# Unit 10: Computer Aided Design (CAD)

# LO1: Be able to produce 3D models using a range of modelling tools

# Produce 3D models using surface modelling tools

## Instructions and answers for tutors

These instructions should accompany the OCR learner resource activity which supports Cambridge Technicals in Engineering Level 3.

**The Activity:**

Below is the outline provided for the learner activity. This document gives a step by step approach for the production of an bar of soap that utilises a range of surface modelling features including lofts, knit surface, solidify and filled or boundary surfaces. This model is designed to reflect what appears to be a simple model. It is important for learners to understand that sometimes simple but ‘organic’ shaped objects are much more complex to model due to the complex nature of how the surfaces are formed in 3D space.

It is encouraged that the tutor works through the guide step-by-step with the learners, demonstrating each stage at the front of the class whilst the learners follow along or subsequently undertake each step after it is demonstrated. This allows the tutor to explain the tools being used in each step, challenge any misconceptions and ensure learners understand the importance of using appropriate geometry, fully constraining sketches, utilising spline geometry and creating good quality surfaces.

Tutor s should throughout the duration of the lesson element ensure they explain the use of converting geometry, encourage learners to use relations/mates and symmetrywhere possible, fully-define/constrain sketches, understand the use of reference surfaces to drive tangency and ensure learners fully grasp why they are using each step to achieve the end geometry. Surface modelling can be an abstract process if learners are not fully informed of why they undertake each stage.

Following the completion of the demonstration learners should aim to independently analyse the completed ‘soap bar’ geometry. They will notice that the surfaces have not formed perfectly due to the constraining nature of the reference sketches.

Learners may take some time analysing the model here and make multiple errors whilst trying to fix or modify the geometry. They should be encouraged to do this and try to work out creative solutions to fixing the geometry issues. This activity should allow learners the opportunity to develop skills in ‘design for CAD’ rather than just the operation of the software package.

The tutor should facilitate this learning and assist learners throughout the modelling process again, reinforcing misconceptions, ensuring effective use of surface modelling tools and assisting in the guidance of possible solutions.

Activity 3 is a step-by-step online tutorial. This activity is specifically for use with SolidWorks but could be adapted for other packages. Learners should be encouraged to explore the internet for tutorials that develop their competency whilst also assisting them in the modelling process if they were unsure of how to approach certain geometry.

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| ABC icon | *This activity offers an opportunity for English skills development.* | 123 icon | *This activity offers an opportunity for maths skills development.* |

**Suggested timings:**

Activity 1: 1.5 hours

Activity 2: 1 hour

Activity 3: 1 hour

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# Unit 10: Computer aided design (CAD)

# LO1: Be able to produce 3D models using a range of modelling tools

# Produce 3D models using surface modelling tools

# *Learner activity sheet*

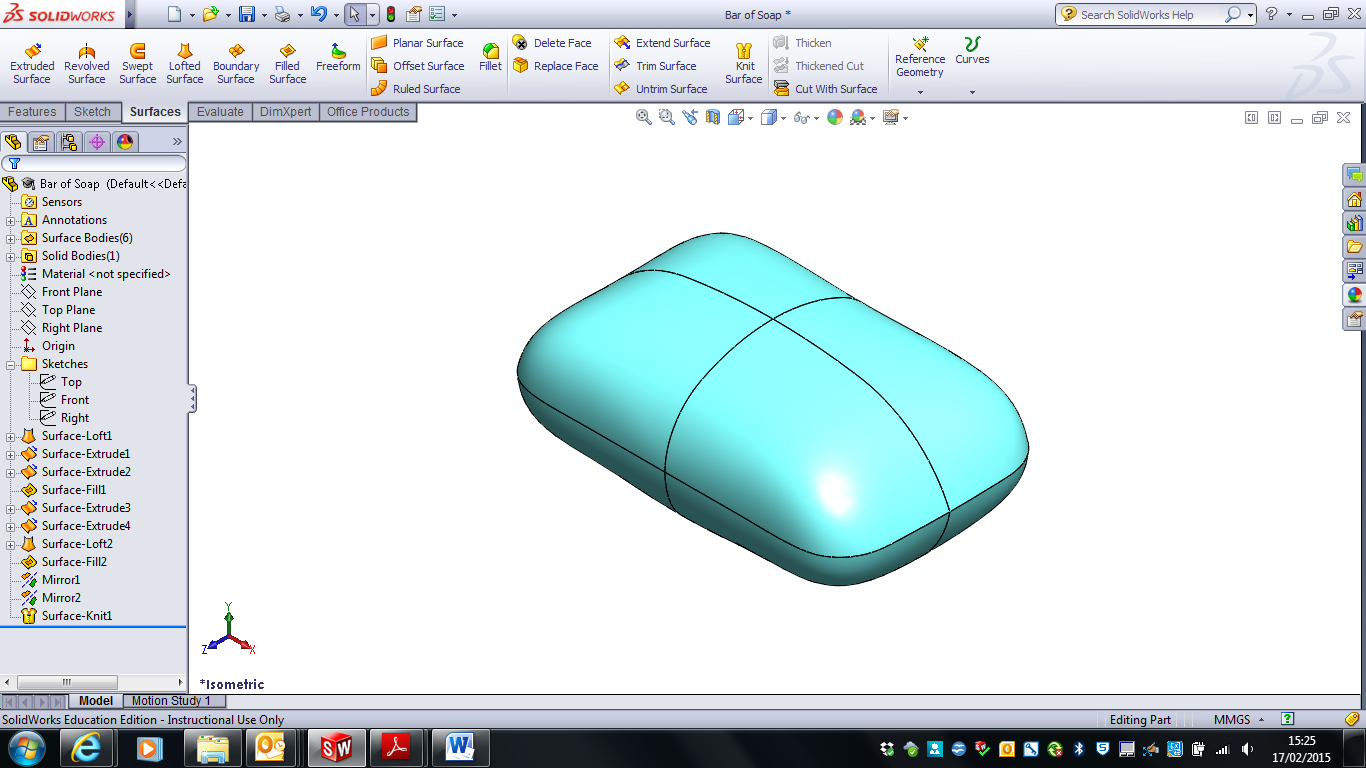
### Activity 1: Create a 3D model of a soap bar using surface modelling techniques

Surface modelling techniques are generally used to produce advanced geometry that is difficult or impossible to manufacture using solid modelling techniques. Some shapes cannot be created using solid modelling tools. Even advanced solid modelling tools such as sweep and loft tend to have flat sides at the beginning and end due to the limitations and nature of the construction process. Surfaces are regularly used to produce geometry that has no flat ends or sides.

Surfaces tend to be constructed one face at a time where solid features generate multiple sides of geometry in a single operation.

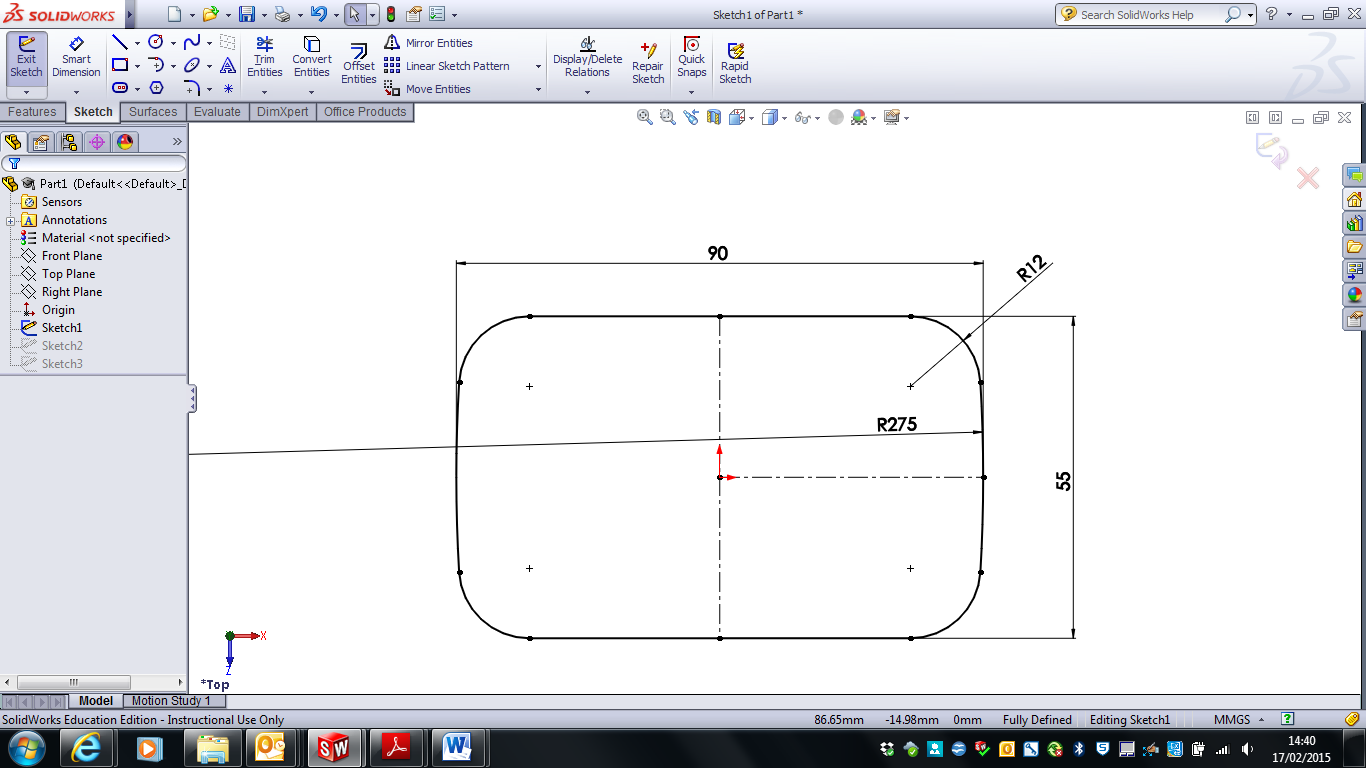
This lesson will focus on the production of a surface model for a bar of soap. This may initially appear to be a simple model, but the ‘organic’ nature of its geometry makes the construction of the shape reliant on surfaces to produce accurate geometry.

1. Symmetry is a critical feature of this model so will be utilised to optimise geometry creation. A top and bottom quarter will be created and mirror tools used to complete the overall model geometry.

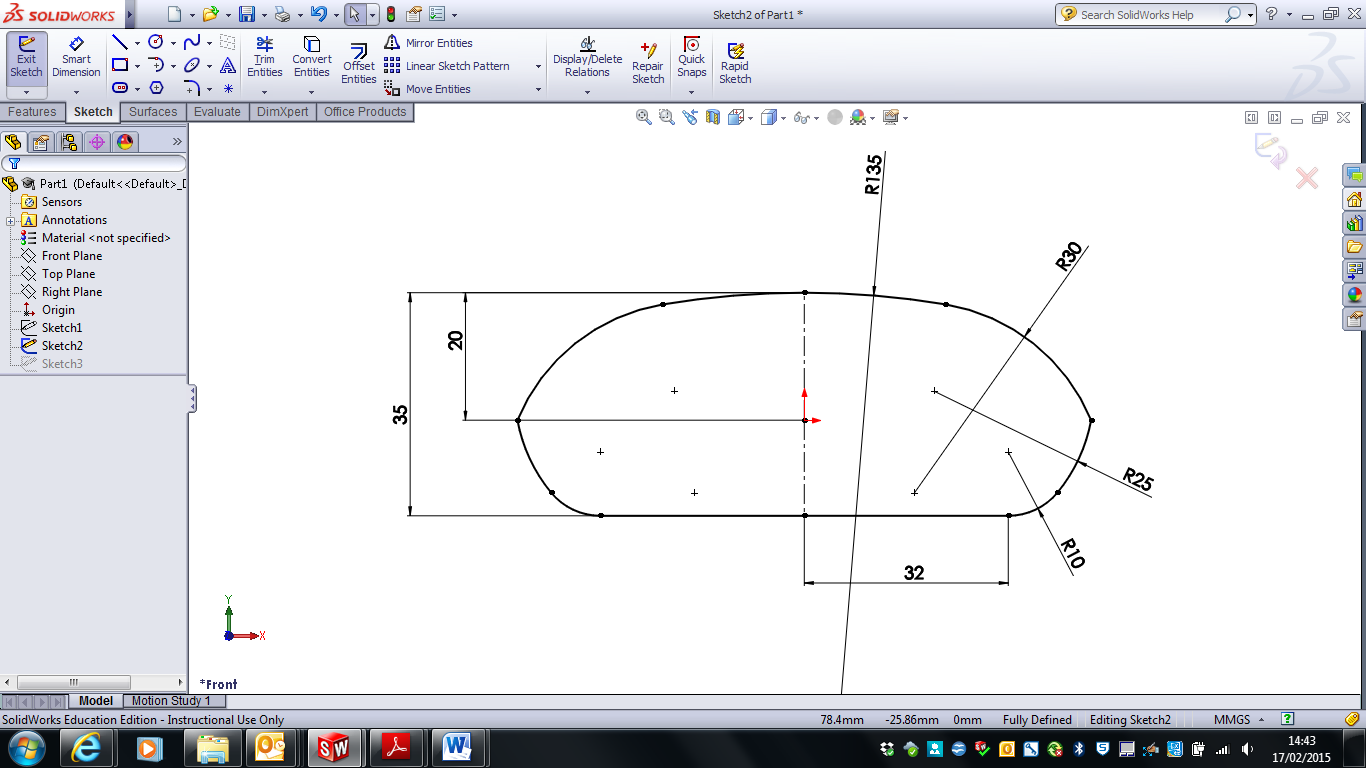


2. Overall sketch geometry of the soap bar is required on the 3 primary planes to define the side, front and top profiles of the final model.

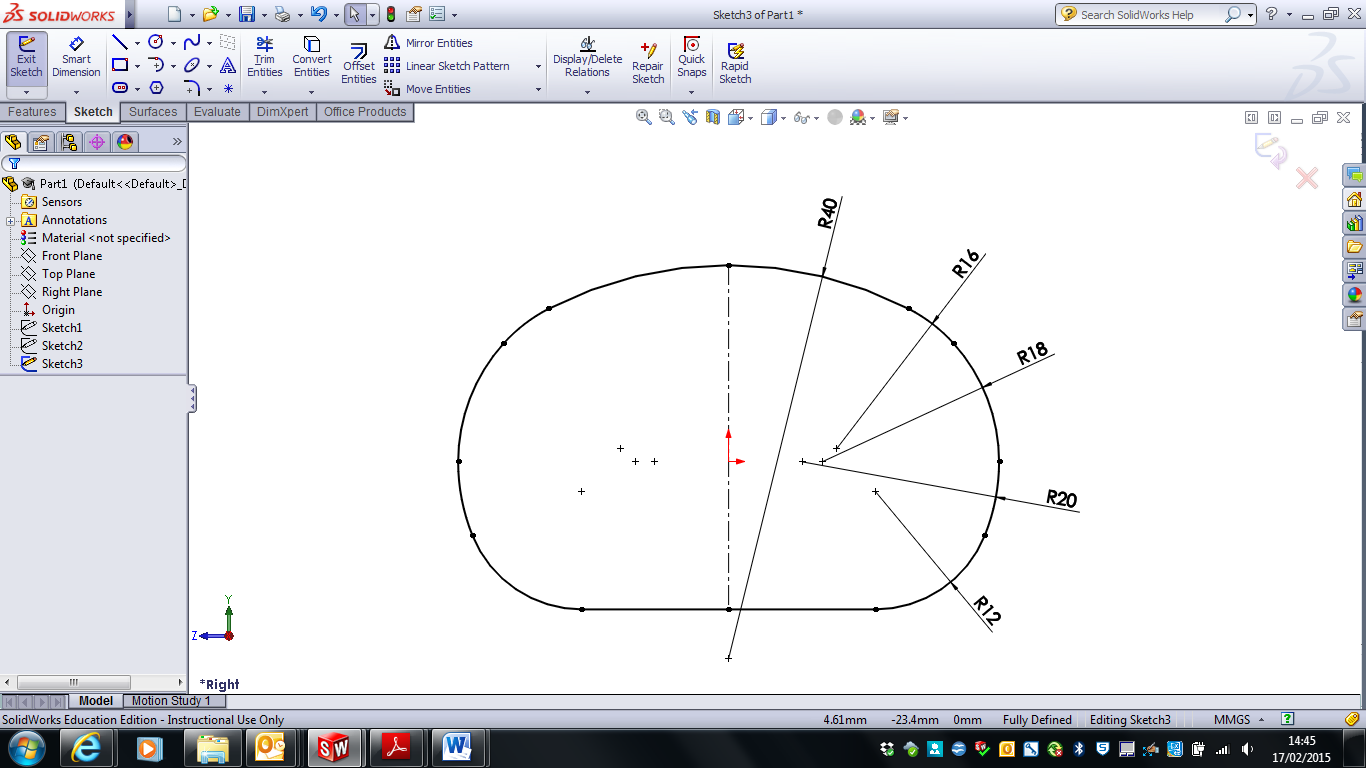
Create the sketches below on the Top, Front and Right (or equivalent) planes within the modelling environment. All the sketches are symmetrical.



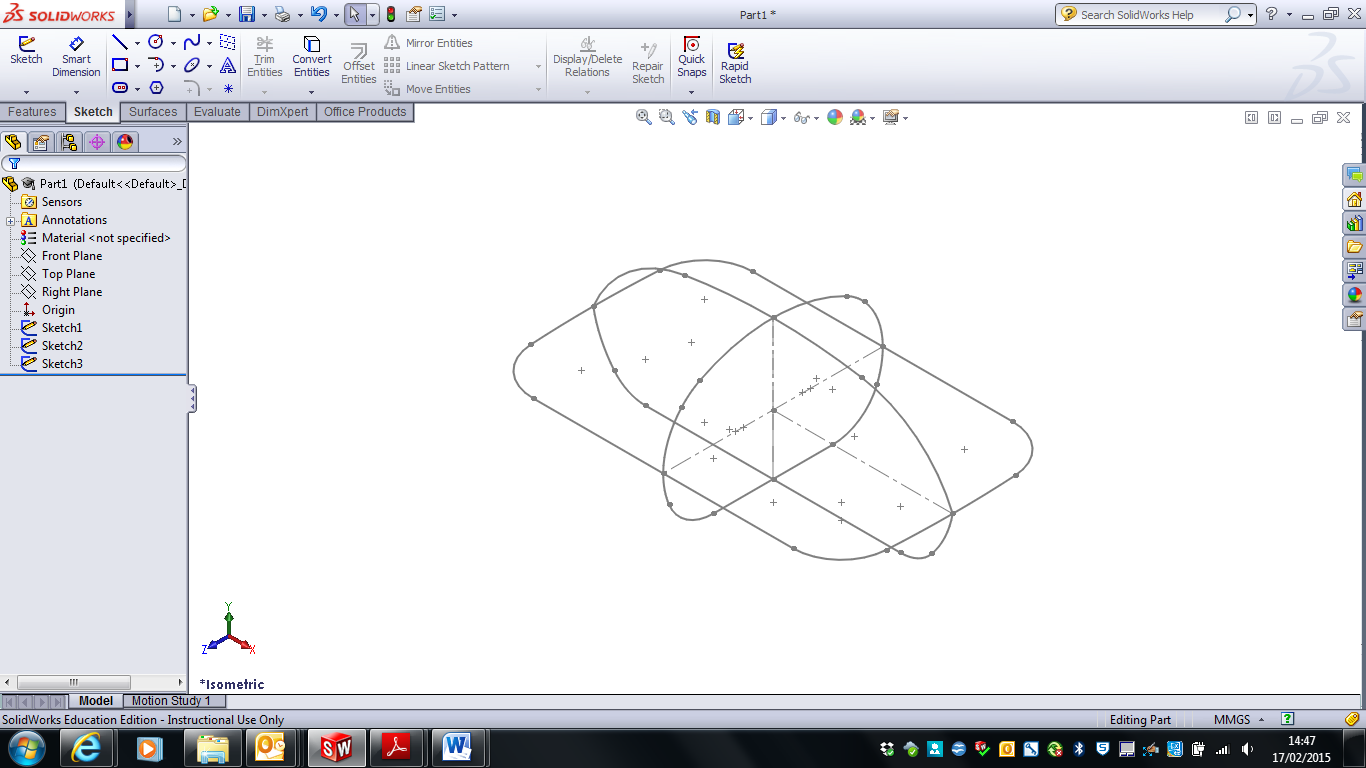
*Sketch created on Top Plane*



*Sketch created on Front Plane*



*Sketch created on Right Plane*

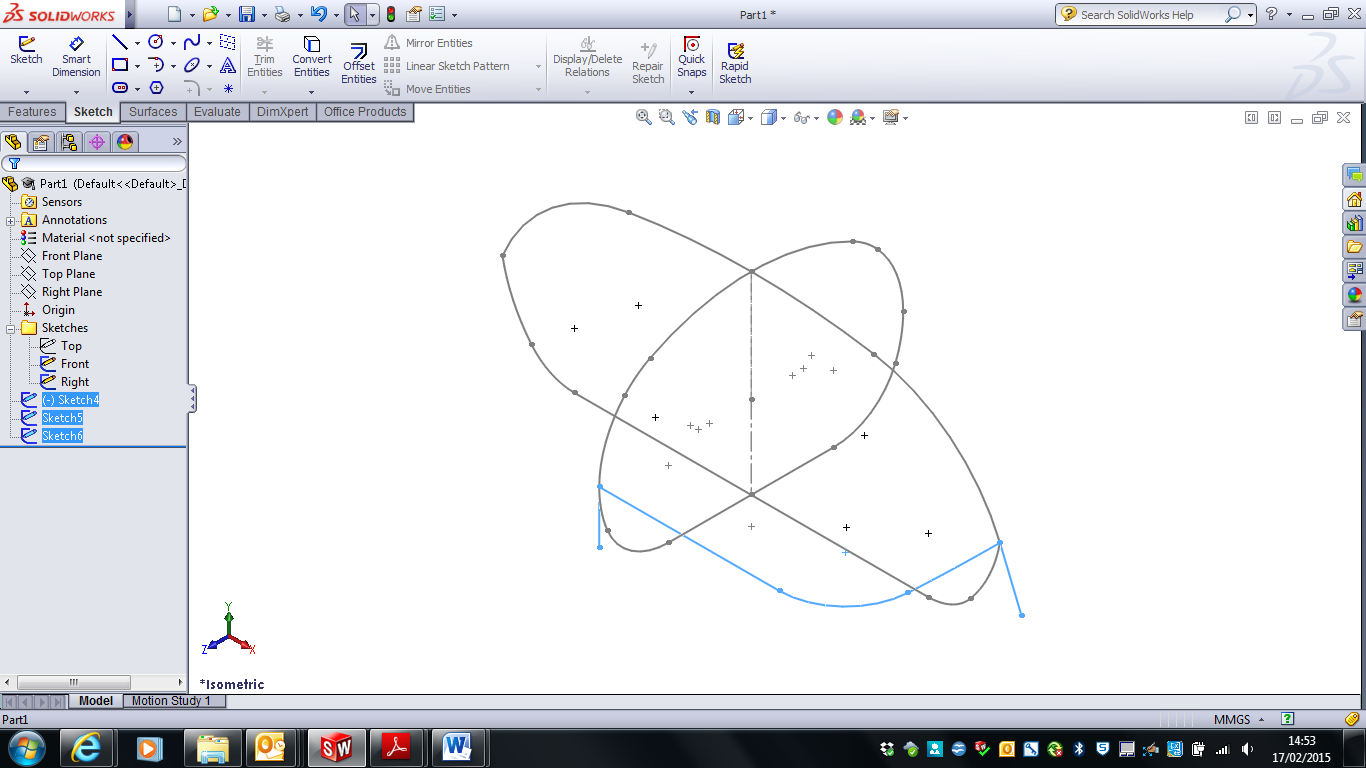


*The 3 sketches intersect as shown*

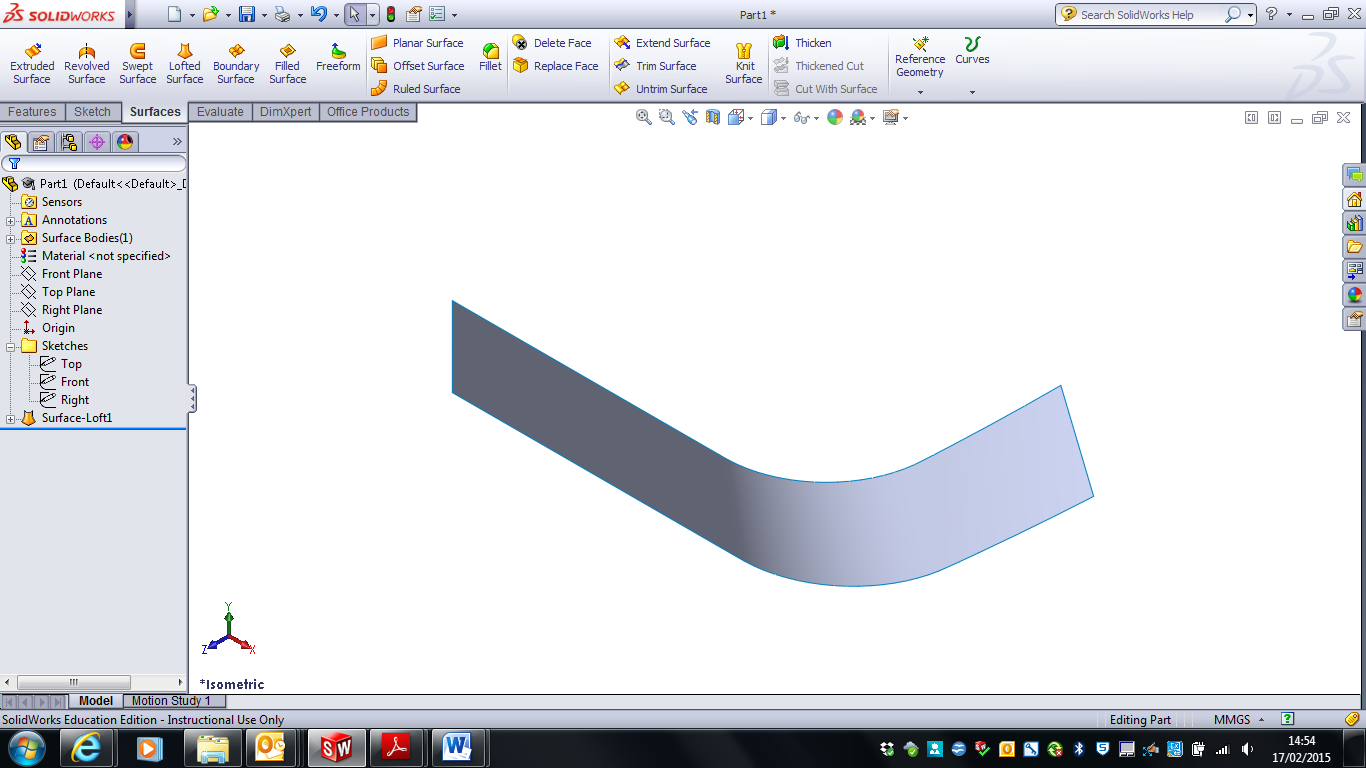
3. Using the overall reference geometry created in the 3 preliminary sketches create the following sketch geometry in the closest quartile of the part.

Use the ‘convert’ feature in the software where possible to save valuable sketching time.

Add additional line geometry tangent to the side profile geometry on the Front and Right planes. Convert the geometry on the Top plane to a single ‘spline’ curve if necessary to ensure a singular geometry construction without intersections when the surface is created.

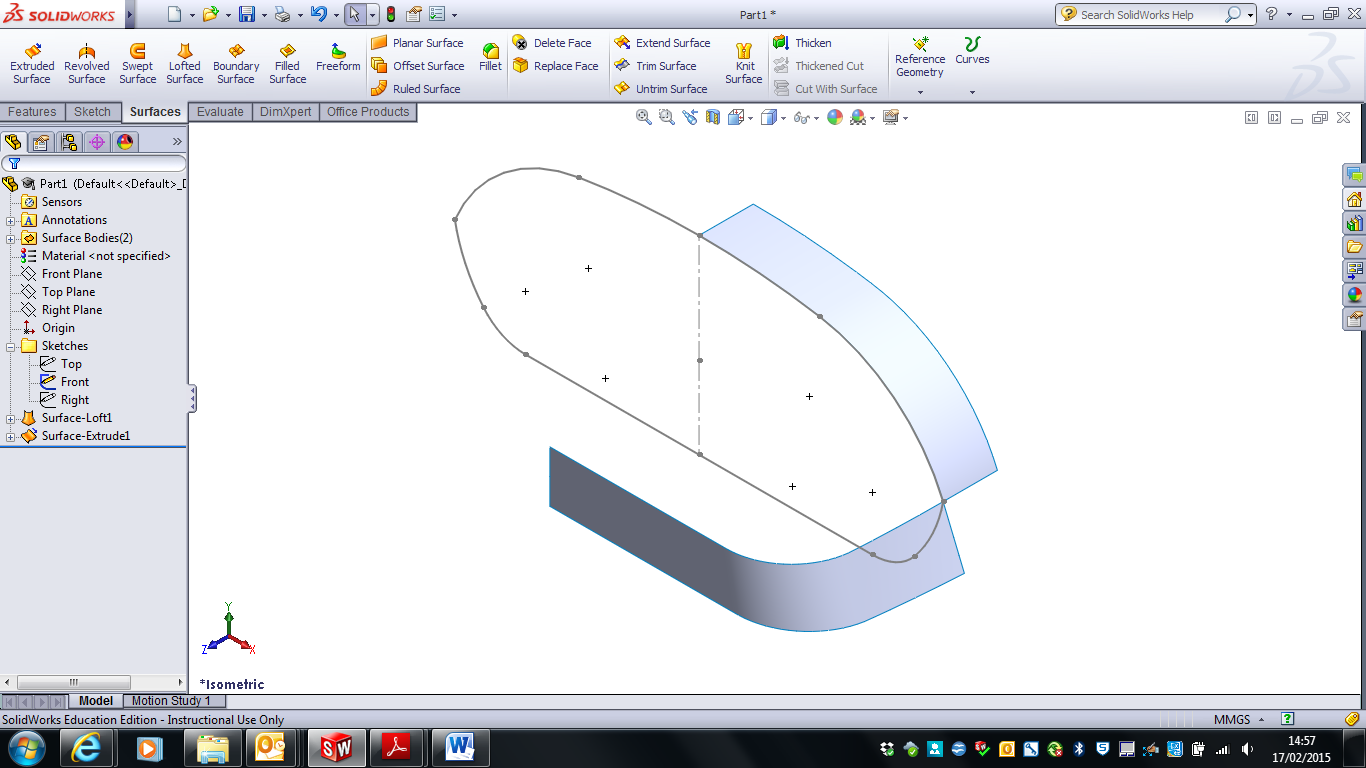


Loft a reference surface between the lines and through the ‘Top’ plane layout sketch.



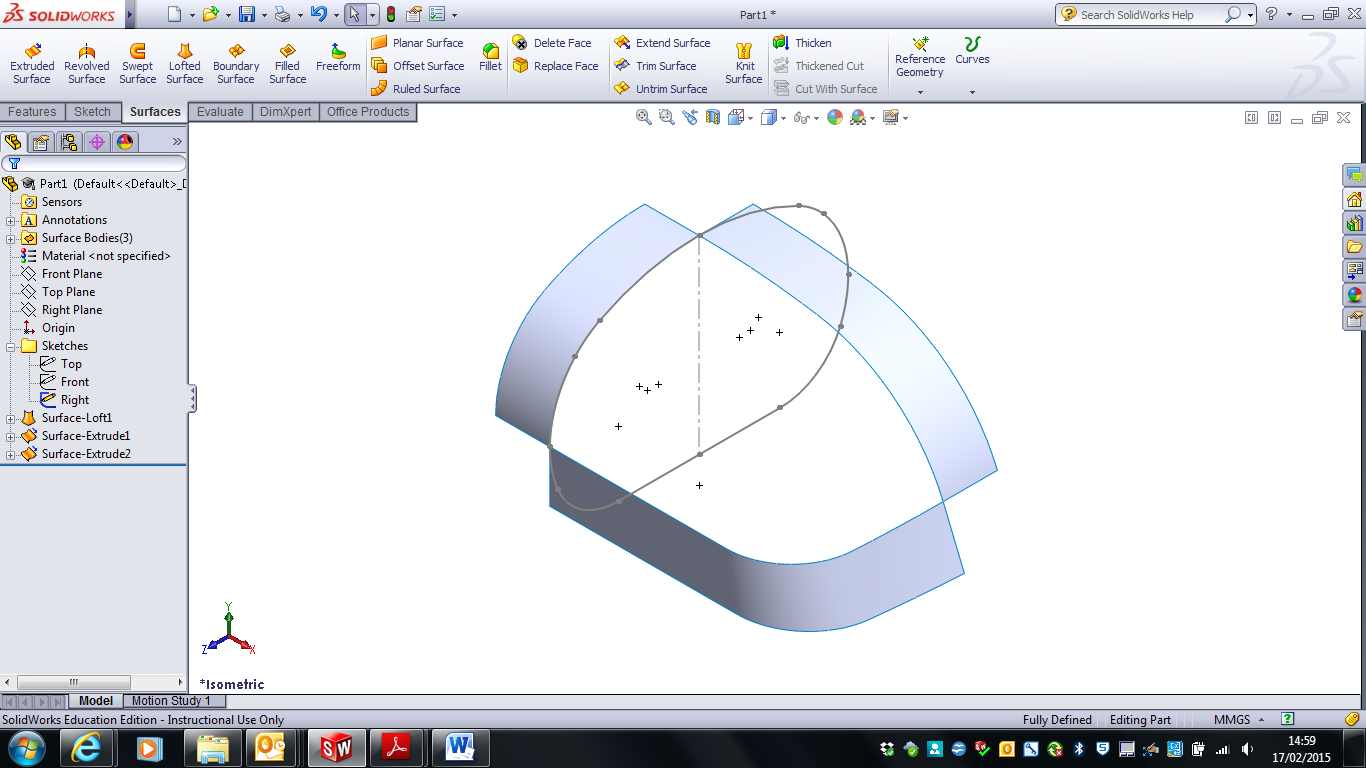
4. Create a spline curve converted from the upper front quadrant of the reference sketch on the ‘Front’ plane.

Extrude this geometry as a surface to any length above 10mm. Ensure the geometry is a **single piece of spline geometry** to ensure the surface has no joins.

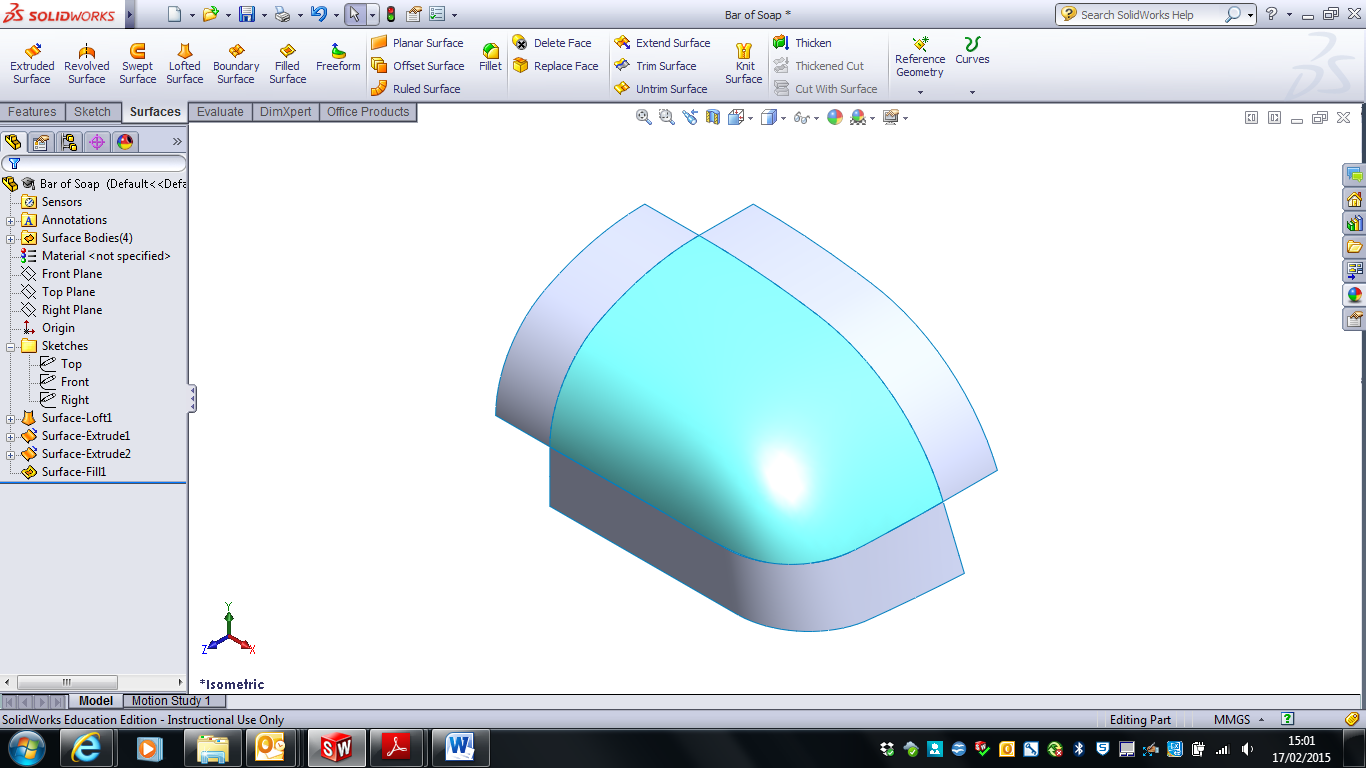


5. Create a converted spline sketch on the upper left quarter of the ‘Right’ sketch plane reference geometry.

Extrude this geometry as a surface to any length above 10mm. Ensure the geometry is a **single piece of spline geometry** to ensure the surface has no joins.

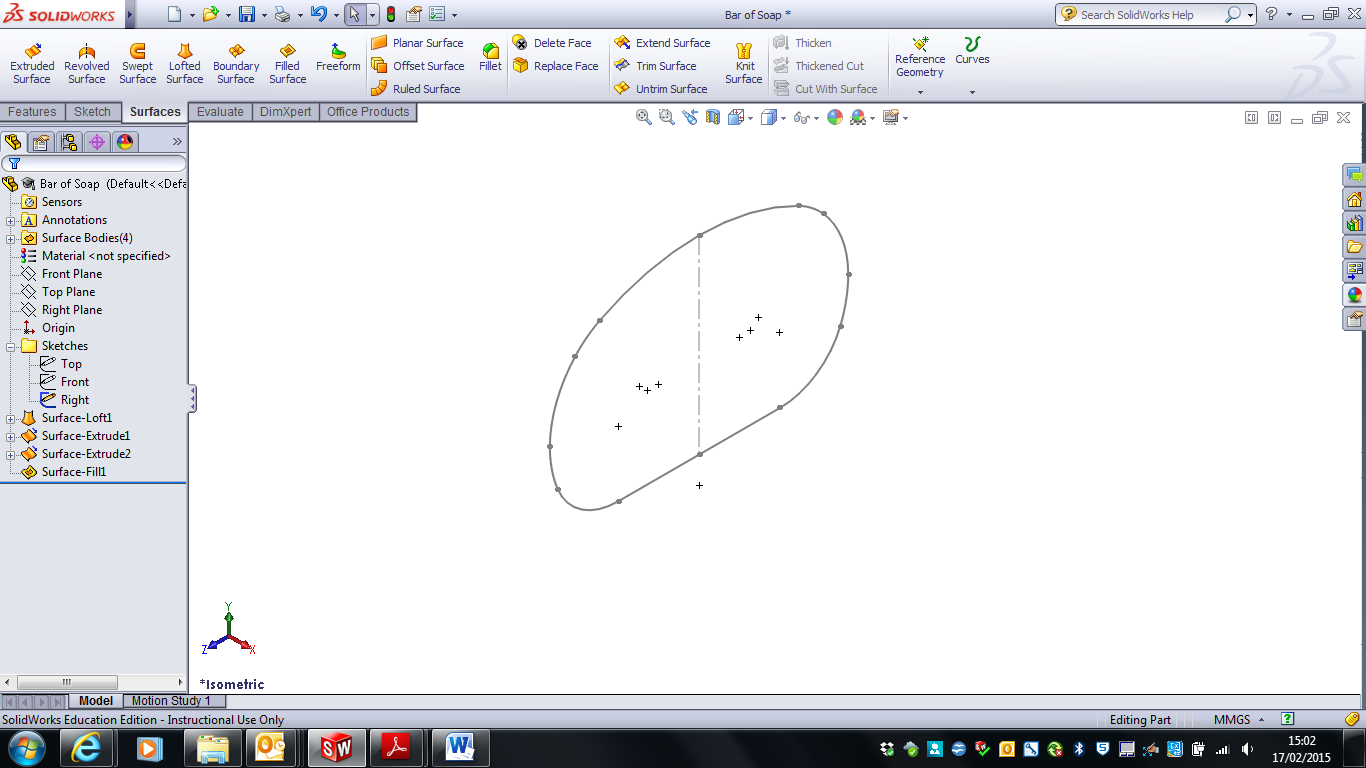


6. Create a boundary or filled surface that is tangent to the three reference surfaces created so far.

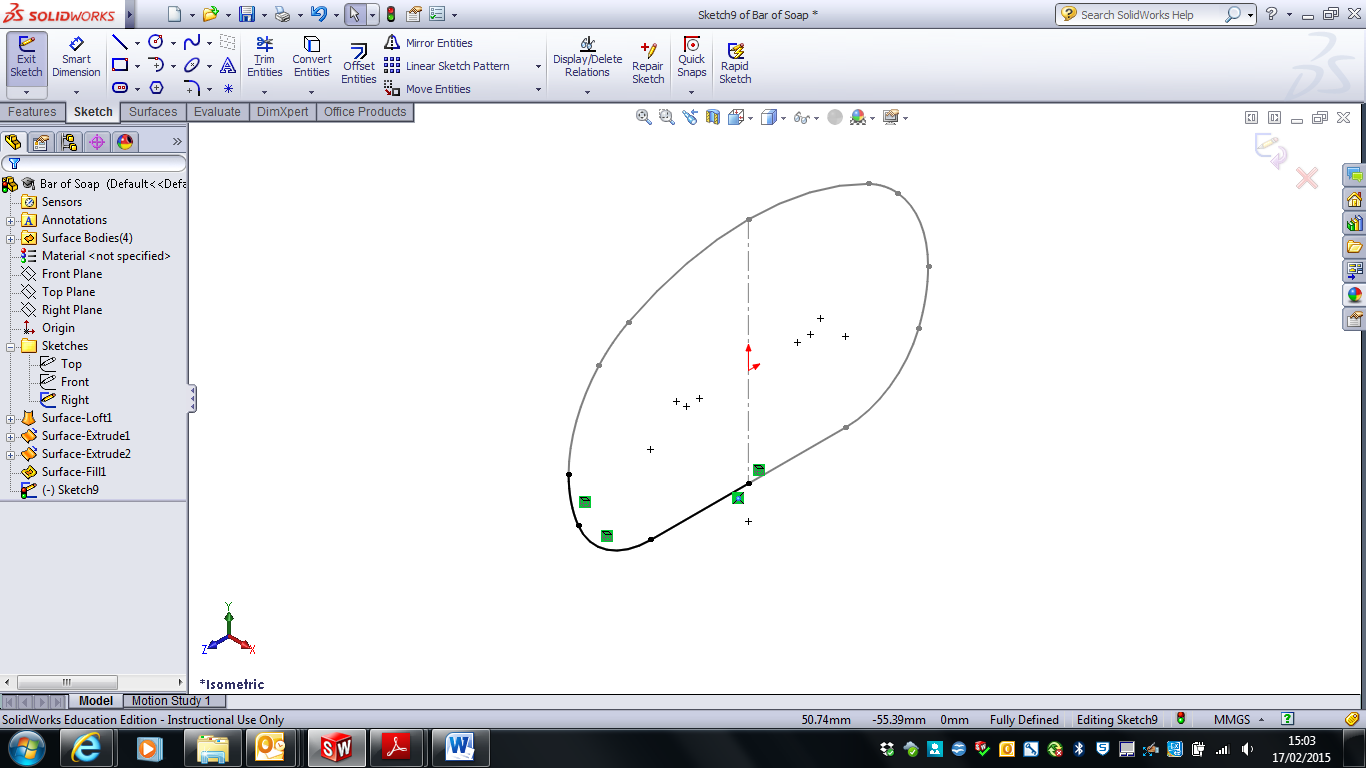


7. Turn off or hide all of the surfaces that have currently been created.

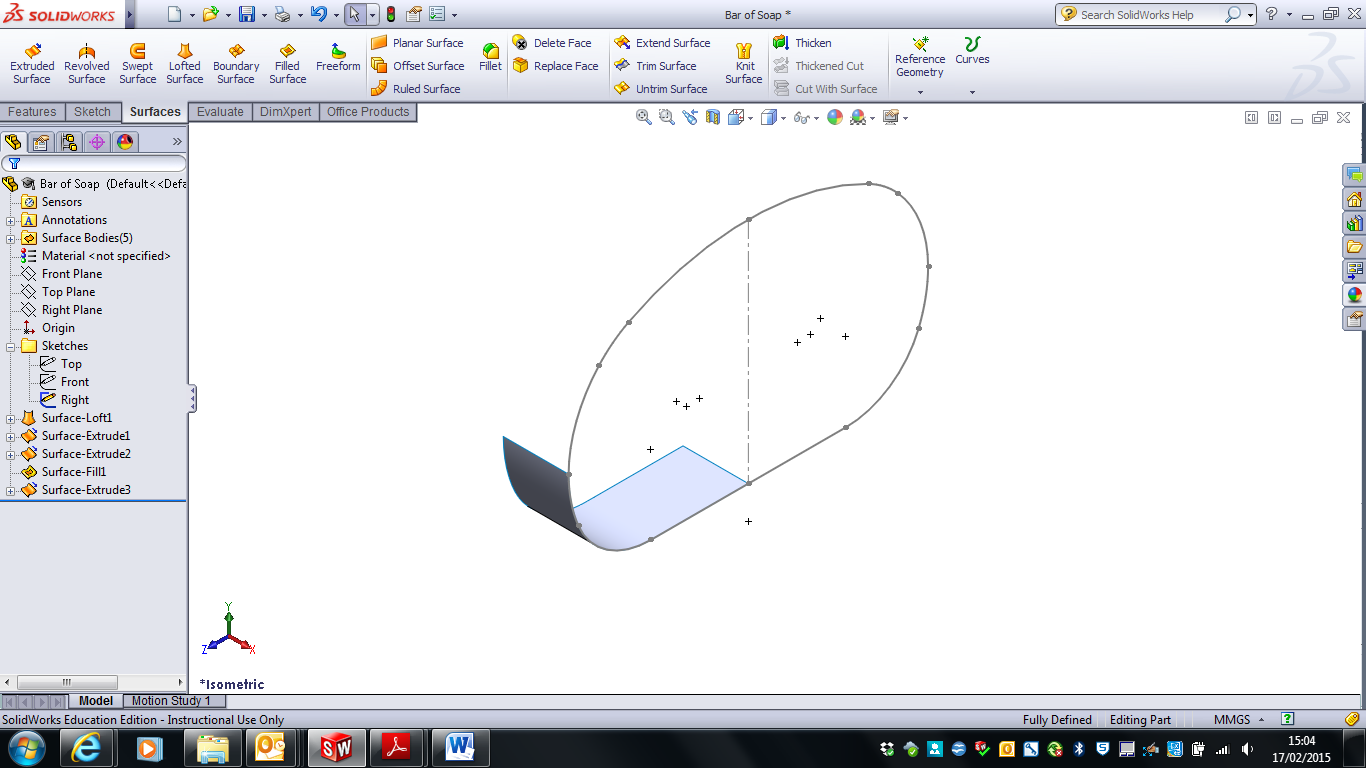
Turn on the sketch that is positioned on the Right plane.



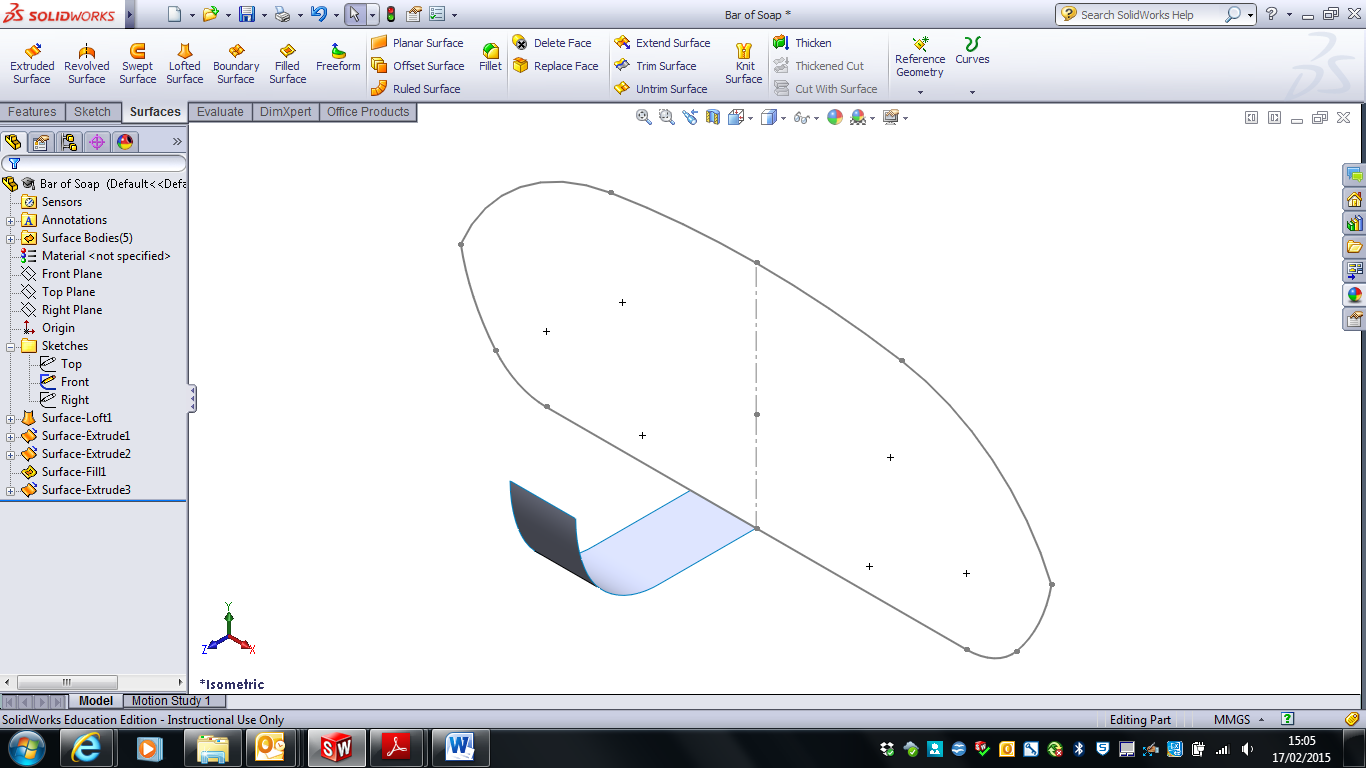
8. Open a new sketch on the Right reference plane. Convert the sketch geometry in the bottom left hand corner of the sketch.



9. Extrude the converted geometry sketch to 10mm. Ensure the geometry is a **single piece of spline geometry** to ensure the surface has no joins.

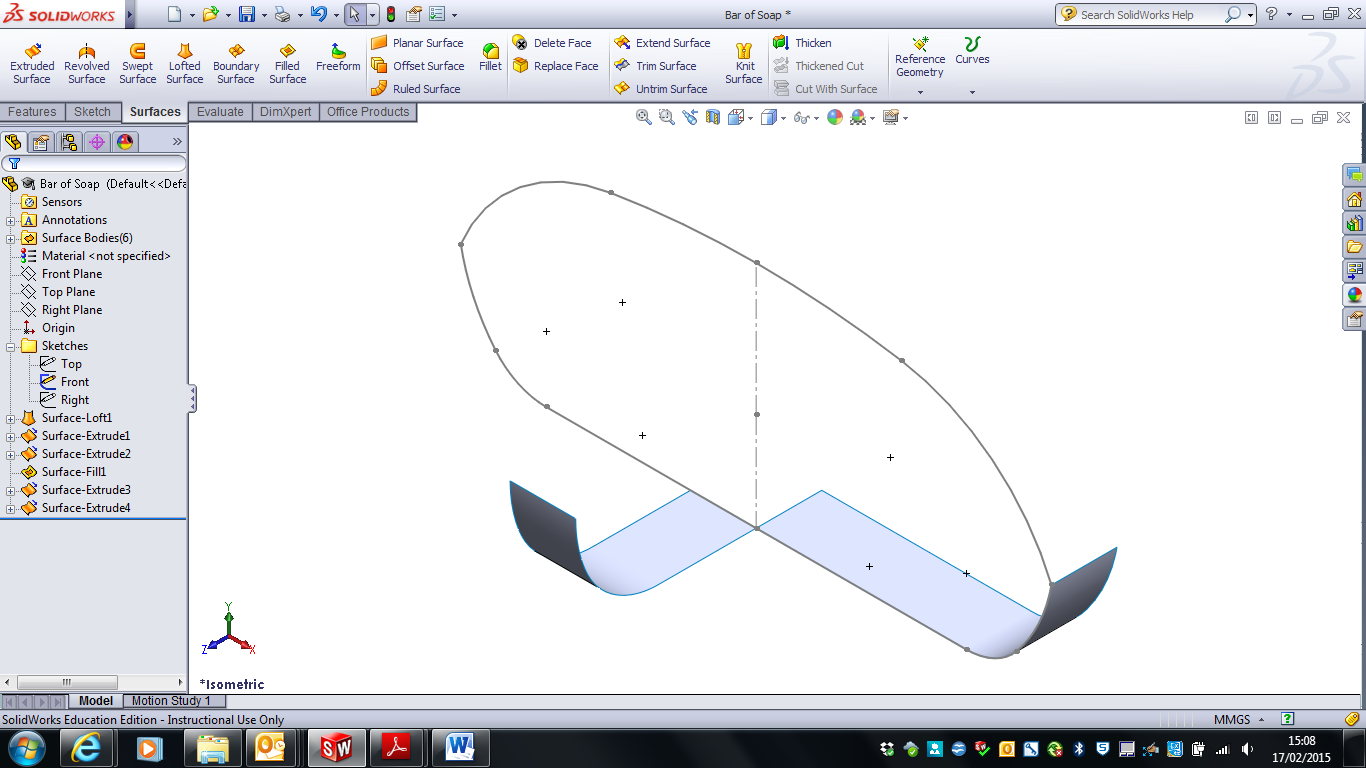


10. Turn off the reference sketch on the Right plane and turn on the reference sketch on the Front plane.

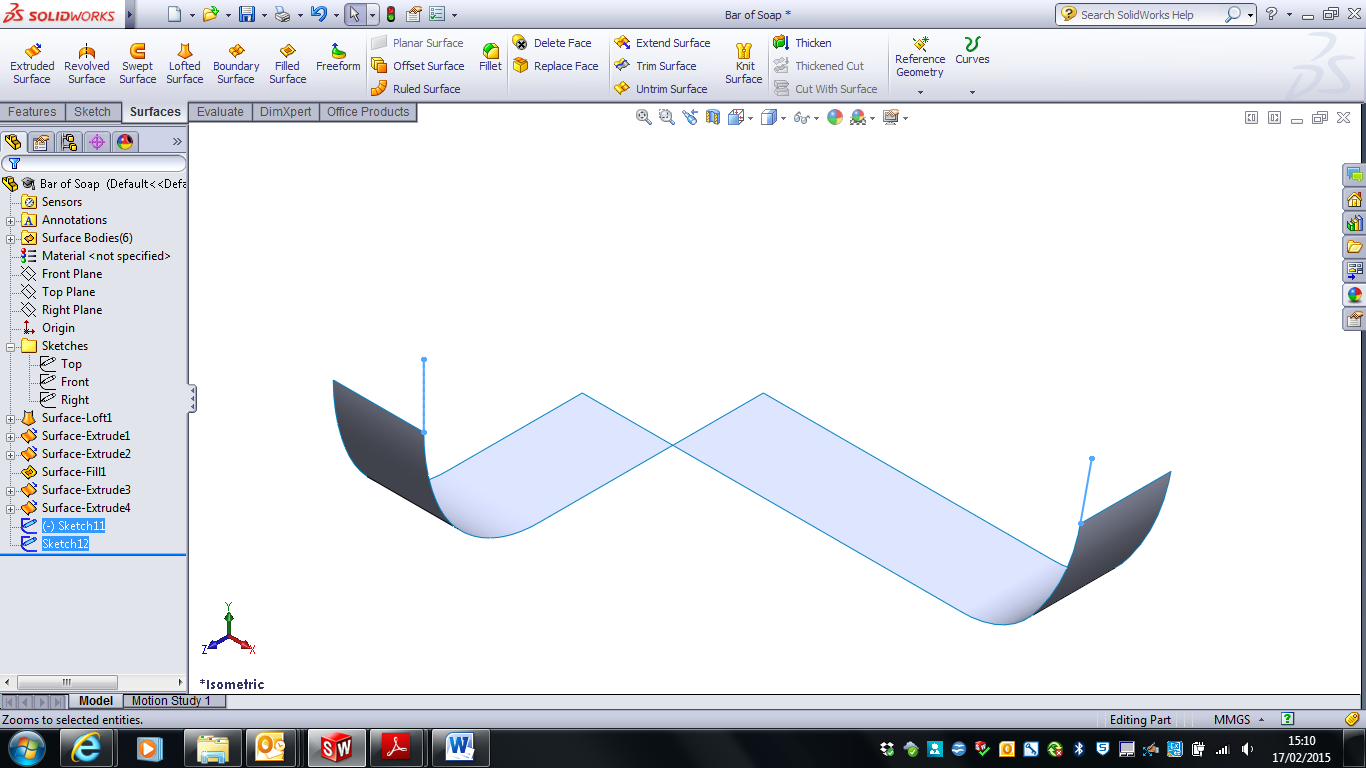


11. Open a new sketch on the Front plane and create a sketch from the converted geometry taken from the front reference sketch. Convert the geometry in the bottom right hand corner of the sketch.

Extrude this surface to 10mm. Ensure the geometry is a **single piece of spline geometry** to ensure the surface has no joins.

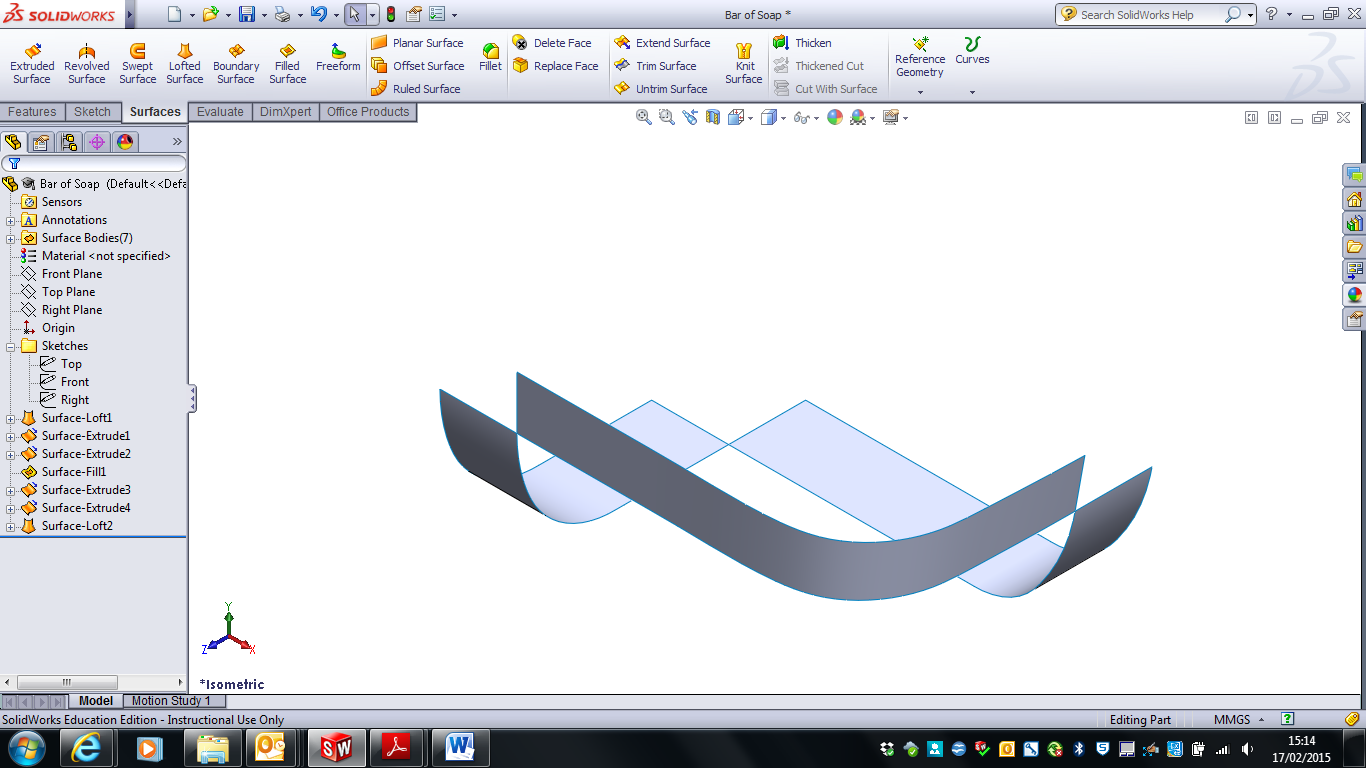
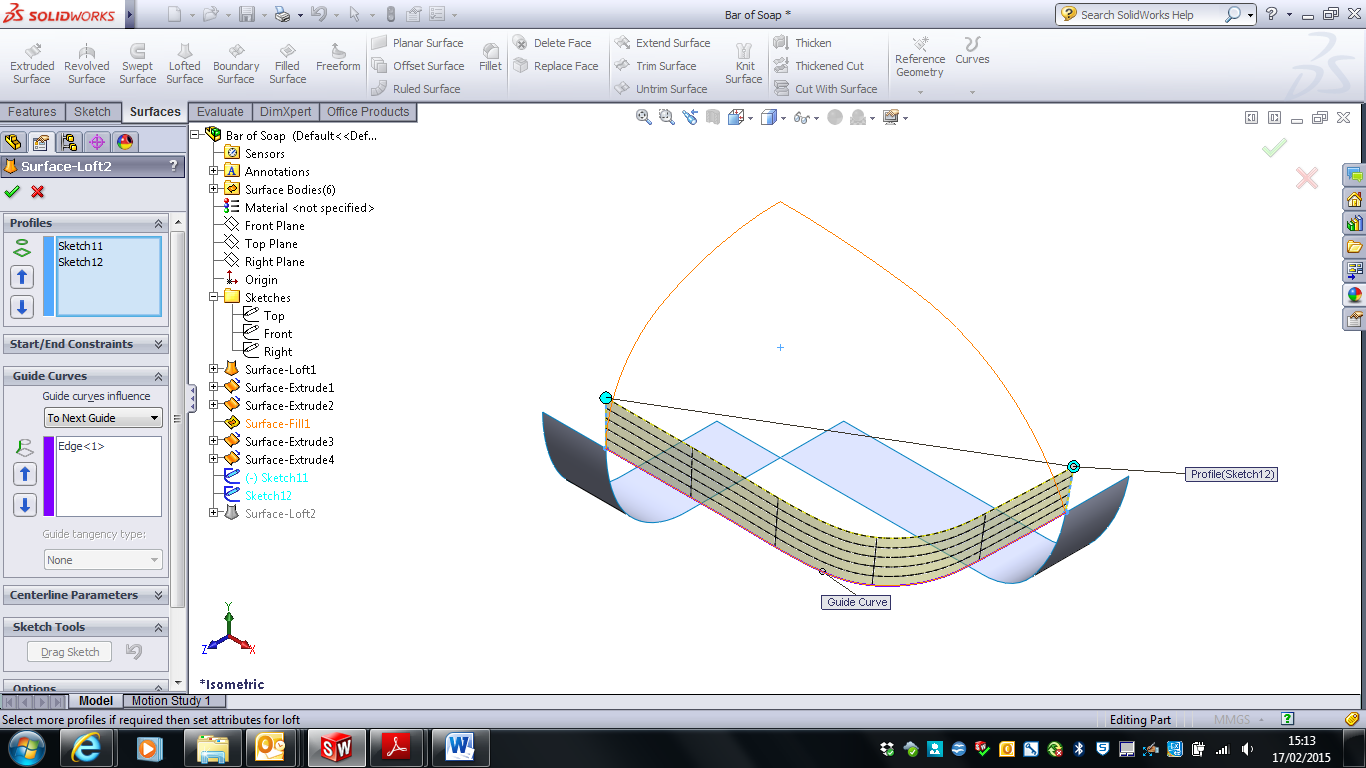


12. Create two reference sketches that will form part of a lofted surface. These should be approximately 10mm in length and tangent to the two extruded surfaces created in steps 9 and 11.

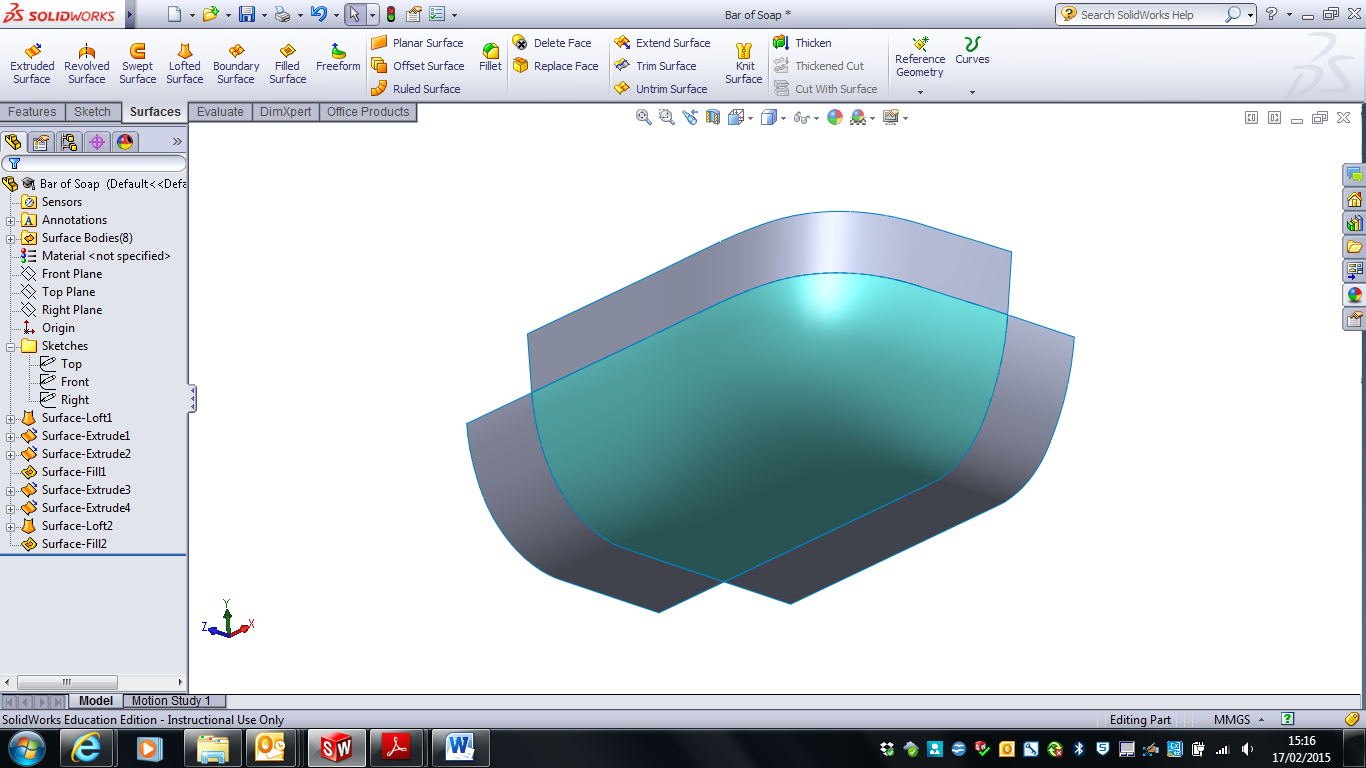
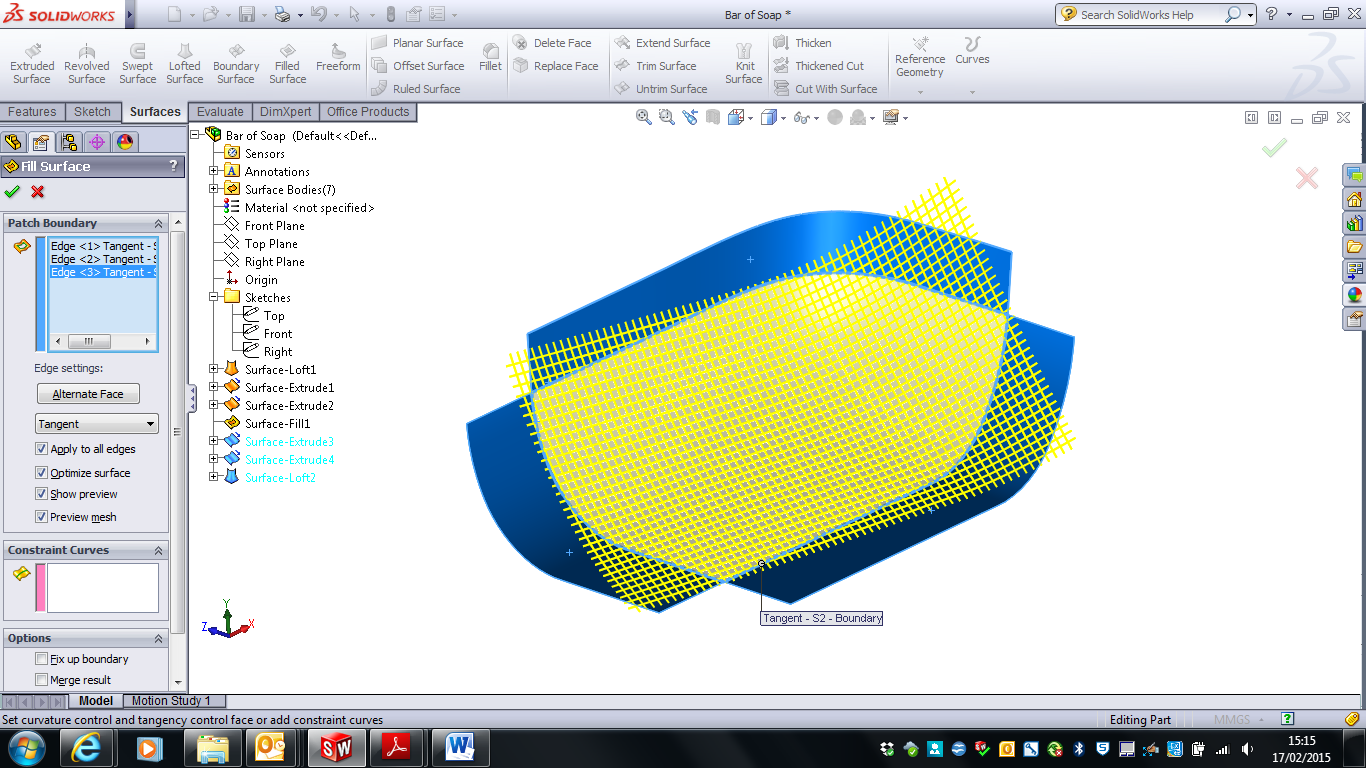


13. Turn on the tangent filled/boundary surface created in step 6.

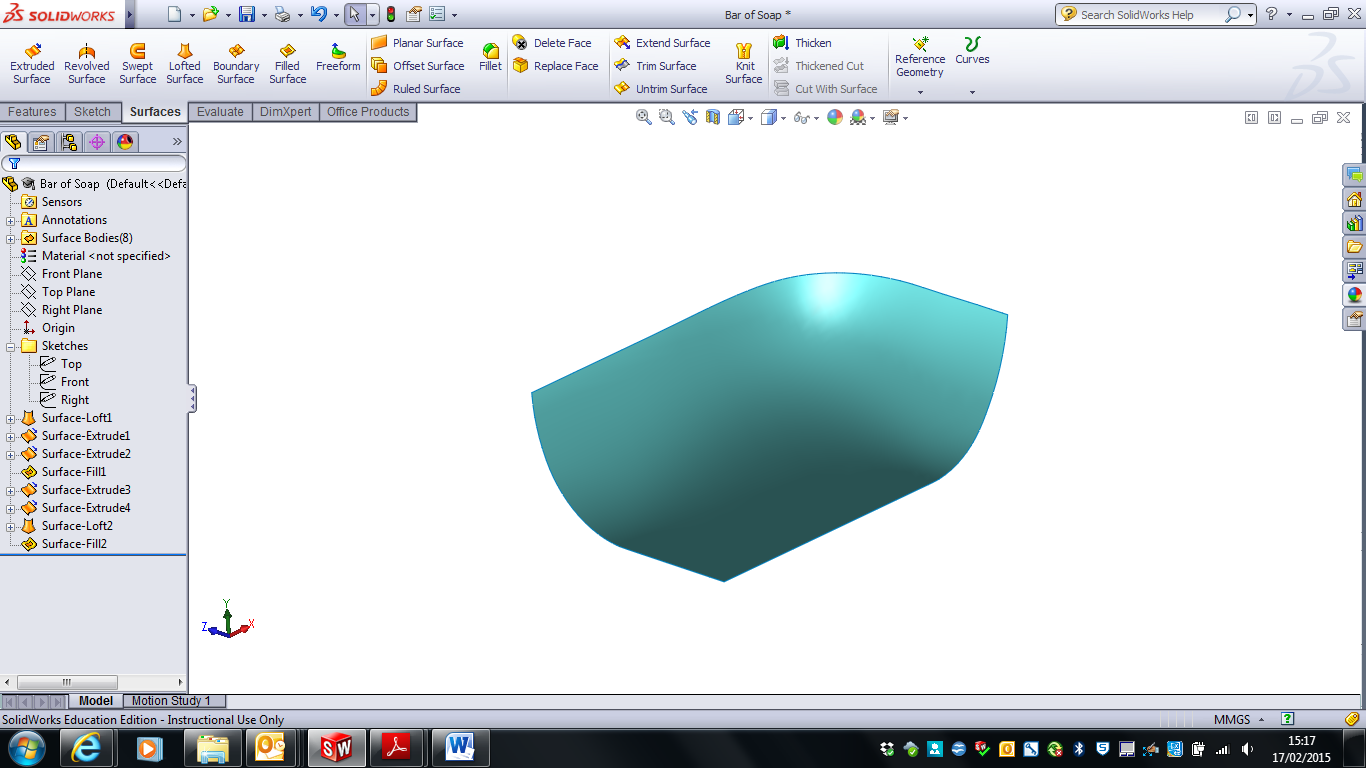
Using the edge of the filled/boundary surface that is coincident with the top plane as the guide curve, loft a surface between the two reference sketches created in step 12 following the edge of the filled/boundary surface. (Dependent on the software package being used it may be necessary to convert the edge of the filled/boundary surface to sketch geometry.)



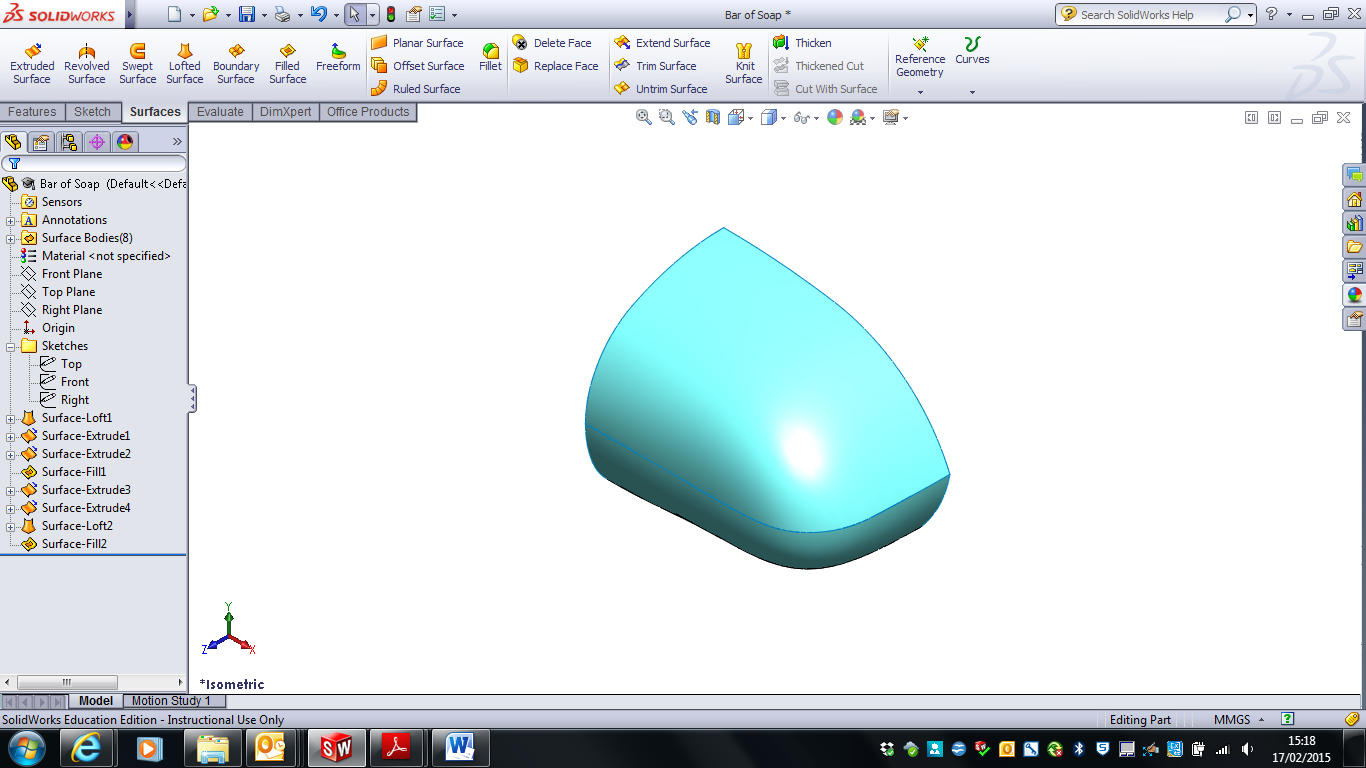
14. Create a filled/boundary surface that is tangent to the edges of all the reference surfaces created in the steps 9 to 13.



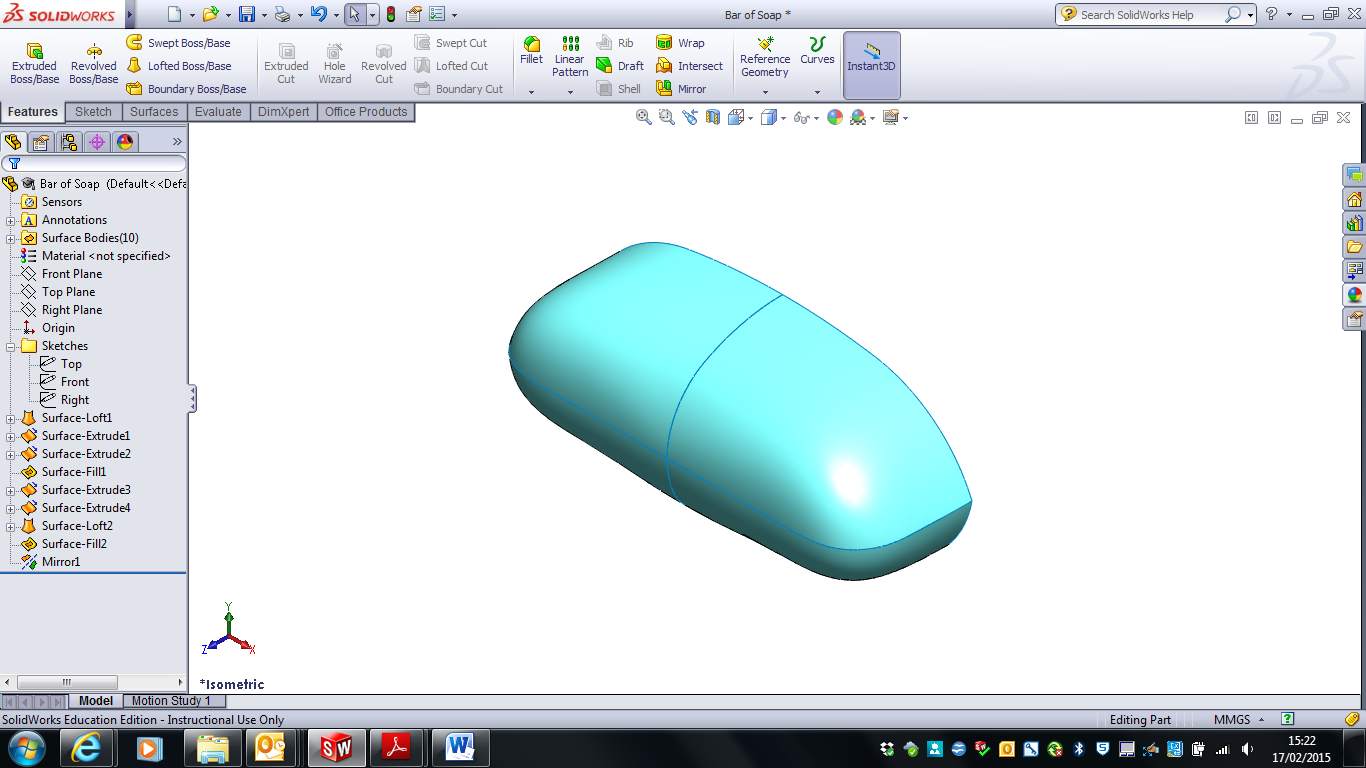
15. Hide all of the reference surfaces that have been used to create the filled/boundary surface in   
step 14.



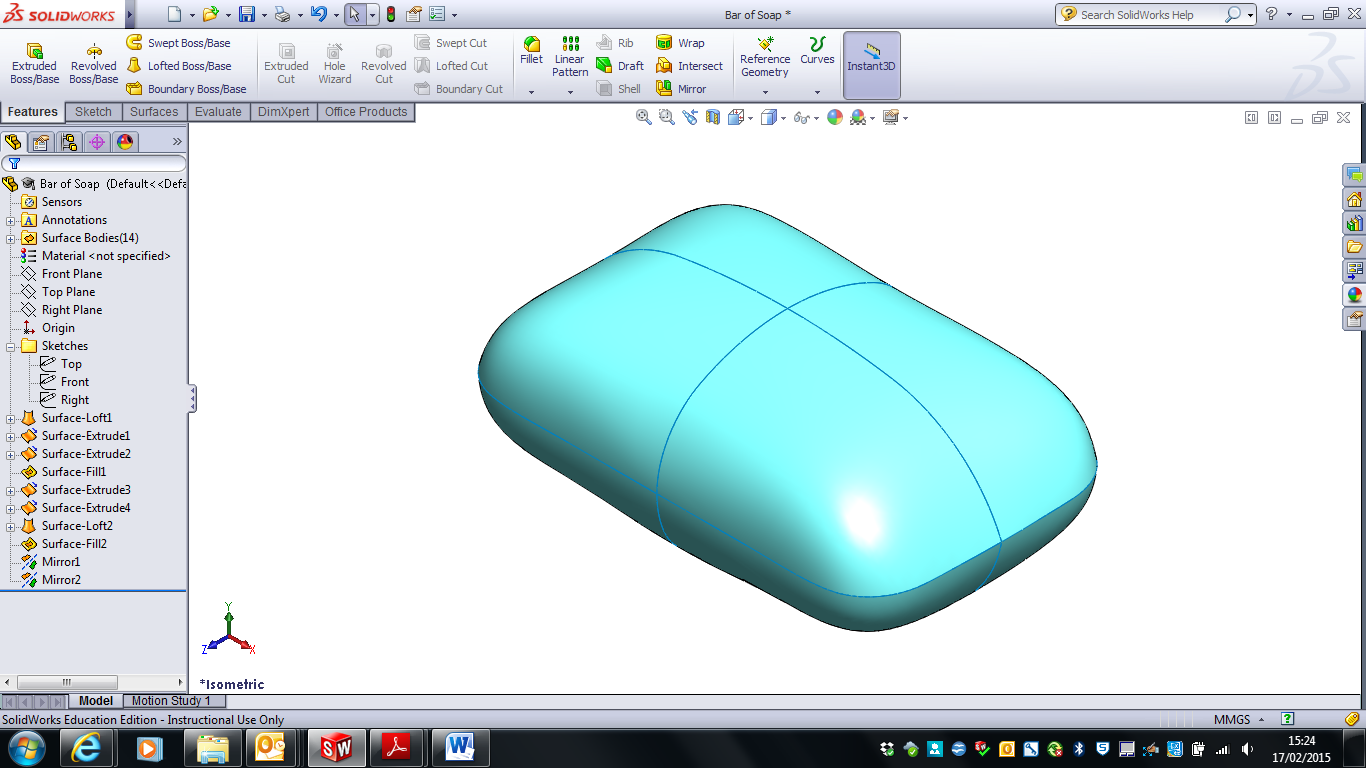
16. Turn on the filled/boundary surface initially created in step 6.



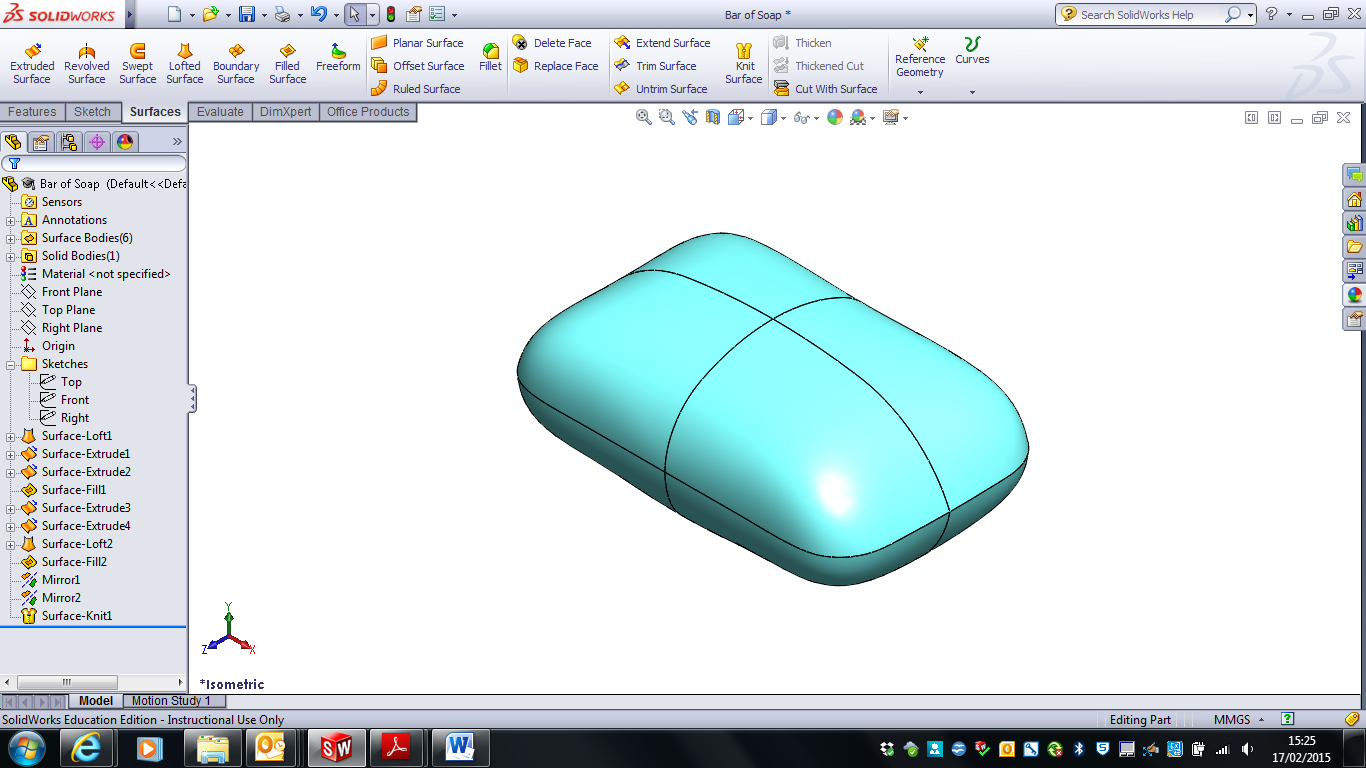
17. Mirror both surface bodies about the Right reference plane.



18. Mirror all surface bodies about the Front reference plane.



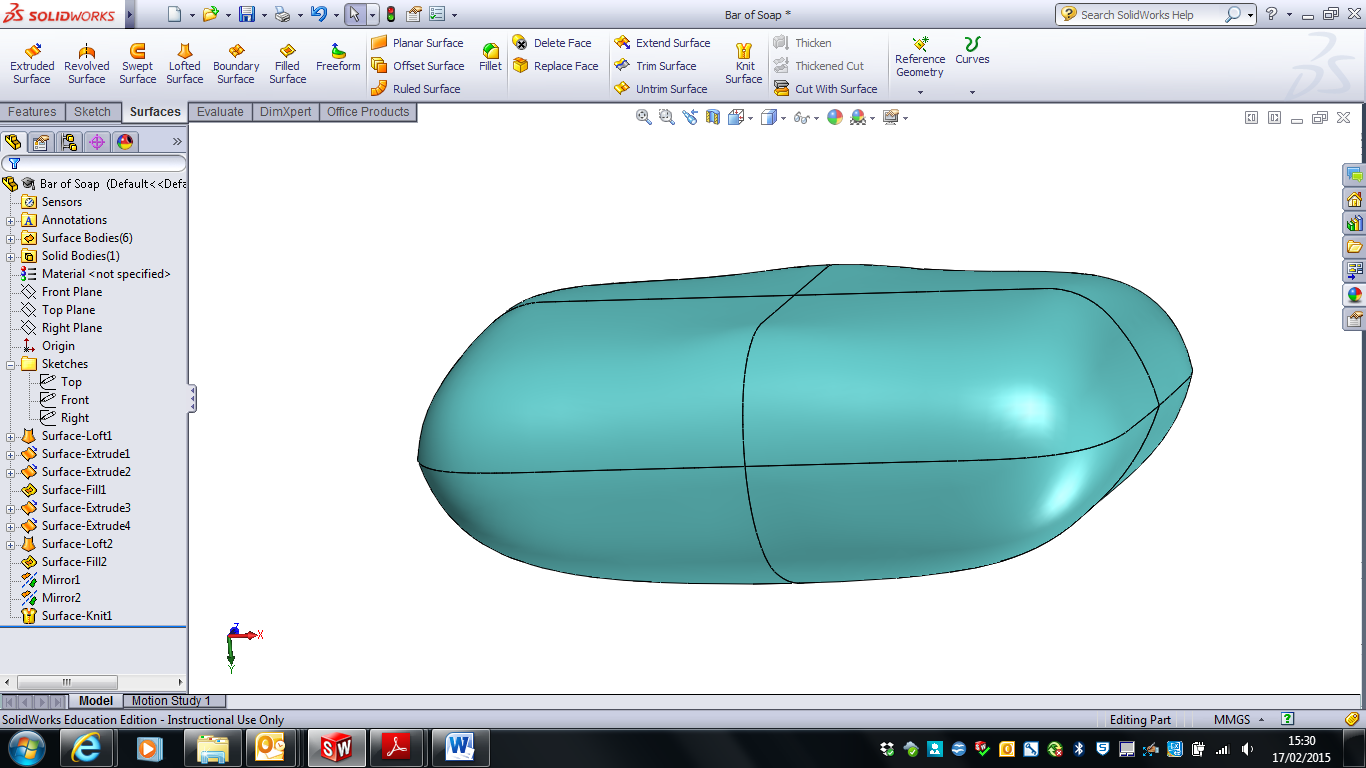
19. Knit/merge/join all the surface bodies together and solidify the model.



20. Save and close the component model.

### Activity 2

Following the completion of the ‘Soap Bar’ demonstration. It is now important to interrogate the model. You will notice that some of the surfaces do not appear to form perfect surface geometry. See example below.



*See the ‘bump’ in the surface when the model is flipped over.*

Based on your knowledge of surface modelling try modifying the sketch geometry used to construct the surfaces to try and remove the error.

You may consider the following;

* Changing the original reference sketches
* Modifying the design of the bar
* Manipulating the size of radii within the sketches
* Adding additional guide curves to assist the direction of the surface

NOTE: You may have to delete some surfaces and add them again to make drastic changes to geometry.

### Activity 3

Following the completion of the instructional activity carried out in activity 1, apply your knowledge of 3D surfacing techniques to complete the tutorials available online.

<http://learnsolidworks.com/solidworks_tutorials/how-to-model-a-deodorant-roller-in-solidworks>

