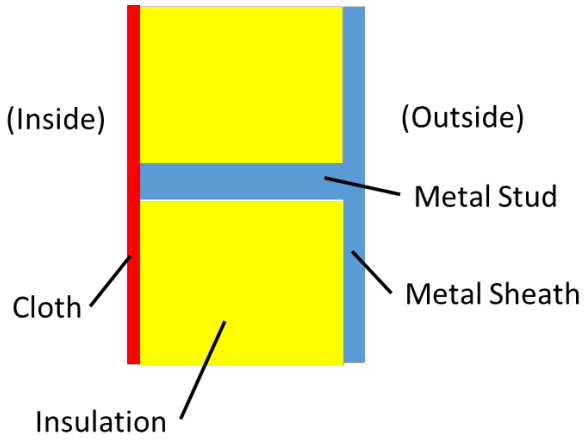
**Heat Transfer Workshop 7 Thermal Resistance Introduction**

**Name** _____

In metal buildings insulation is often installed between the metal studs and the outer metal sheathing of the building. Consequently, there are two parallel pathways for the heat transfer – through the insulation and through the high conductivity metal studs. In addition, a layer of cloth is sometimes installed over the studs and insulation as shown below.




Draw a thermal resistance network for the different heat transfer pathways for this system. Clearly identify which pathways are in series and which are in parallel. Write an expression for the overall thermal resistance of the wall.

Look at the overall thermal resistance in the limits as the resistance of the metal stud becomes very small and very large. What is the effect of a small thermal resistance of the cloth in either case?

You are embroiled in an argument over the value of the cloth. One side is arguing that the presence of the cloth has negligible effect on the heat transfer through the wall because it is so thin relative to the insulation. Therefore. it has a negligible effect on the overall insulation of the building. But the other side says that a covering over the metal studs will have a substantial impact on the heat transfer. Is there a way to prove who is right and convince everyone? What is the truth in this situation? This is often the task for engineers to develop logical explanations.

**Heat Transfer Workshop 7 Results**

**Name** _____

You are tasked with making some simple measurements to prove or disprove this argument by inserting a piece of cloth over the metal and then the insulation (for example carpet or a mattress). Use your hand as a heat source on the heat flux sensor like you did in Workshop 5. This time compare the results while also adding a piece of cloth. Take about 20 or 30 seconds of data for each of the four combinations:

a) sensor directly on the metal piece from your kit.
b) cloth between the sensor and the metal piece.
c) sensor directly on the insulation.
d) cloth between the sensor and the insulation.

1. Plot the heat flux values for each case and compare the resulting curves all on one graph. Attach your graph.

Calculate the approximate ratios of heat flux with and without the cloth for the same time after application of your hand (average several values from 10 to 20 seconds after the peak to provide a good comparison):

Metal: $q''_{\text{with cloth}}/q''_{\text{without cloth}} =$ _____ Insulation: $q''_{\text{with cloth}}/q''_{\text{without cloth}} =$ _____

2. What is the change in thermal resistance by placing the cloth onto the insulation? (measurement uncertainty is at least 5%)

3. What is the change in thermal resistance by placing the cloth onto the metal?

4. Why is there a difference between the effects of putting the same cloth on insulation versus metal?

5. What is the answer to the original dispute? Will adding the cloth make a difference for the building? Why?

6. How does the cloth make a difference in what you feel?

7. The cloth could be representative of fouling in a heat exchanger. What does this tell you about when fouling will or will not be important in heat exchangers?