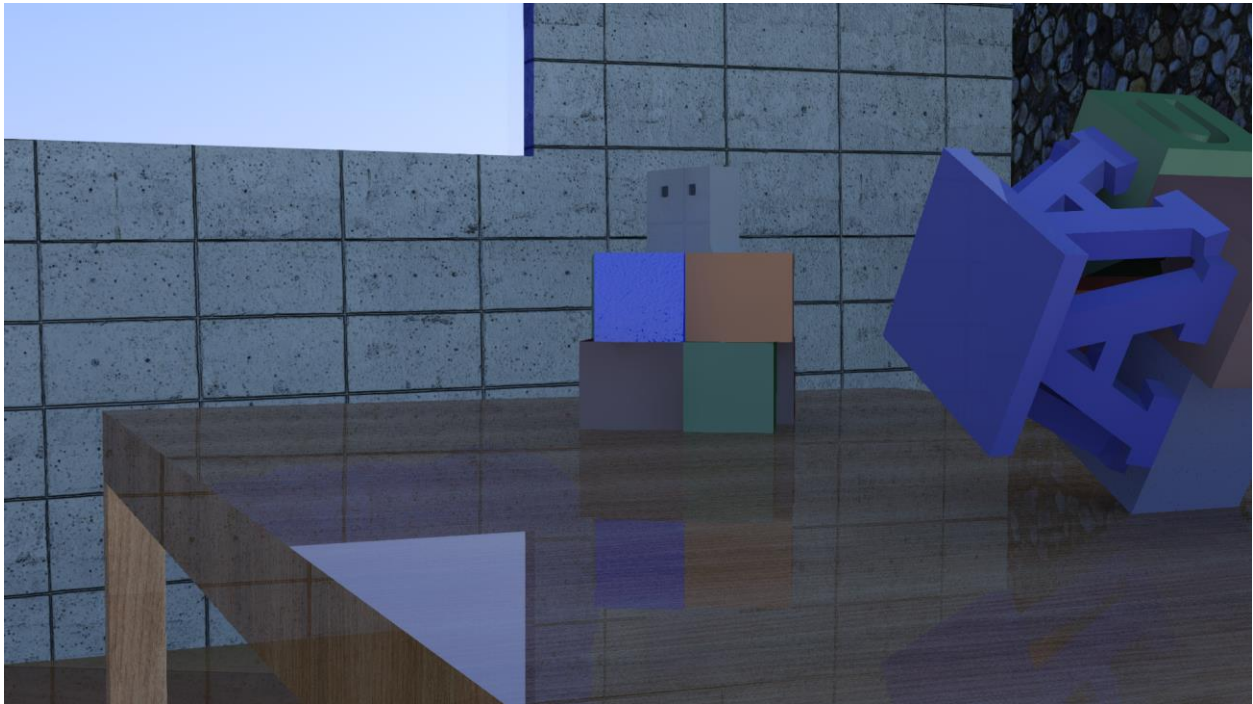


**Example 1: Interior environment flash drive design**

Start with your flash drive design, add an environment such as walls, floor, window and table as shown in the design above then render with your choice of lighting and background.

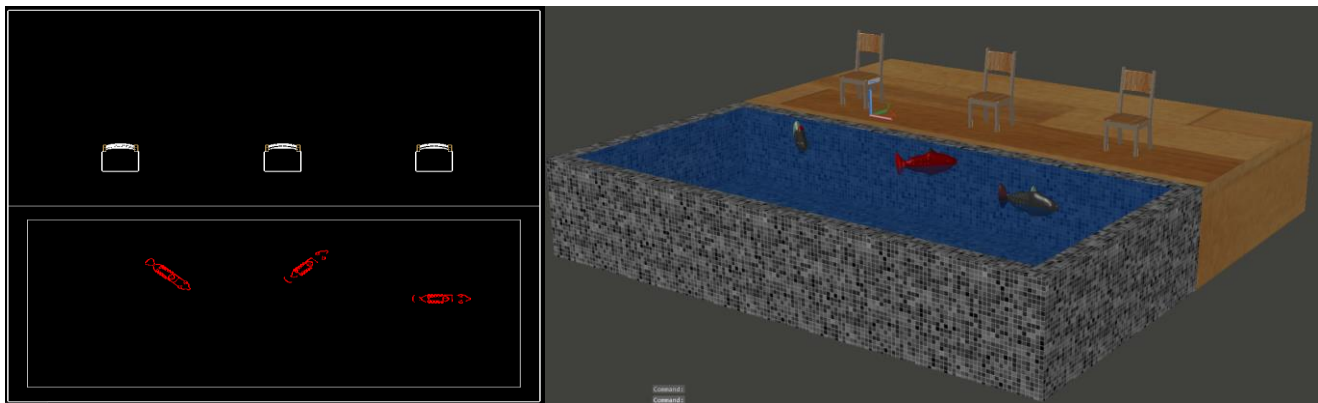


Flash drive render with the two parts put together



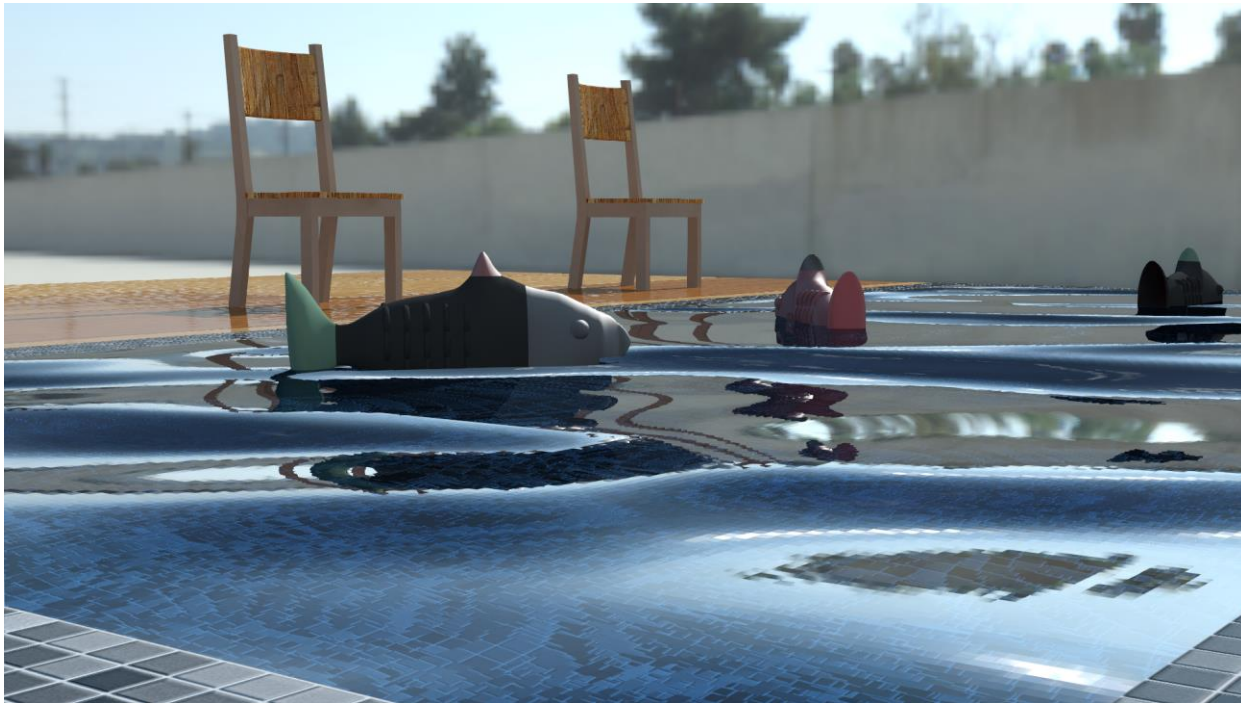
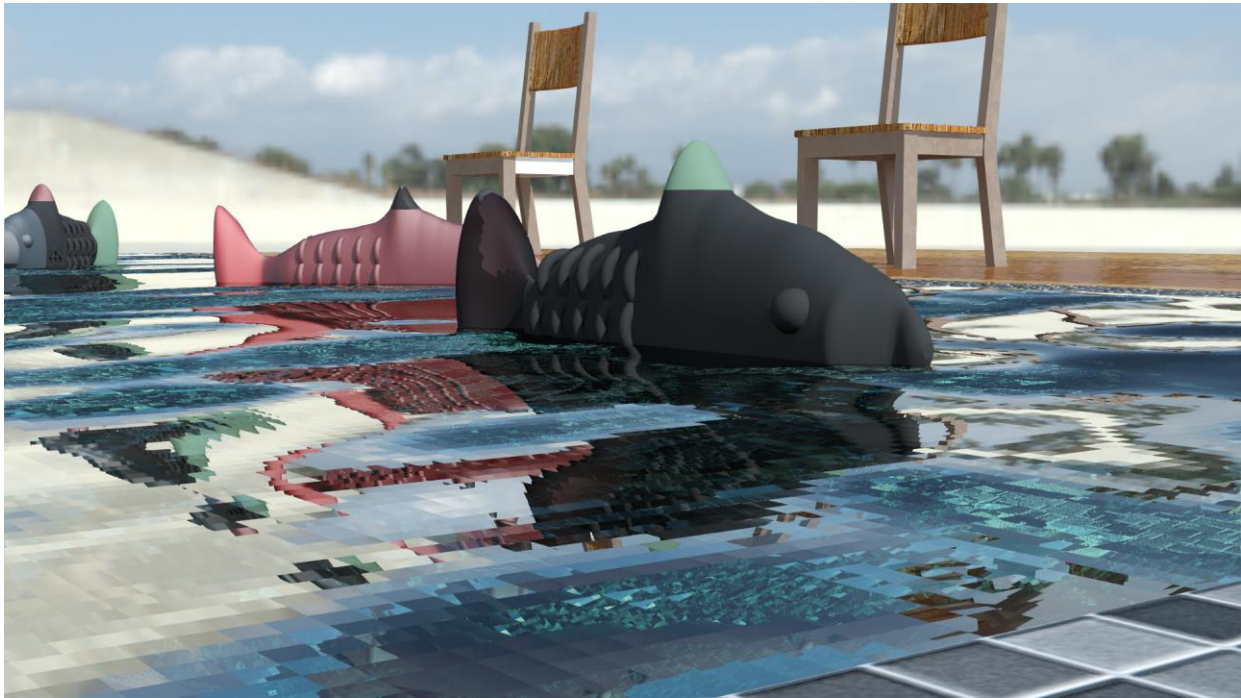
Flash drive render with the two parts split and the actual thumb drive added

### Example 2: Exterior environment flash drive design

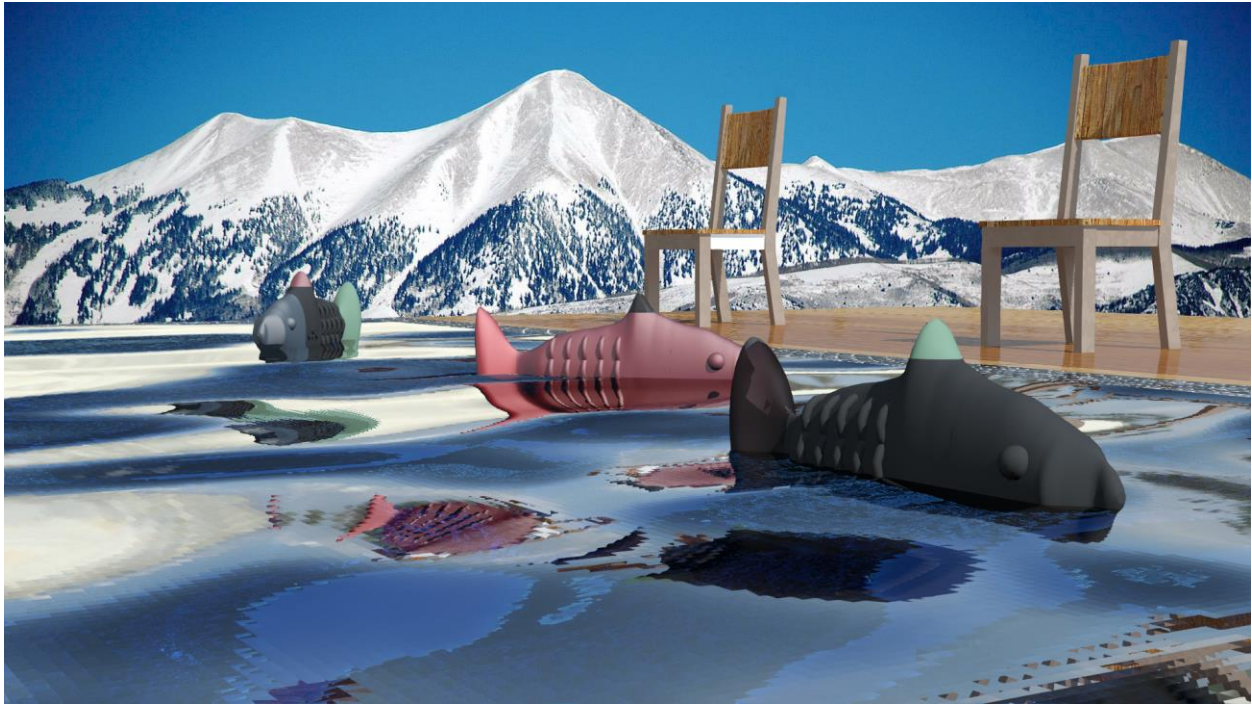


Start with your flash drive design, add an environment such as pool, floor, chairs and duplicates of your flash drive as shown in the design above then render with your choice of lighting and background.





Two renders with one of the default environments available in AutoCAD



Same design rendered with a background downloaded from the Internet.