



## Fabrication Guide Activity Worksheet SDM FINGER

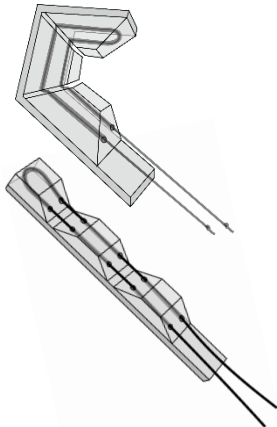
### Before you Build

1. Why is this structure named after a finger?

The SDM Finger<sup>[1]</sup> was an adapted design of published soft robotic research that mimics the motion of a human finger evidenced by the construction of three distinct joints when flexed, just as our own finger have three segments.

1. A. M. Dollar and R. D. Howe, "A robust compliant grasper via shape deposition manufacturing," IEEE/ASME Transactions on Mechatronics, vol. 11, pp. 154–161, 2006.

2. What is your hypothesis on how this finger may move when the strings are pulled? Sketch the finger showing what motion it may take.



Although this motion may be shown on the cover of the guide, students should practice the skill of drawing out the motion of a proposed robotic device, both with and without controls applied. The image left demonstrates roughly how a student drawing should look. Above, the Finger is flexed and below, the finger is extended as there is no force being applied with the strings. Student drawings should appear similarly.

3. What features of the finger influenced your hypothesis for how it moves?

Student's answers will likely indicate if they correctly hypothesized that the finger was designed to mimic a human finger. Answers should include that the segments of the fingers influenced the assumption that the device would fold over at the 'joints' of the structure.

### While Curing – Part 1

1. What could this device be used for?

Name a use for the finger or discuss someone who may use it.

Possible answers vary, however these types of 'fingers' can be added together to create a number of soft gripper variations. When customized to an application soft grippers can perform an assortment of tasks such as manufacturing, research sample collection, prosthetics, the robotic hand, etc. Within those areas are a number of users who can be called out specifically. Their requirements for this gripper may also vary as well.

2. Based on your chosen application or user, what are some features you could add to this finger to make it more useful or more effective?

Students should show an understanding that by customizing the fingers and the device for each user the device will be better suited to the particular application. For example, in research sample collection, the fingers should be made soft and gentle for small delicate objects which are well suited for soft robotic applications.

### While Curing – Part 2

1. After pouring both layers of the silicone, did you notice any differences between the two silicones?

Student observations may vary however silicone properties that vary between the two can be listed, color, density of the liquid, mixing ratios, and thickness can all be indicators of how this silicone may feel once it is cured.

2. What is your hypothesis for how each silicone will feel once it is cured? Explain why you had this conclusion.

Student observations may vary however silicone properties that vary between the two can be listed, color, density of the liquid, mixing ratios, and thickness can all be indicators of how this silicone may feel once it is cured.

3. What do you think is the purpose of using two different kinds of silicone?

Hypotheses should logically be based off of the observed performance of the silicones when pouring. These observable features will influence the final result of the silicones.

## Post-Activity Reflection

1. Use your finished finger to pick up a few objects around you. What kind of objects is it able to successfully pick up? If you were to alter the finger, how might changing the geometry of it affect the way it handles various objects?

Testing among the objects around them, students should find that the smaller objects are able to be grasped with only one of the fingers and larger objects are not, similar to how our own fingers would be fairly limited if they were to singularly grasp larger objects.

2. What is the purpose of the finger's structure?

The structure of the fingers are designed to mimic human grasping. The three segments allow there to be a natural joint between each segment.

3. How does the SDM Finger mimic your own finger?

When the string controls are applied, the motion and force applied to the finger act as ligaments and muscles in the body, pulling the joints and finger segments into a cured position for grasping. Mimicking movements in nature is common for soft robots as this was previously very difficult to achieve with traditional rigid robotics components.

4. Were there any issues with your final result? What part of the fabrication process would you do differently next time to correct this?

Reflections on the fabrication process offer valuable lessons for future iterations. Recognizing what worked and didn't work will allow students to develop a repertoire of knowledge that be accessed for engineering challenges they may encounter in future.