

The Customer



Captain Derrick Ray of the Discovery Channel's hit show, *The Deadliest Catch*, is a captain for one of Alaska's most successful and beloved crab fishing tours, Bering Sea Crab Fisherman's Tour.

Every summer, which is the off season for crabbing, Ray takes customers on the high seas to simulate the experience - at least without the rough weather, long hours and extreme danger.

A staple of the tour is that the customers get to see the massive 10 lb crabs up close.

Every year the team catches between 500 and 800 of these crabs during the season and keeps them in tanks for the tourists during the summer.

The Problem



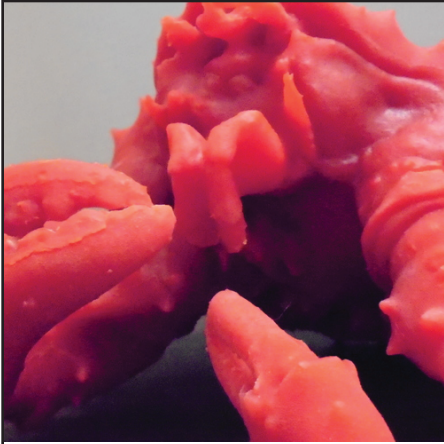
Seeing up close crabs may be the highlight of the tour, but the costs and casualty of such a display were very high.

The crabs that are stored for use on the tours are put into nets and placed into the ocean. During the tour they are pulled up to simulate a catch.

After every tour and season many of the crabs do not survive. When they die they start to rot and smell, then must be thrown away. Not only does the high value of the crabs cut into the company's bottom line, but the whole process is wasteful.

Ray and his company wanted a more sustainable approach.

The Solution



A close-up of one of the rubber crab dummies, cast with custom colored resin.

Rubber Crabs!

If only there was a way to make an army of exact replicas of frozen crabs. Then Ray and his crew would only have to buy the rubber dummies once and reuse them tour after tour, season after season. This would nearly eliminate the wasted crab produced by their business every year.

So Captain Ray contacted RapidMade to see if they could solve his problem.

RapidMade told Ray that despite the uniqueness of his request, they would have no problem creating a product that would exceed his and his customers' expectations.

Let's Get Started!



A frozen crab shipped directly from Alaska. Looks tasty.

To kick off the job, Ray put two of his finest frozen crabs on a plane from Alaska to Portland, Oregon.

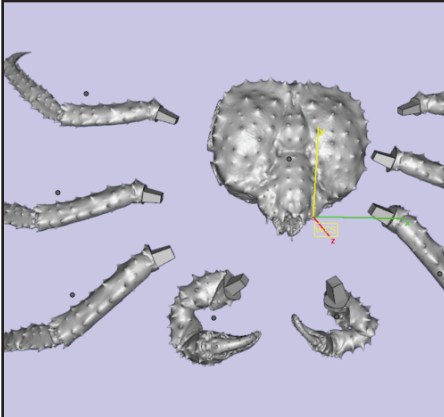
The first step was to figure out how to digitize the crabs through 3D scanning.

This was a difficult process because the frozen crabs were crumpled up (see left,) an unnatural position for a live crab, and therefore a direct scan of a whole crab would make for an unconvincing dummy.

Additionally, to make a workable mold, good casting requires obvious parting lines for demolding and easy flow from the gate into the cavities.

A 2-foot long, 8-legged object is not conducive to making an easy casting, so RapidMade had to get creative.

3D Scan



Individualized scanned components, including claws, legs and the body.

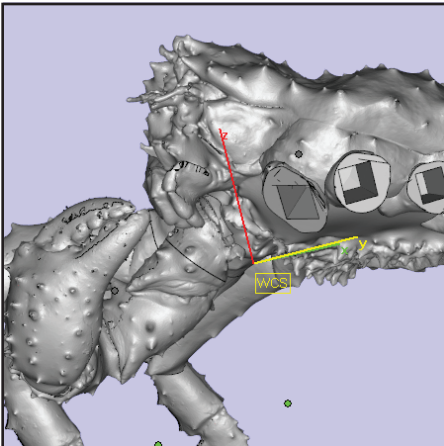
The solution for making a realistic crab - both collecting hard-to-reach scan data (the scanner requires line of sight) and making manufacturable dummies - is to rip the crab apart into segments consisting of the six legs, two claws and bodies and scan each segment individually.

Actually, RapidMade only scanned two legs, two claws and the body. A neat trick to reducing the workload and getting better consistency from leg to leg was to scan the front and back legs of the left side of the crab.

The largest leg was then scaled down in our CAD software to become a medium-sized leg. With three legs digitized, the team could simply mirror the set of left legs to create a set of right ones.

Reducing scanning time was a priority for RapidMade before the team's office started to smell too much like Pike's Place Market.

Design for Manufacture



A close-up of the roman joints designed to make a fully assembled crab that is extremely tough.

Creating separate rubber legs and gluing everything together with a saltwater and low-temperature-safe epoxy was the best way to proceed with this project.

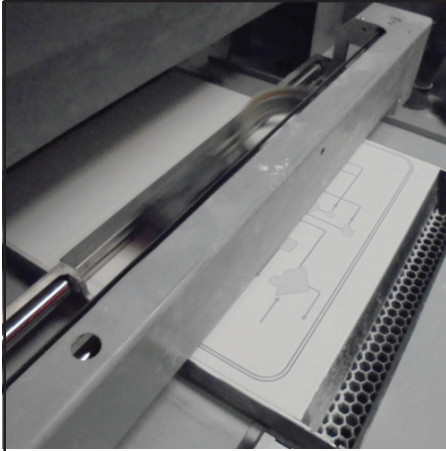
By designing roman joints (left,) tapered "peg-and-hole" mating features, RapidMade created a strong bond that actually is more tear resistant than the rubber material itself.

With segmented legs, RapidMade was able to digitally manipulate the legs into straight and bent positions. This way, half the crabs could look different than the others and add to the variation and realism without increasing the project's cost.

Additionally, RapidMade now had to design molds for the 12 legs, two claws and bodies as well as source rubber that could survive the harsh undersea conditions of the crab pot including: near-freezing temperatures, extremely high pressure and salt water corrosion.

In all, RapidMade would have to purchase hundreds of pounds of silicone and urethane resin weeks in advance of production to fill the order.

3D Printed Master Pattern



A live 3D printer (colorjet technology) in action. It lays down 0.004" layer after layer in a bed of powder until the entire pattern is finished. An 8" tall part consists of 2000 unique layers.

Once all the data was captured, the project planned, and the models redesigned, the team was ready to create the first physical representation of the crab, the master pattern.

The pattern is an exact replica of the final crab, but made of a hard and brittle 3D printed composite. The patterns are much more expensive and time consuming to make than the castings and would not survive the harsh underwater environment.

For this reason, RapidMade only creates one 3D printed master pattern for the tooling. For large objects, due to machine time and high material cost, casting is a superior method for manufacturing units at quantity. Casting also gives customers a wider range of material options.

The pattern is 3D printed in very thin (0.004") layers over the course of days. When finished, the pattern is dried and cured, so it becomes rock hard.

Afterwards, the patterns are painted to improve the texture of the finished product.

Silicone Mold Making



Silicone tooling for the crab. Top: small claw mold. Bottom: two-part crab mold with master pattern pictured.

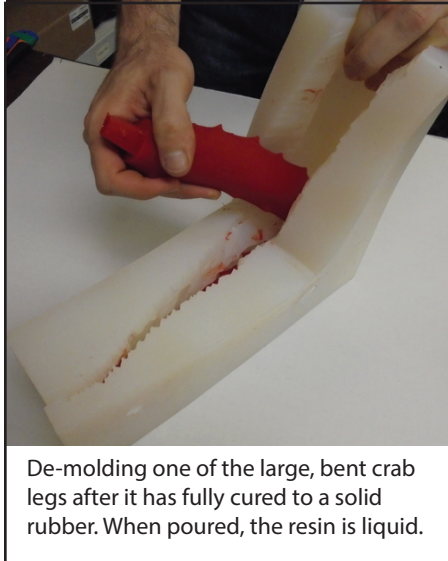
Once the pattern is finished, the mold making can begin.

RapidMade makes soft-mold tooling by pouring silicone around the patterns to form a mold. The pattern itself is called a positive. The mold creates a negative around the pattern as it hardens. When the pattern is removed, it creates a large open cavity into which urethane resin can be poured to form the final part.

Molds are made by making large boxes and "claying up" the pattern to form a parting line. The top of the mold is poured first. After it hardens, the pattern is removed from the clay. The mold is flipped over and the clay removed, exposing the parting line. From there, the bottom half of the mold is poured over the top half and cures. Mold release prevents the two silicone halves from bonding together.

Once everything has cured, RapidMade has a complete set of tooling that can be used repeatedly for many castings.

Urethane Rubber Casting



De-molding one of the large, bent crab legs after it has fully cured to a solid rubber. When poured, the resin is liquid.

The casting step is fairly simple: Mix, pour, wait then demold and repeat. Urethane rubbers are generally 2-part thermoset polymer blended with a custom color (in this case red-orange) chosen and approved by the customer. Rubbery resins generally take longer than rigid ones to cure, from 8 to 16 hours, so for faster production, often multiple molds are necessary.

RapidMade generally casts parts in pressure pots to shrink air bubbles and create the most aesthetically pleasing part possible.

Once cast, legs and bodies are inspected for quality and paired up into sets of straight and bent.

From there, the team completes final assembly by gluing the crabs together with specialized epoxy.

After one final inspection and quick cleaning, the crabs are ready to be boxed up for shipment.

The Result



A completed lot of crabs after final inspection and cleaning. These are ready to be boxed up for pickup by the customer. Job well done.

A very satisfied customer.

For a fraction of the cost of one year's crab inventory, Bering Sea Crab Fisherman's Tour now owns a large supply of crab dummies that can be used year after year.

Before, the majority of their massive crab stock would die during the season. Now, they reduced their stock to under 10% of its previous size.

The dummies now go in the net and live crabs are shown to tourists safely in the tanks.

This summer they have gotten through the season without a single casualty.

Additionally, the tooling is available in the future for spot orders as the army of crabs experience wear and tear, keeping the process affordable.

The customer saves tens of thousands of dollars in wasted crab every year and gets to market itself as a more sustainable business.