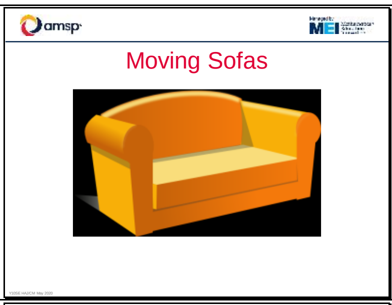
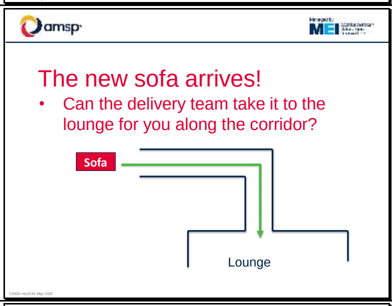
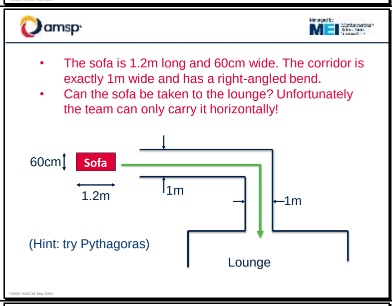
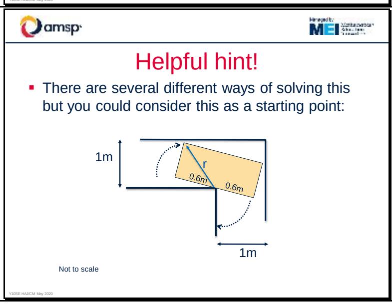
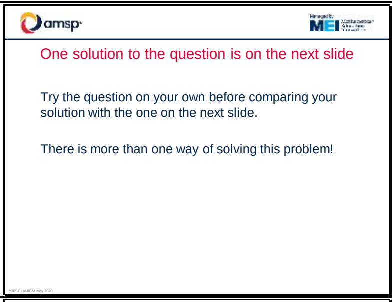
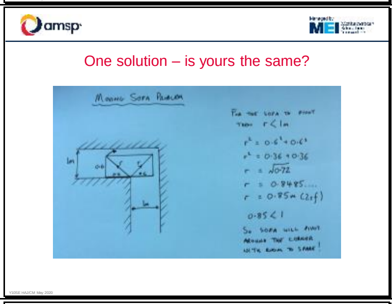
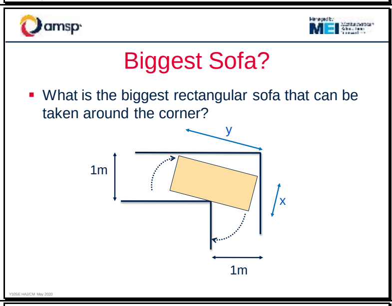
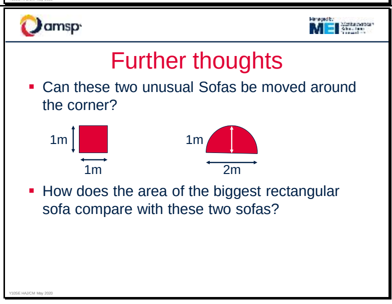
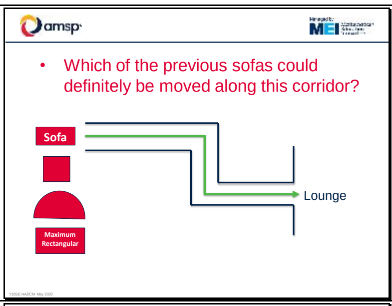
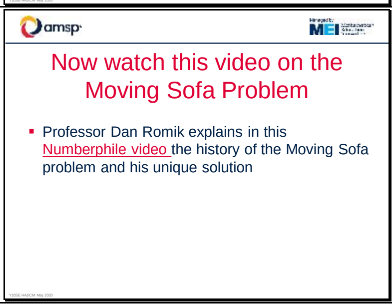
Slide 1		There is a progression of challenge throughout this activity with the Numberphile video being introduced before the final 'Ambidextrous Sofa' tasks but after earlier student exploration of the problem. The initial challenge on the moving sofa problem is presented on slides 3 and 4. The sofa **can** fit around the corner and there are many ways students can demonstrate this, the hint on slide 5 is one possible way of approaching this. The initial activity is extended by finding the largest area rectangular sofa that can pass down the corridor on slide 6. Slide 7 poses the idea of two different shaped sofas that will both navigate the turn in the corridor and again looks at comparing areas as finding the maximum area is the fundamental aim of the moving sofa problem. Slide 8 introduces the idea of a sofa that has to turn in two different directions in preparation for Professor Dan Romik's Numberphile video (slide 9) and the final tasks. Slides 10 and 11 introduce a potential ambidextrous sofa design where students are asked to find it's maximum possible area. There are several possibilities here for students as outlined but differentiation can also be used. Slide 12 – a possible practical task to see if the proposed sofa can always travel along the corridor. Interested students might like to explore the mathematics for this for **particular** values as they did for the original example.
Slide 2		In 1966 L. Moser asked what is the shape (planar) with the largest area that can be moved around a right angled turn in a 'corridor' of unit width. This is an open mathematics problem as many mathematicians have improved on the bounds of previous attempts. It is known as the moving sofa problem.
Slide 3		
Slide 4		
Slide 5		

<table>
<tr><td>Slide 6</td><td>
</td><td></td></tr>
<tr><td>Slide 7</td><td>
</td><td>There are different ways to demonstrate that there is enough room for the sofa to move around the corner, this is just one.</td></tr>
<tr><td>Slide 8</td><td>
</td><td>A similar method to the one at the end of the notes will yield the answer of the maximum sized rectangle with dimensions:
length = $\sqrt{2}$ and width = $\sqrt{2}/2$ giving an area = 1 unit^2</td></tr>
<tr><td>Slide 9</td><td>
</td><td>Yes, both can be moved around the corner. The square slides along horizontally and once in the corner then moves directly down. The semi-circular sofa moves along horizontally and then pivots around the corner of the corridor before moving down.
Area of square sofa = 1 unit^2
Area of Semi-circular sofa = $\frac{\pi}{2}$ unit^2 (1.57 unit^2 3sf)
Area of biggest rectangular sofa = 1 unit^2
So a more unique shaped sofa can navigate the corner and have a bigger area.</td></tr>
<tr><td>Slide 10</td><td>
</td><td>The only sofa that cannot move all the way along this corridor is the semi-circular sofa, it can only turn around the right turn and not the left hand turn.</td></tr>
<tr><td>Slide 11</td><td>
</td><td>Lovely video from Dan Romik on the background to the Moving Sofa problem and different solutions that have occurred such as Hammersley and Gerver for a single right-angled bend. It then leads up to Dan Romik’s solution for an Ambidextrous Sofa which can turn both ways along a corridor and the shape that gives the maximum area in this situation.</td></tr>
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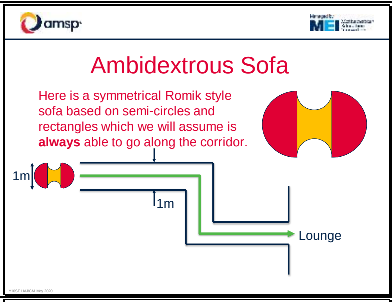
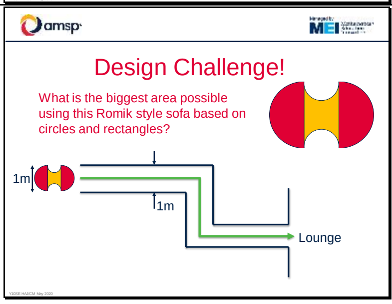
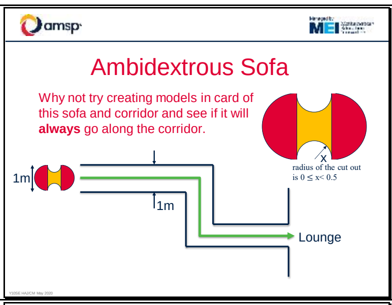
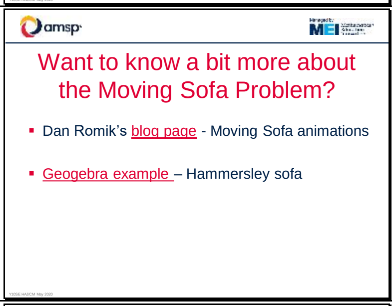
Slide 12		Introduction slide for the challenge on the next slide.
Slide 13		The radius of the red semi-circles is equal to 0.5 (for a 1m wide corridor) and the radius of the cut out can be in the range $0 \leq x < 0.5$. The maximum area is therefore determined by the size of the yellow area. Looking at the extremes if x = 0, then Yellow Area = 0, a minimum overall area = Red Area = $\pi(0.5)^2 = \pi/4$ If x = 0.5 then the Yellow Area = 1 - $\pi/4$ = 0.215 (3sf) and an overall area of $\pi/4$ + 1 - $\pi/4$ = 1 (i.e. the same as a 1m square!) The maximum area lies in between these two values and reasonable estimates can be found by trial and error or by a systematic decimal search for the radius of the cut out or by drawing the graph of $A_{yellow} = 2x - \pi x^2$ and finding the position of the maximum. This problem could also be used as an opportunity to introduce/use differentiation as $\frac{dA}{dx} = 2 - 2\pi x$, the maximum yellow area occurs when $\frac{dA}{dx} = 0$ which gives $x = \frac{1}{\pi}$ or 0.318 (3dp) The maximum area A_{max} = Red Area + Yellow Area $=\pi\left(\frac{1}{2}\right)^2 + 2\left(\frac{1}{\pi}\right) - \pi\left(\frac{1}{\pi}\right)^2 = \frac{\pi}{4} + \frac{1}{\pi}$ or 1.1037…….
Slide 14		Practical task to see if the sofa can move along the corridor.
Slide 15		
Slide 16