

Design World

April 2011

www.designworldonline.com

CAD ||||

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Mass customization gets its body on

Sculptural CAD is increasingly used to help create implants and surgical devices.

A key driver behind mass customization for medical products has been the recent availability of digital tools that effectively enable product design for the organic shapes found in the human body. The 3D digital design and modeling process can be roughly broken down into two tasks: making a 3D digital model of the deficit body area, and then using that model to design the solution. The initial 3D digital

model may start as a direct scan of the body itself, such as with CT or MRI, or may be a scan of a cast of a body part made with a laser scanner.

However, once an initial 3D digital model exists, the available features within traditional CAD solutions for handling form generation and modification are not well suited for organic, randomly planned polygon or surface patch models.

Traditional 3D CAD solutions have been targeted at designing mathematically precise forms such as auto bodies, aerospace surfaces, or mechanisms.

Sculptural CAD products are based on voxels, not typical solids or NURBS surfaces. Voxels can be repositioned in 3D space and facilitate speed and design freedom. This flexibility means voxels better accommodate the modeling and prep-for-manufacture

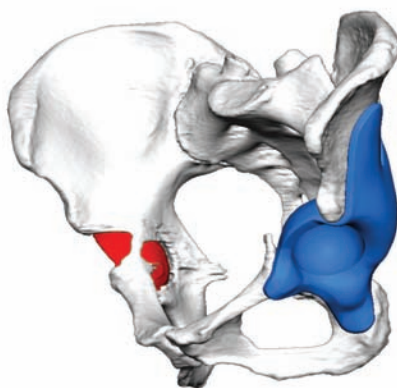
of highly detailed, complex, organic shapes such as those found in the human body.

One example of a Sculptural CAD solution is Freeform® from Sensable. The software can be used from concept design to prepping models for tooling and helps you combine multiple geometry types, including voxels, surfaces, solids, and meshes in one integrated environment. Freeform users have complete design freedom, using digital clay and a haptic (touch-enabled) device instead of a computer mouse. This arrangement lets you model rapidly in the 'carve here, smooth there' fashion of physical modeling but with digital accuracy, precision, and consistency.

Custom implants

In cases of blunt head trauma or when cancer or congenital-related defects affect the craniomaxillofacial region and bone replacement or augmentation is required, a custom implant will maximize patient aesthetics. For example, an implant specialist firm Osteosymbionics designed a custom cheekbone implant for an adult male with a congenital condition where the left cheekbone was concave, making the left side of his face appear sunken in, and his right side appear to bulge out.

Osteosymbionics' team created the cheekbone implant at least 50% faster than when designing from a manual model. The designers moved from an STL file created from a patient-specific CT scan, through to completed design and 3D model, in about one week.



Revision hip implant

designed by Medical Modeling for Enztec. Blue areas showing newly designed sections. The area covered by the existing implant appears in red.

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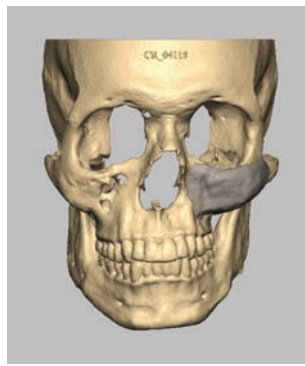
Custom spinal brace designed by Kallisto using BYOSYS MIZAR.



First the designer created the STL file from the patient's CT scan and then imported it into Freeform. He mirrored the intact, healthy right cheekbone onto the left defect area to begin the implant design. The software allowed for mirroring of the eye socket from the left to right side, so that the face could look aesthetically pleasing and balanced without appearing to be computer-generated.

The final digital design was approximately 15% smaller than the first pass and contained more rounding and gently curved edges that could contribute to a more natural look.

The team emailed a PDF of the design to the surgeon for approval and created a rapid prototype on a 3D printer. Once the surgeon commissioned the creation of the implant, Osteosymbionics output the design as an STL file and used its manufacturing process to fabricate the final as a clear implant made from polymethyl methacrylate (PMMA) material.



Custom cheekbone implant designed by Osteosymbionics using Sensable's Freeform.

Revision hip implant

Enztec, a designer and manufacturer of orthopedic medical devices, created a custom revision acetabular (hip) cup for a 70-year old female patient whose existing off-the-shelf hip implant did not fit comfortably in her pelvic cavity. The company worked with Medical Modeling Inc., which specializes in digital workflows for the creation of custom body parts. The resulting patient-specific implant that Medical Modeling designed in sculptural CAD fit so well that it allowed the surgery to be completed in half the time. In addition, implant design and production also took place in half of the usual time required – two weeks from CT scan transmission through to delivery of the finished implant to the surgeon.

Orthotics and prosthetics


Orthotics and prosthetics practices typify mass customization because they are in the business of creating replacement limbs, braces, and assistive devices. These forms must match perfectly so that no rubbing or soreness is present where the device meets the body, yet retain common structural elements – for example, a scoliosis brace with straps. In addition, their designs are often reused and revised once the patient grows or the prescription changes.

Digital methods are increasingly replacing the creation of initial forms using traditional plaster applications. For example Technic' Ortho

used BYOSYS MIZAR software from Kallisto to scan, design, and manufacture a final foam model of a custom spinal brace. The digital workflow enabled Technic' Ortho to shorten the average time from an initial patient meeting to supplying a patient with a final wearable spinal brace from six to four weeks.

Dental implant surgical guides

Mass customization is also affecting the creation of custom surgical guides for dental implant surgery – used to direct the dental drill to place a Titanium anchor into the bone and not into another tooth root or nerve. Guides are made through the SLA process and look similar to a mouth guard with holes at the proper location and angulation. During implant surgery the specialist places the implant and then the dentist follows with a crown, bridge or overstructure on it. Traditionally service bureaus have used vacuum forming methods to manually shape the surgical guide. Today digital methods using sculptural CAD design solutions allow for an extremely thin yet rugged and highly accurate guide that can be created faster and more cost-effectively.

Surgical guides service bureau Pro Precision Guides creates various custom guides. Using Freeform, the company is designing a typical surgical guide in 15 minutes, instead of 45 minutes. The firm avoids the heat, fumes, dust, and debris involved when manually forming acrylic guides and grinding them to fit. It simply designs in Freeform, then outputs to a 3D printer. Pro Precision Guides can deliver guides with increased precision – adjusting implant placement in as little as 0.001 millimeters, and supporting high-end 3D printers with 16-micron accuracy for accurate fit. 



Dental implant surgical guide from Pro Precision Guides was designed in Freeform.


3D DESIGN more possibilities

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