JAMES DYSON FOUNDATION UNDERGRADUATE BURSARY

Outreach Activity Proposal

related to the 2019/20 funded project:

Capacitive Soft Skin for Shape Estimation

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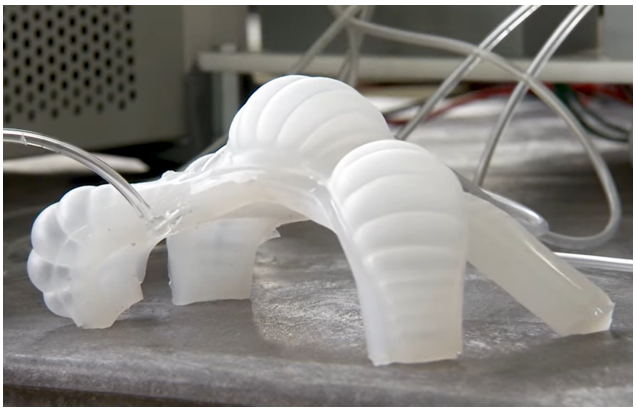
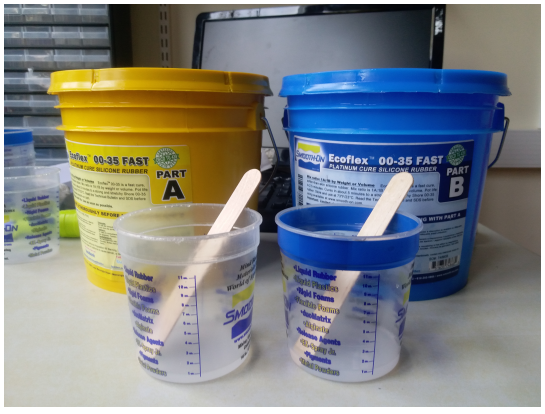
1 Introduction

The outreach activity to be proposed intends to inspire and educate schoolchildren interested in engineering. Since certain types of engineers often design and make gadgets, it will be great for these high-schoolers to be given an opportunity to attempt such tasks, in a context related to the funded project.

The project fabricated a new type of sensor to estimate the shapes of soft robots, such as one shown in Figure 1a. The single most important raw material in soft robots is silicone, and its high deformability allows the bodies of soft robots to be very flexible. In the light of this, the proposed activity will ask participants to fabricate their own silicone structures, offering fun and hands-on experience.



(a) Soft, pneumatically-actuated crawling robot invented by NASA [1].



(b) Raw material silicone consists of two components, named part A and part B.

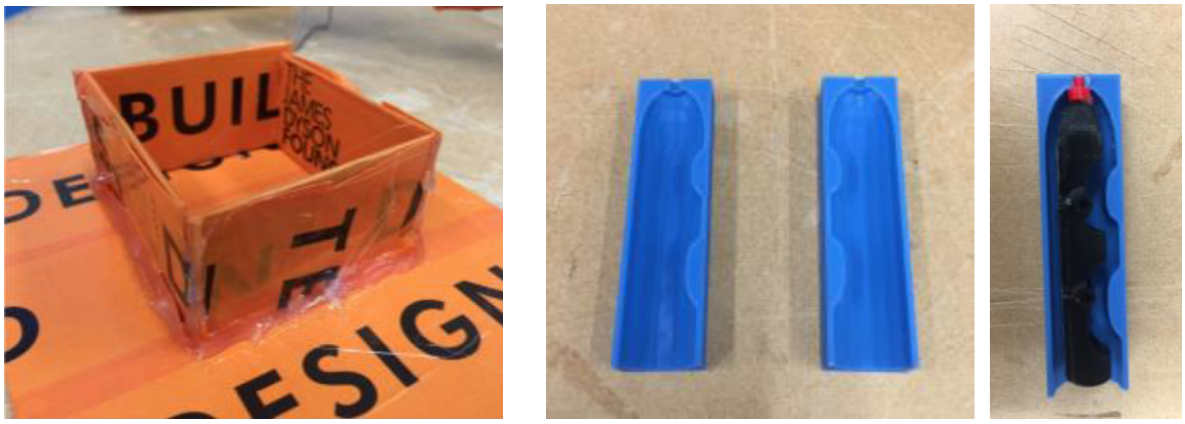
Figure 1: Example soft robot and its raw material.

As some fundamental knowledge for the activity, the stretchable silicone is a composite of two viscous liquids named part A and part B (Figure 1b). Silicone object of custom shape can be fabricated by first mixing the two parts together, then immediately pouring the mixture into a mould of the desired shape, before it fully solidifies a few minutes later.

2 Activity Design

The design of the following outreach activity is a simple adjustment to another activity delivered by last year's bursary recipient, Neil Kraewinkels. His activity report [2] is taken as a reference because my project was essentially a renovation of his. Therefore, Neil should take full credit to the new proposed activity.

Last year Neil assigned two mini-tasks to the school children. In the first task they were asked to come up with a simple shape which they wanted their to-be-fabricated silicone to have. Then they were provided cardboards, glue and scissors to build their own moulds (Figure 2a), such that after they poured their A-B mixture into the moulds, silicone toys of the desired shapes would form. This could stimulate the students' creativity, an important quality design engineers must possess. Hence I propose keeping this task in the outreach programme.



(a) Simple mould made of cardboard. (b) Mould for fabricating soft prosthetic finger.

Figure 2: Demonstrations of the two mini-tasks.

Figure 2b displays the 3D-printed mould given to each student in the second task. It is a mould to fabricate a soft prosthetic finger, and comprises a blue outer case to shape the finger, and a black skeleton to be embedded into the resulting finger. This task was easier than the first because students were only asked to assemble the mould, pour the viscous mixture into it, and finally wait for the silicone to cure. The idea behind this task was to inspire participants with the possibility of embedding rigid components into soft robots.

While I believe both tasks designed by Neil were valuable for educating the students, one problem he faced when running last year's activity was the 30-minute time constraint. Some students were only able to finish either task but not both. Having observed that the cardboard task requires creativity and hence is more challenging, I propose the following arrangement for a future activity. The finger task should be posed to the students first instead, so that they can gain experience in casting silicone, without being overwhelmed by the open-ended challenge in the cardboard task. Then if some students manage to complete the finger task early, they can optionally move onto the cardboard task.

3 Proposal Summary

In summary, the future activity can be conducted in the procedures as follows.

1. A two minute video by NASA [1] can be played so as to introduce the soft robotics field to the participants, in the hope of exciting them for the rest of the activity.

2. Participants will be asked to fabricate a soft prosthetic finger of their own. They will be provided silicone components (part A and part B) of the correct volumes, and will only need to assemble the mould and cast the finger. They can work in pairs to facilitate the process, with one person holding the mould while the other person pours the viscous silicone into it. The activity marshal can also perform the task at the same time so as to give participants a reference.

3. Finally, if time allows, participants can proceed to the cardboard task where they can put their creativity in use and fabricate stretchable objects of whatever shapes they want.

At the end of the activity, participants will be allowed to take their prosthetic fingers home, leaving them an impression that engineering can be cool and fun.

References

[1] NASA Langley Research Center. "Life at the Lab: Soft Robots". 2019. https://youtu.be/iwQRYzLZvGE

[2] Neil Kraewinkels. "Distributed Sensing in Soft Robotics - Activity Report". 2019. https://www.dysoncentre.eng.cam.ac.uk/jdf-ugrad-bursaries/previous/previous-projects-2018-19/neil-kraewinkels-activity-report-pdf