

An aerial photograph of several sea turtles swimming in the ocean. The turtles are seen from above, showing their heads, shells, and flippers. The water is dark, and the turtles' shells have various patterns of brown, tan, and white. The image is framed by a light green border.

Prosthetics for Sea Turtles

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*A Major Qualifying Project focused on how to build your
own prosthetic for sea turtle amputees.*

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Figure 1: Rocky the green sea turtle, the turtle this particular prosthetic was designed for.

Goal

The purpose of this booklet is to provide an easy to follow, step-by-step procedure to produce a prosthetic flipper for a sea turtle amputee. This is a recommended method used for a Capstone project at Worcester Polytechnic Institute. There are suggestions throughout, but the user is free to adjust the procedure if needed.



Figure 2: Lola, the ridley sea turtle, swimming with her custom fit prosthetic flipper.

Flipper Preparation

1. Get measurements of the healthy flipper.
 - a. Length, Width, and Thickness.
2. With attached CAD file (SolidWorks), scale flipper to match the measurements of the healthy flipper.
 - a. This is done through the scaling function in SolidWorks.
 - b. For this particular flipper, the scale was 8:13 inches because this is ratio of the previous turtle's flipper size to the turtle currently in need of a prosthetic.
3. Look at the volume of the flipper (in CAD file) to get an estimate on how much material you will need.
4. 3D print CAD model of new flipper. File may have to be sent in two parts depending on the dimension abilities of the 3D printer. If the file is printed in two pieces, glue them together to create a full flipper.
5. Order material (all materials listed on Materials page)
 - a. Smooth-Sil 950
 - b. Mold Star Platinum Cure Silicone Rubber (Part B)
6. Find a container large enough for the flipper to stand upright with sufficient space around the flipper (recommended 1-2 inches on each side). If no container is available, build a wooden box to make a mold for the flipper*.
 - a. The box should be made to be two inches bigger than each dimension of the flipper

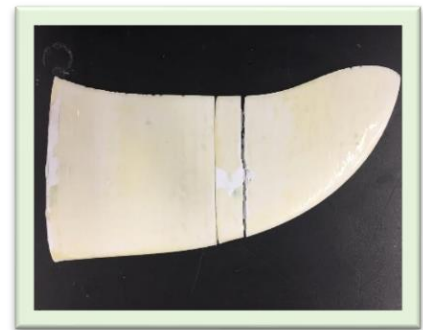


Figure 3: 3D printed flipper. Printed in 2 pieces that must be glued together.



Figure 4: Metal box created to make mold of 3D flipper in.

**Step 6 is a recommended method. When making our mold, we welded sheet metal to make a box. We reviewed our process and found that a wooden box would be more convenient. This is because it can be screwed together and easily taken apart to release the mold. This makes it reusable if another mold is needed.*

Making the Flipper

1. First the outer mold is made using the Mold Star 15 Slow series. Follow the instructions written on the material container to create the silicone mixture.
 - a. The instructions will tell what ratio of each material should be mixed.
 - b. For this mold, the ratio is 1A:1B by volume

2. Pour the silicone mixture into the wooden box around the 3D printed flipper.
 - a. Have the tip of the flipper at the bottom of the box, and the wider, medial end of the flipper at the top
 - b. The flipper will begin to float and move as the mold mixture is added. Be sure to hold the flipper in place until the silicone mixture surrounds the 3D flipper



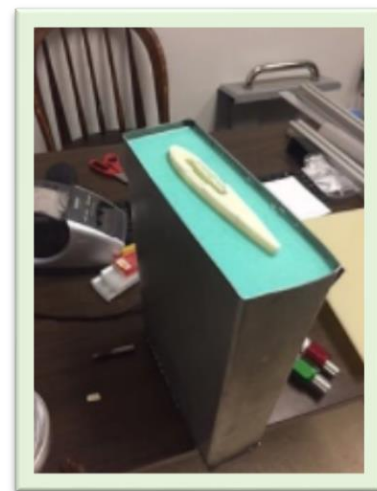
Figure 5: Holding the 3D printed flipper in place while the mold mixture is poured around the flipper.

3. Once the box is full and the flipper is completely covered besides the very top, cover the box with a lid.
 - a. This step is done so the end of the flipper is seen at the surface of the mold but does not float too far out of the box, changing the flippers position in the box.



Figure 5 (Left): Covered box to keep flipper in place and weighted down to prevent floating.

Figure 6 (Right): How the flipper should look once the mold hardens. Approximately 1/2 inch should be showing.



4. After 24 hours, remove the mold from the container. Then remove the 3D flipper from the mold*.
 - a. Depending on the size of your flipper, the mold may have to be cut open to remove the 3D model. If this is the case, make a straight cut down the side of the mold. Once the flipper is removed, glue the mold back together using superglue.
 - b. Spray the inside of the mold with SmoothOn Universal Mold Release (price and information in materials section of pamphlet). Let the spray dry for at least 24 hours.

**We recommend the mold be sprayed multiple times over the course of 3-4 days. This will make the removal of the prosthetic flipper significantly easier.*

5. Next, the material for the new flipper is to be mixed using Smooth-Sil 950 (ordering information in materials section). Follow the written instructions on the material container to create the mixture.
 - a. This ratio is 100A:10B by weight.

6. Pour the mixture into the mold

7. Let this sit for at least 12 hours



Figure 7: Pouring the Smooth-Sil 950 into the mold



Figure 8: Final prosthetic flipper removed from mold.

8. Cut the mold so the final flipper can be removed
9. Sand down the flipper to ensure it has a smooth surface
10. Create 3D model of the remaining damaged fin using CT scans or casting

Products Used

SMOOTHON MOLD STAR 15 SLOW

Both A and B parts are included.
Mixing ratios are explained in instructions.
Used for mold of 3D printed flipper.

Price: \$185.05

Type: Gallon



<https://www.smooth-on.com/products/mold-star-15-slow/>

SMOOTHON SMOOTH-SIL 950

Both A and B parts are included. Mixing ratios are explained in instructions. Used for prosthetic flipper.

Price: \$138.94

Type: Gallon



<https://www.smooth-on.com/products/smooth-sil-950/>

SMOOTHON UNIVERSAL MOLD RELEASE

Spray used to release mold from container as well as to release new prosthetic from inside of mold.

Price: \$13.94

Type: 12 oz can



<https://www.smooth-on.com/products/universal-mold-release/>