Prototyping Personalized Medical Solutions

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This article offers the personal perspective of an industrial designer in his quest to utilize advanced prototyping technology to enable the fabrication of custom orthopedic prosthetics that not only offered the standard function required of such a device, but also one that reflected the personality and style of its owner.

There was a time when the only way to create a new product—or worse, a line of new products—involved vast upfront investment, painfully slow time to market, and endless trips to Asia to debug tools and haggle with overseas tooling engineers. And for most mass-produced products, this remains the underlying story that describes the lives of designers and their product. But things get interesting when you abandon these confines in favor of an entirely new approach to the design process.

I originally set out to explore the idea of a marriage between design and the traditionally bland medical product by challenging the common thinking behind the modern prosthetic leg. Instead of the mechanical, impersonal collection of unrelated hardware parts that comprises the modern leg, I intended to create one that met the biomechanical requirements, but also then infused it with individuality, personality, and flair. I wanted to transform the product from something intended to be hidden into something bound to be showcased.

While this research continues, Bespoke Innovations [1] evolved from this exploration, founded on the principal that good design and sound medicine can co-exist, enabled by the versatility offered by additive fabrication. Specifically, we

sought to infuse those often-necessary medical products with a renewed quality, transforming them from a “need to have” into a “want to have.” Tapping into the freedom to create complex forms, we found that we can design these products with pattern, ventilation, and a quality of fit (aided by a 3D body scan to initiate the geometry creation) unprecedented in either custom medical products or in mass-produced consumer products. And because good design comes from well-considered geometry and not additional cost, we’ve been able to create products that not only fix the body, but also excite the spirit.

Bespoke debuted its “prosthetic fairings” in 2010 to a receptive audience, eager to see this foray into the much-promised world of “mass customization.” This concept offered, for the first time, an amputee that chance to recreate symmetry in the body, referencing a 3D scan of their “sound side” leg, and several parts created additively that attach to their hardware, recreating their shape. The fairings, however, do not attempt to recreate a facsimile of the lost limb; instead, they embody the lost morphology artfully, drawing from the wearer’s sense of taste and style. Black and white polyamide allow us to create parts that are strong, washable, and lightweight, while parts created by stereolithography accept metal plating, offering a durable, jewelry-like quality to the parts.

A much wider range of products remain in research phase at Bespoke, awaiting further testing before they can be released publically. Suffice it to say, all expand on this idea of ‘scan-design-print’ in order to create custom-designed solutions, where the end user becomes the very DNA of the product at inception. All address complex musculo-skeletal challenges within the body with external bracing, where highly conformal contours lead to great improvements in comfort, and therefore, quality of care. And all infuse a high degree of industrial design into their form, creating products that, though necessary for the user’s condition, compliment their sense of taste and comfort.

It was the maturation of selective laser sintering (SLS) that allowed this unique new approach to be fully realized. Unlike stereolithography—the first of the additive technologies to demonstrate value—SLS can create parts that can be durable, flexible, and ideal for body contact directly from fabrication. The result is a process that is as nimble as software, while still offering the tangible results that can only be achieved through a physical product. When the convenience and flexibility of “printing” the product offering replaces “manufacturing” it, a world of benefits emerge to be enjoyed.

The greater dividend from this manufacturing model lies in its departure from tradition. Unlike a mass-produced business model, each successful part that we create represents a product line, more than just a part. When a prototype functionally solves its medical task, the word simply changes from “prototype” to “part,” and the template is then modified to make it universally adaptable to all people. Ultimately, the design will see modification as new ideas take shape, and these changes can be implemented within an iteration cycle.

Of course, unlike a traditional model where parts are tested and ultimately mass-produced, our process assumes that every part created will be entirely unique, unlike any part fabricated before or after. This approach invites its own set of challenges, since we’re expected to create products that fit the user perfectly every time, regardless of great individual differences in their morphologies. To this end, we create many prototypes, in an effort to understand the range of bodies that we may encounter and how each may be impacted by the various forms. Each part may see over a hundred prototypes in various materials, with a wide range of permutations per concept.

The key to this new development model lies in the rapid and predictable iteration cycle. We prototype, test, modify, and prototype again, often within the same day. The immediacy and convenience of creating new parts sets the pace for our development. And it's the wide range of prototypes that allows us to review many competing concepts before moving forward with implementation. We use Quickparts [2] extensively, since rapid turnaround and consistent results are crucial to our success. We also need to have the vast array of new materials available, and we've found that Quickparts also allows us to experiment with material properties.

Bespoke hopes to launch a range of new products, beginning in the winter of 2012, based on the benefits that can be achieved through the combination of 3D scanning, parametric models, and additive fabrication. We've been encouraged by the results that we've seen so far, and hope to extend the flexibility of this technology so that it addresses an increasingly wider set of human needs all over the globe. And as additive fabrication continues to improve in cost and mechanical quality, we expect to see the technology transform from a mechanical and technical tool, to a human needs enabler.

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