Design out the box

Lesson Objectives…

Computer Aided Engineering: Step by Step Guide to Lamp Construction

- To understand the basic tools used in SketchUp.

- To understand the advantages of using CAD

- To be able to successfully use CAD independently to complete a range of tutorials in 2D and 3D

- To develop advanced skills and problem solving skills when using Sketch Up

- To use correct dimensions when using sketch up to draw models that can be 3D printed or manufactured using CAM machines in school (i.e. Laser Cutter, 3D Router).

Skills to be used in this project…

| Basic Skills	New and Higher Skills
Zoom tool	Rotate tool
Orbit tool	Move tool
Pan tool	Offset tool
Line tool	Arc tool
Rectangle tool	Follow Me tool
Circle tool	Paint Bucket tool
Eraser tool	Dimensions tool
Push/Pull tool	Making Components

Basic skills are those required to do very basic drawings and are detailed as part of this presentation.

New and higher skills may be new to the novice and are the focus for learning in this presentation.

Lesson Outcomes…

By the end of this tutorial you will be able to…

- Use the push pull and move tool
- Learn about centre lines
- Create, Move and Rotate components
- Use the offset tool to make objects and add detail
- Shape and form your design
- Draw your design to the correct size to enable it to be manufactured.
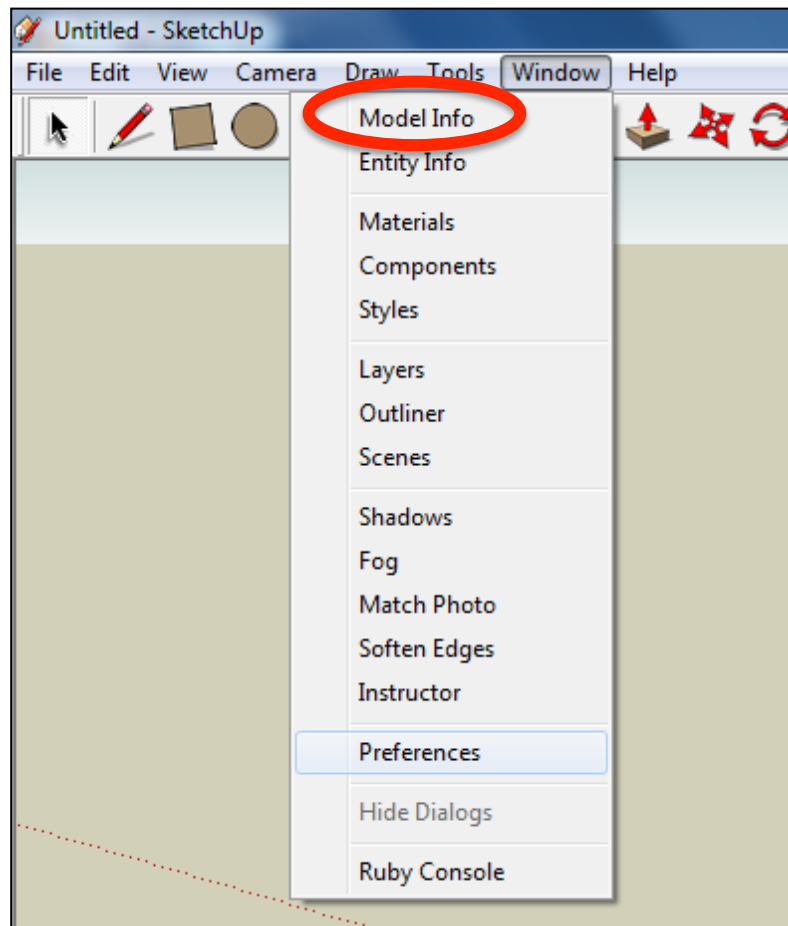
1. Open the sketch up drawing. Once you have opened SketchUp, go to **Window** and select **Model Info**
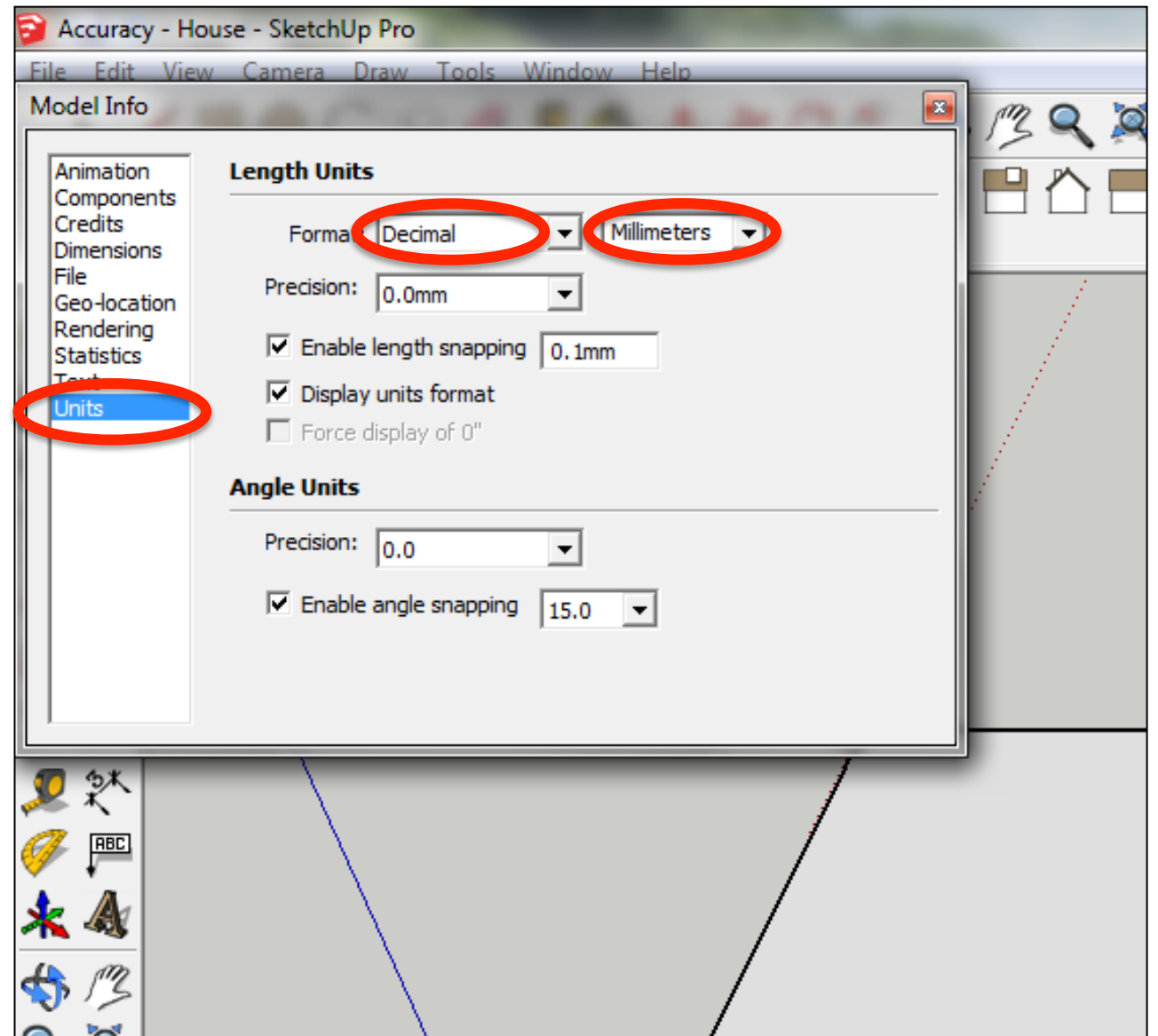
2. Select **Units** and choose **Decimal Millimetres**. We are using this template because we are doing a product design.

Note: *It is often necessary to start a new file to use the new template. Go to **File** then **New**.*

3. Now select the **View** then **toolbars** and ensure **Getting Started** and **Large Tool Set** are ticked
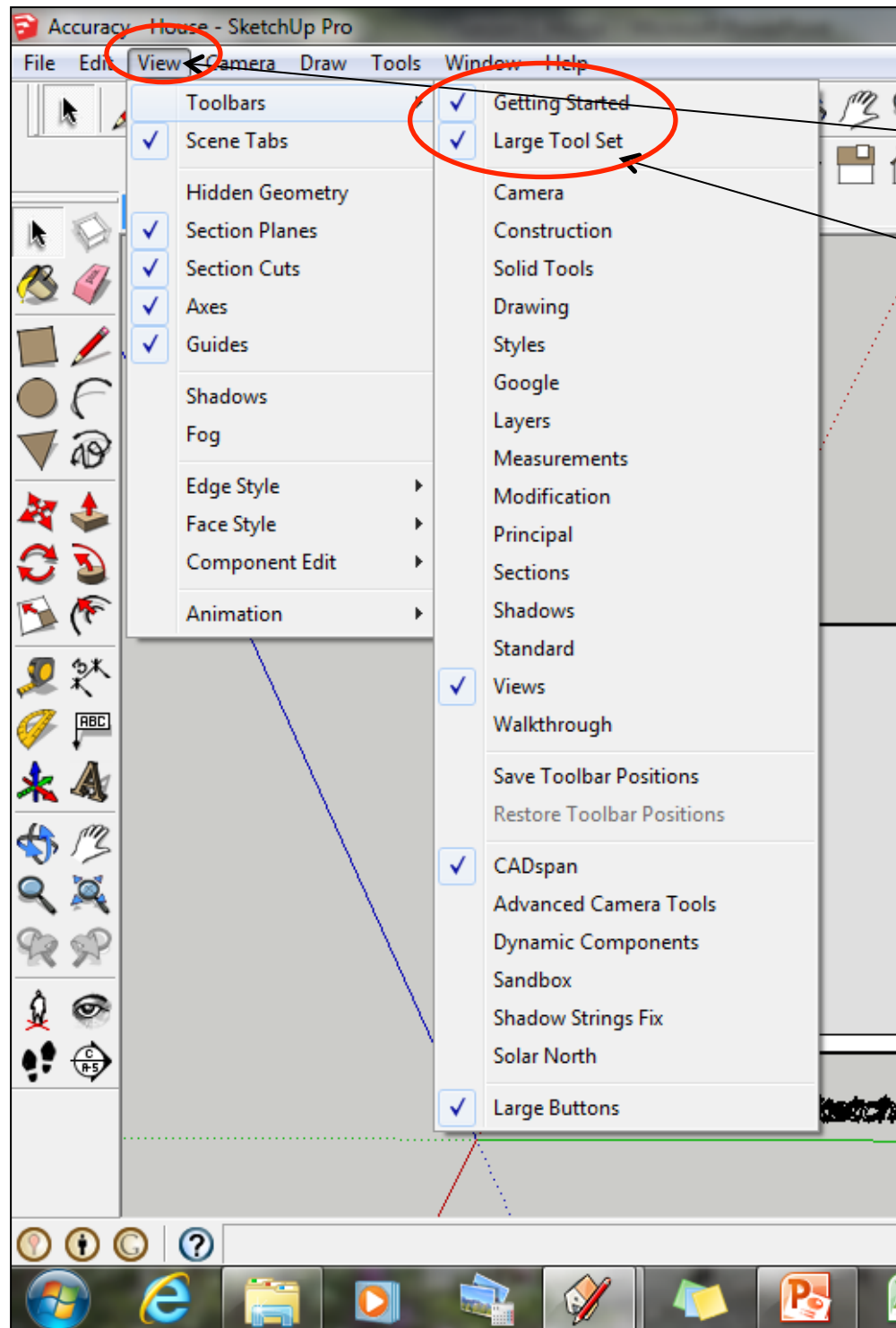
3a Select **View**

3b Tick Getting
    Started
3c Tick Large Tool Set

Note: this will place a tool bar across the top *(getting started)* and the side *(Large Tool Set)*

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction
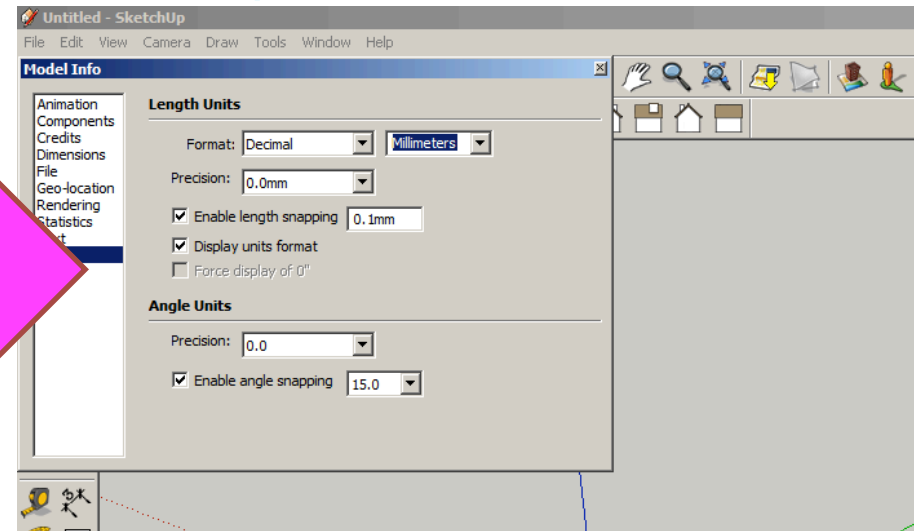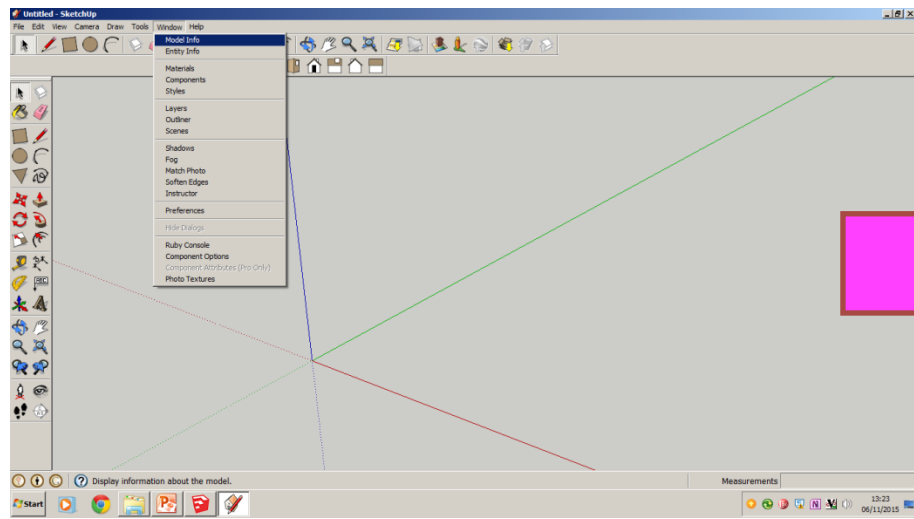
Start by stetting up *window/ model info*.

Select Units and change to *decimal - millimetres*

Select engineering Style allows me to use the following equipment in school

CNC router
CNC laser cutter
CNC 3D Printer

CNC means computer numerically controlled and converts CAD drawings to co-ordinates and codes to be cut out by a machine.

3D printers
3D printers print 3D models, using a process called additive manufacturing or AM. This process uses computer control to lay successive layers of material to build a 3D
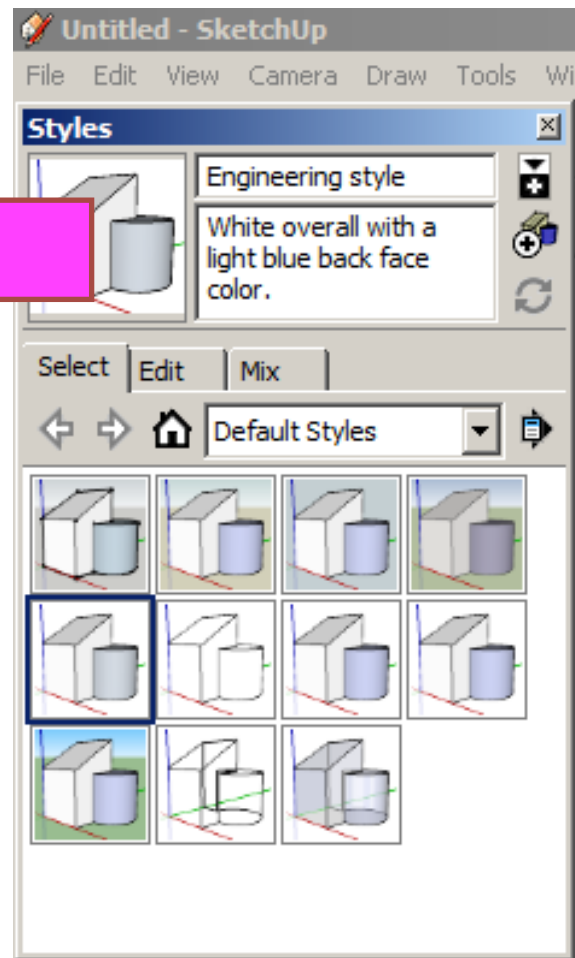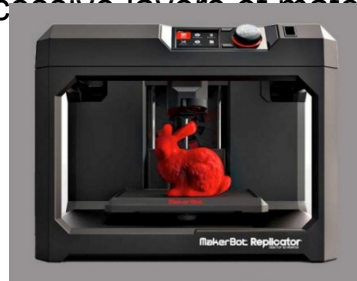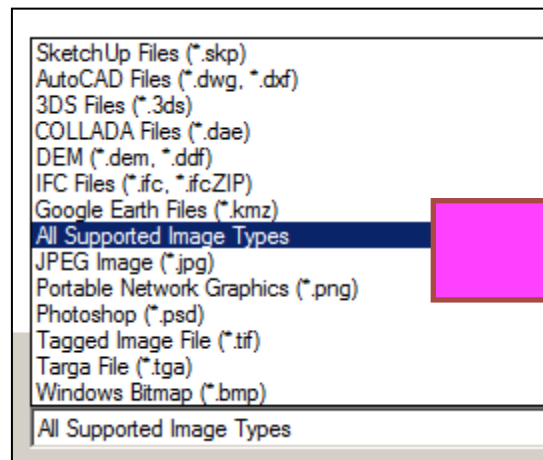

Select *engineering* Style
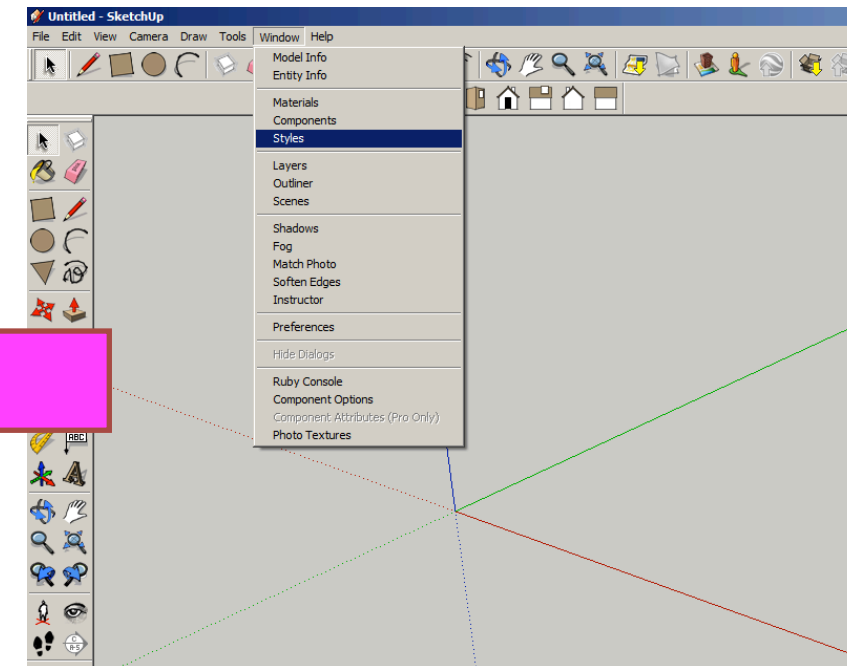
Select *Window-Styles*

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

CNC Router

A **CNC router** is a computer controlled cutting machine related to the hand held **router** used for cutting various hard materials, such as wood, composites, aluminium, steel, plastics, and foams. **CNC** stands for computer numerical control.

CNC Laser cutter

**Laser cutting** is a technology that uses a **laser** to **cut** materials, and is typically used for industrial manufacturing applications, but is also starting to be used by schools, small businesses, and hobbyists. **Laser cutting** works by directing the output of a high-power **laser** most commonly through optics
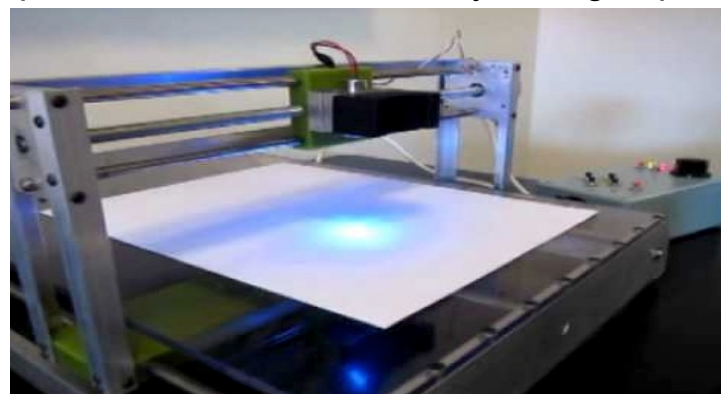
Products which are designed for self-assembly are popular for many reasons and help to keep costs as low as possible. An international furniture warehouse chain is constantly on the look-out for fresh ideas for their lighting sections. They are particularly interested in cutting edge designs which allow the customer to assemble the products in a variety of ways.

Design and make a lamp based around a famous buildings, structures or a retro theme . The product will need to be manufactured in full-scale and will need assembly instructions which do not rely upon text. The use of commercial knock-down fittings and/or standard components might be a key feature of the product. Accuracy will be a vital requirement and manufacturing aids such as drilling jigs or the use of CAM should be regarded as essential.
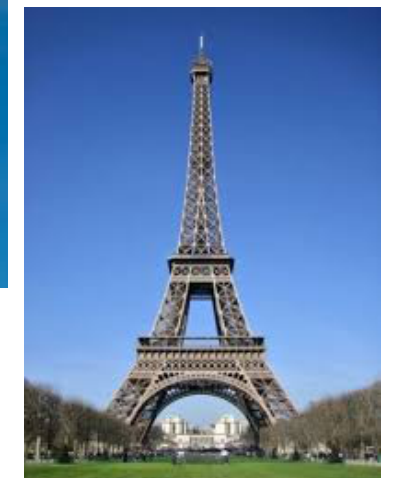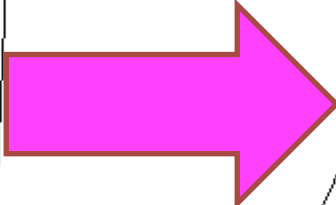
Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Click Scene 1

To Here

500.0mm

From Here

300.0mm
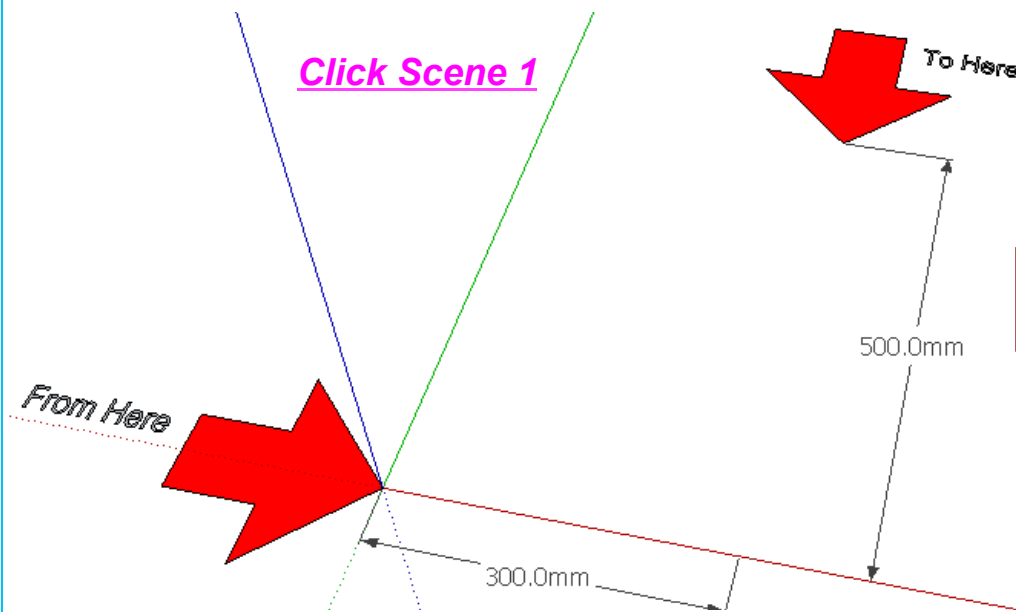
Use the *square tool* to draw a rectangle measuring 300mm by 500mm. Use the guide arrows to assist.

To Here

Endpoint

500.0mm

From Here

300.0mm

Click Scene 2

Click Scene 3

Add image here

Follow the next steps to get an image of Big Ben to trace.

Push/pull tool used to turn solid objects into 3D objects instantaneously. Typing a size allows a user to extrude or pull an object to a certain size or height

Advantages:
Allows user to draw or modify 3D shapes very quickly faster than traditional hand drawings. You can click on a face (plane) and adjust. Can be used to extrude shapes on 3D objects already drawn.

Use the *push/pull tool* and pull upwards. Type in 4 and press enter. For this product we will be using 4mm laser ply

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction
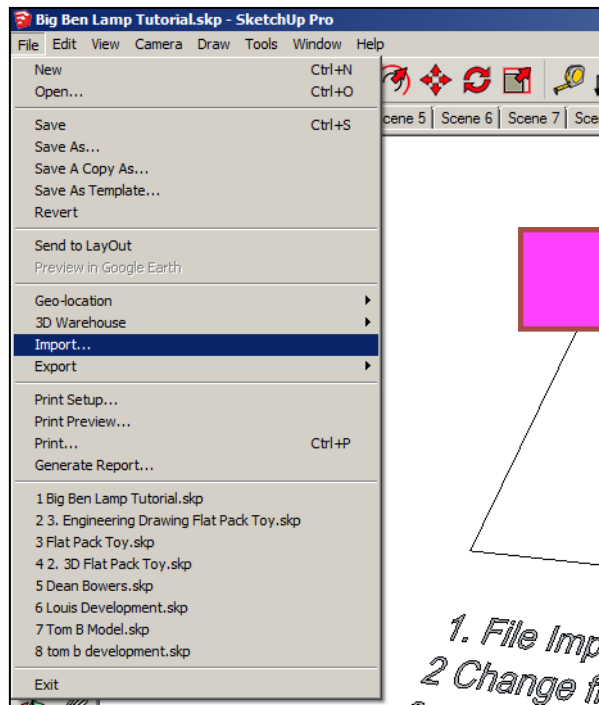
Click *file / import*

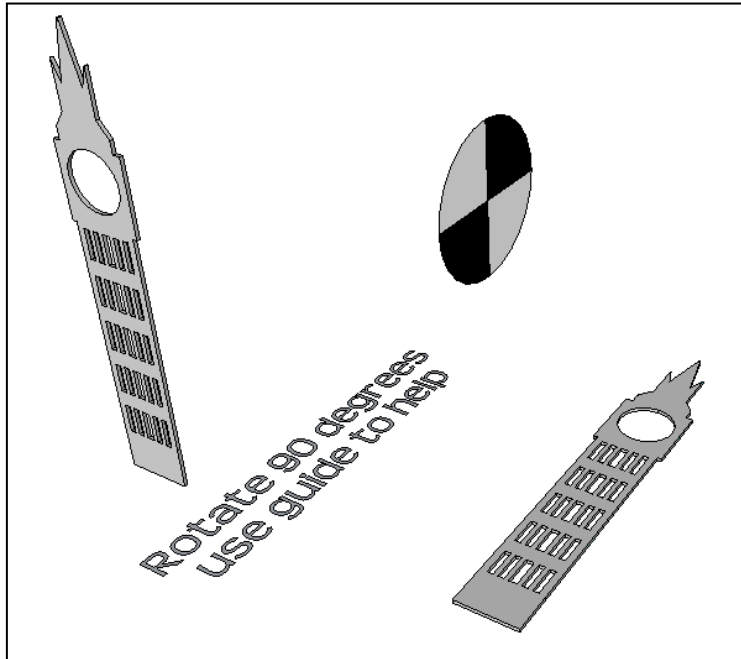Change the file types to all *supported images*
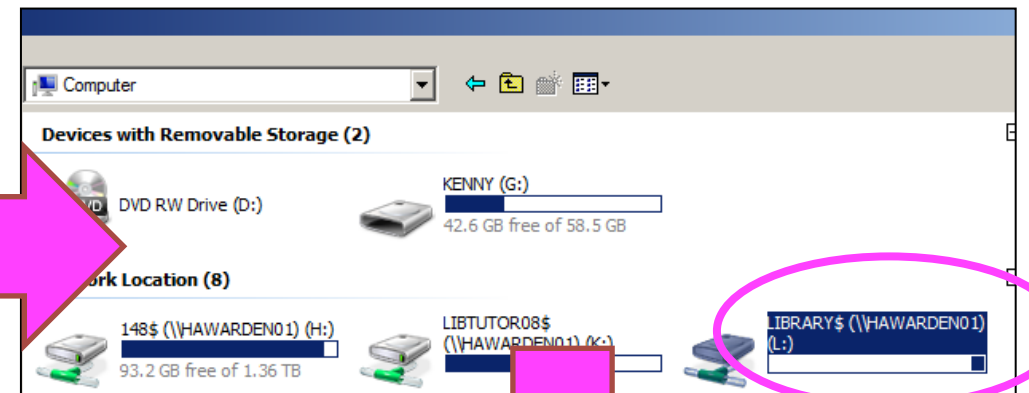
Click *Library*
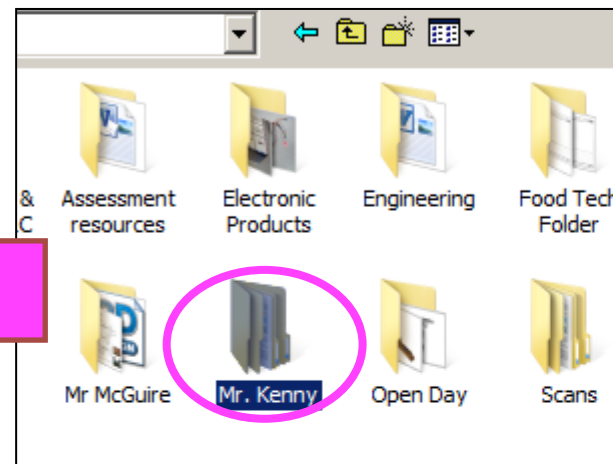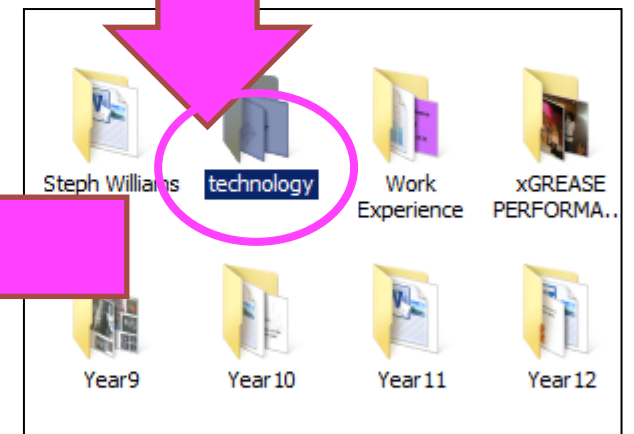
Click *Technology*

Click *Mr Kenny*
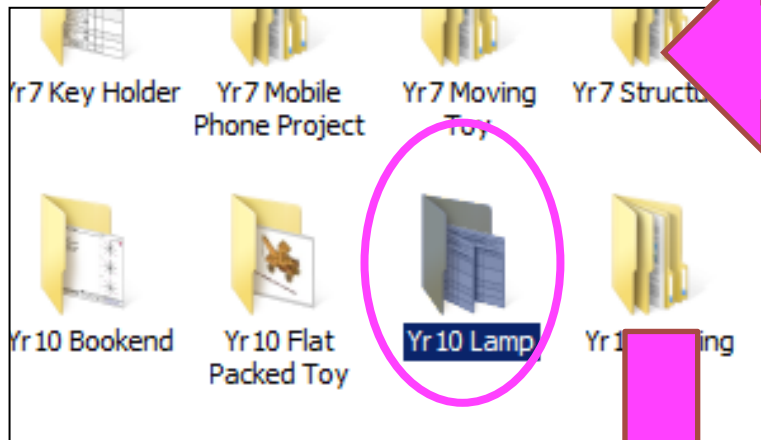
Click *Yr10 Lamp*
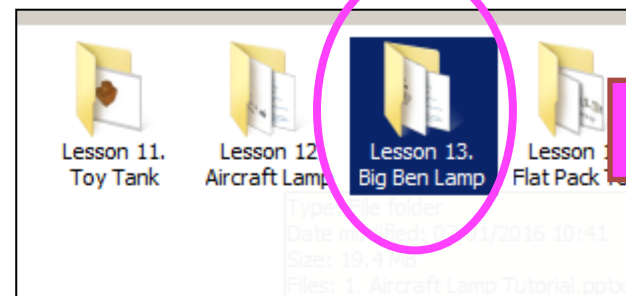
Click *lesson 13 Big Ben Lamp*
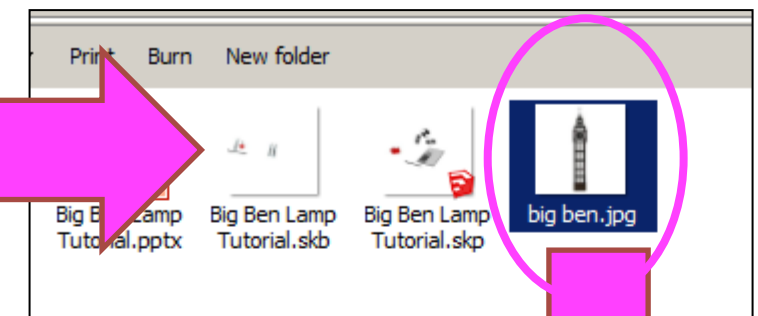
Click *Big Ben.Jpg*

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Click Scene 3

Add image here

Endpoint in Group

Endpoint in Group

Add image here

Endpoint in Group
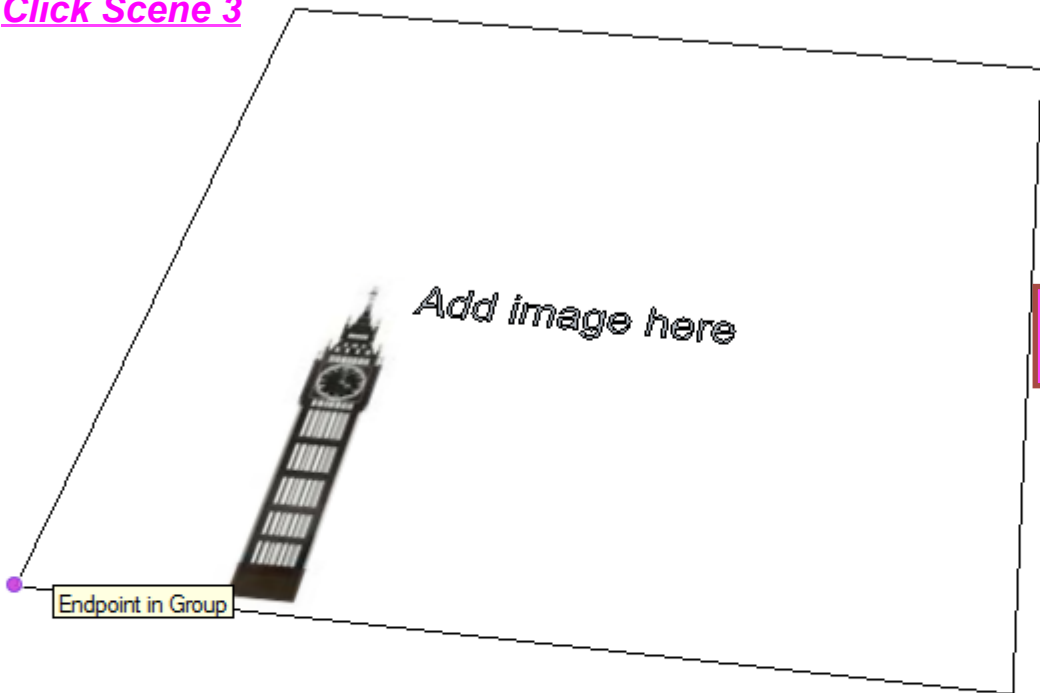
Add the *image* onto the square shown using bottom left hand side endpoint.
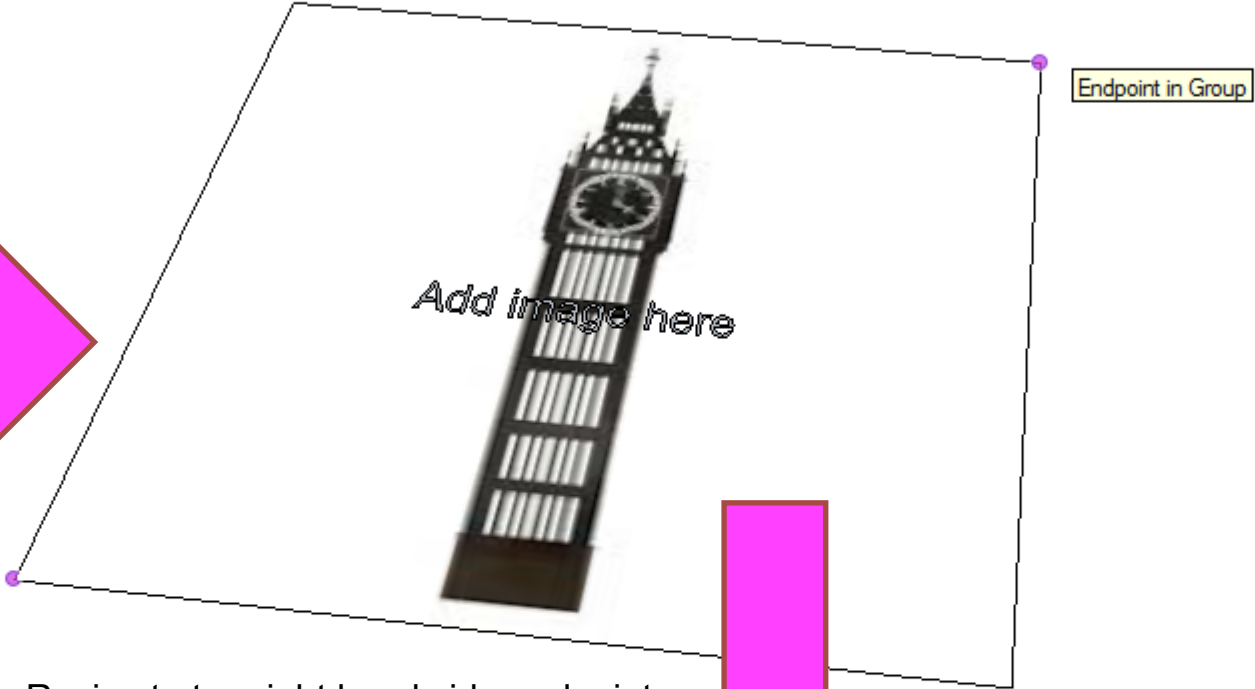
Resize to top right hand side endpoint.

To Here

Endpoint in Group

Click Scene 4

To Here

From Here

From Here
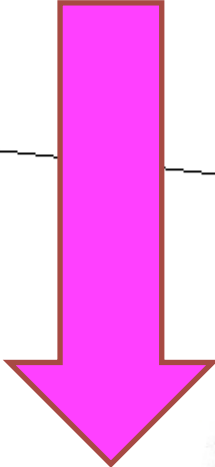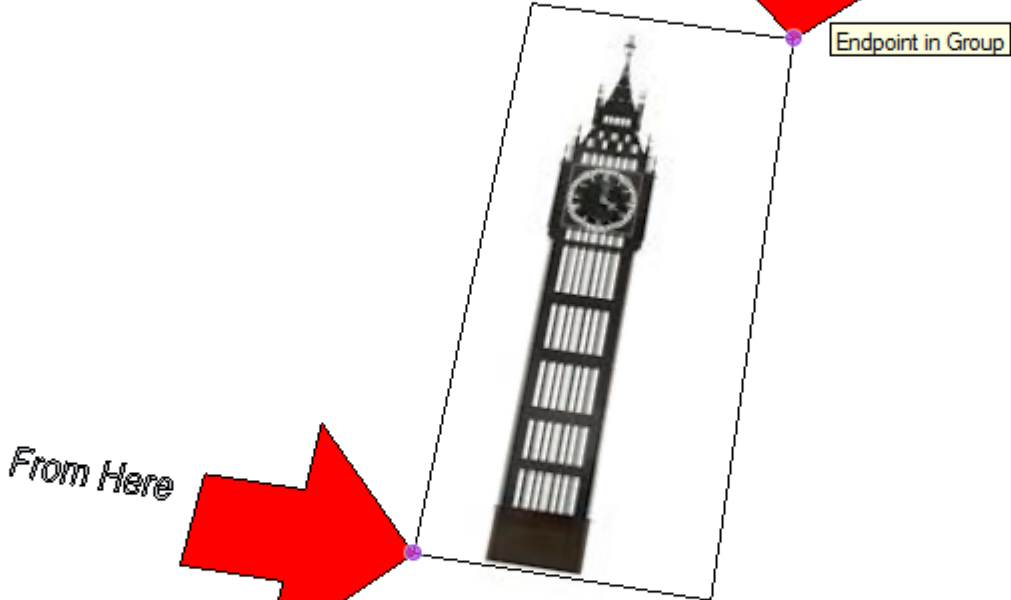
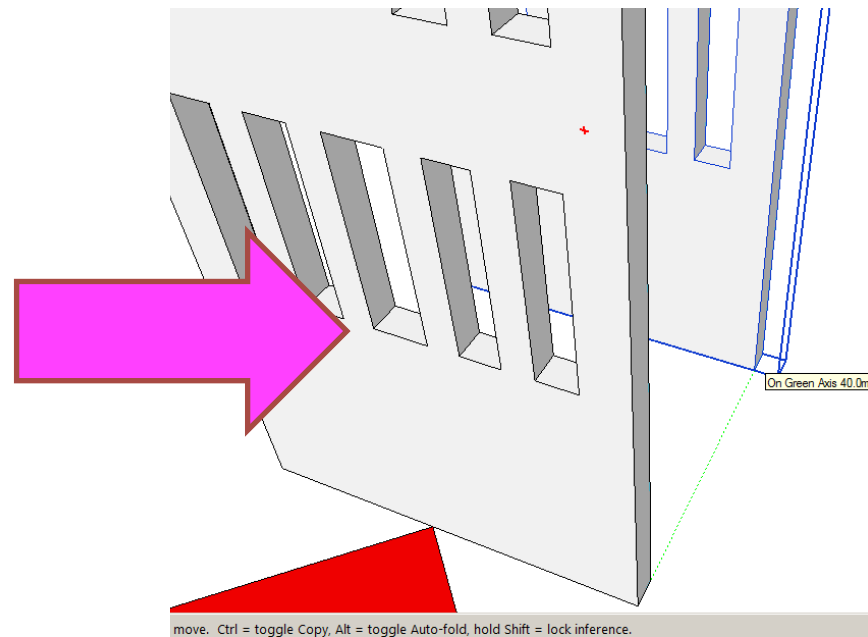Use the *square tool* to draw a rectangle. Use the guide arrows to assist.
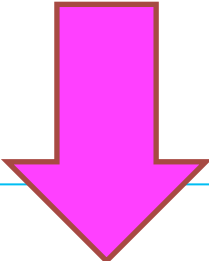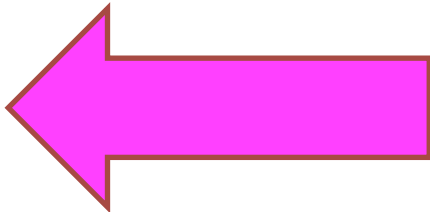
Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction
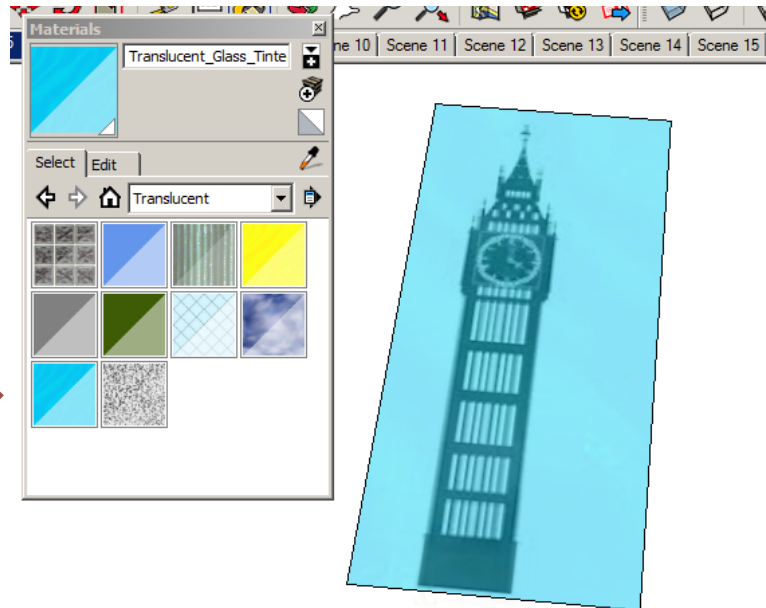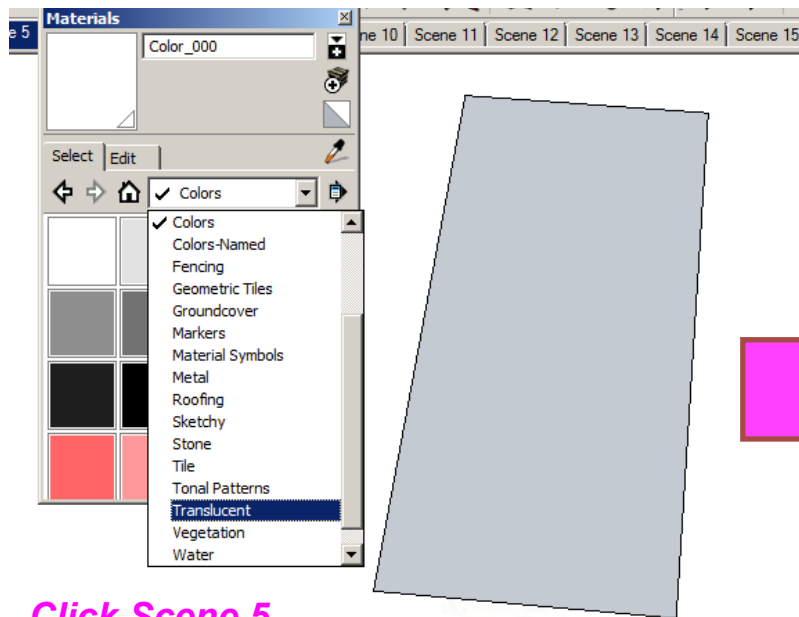
Click Scene 5

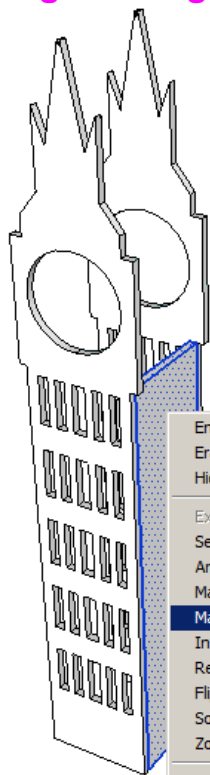Use the *colour bucket tool* to colour the square in translucent.

Use the *colour bucket tool* to colour the square in translucent.

Click Scene 6

Endpoint in Group

Click Scene 7

Trim tool allows the user to remove overlapping elements.

Advantages:
Allows user to erase overlapping lines and edges to draw complex 3D shapes very quickly.
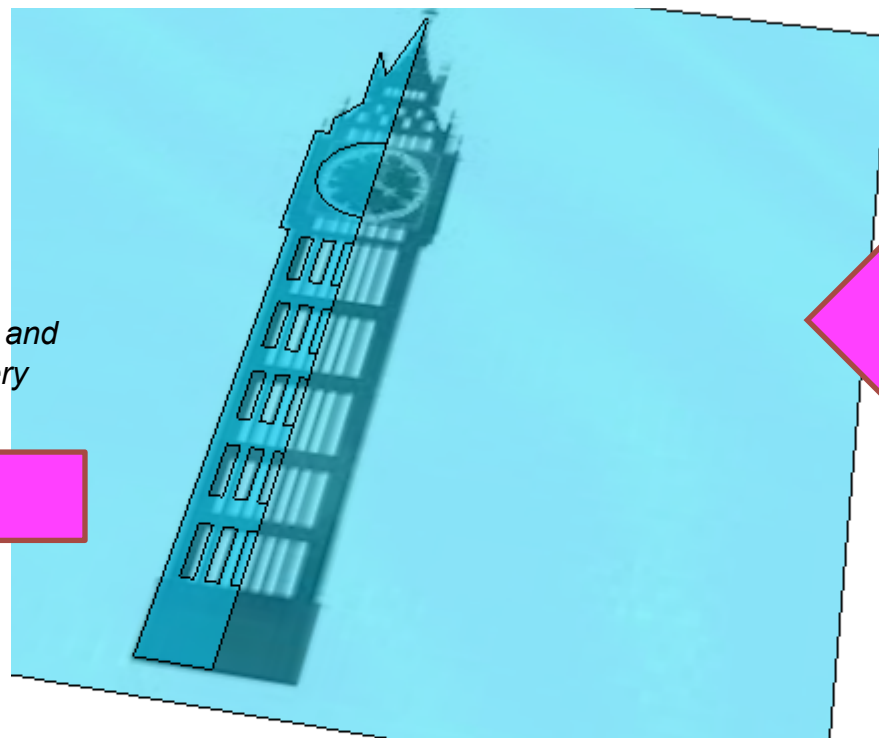
From Here

Use the *pencil tool and circle tool* to trace half of Big Ben. Use the rubber tool to delete any lines that go over the centre line.

Use the *pencil tool* to add a centre line from the two guide arrows. You may need to adjust this if your Big Ben is not sized correctly

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction
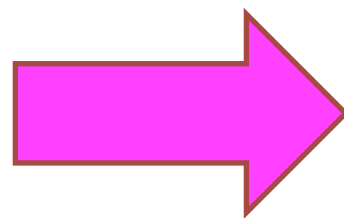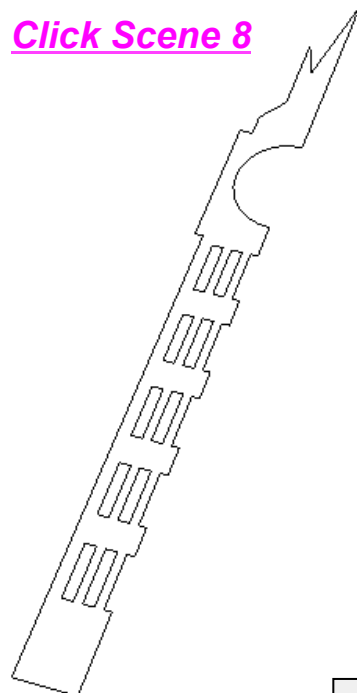
Click Scene 8

Click Scene 9
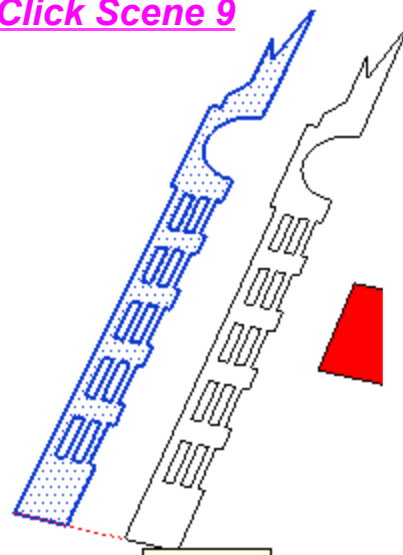
Move Tool used to move entire shapes or pull lines on a drawing.

Advantages:
Allows user to draw or modify shapes very quickly and can be used to construct unusual 3D shapes quickly
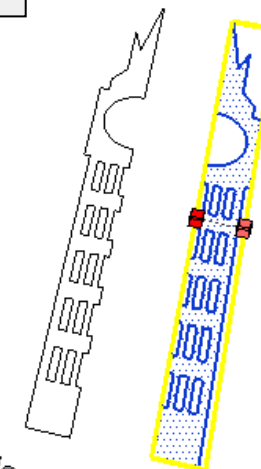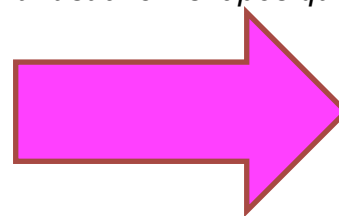
Click Scene 10

Use the scale tool to reverse the image
The red scale measurement should read 1 or -1

Red Scale -1.00

Use the **rubber tool** to delete the box and the rest of the Big Ben details as shown above

Highlight Big Ben. Click *edit / Copy* and then *edit / paste*

Click Scene 12

Click Scene 13
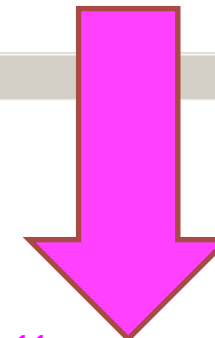
Click Scene 11
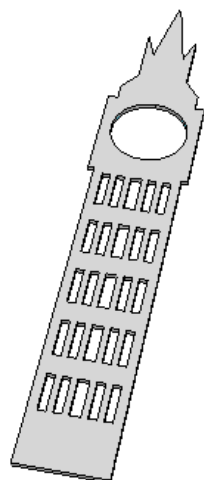
1. Highlight entire object
2. Right Click
3. Make component
4. Copy and paste two Big Ben's

Use the **push/pull tool** and pull upwards. Type in 4 and press enter. For this product we will be using 4mm laser ply

On Red Axis

Highlight one half of Big Ben and then click the **move tool** grab the bottom right hand corner and join with the opposite bottom left hand side

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step

Rotate 90 degrees
Use guide to help

Click Scene 14

Click the **Big Ben on the floor**.

Rotate 90 degrees
Use guide to help

Endpoint in Group

Rotate 90 degrees
Use guide to help
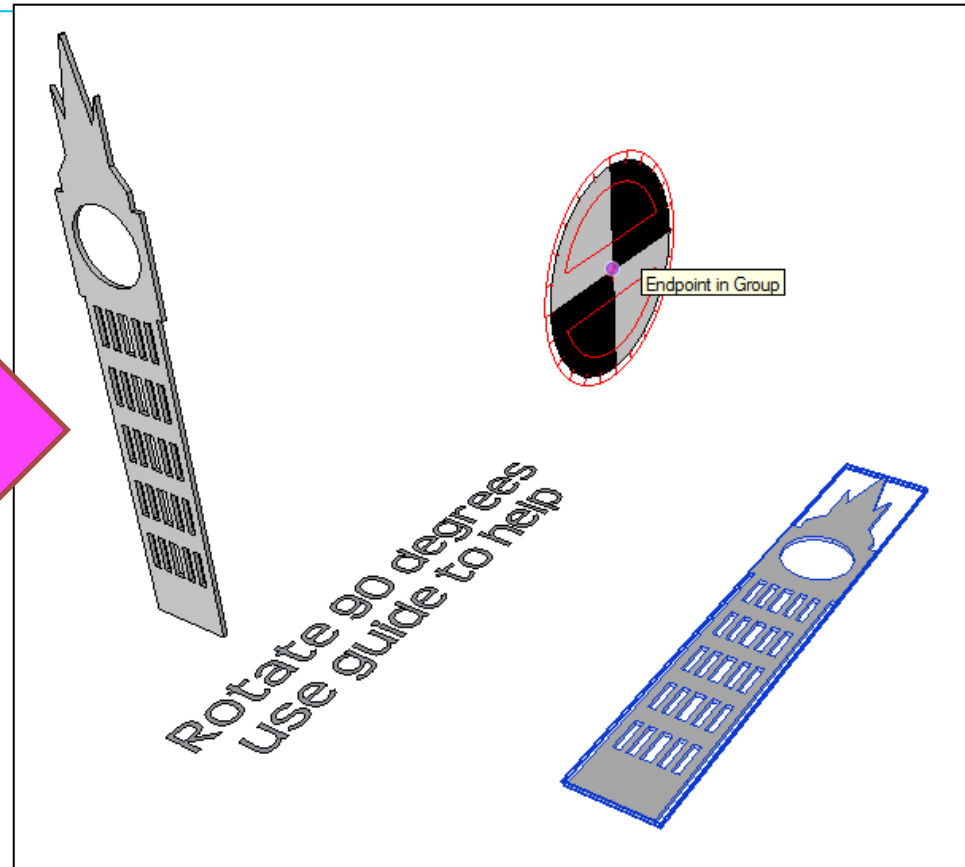
Use the **rotate tool** and position on red axis in the centre of the black and white target by clicking once to set it in place
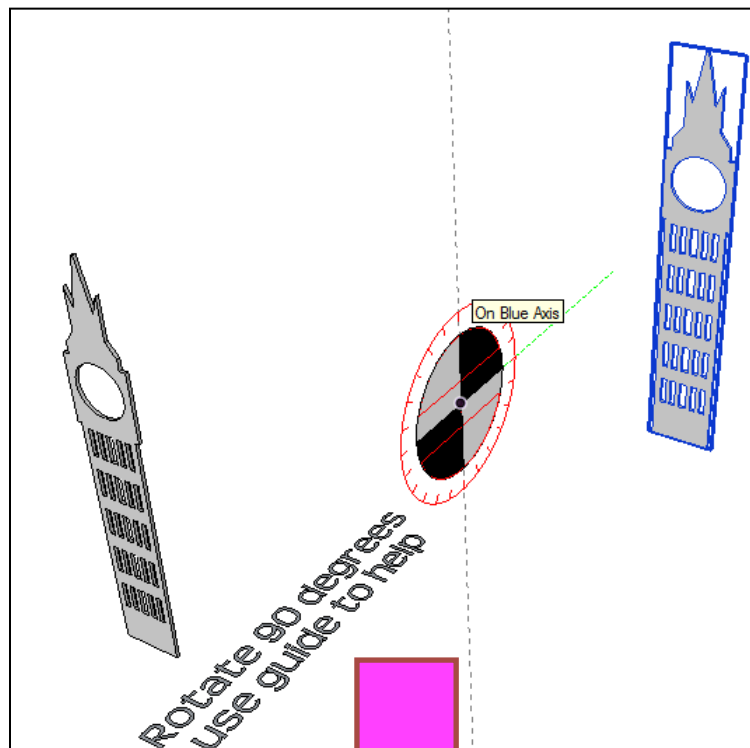
Rotate Big Ben upwards on blue axis or type in 90 and press enter

On Blue Axis

Rotate 90 degrees
Use guide to help
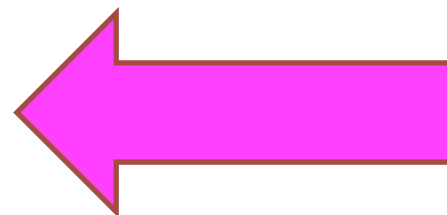
Pull line out on **green axis. Click once to set it**
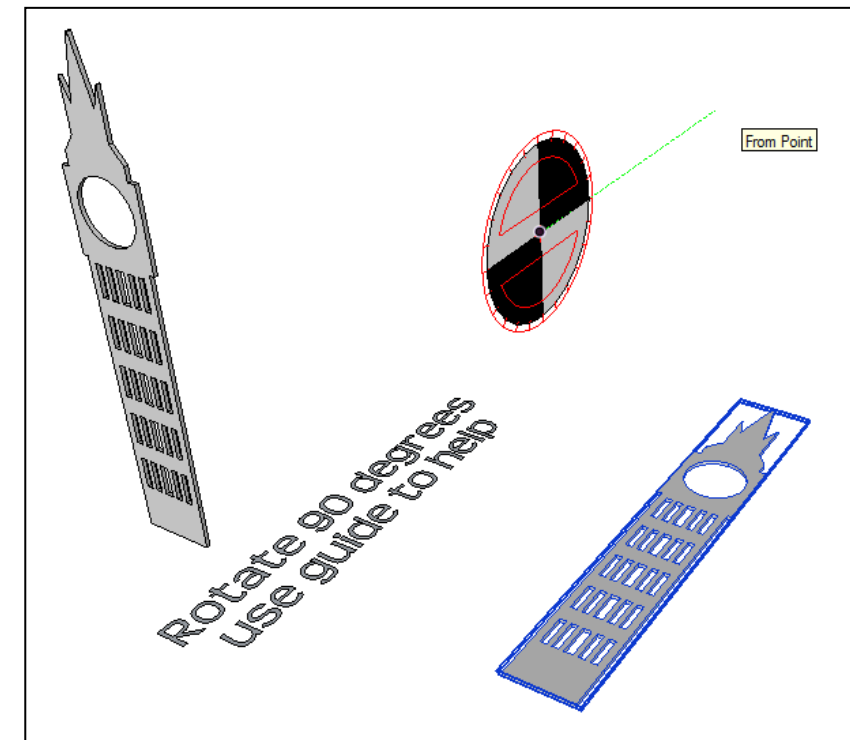
From Point

Rotate 90 degrees
Use guide to help

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Click Scene 15
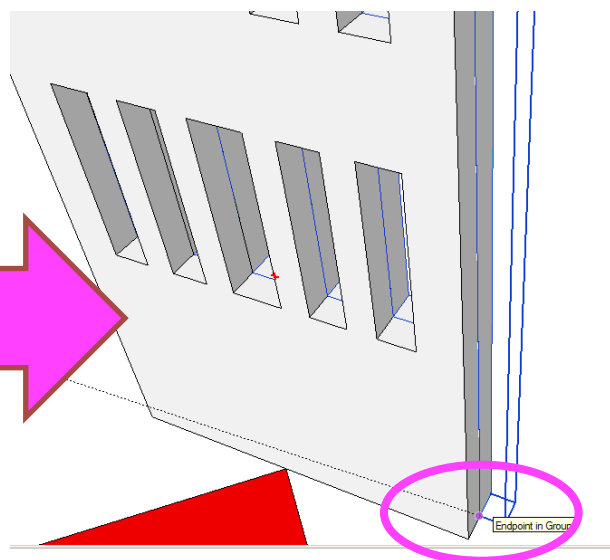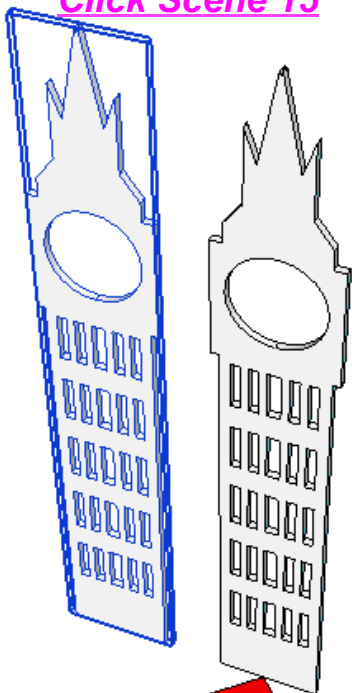
Click the move tool. Click bottom right hand corner and line up the two pieces as shown above

Click the **Big Ben highlighted in blue**.

Move the piece back on the *green axis*. Type 40 and press enter

Click Scene 16

On Green Axis 40.0mm

Length 40.0mm

move. Ctrl = toggle Copy, Alt = toggle Auto-fold, hold Shift = lock inference.

Endpoint in Group

Click the side piece *three times*. Right click and group.

Entity Info
Erase
Hide
Explode
Select
Area
Make Component
Make Group
Intersect Faces
Reverse Faces
Flip Along
Soften/Smooth Edges
Zoom Selection
Add Photo Texture
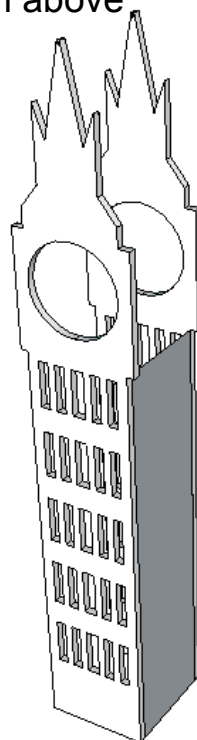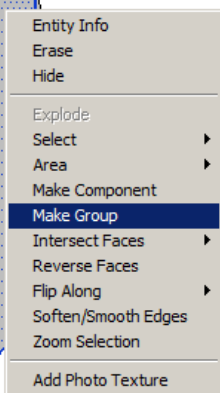
Click the *push pull tool*. Pull out and type in 4 and press enter.

Click the *square tool*. Click bottom left hand corner and top right hand corner as shown

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Click Scene 17

Repeat process on opposite side.

Entity Info
Erase
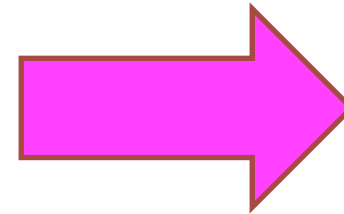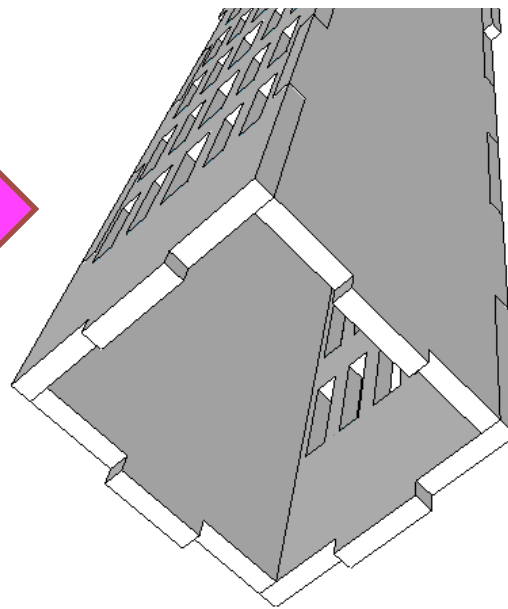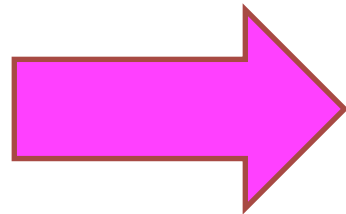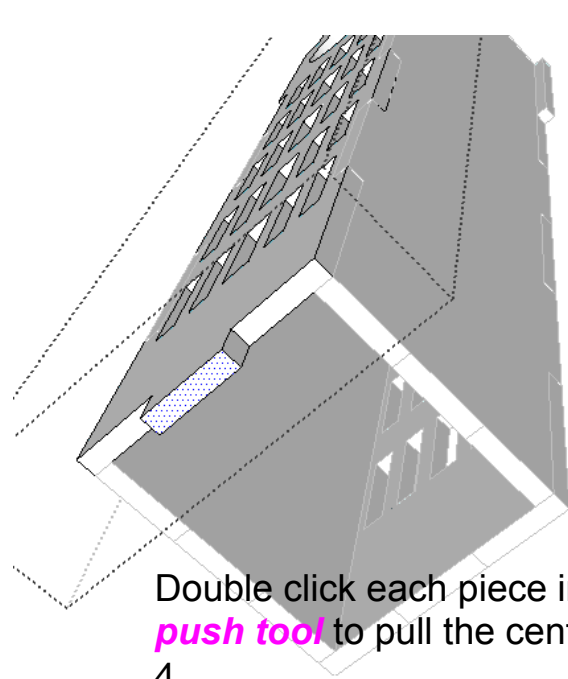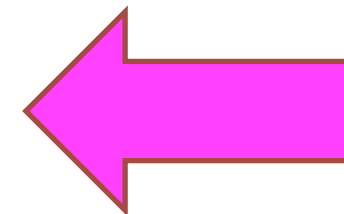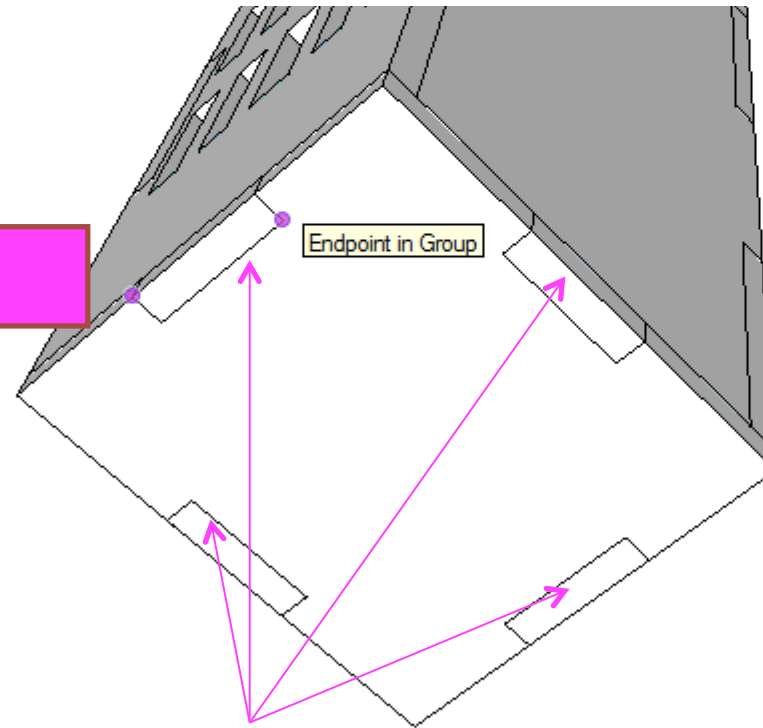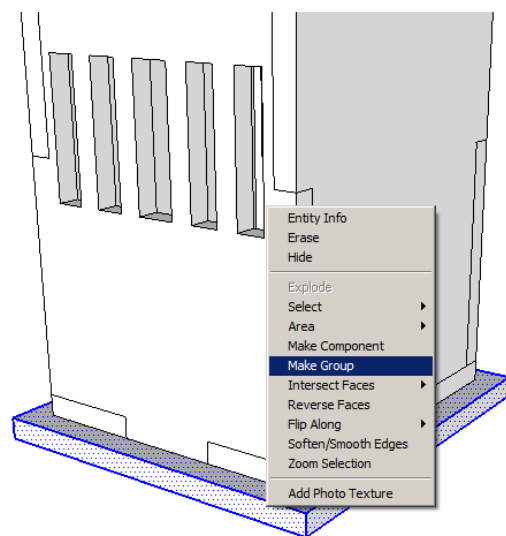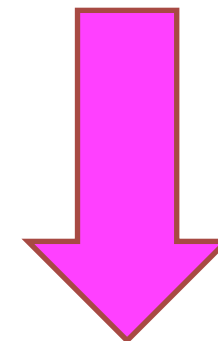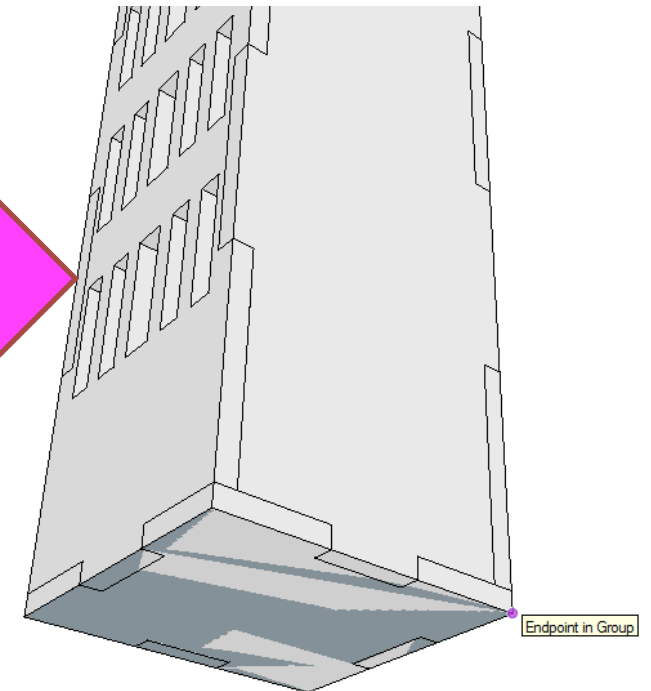Hide

Select ▶
Soften
Divide
Zoom Selection

Click the ***front piece twice to edit***. Click the line shown. Right click and divide

5 segments
Length: ~ 0.04m

Type 5 and enter or move the cursor until 5 segments appear.

Endpoint

Click the ***pencil tool***. Move down the line you have just divide. When you come to and endpoint draw a line across to the opposite edge.

You should have 5 lines across
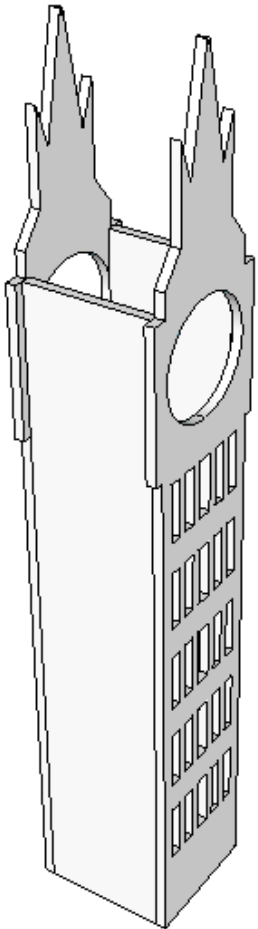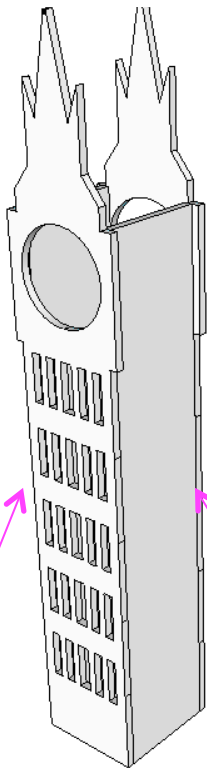
Repeat process on opposite sides. Remember to double click the piece your working on as its grouped.

Computer Aided Design: Big Ben Lamp
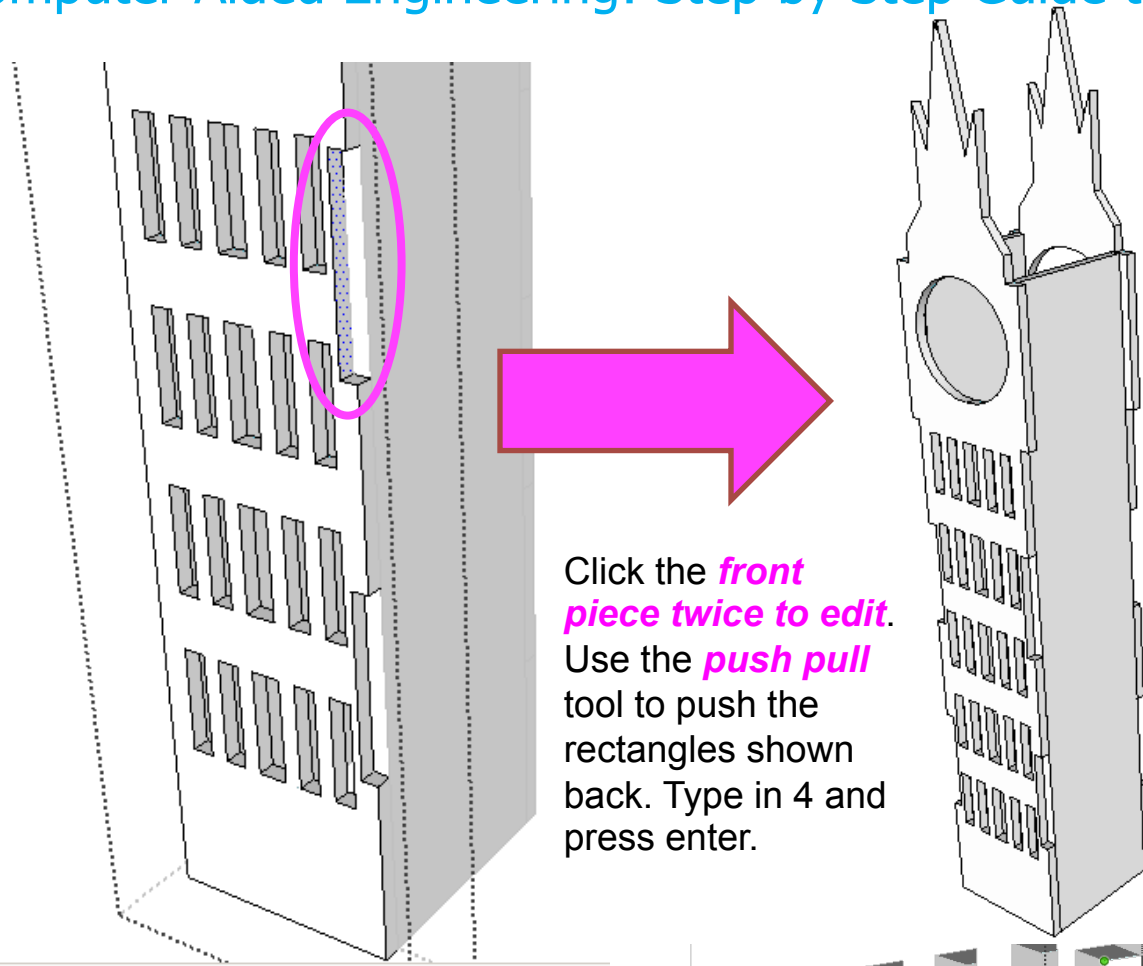
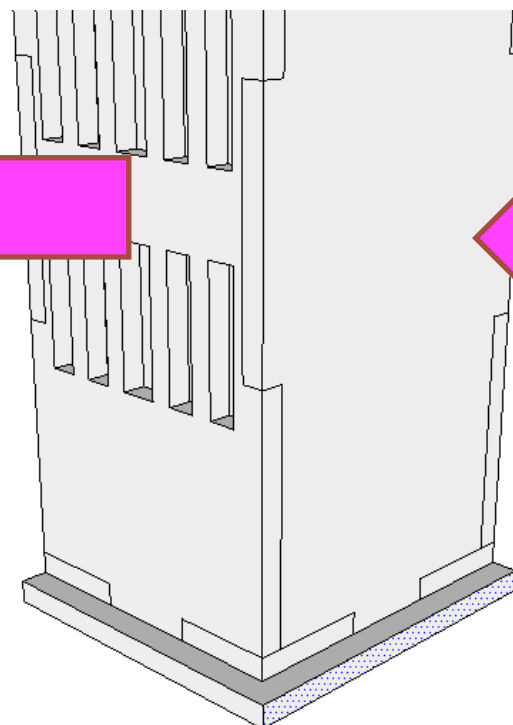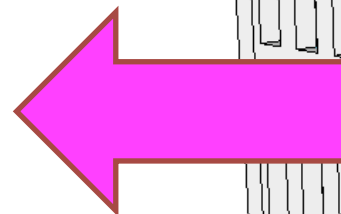Click the *front piece twice to edit*. Use the *push pull* tool to push the rectangles shown back. Type in 4 and press enter.
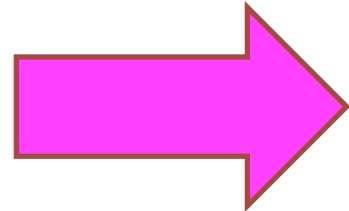
Repeat process on front and back piece
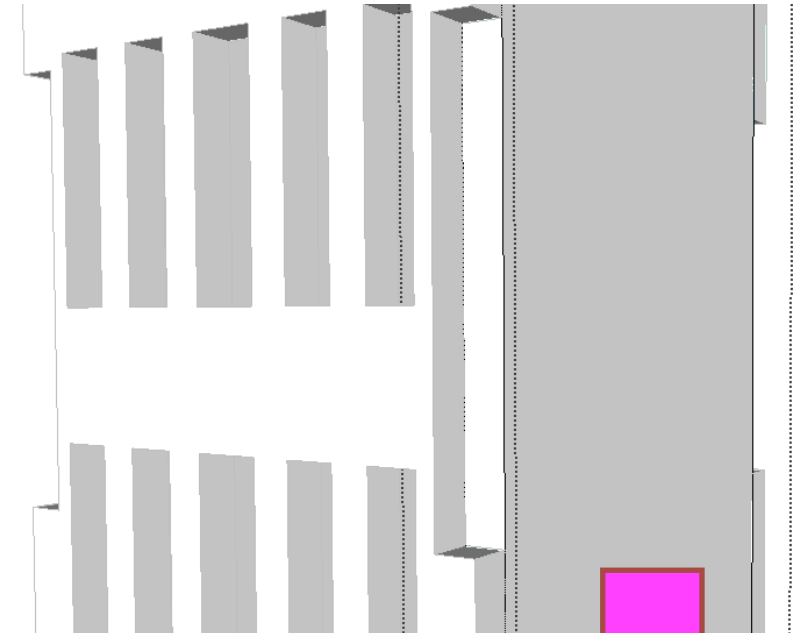
Click the *side piece twice to edit.*

Click the *rectangle tool .* Draw a rectangle from corner shown.

On Face

Endpoint Outside Active

To here

On Edge Outside Active
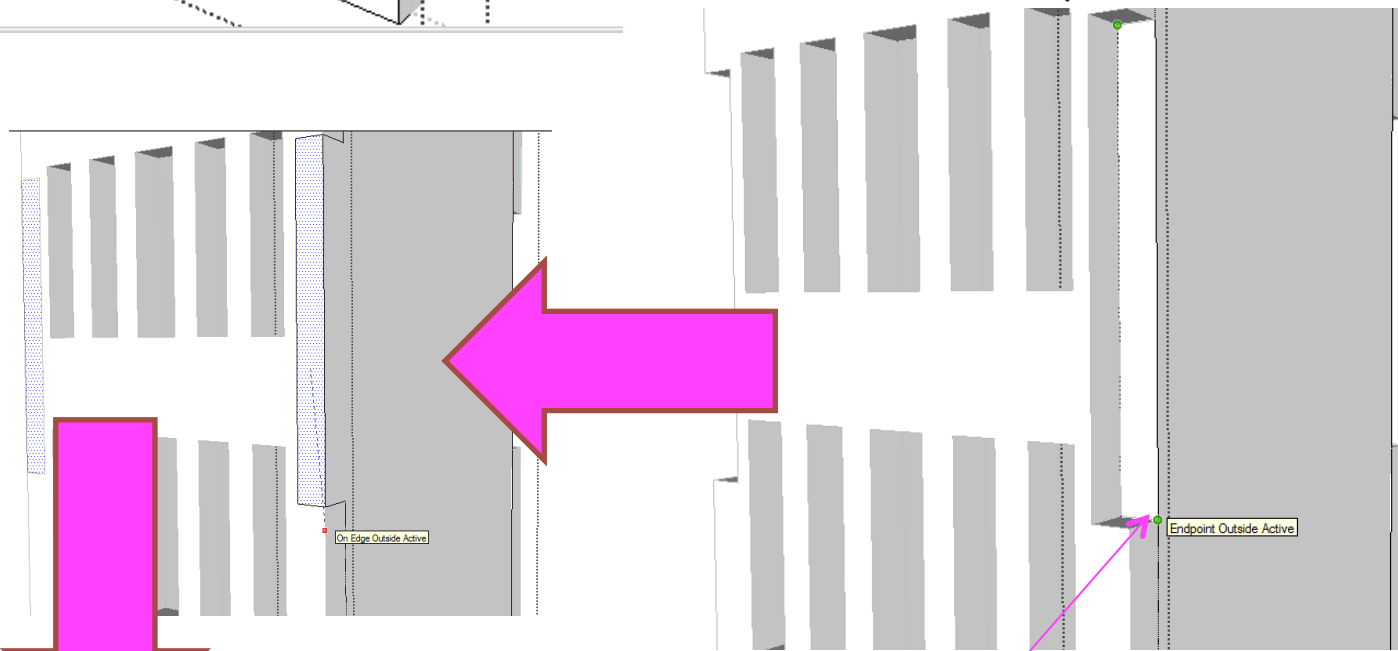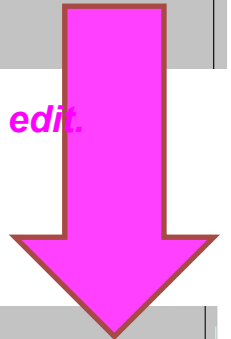
Use the *push pull* tool to pull the rectangles shown forward. Type in 4 and press enter.

Computer Aided Design: Big Ben Lamp
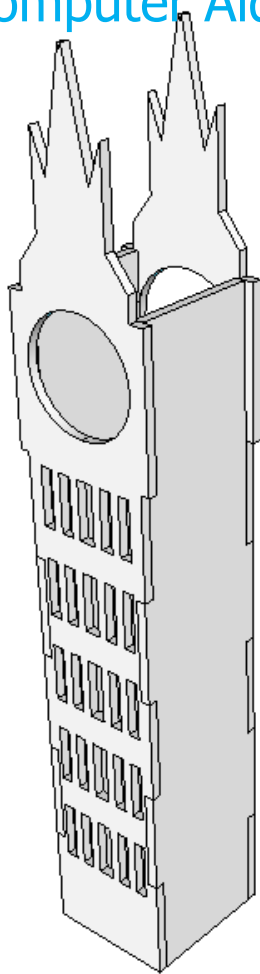
Click Scene 18

Repeat the process on all the side pieces
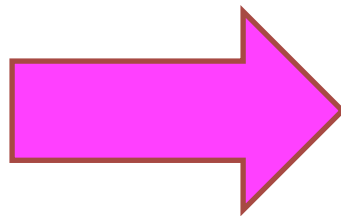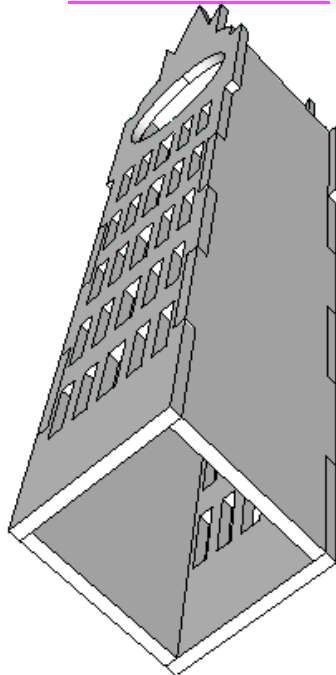
Use the *orbit tool* to see the underneath of the lamp

Entity Info
Erase
Hide

Select ▶
Soften
Divide
Zoom Selection
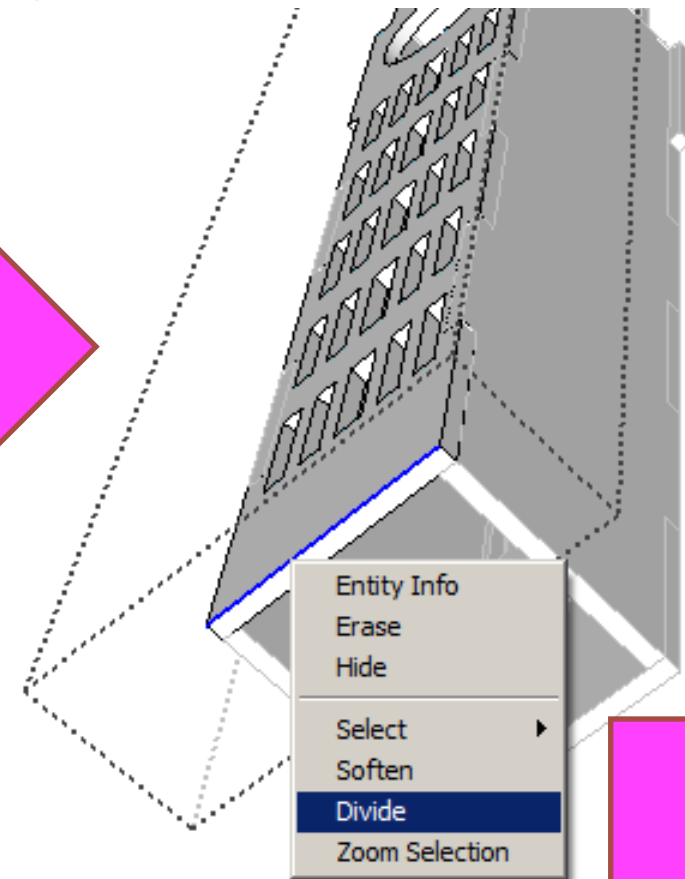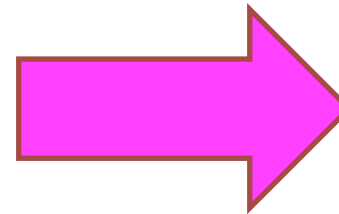
Double click on the front piece and the line shown.
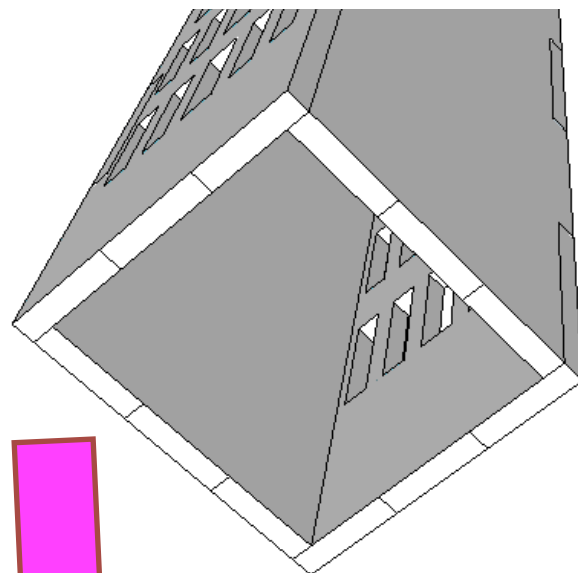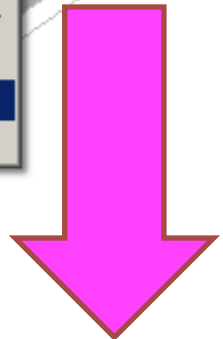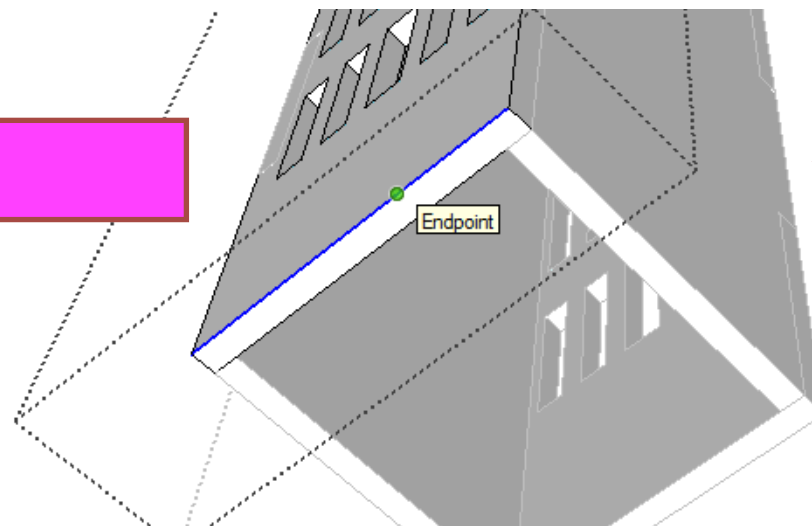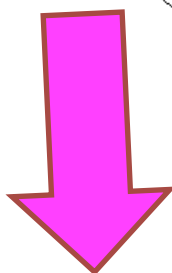
Endpoint

3 segments
Length: ~ 18.13mm

Click the *pencil tool*. Move down the line you have just divide. When you come to and endpoint draw a line across to the opposite edge.

Repeat the process on all the side pieces
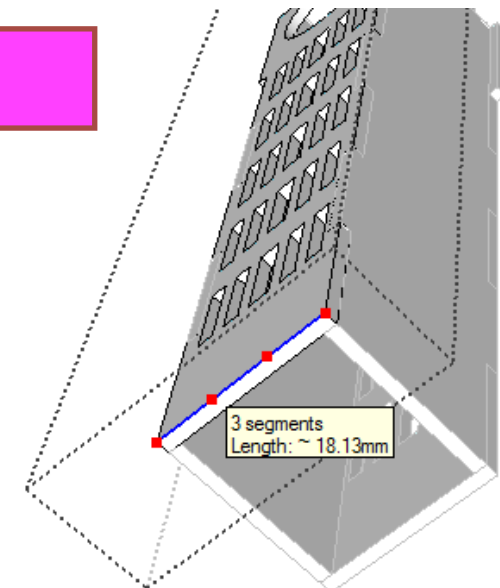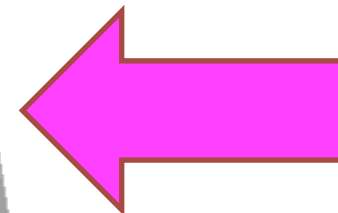
Right click and divide by 3.

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Double click each piece in turn and use the *push tool* to pull the centre rectangle down by 4

Repeat on all sides

Use the *square tool.* Draw a square from the two endpoints shown

Endpoint in Group

Use the *square tool.* Draw a square over each of the squares shown on the base. Use the push pull tool to the push these squares up. Type 4 and enter
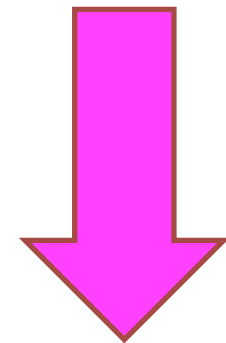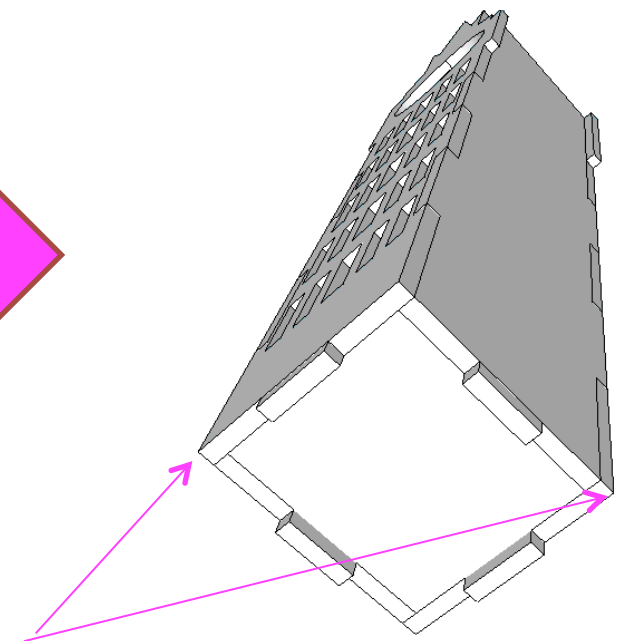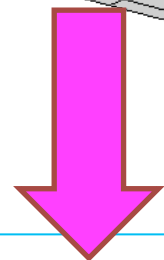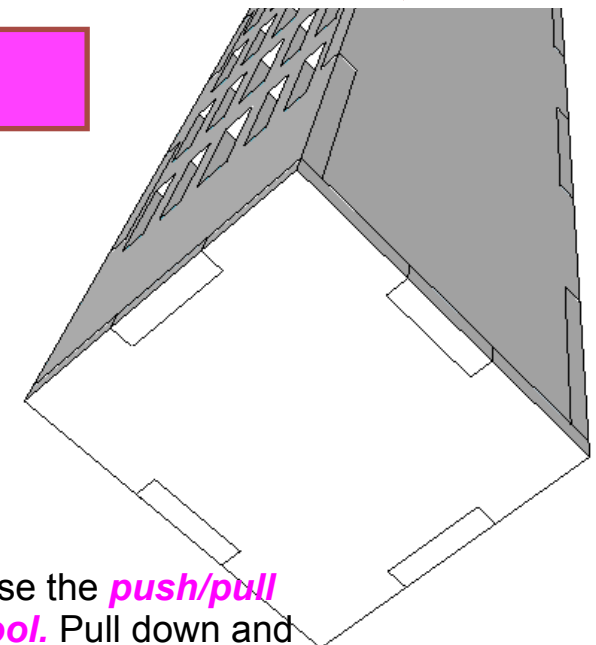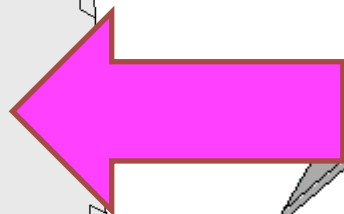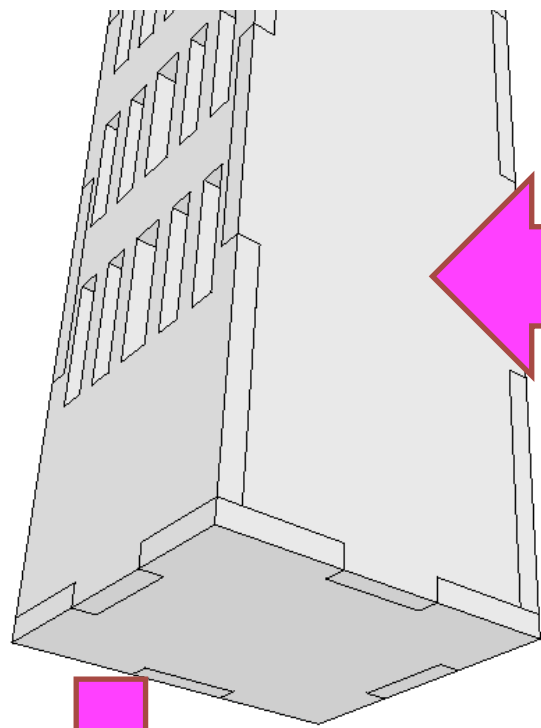
Use the *push/pull tool.* Pull down and press 4 and enter

Computer Aided Design: Big Ben Lamp

Computer Aided Engineering: Step by Step Guide to Lamp Construction

Entity Info
Erase
Hide

Explode
Select
Area
Make Component
Make Group
Intersect Faces
Reverse Faces
Flip Along
Soften/Smooth Edges
Zoom Selection

Add Photo Texture

The base should look like above.
Click three times and make group.

On Face in Group

Use the *square tool.*
Draw a square from
the two endpoints
shown

Endpoint in Group

Use the *push/pull tool.* Pull down and press 4 and enter

Entity Info
Erase
Hide

Explode
Select
Area
Make Component
Make Group
Intersect Faces
Reverse Faces
Flip Along
Soften/Smooth Edges
Zoom Selection

Add Photo Texture
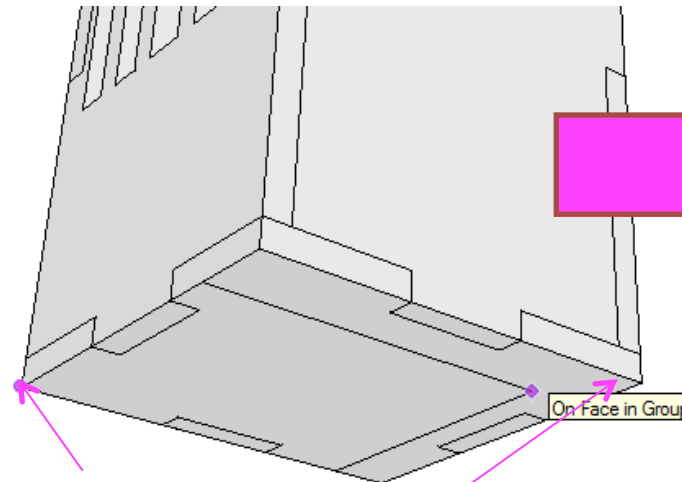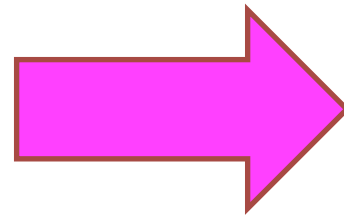
The base should look like above.
Click three times and make group.

Use the *push/pull tool.* Pull all four
sides out. On each side type 5 and
enter

Computer Aided Design: Big Ben Lamp

Repeat process again for the amount of bases you want underneath.

Doubler click side piece
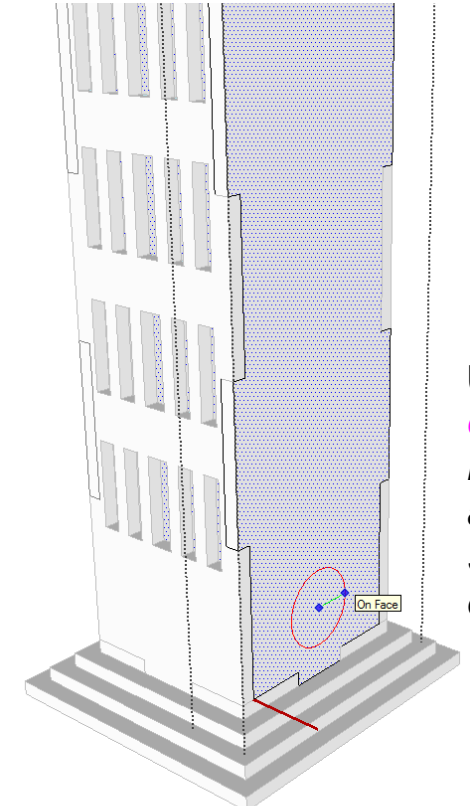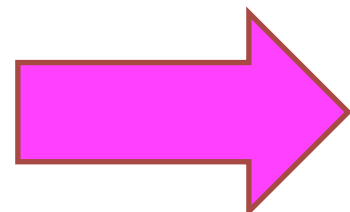
Use the *circle tool.* *Draw circle and type in 5 and press enter*
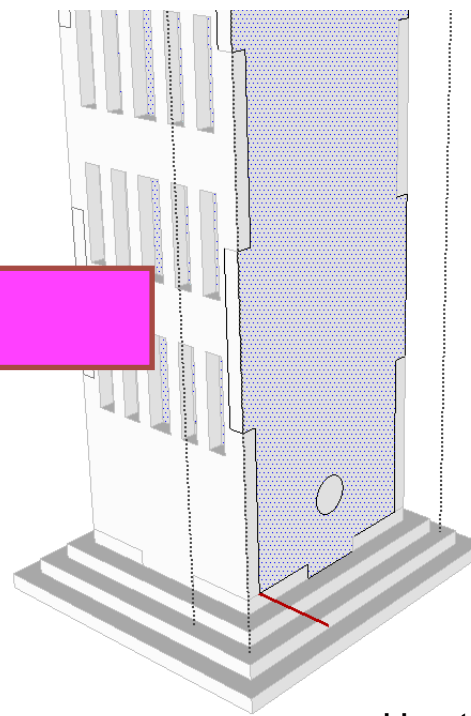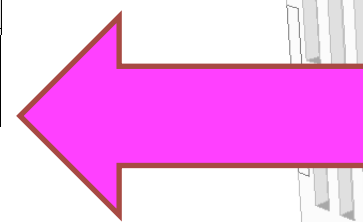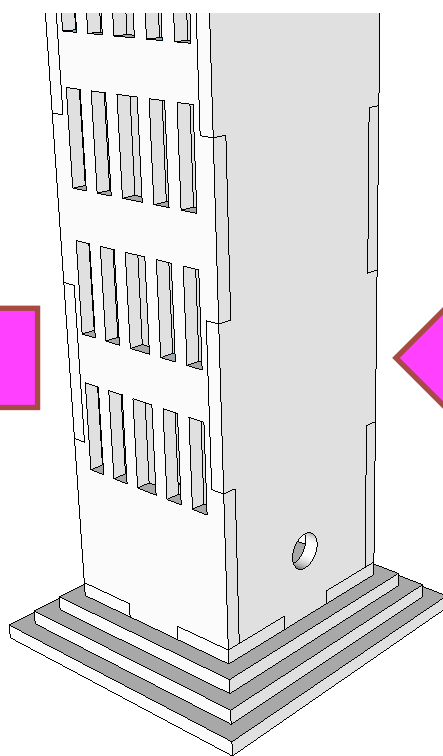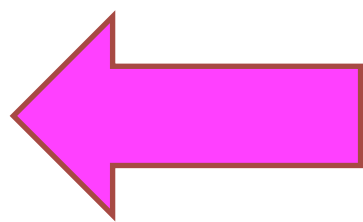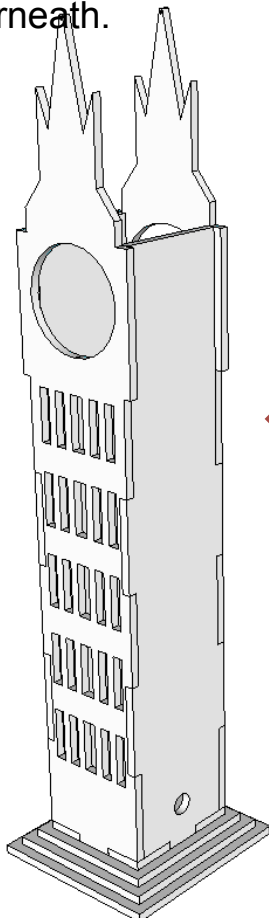
Use the *push/pull tool.* Pull the circle in and type 4 and enter

Computer Aided Design: Aircraft Lamp Working Drawing

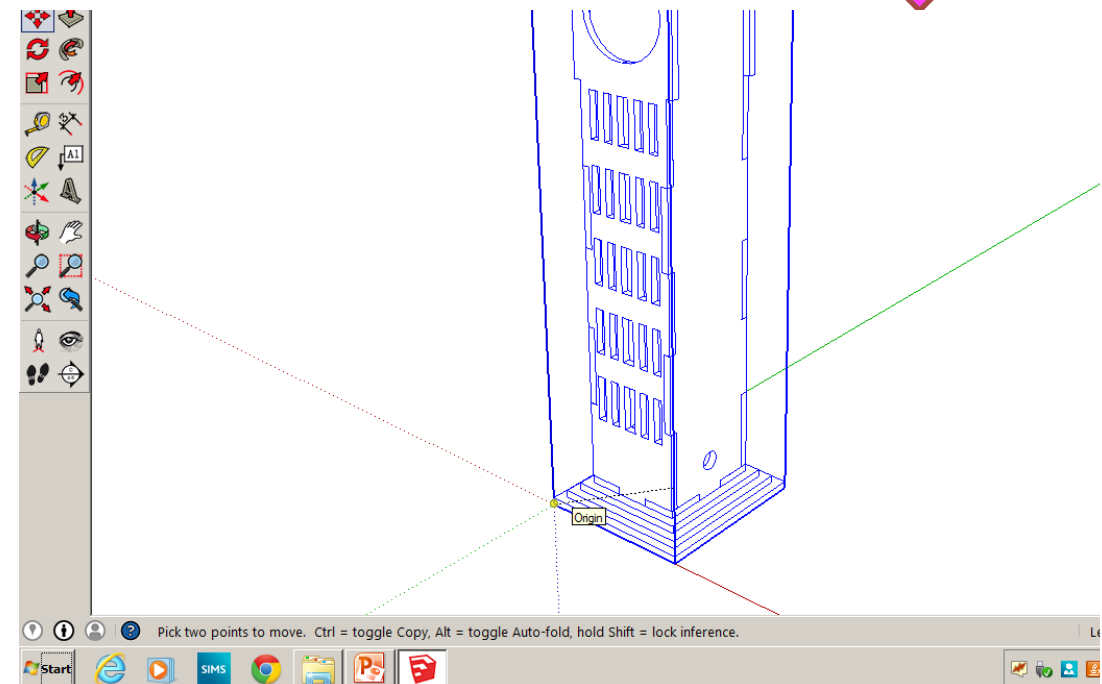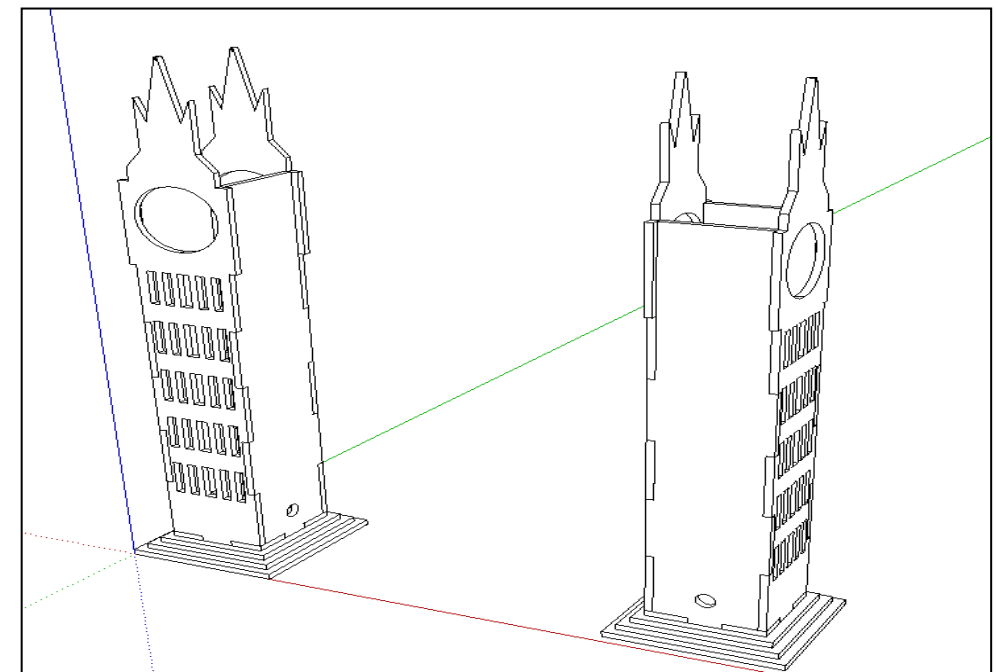## Computer Aided Engineering: 1. Working Drawing Instructions (Setting up Correct Format)

Now its time to convert your drawing into a working drawing (NB this *must be exact* to achieve a level 2. *Click windows / styles*
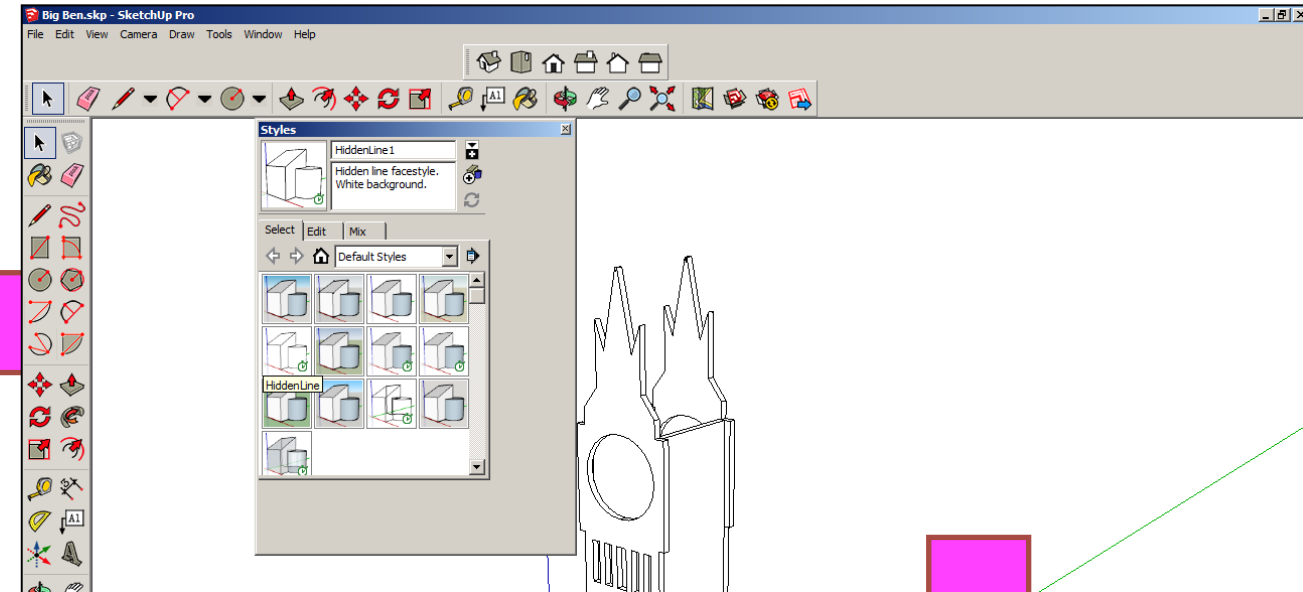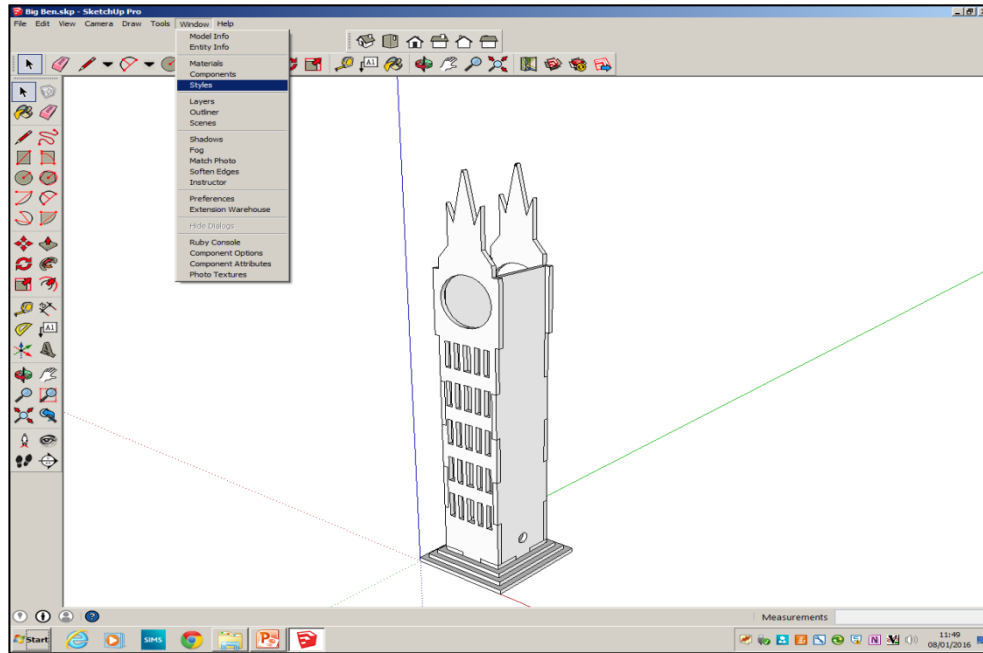
Click on Windows / Default / hidden line
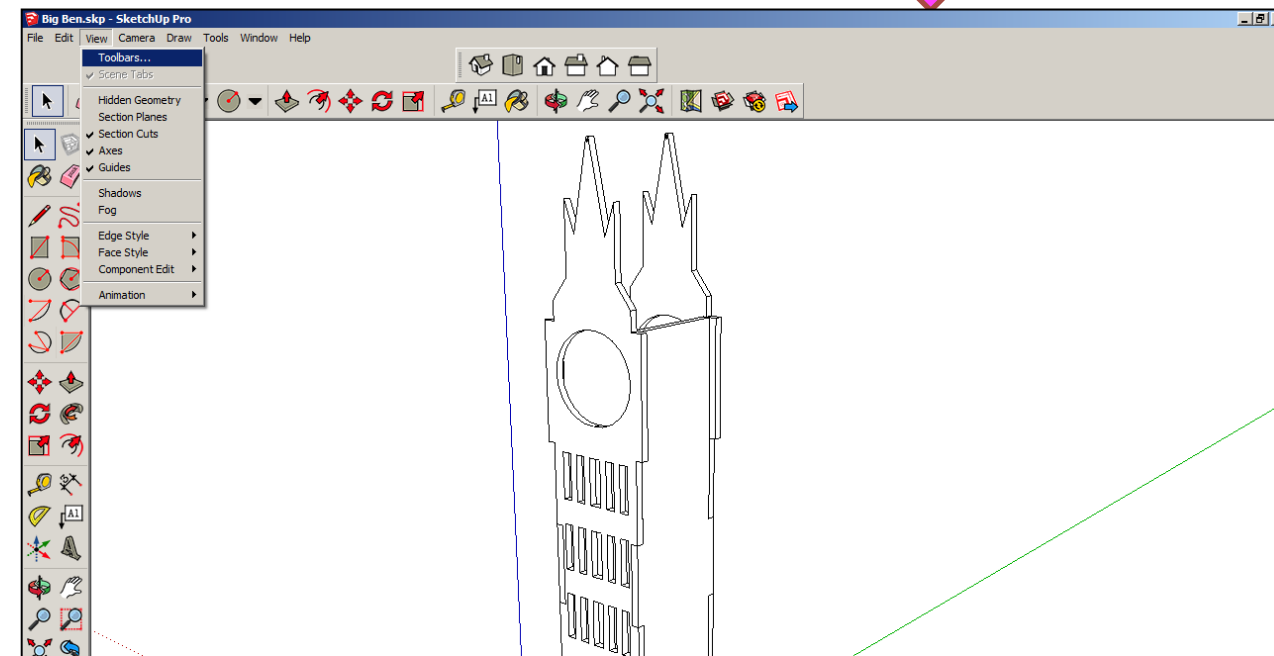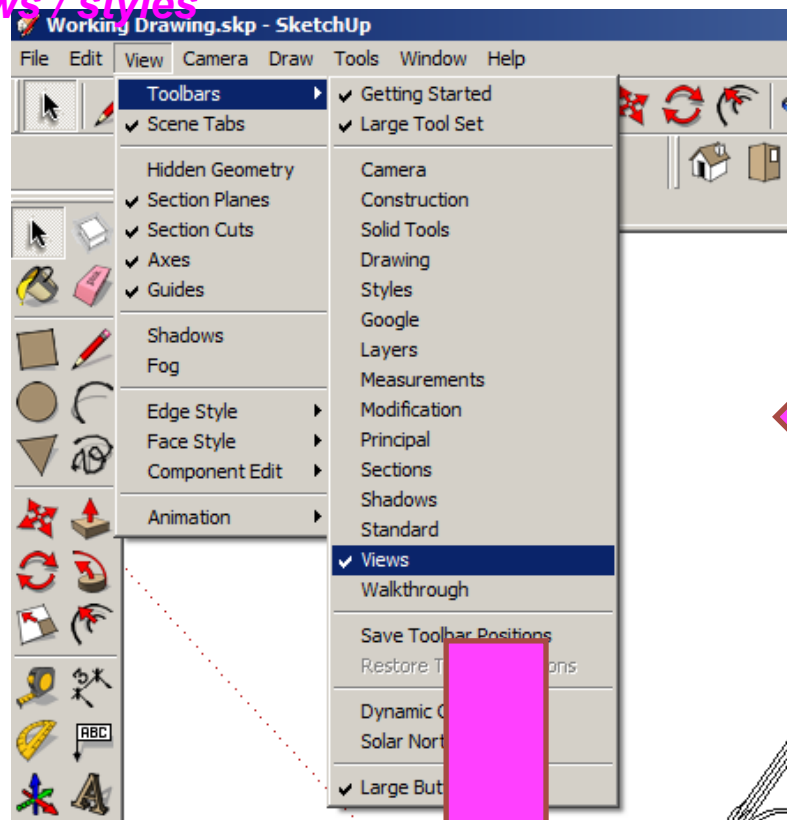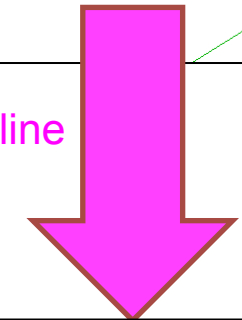
Click on Toolbars / Views

Computer Aided Design: Aircraft Lamp Working Drawing
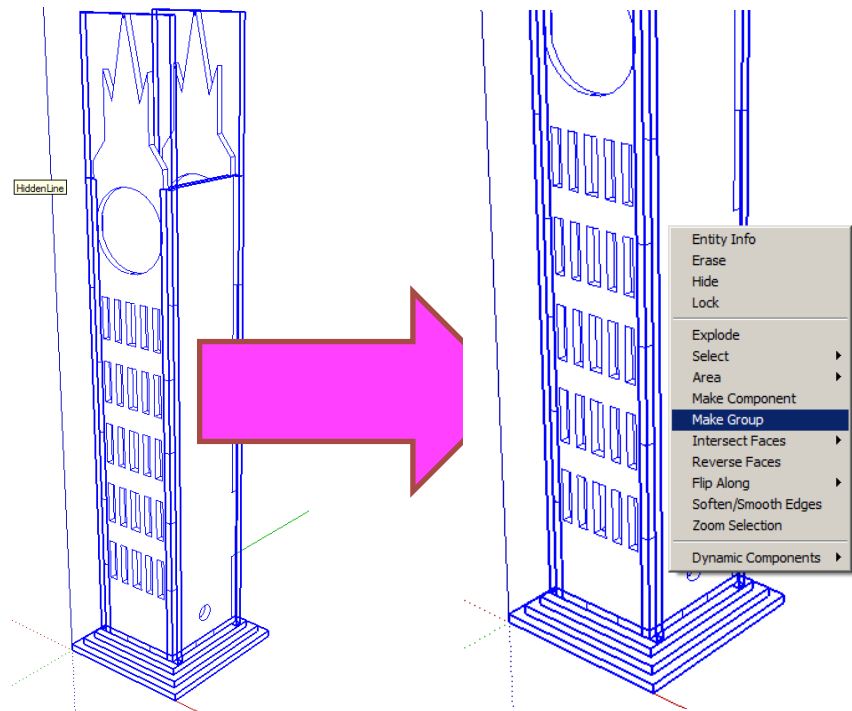
Highlight the entire lamp and right click **make group**
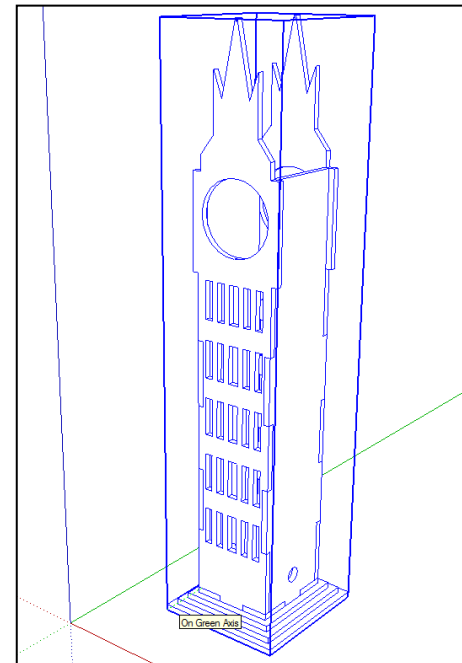
Click on bottom left **corner of lamp using the move tool**
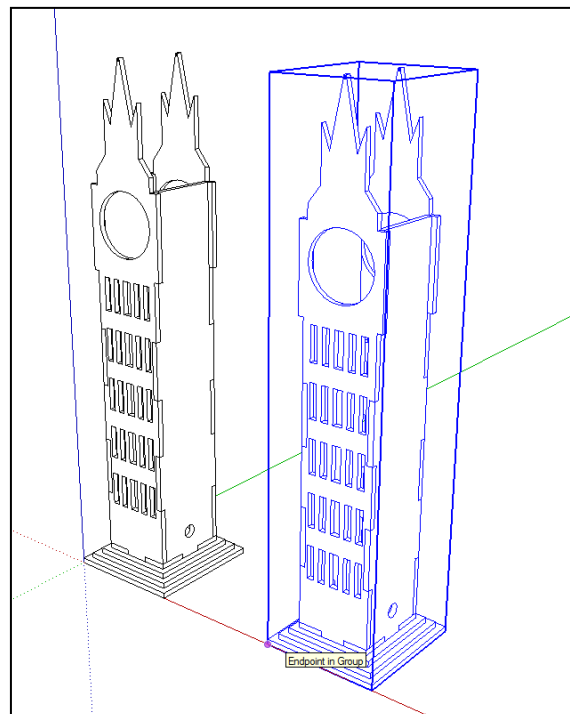
Copy and move a second lamp along the **red axis**

Click on the **move tool** and move the lamp so the corner is on the origin
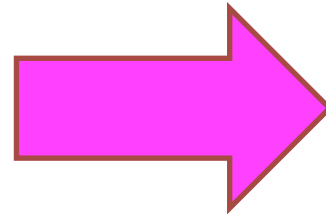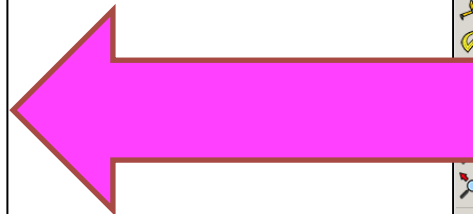
Computer Aided Design: Aircraft Lamp Working Drawing
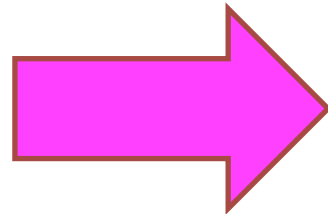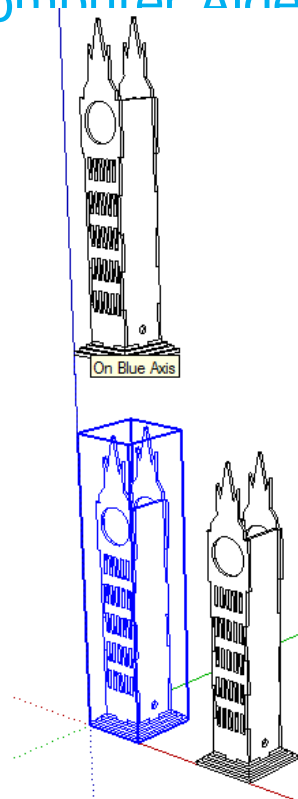
Copy and move a second lamp along the **blue axis**
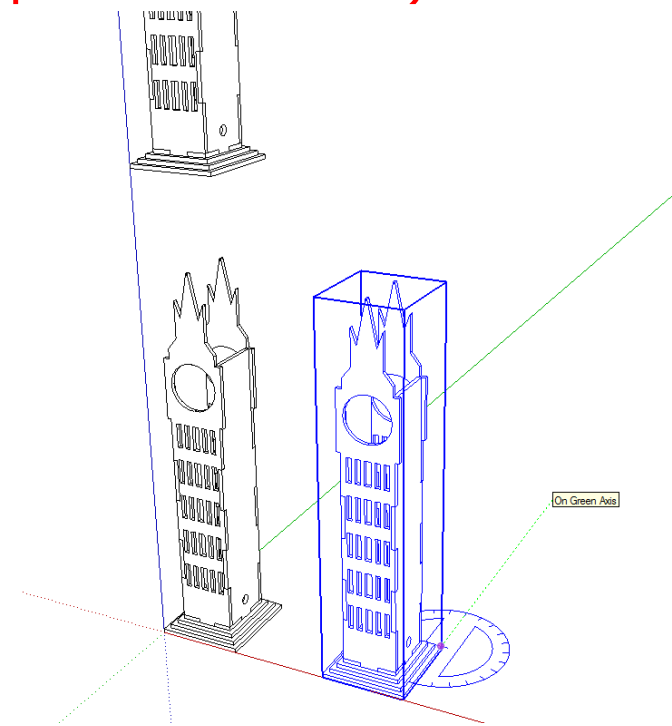
Click on the rotate tool and turn the lamp **around 90 degrees as shown below**
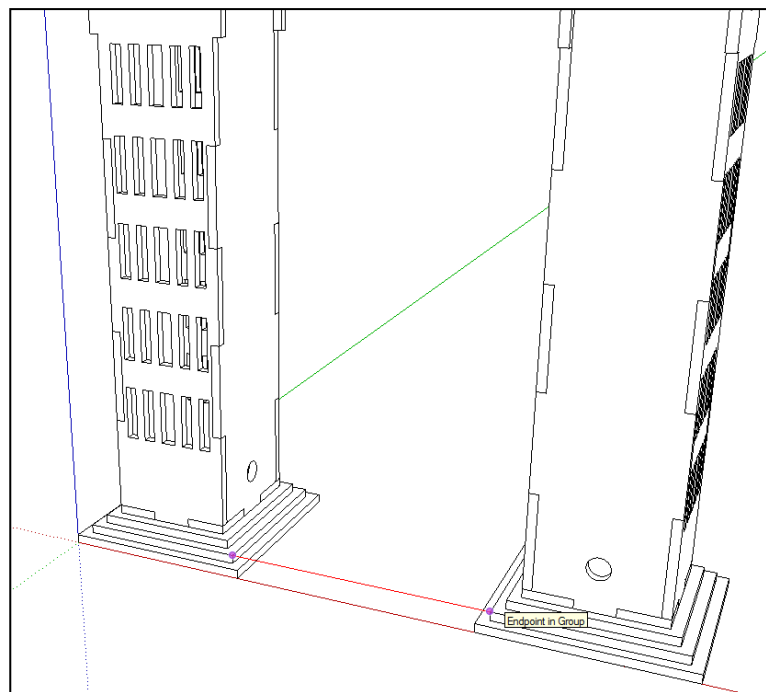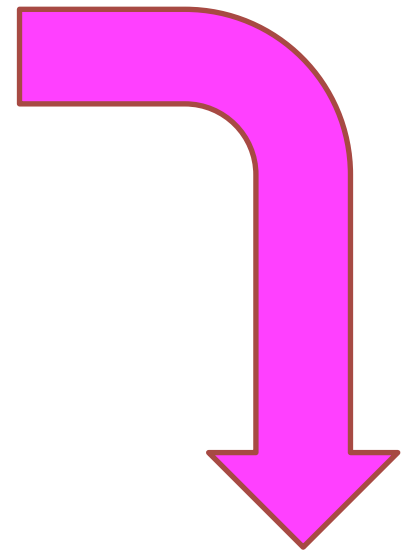
Click on the **move tool** along the red axis. You should be able to draw a line that turns red from corner to corner to indicate it lines up exactly
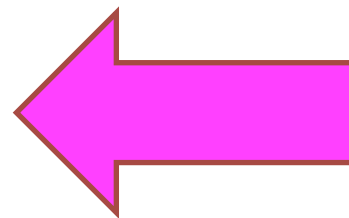
Click on the **move tool** and move the lamp so the corners of the base meet

Computer Aided Engineering: 2. Working Drawing (Setting up Correct Format)
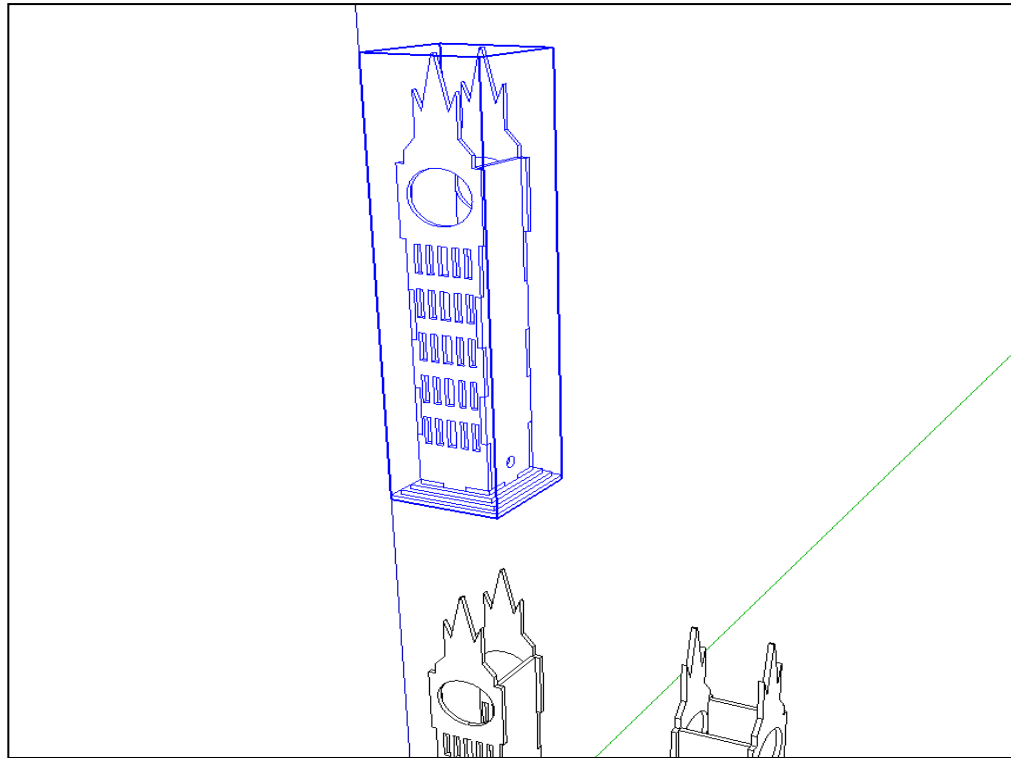
Click on the top lamp
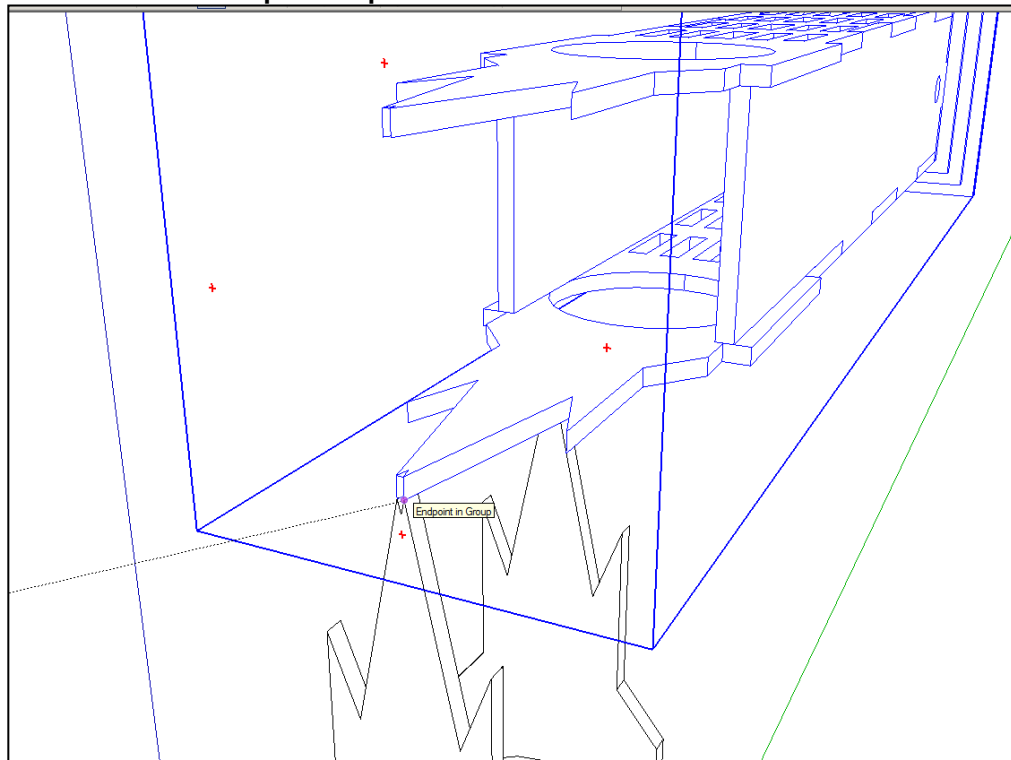
Click on the rotate tool and turn the lamp **around 90 degrees as shown below**
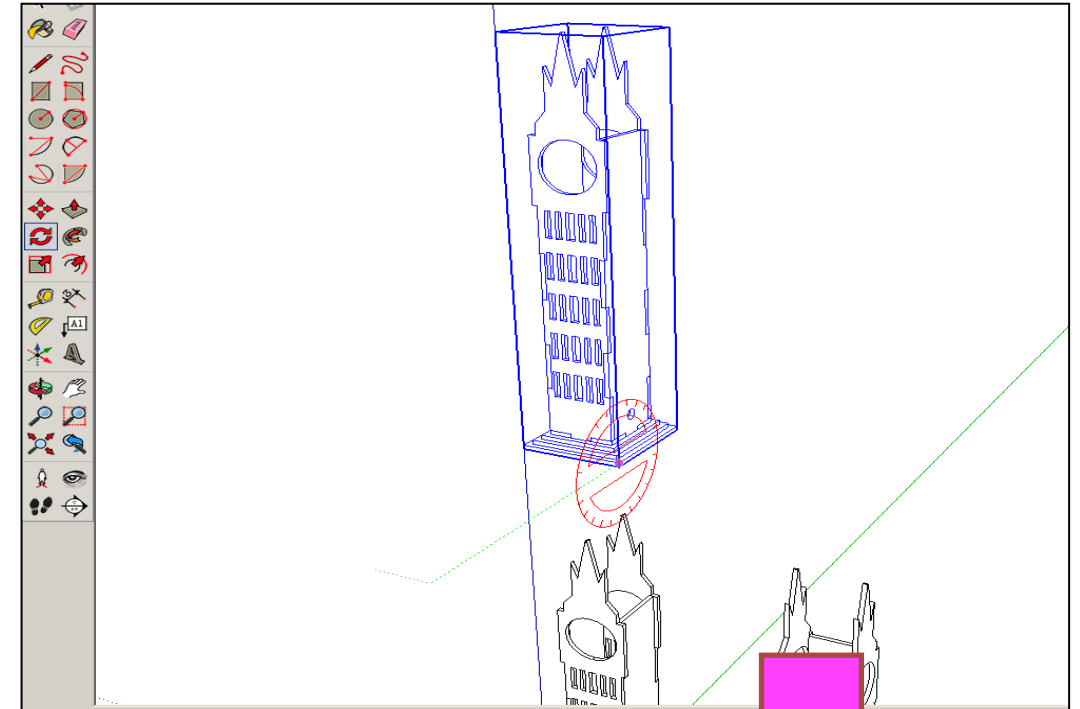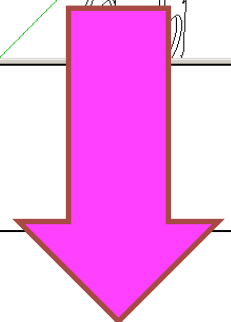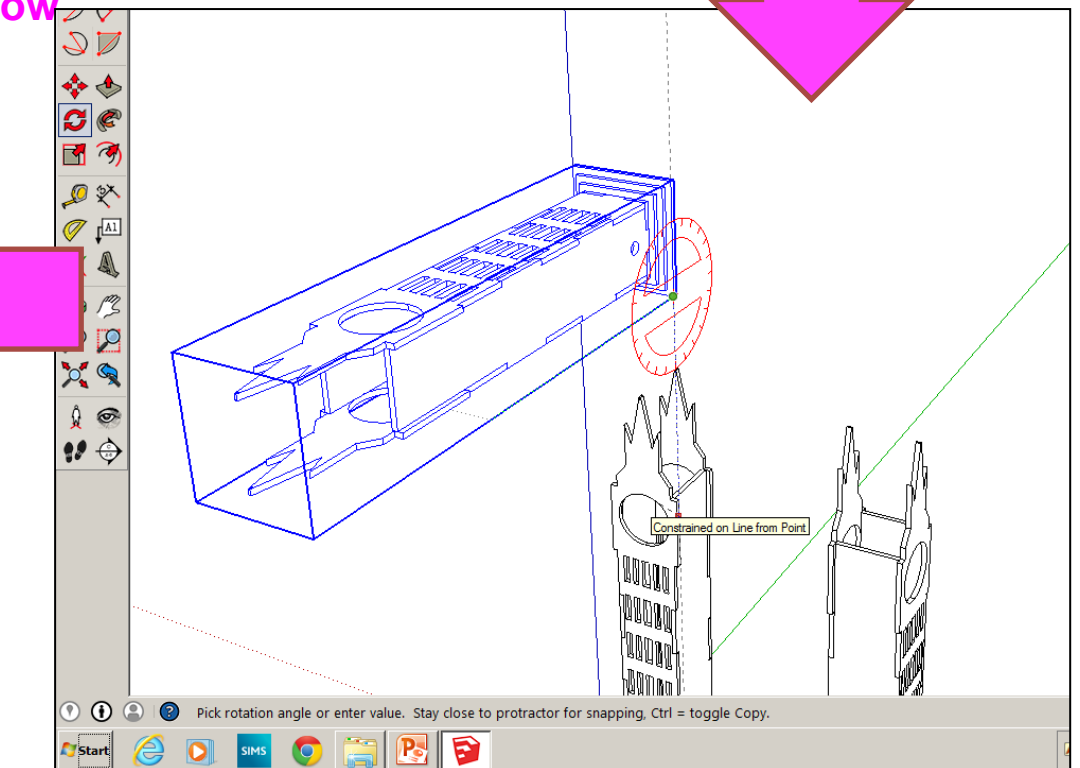
Click on the **move tool** and move the lamp so the corners of the base meet

Computer Aided Engineering: 2. Working Drawing (Adding Dimensions)

Click on the **front view using the view toolbar and the camera parallel projection**
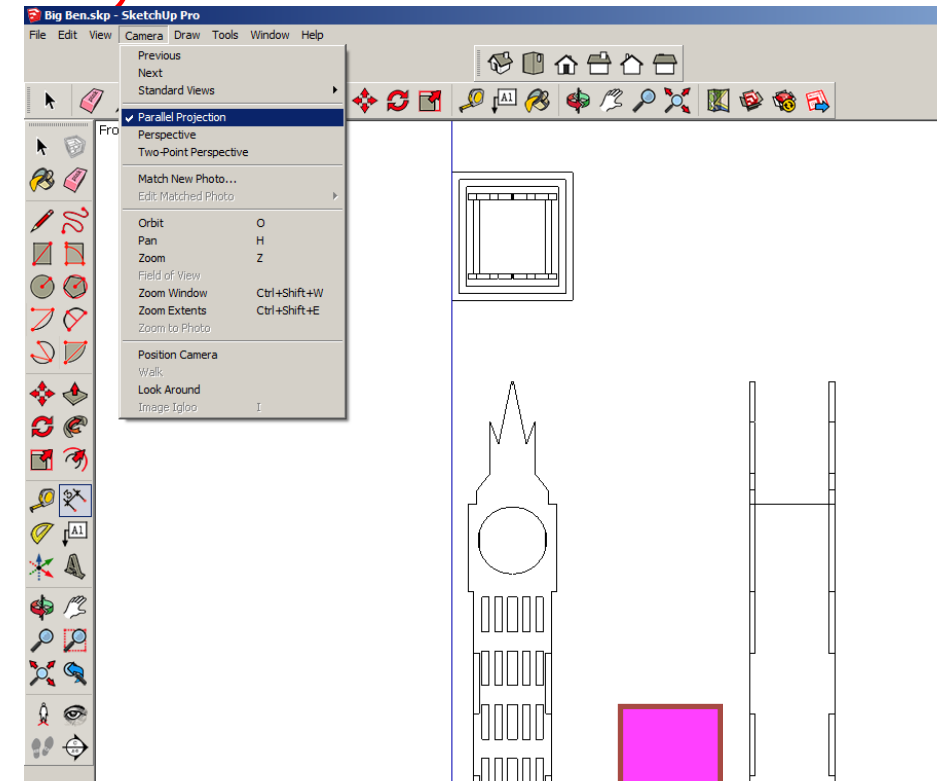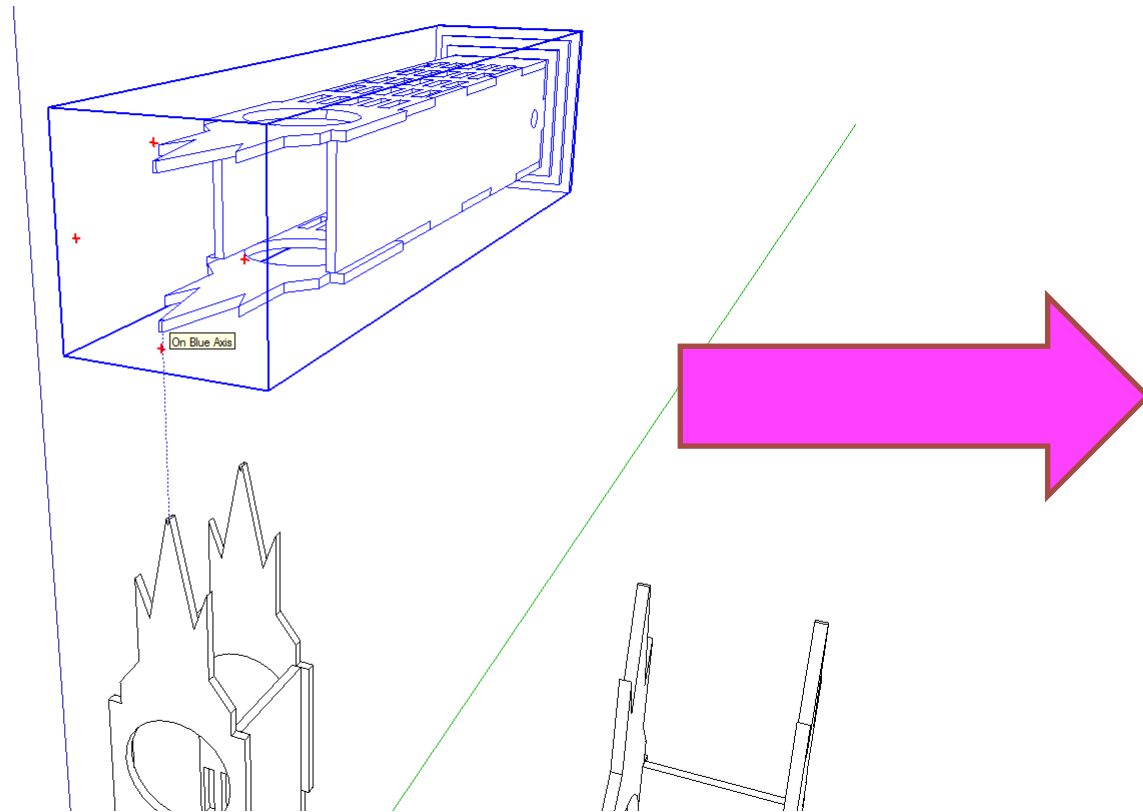
Click on the **move tool** and move the lamp so the corners of the base meet and then separate again.
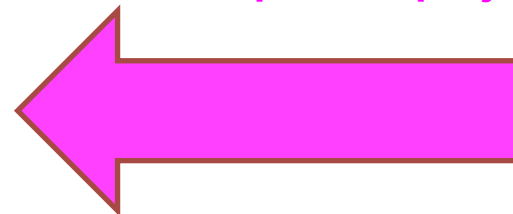
Click on the **dimensions tool bar** and add sizes. All sizes should be below and to the right. Never on the left hand side or on the top.
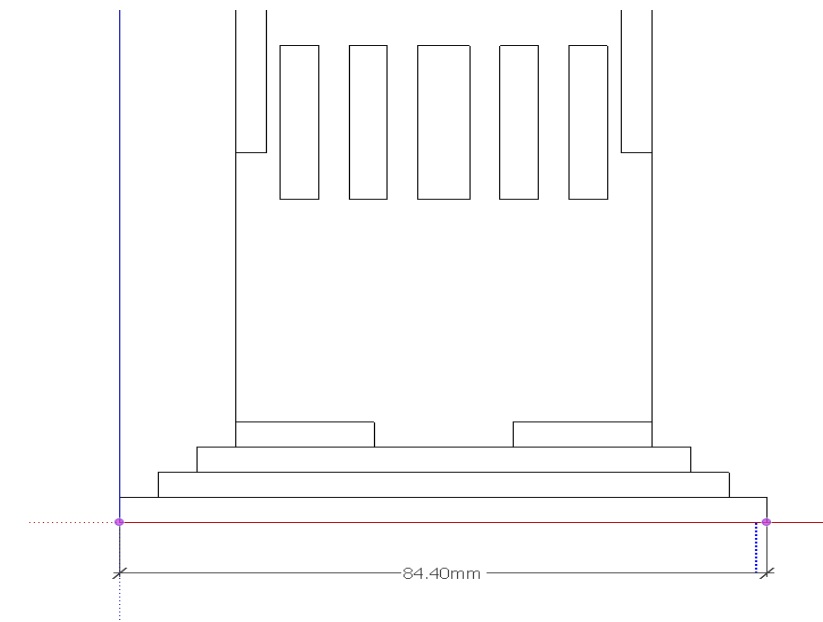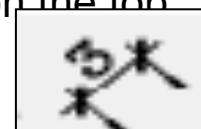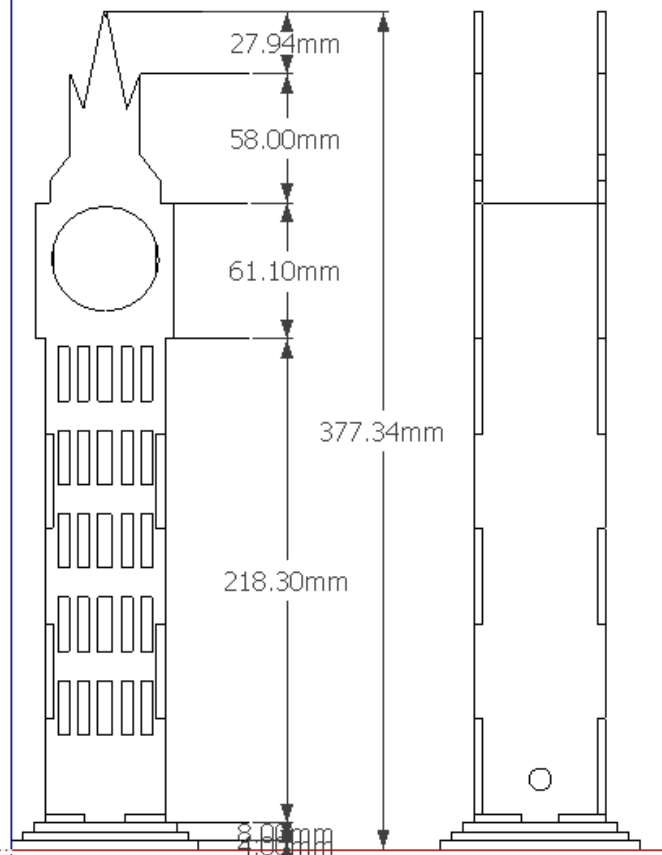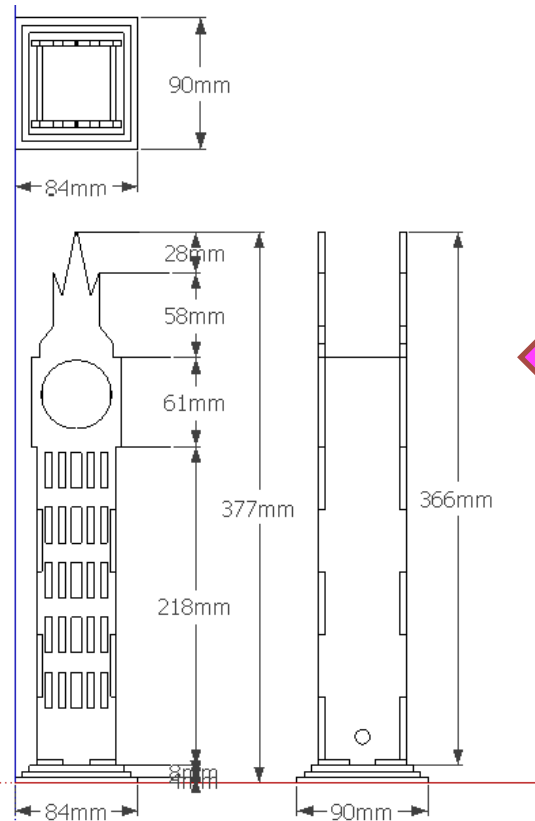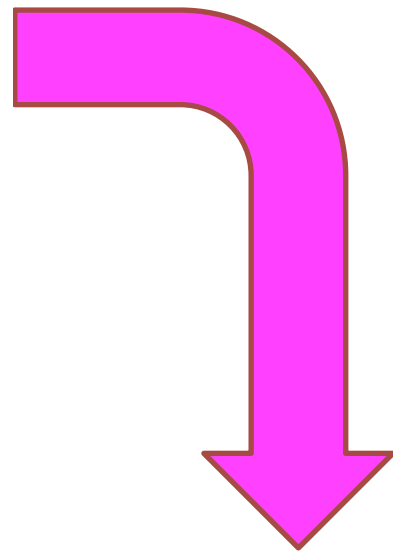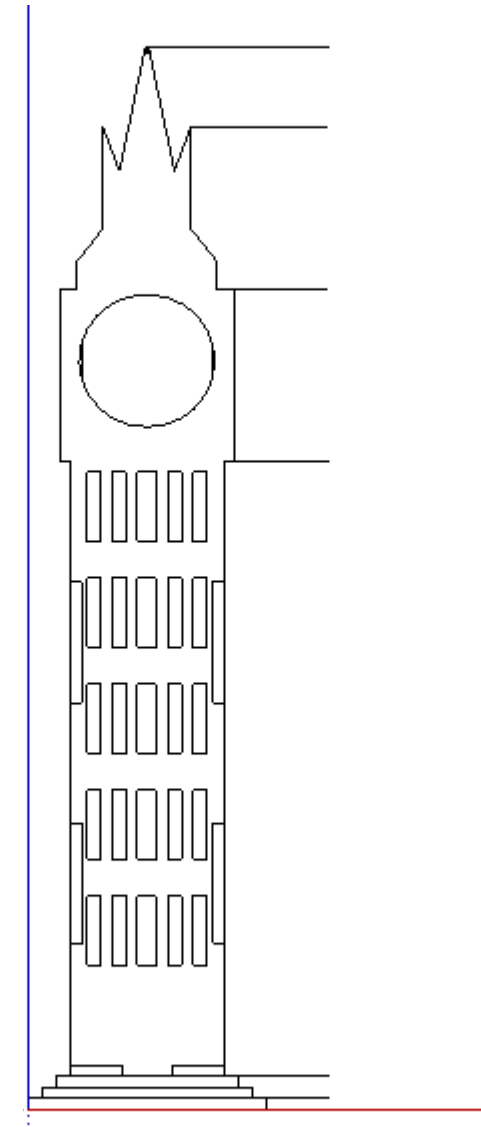
Certain points are difficult to add sizes using the pencil tool to line up edges as shown above.

84.40mm

84.40mm

Computer Aided Design: Aircraft Lamp Working Drawing

Computer Aided Engineering: 2. Working Drawing (Setting up Correct Format)
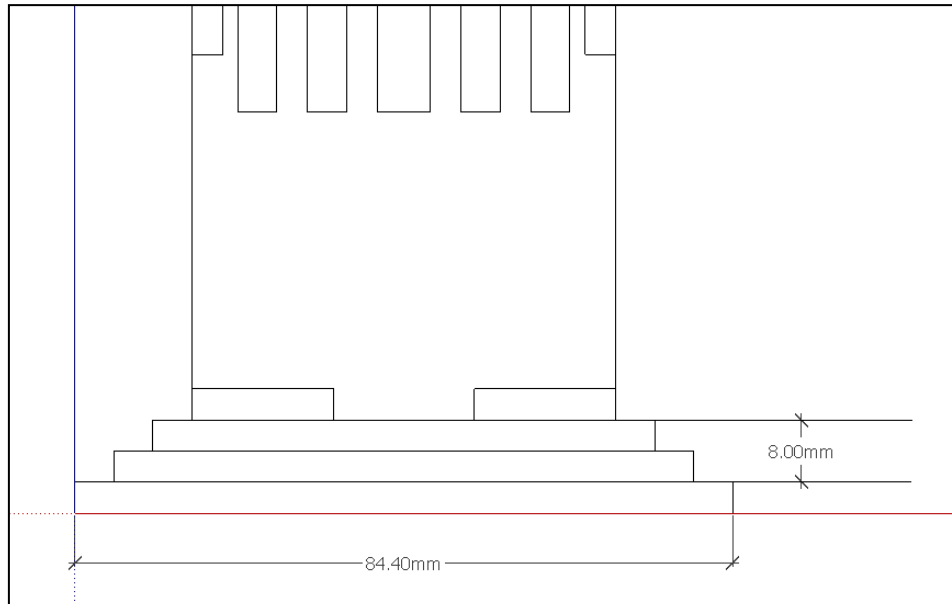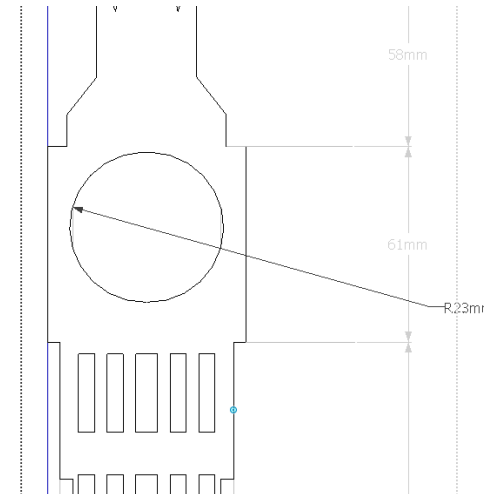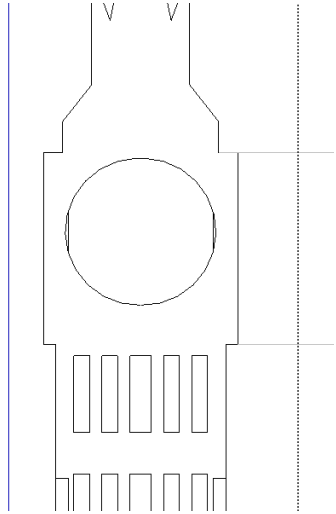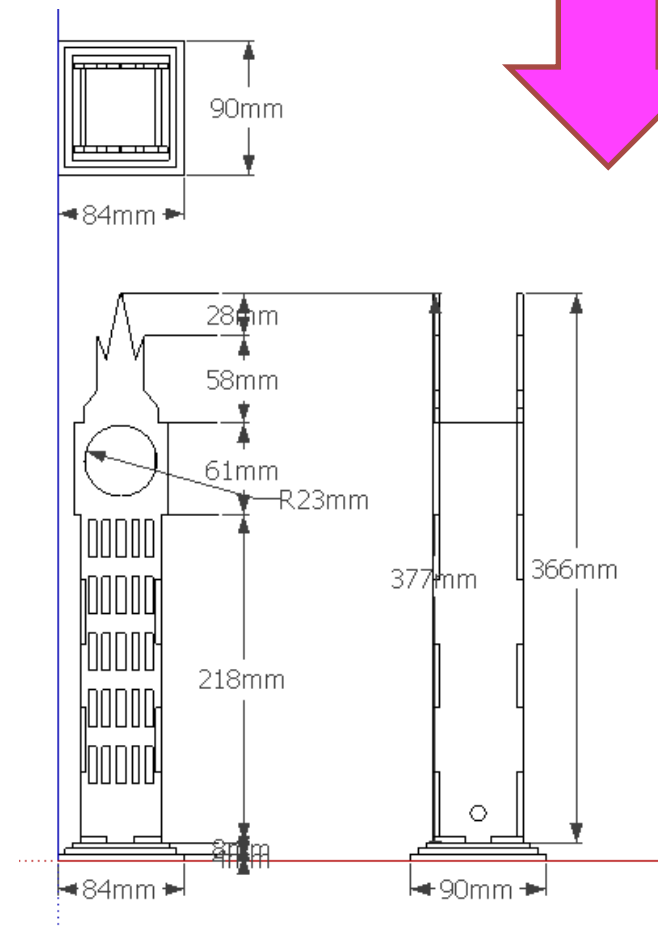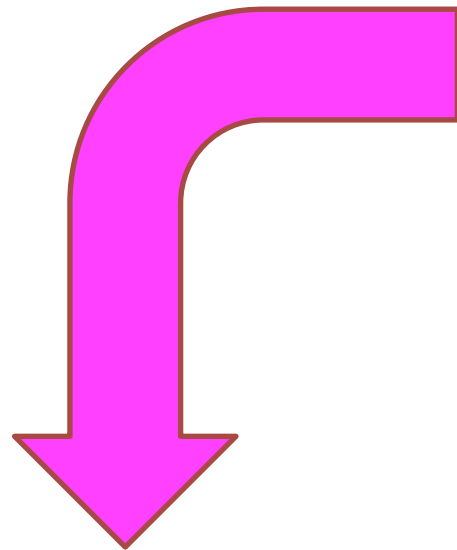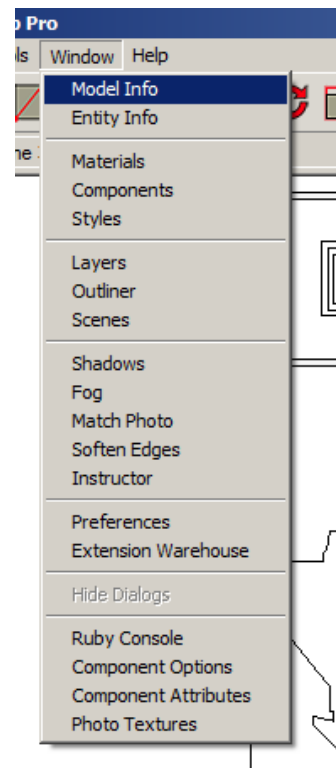

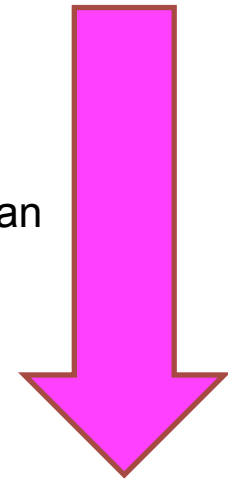Add sizes to show height, width and any other important sizes. You will compare these to the lamp later on
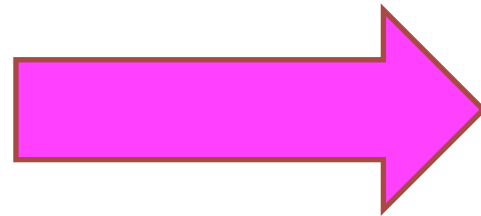
Computer Aided Engineering: 2. Working Drawing (Setting up Correct Format)

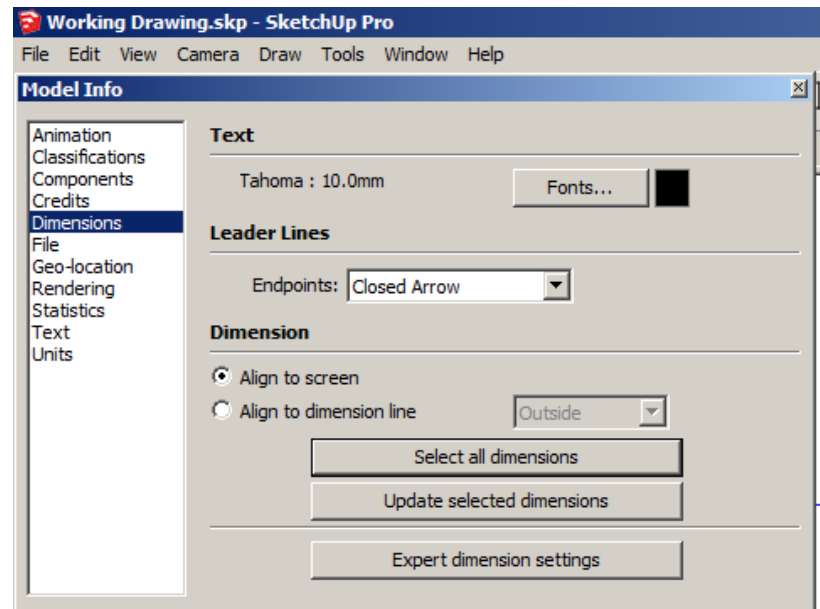If the object is grouped you may need to double click to add some sizes and radius

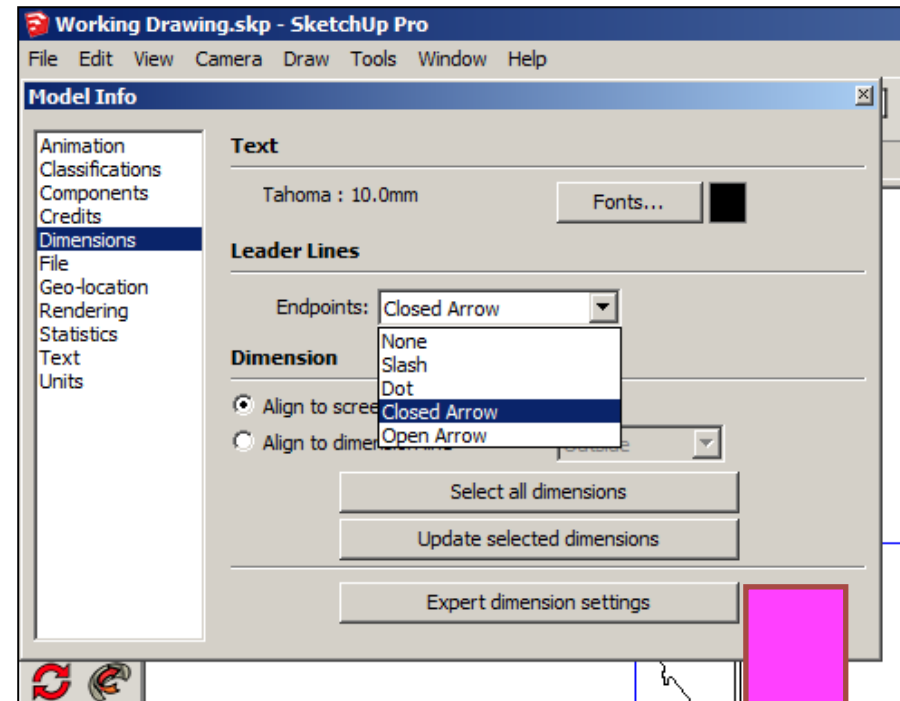Add sizes to the three drawings Front, Side and Plan

Click on *Window / Model Info*

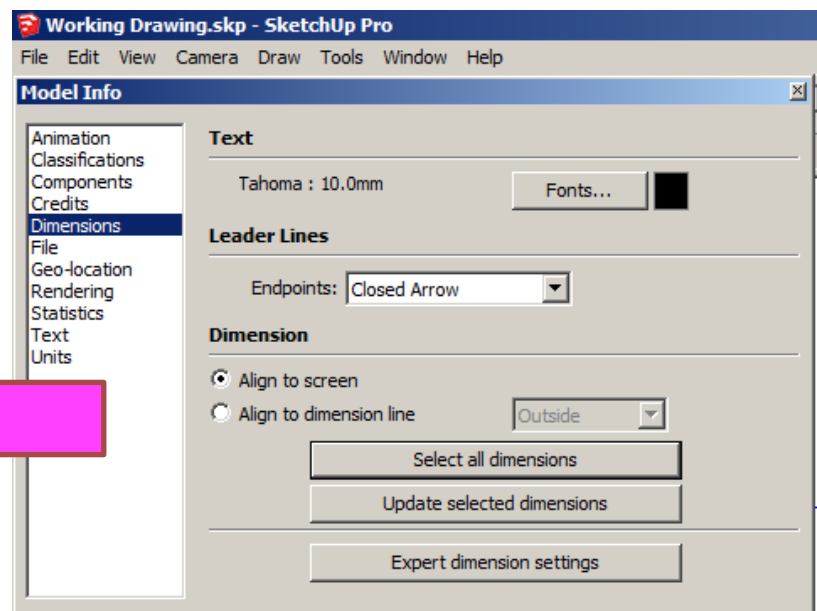# Computer Aided Design: Aircraft Lamp Working Drawing

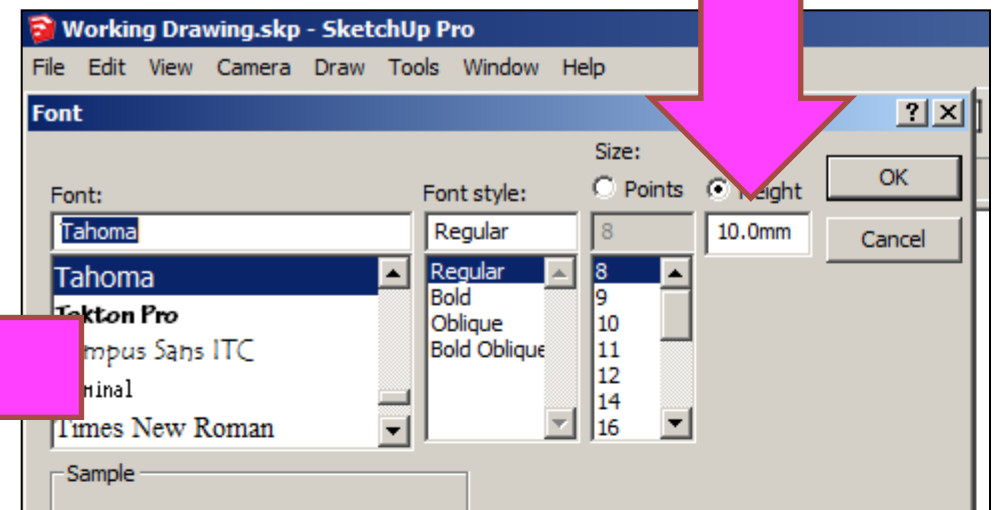## Computer Aided Engineering: 2. Working Drawing (Setting up Correct Format)

Click on *Dimension* and select all dimensions

Click on *Endpoints* and select closed arrow from the drop down menu
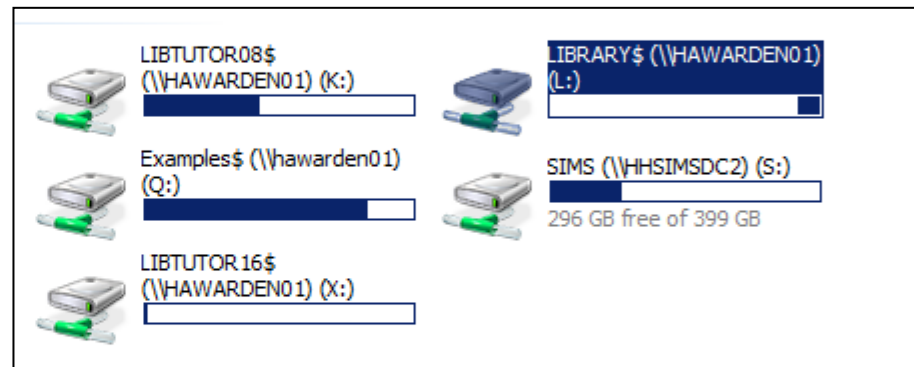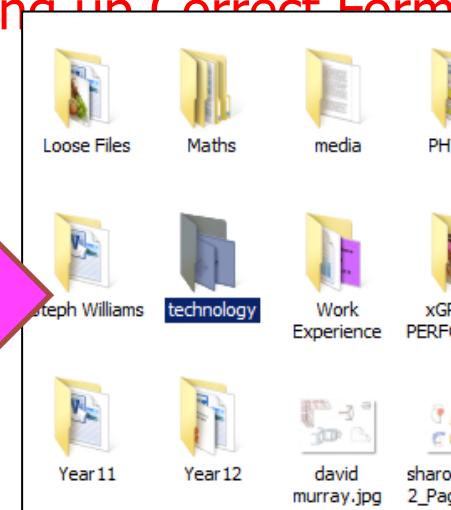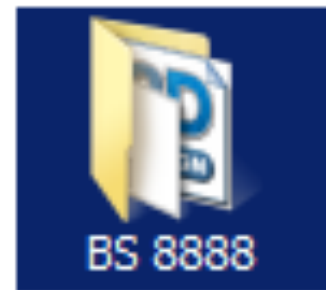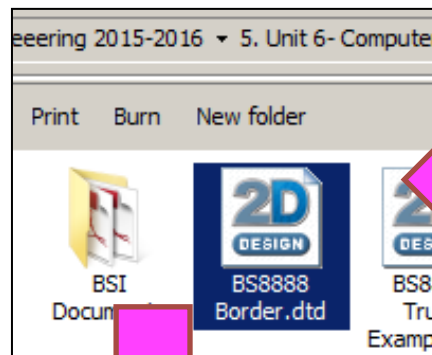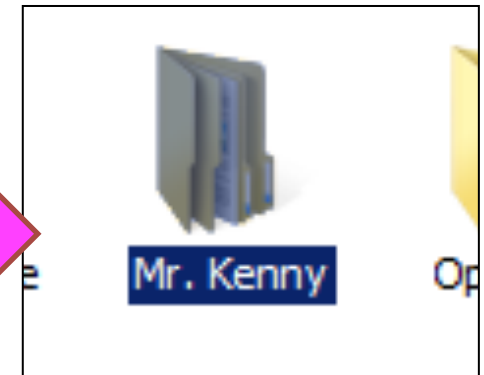
Click on *Fonts* and select a suitable size to be able to read the sizes on your drawing. You may have to repeat the above steps until your happy.

Click on *Update all dimensions.* The dimensions should change on the screen. When your happy close window down.
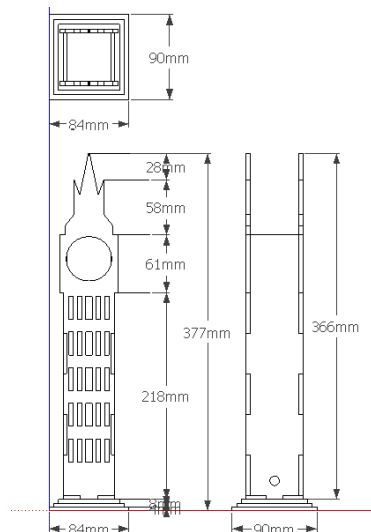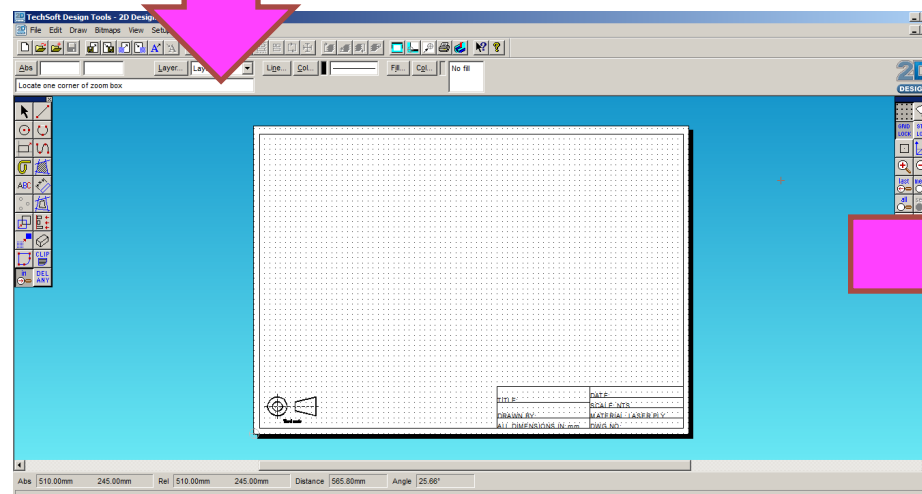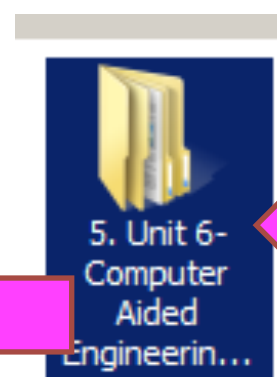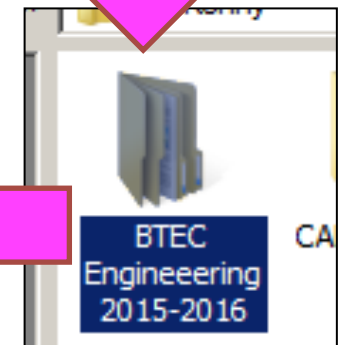
Computer Aided Design: Aircraft Lamp Working Drawing
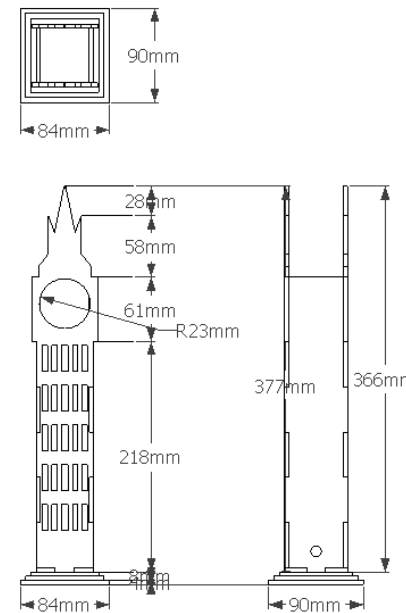
Click on *Library.*
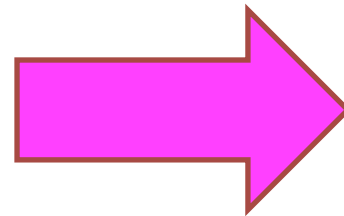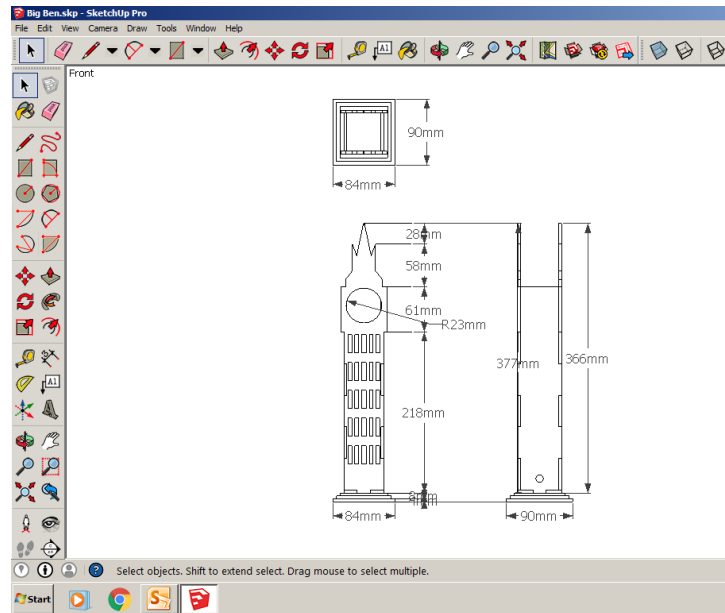
Click on *Technology.*

Click on *Mr Kenny.*

Go back to your working drawing. *Click on camera / Parallel projection, then view and click the axis off and then press print screen*

Computer Aided Design: Aircraft Lamp Working Drawing

Paste into Power point first and then crop.

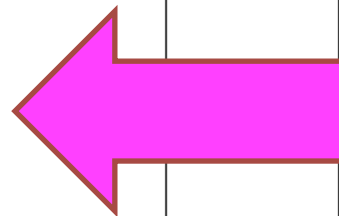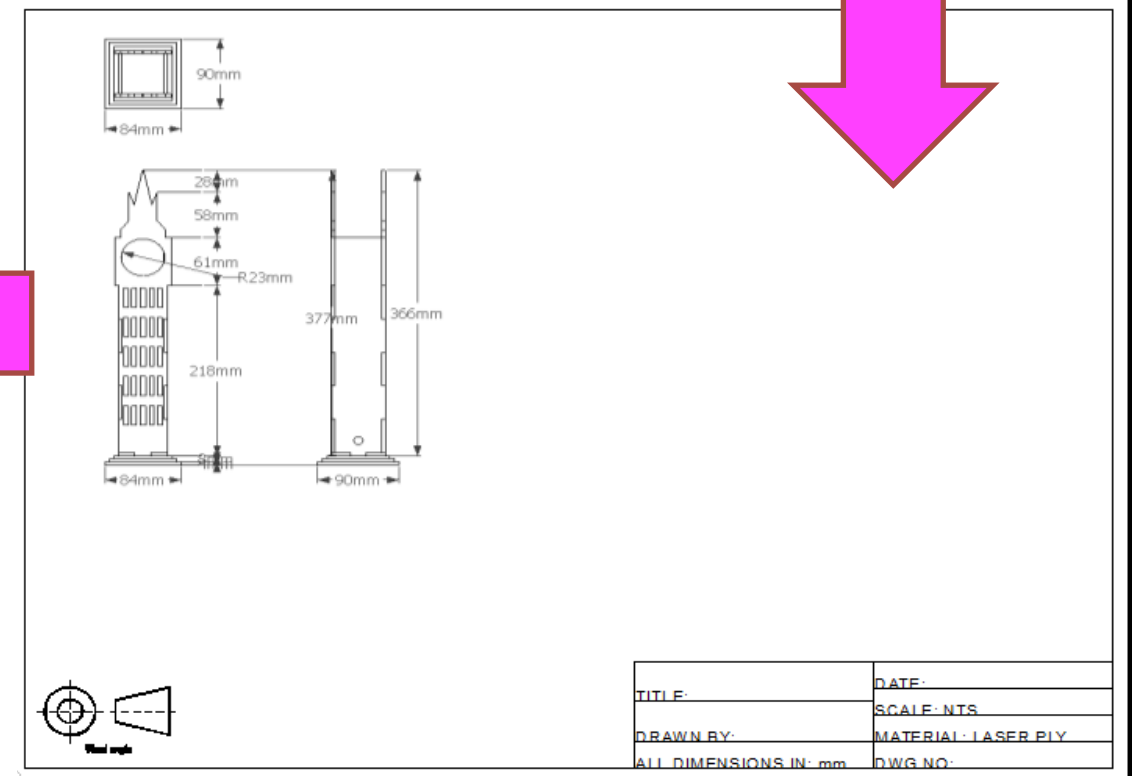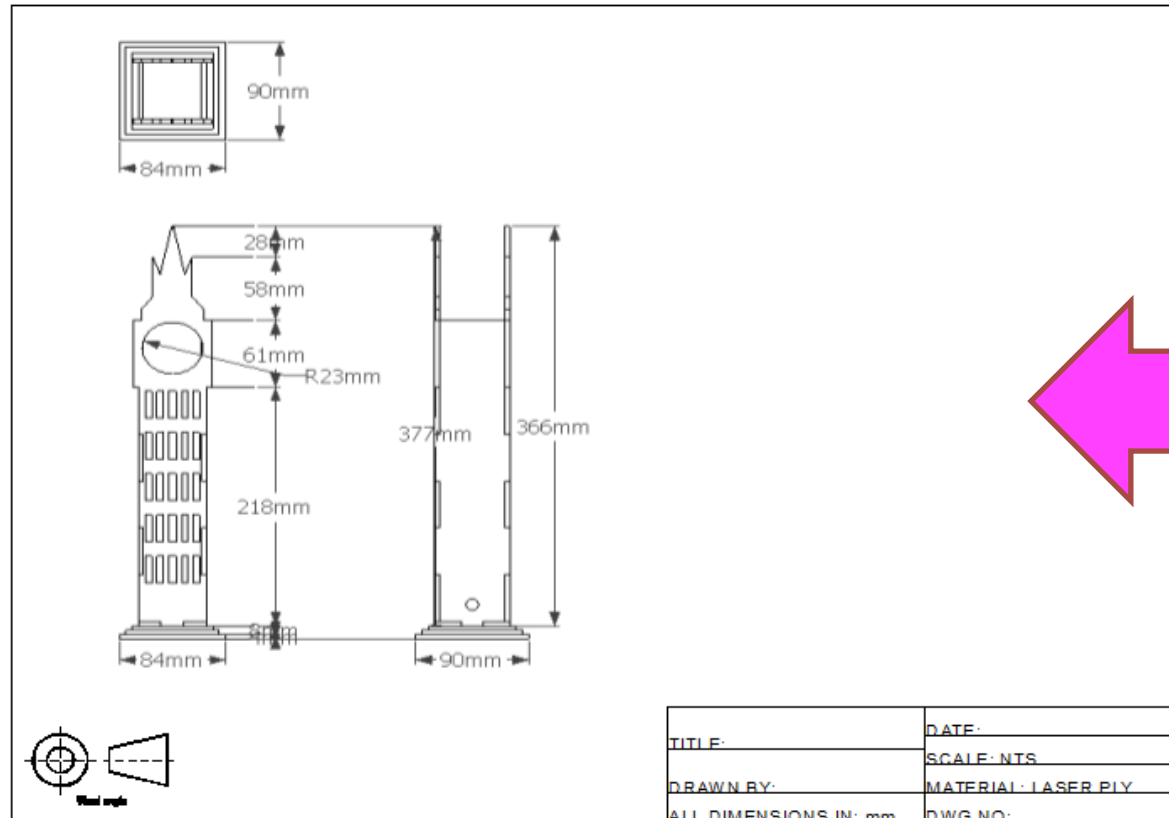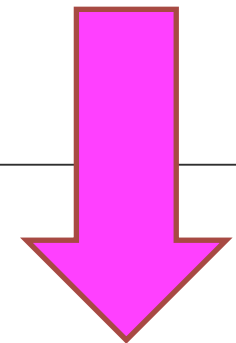Press print screen again.

Resize appropriately

Computer Aided Design: Aircraft Lamp Working Drawing

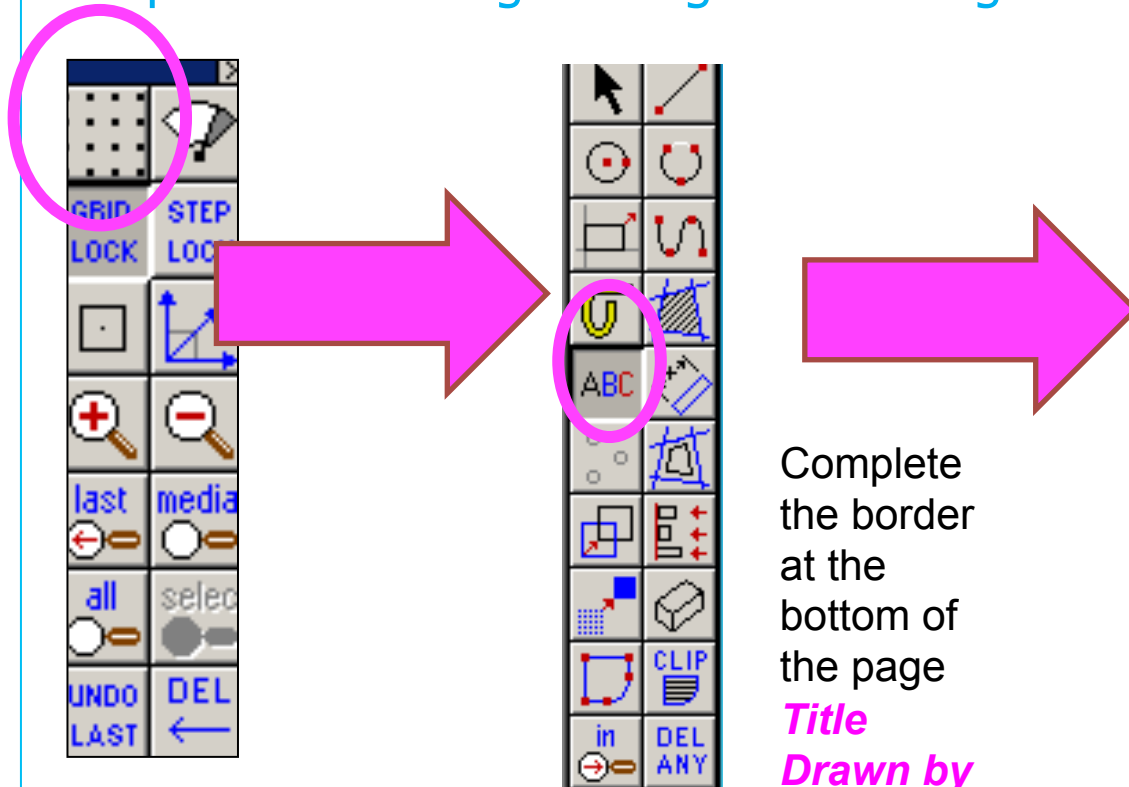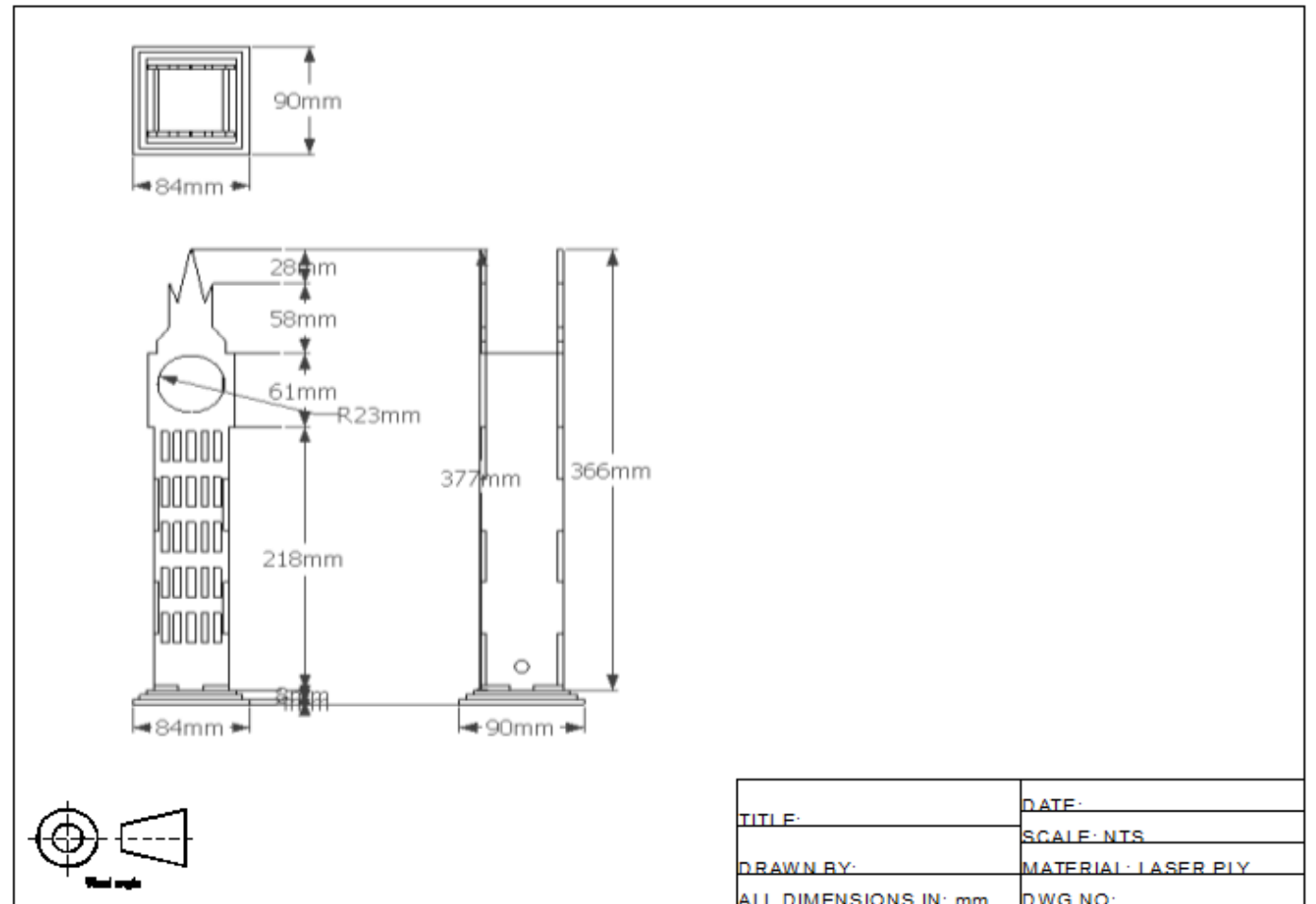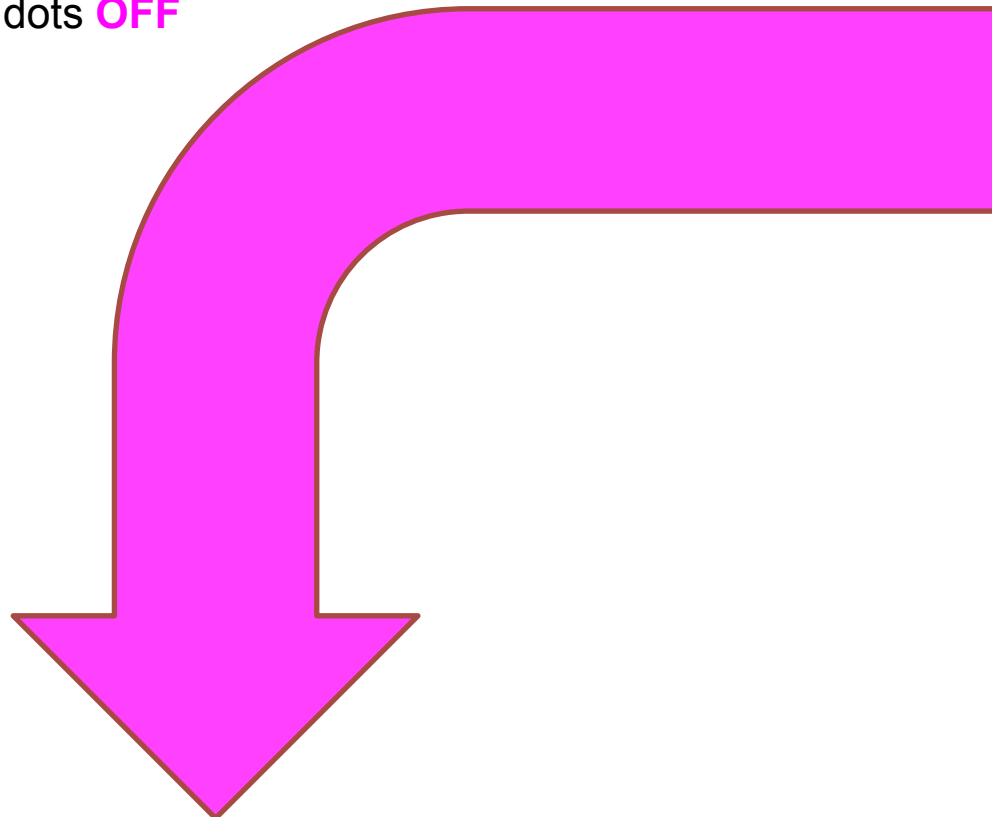Computer Aided Engineering: 2. Working Drawing (Importing DXF into 2D Design)

Click the dots **OFF**

Complete the border at the bottom of the page
Title
Drawn by
Date

90mm

84mm

28mm
58mm
61mm
R23mm
377mm
366mm
218mm

84mm
90mm

TITLE:
DATE:
SCALE: NTS
DRAWN BY:
MATERIAL: LASER PLY
ALL DIMENSIONS IN: mm
DWG NO:

Print screen and paste into your folder. Drawing on the next page represents a correct Engineered Lamp drawing. If yours **does not look like this you cannot achieve a level 2**

Computer Aided Engineering: 2. Working Drawing (Importing DXF into 2D Design)

90mm

84mm

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61mm

R23mm

377mm

366mm

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TITLE:

DATE:

SCALE: NTS

DRAWN BY:

MATERIAL: LASER PLY

ALL DIMENSIONS IN: mm

DWG NO:
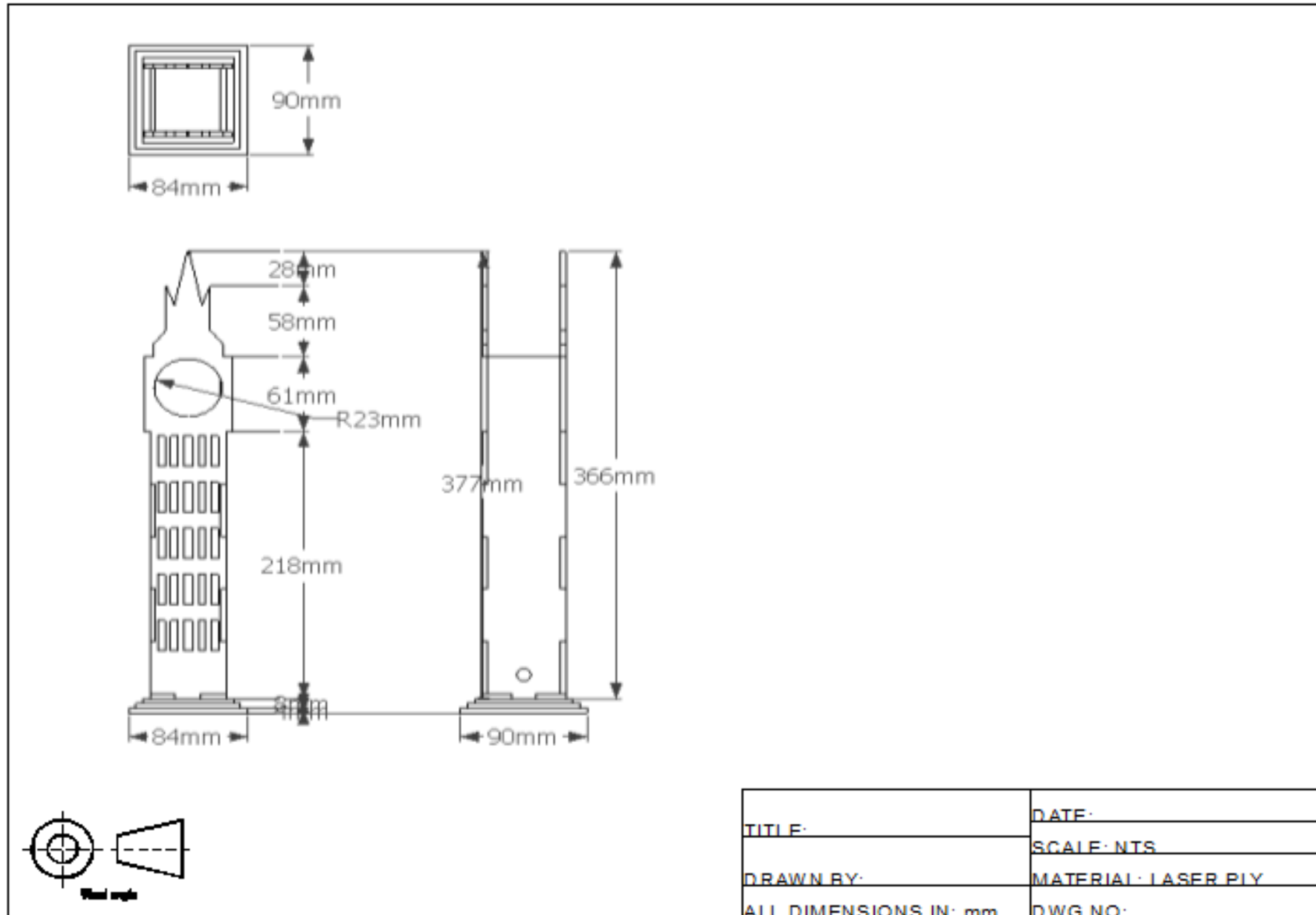
Extension Activity

- Design your own lamp based around a famous building or skyline…...........