Bringing Hollywood to Worcester: The Art of Model-Making

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Introduction

The 3D printing process utilizes a computer-aided design (CAD) model to build a three-dimensional object by adding layer-upon-layer of material, a process known as additive manufacturing. Recent advances have led to the use of 3D printed objects in medicine for patient-specific medical devices such as cranial implants and functional external prostheses, with rapidly expanding applications every year.[1]

From computer-generated imagery (CGI) in animated films like *Toy Story*, to the creation of intergalactic armor in films like *Star Wars,* the use of 3D technology is considerably prevalent in cinema. Even some of television's favorite monsters were 3D printed, such as the Demogorgon from *Stranger Things*.[2] Despite their vastly different end products, the process for designing and rendering these models remains the same. As access to both open-source rendering software and consumer printers becomes more readily available, it's important to understand the method behind how these models are made.

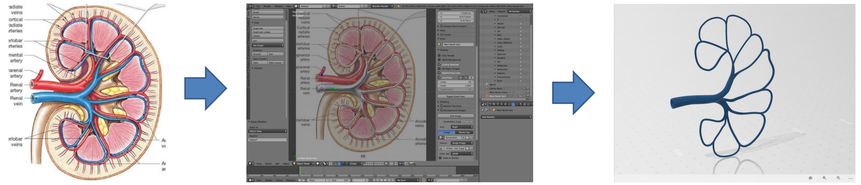
Materials

Software	Printer	Medium	Other
blender AUTODESK MESHMIXER MakerBot			

Methods

A 2D to 3D model of the vasculature found inside of a kidney was created using Blender, a free and open-source software used for creating animated films, video games, and 3D printed models. The image was positioned along the Z-axis and relevant structures were traced with path lengths. A Bezier circle was then extruded upon the traced path to create a three-dimensional mesh. This mesh was refined and manipulated in a manner to reflect the correct anatomy. The 3D model was then printed in blue polylactic acid (PLA) filament, a thermoplastic derived from renewable biomass, using a MakerBot Replicator 5th Generation printer.

A 3D tray was also designed and printed in a similar manner to create a mold to produce silicone skin phantoms replicating the epidermal skin layer. However, even the highest quality printers will leave behind layer lines which show slice-by-slice how the material was stacked to form the 3D object. These were removed using several rounds of filler, primer, and sanding techniques until a smooth, continuous surface was achieved. A matte clear coat of spray was applied, and a pleather pattern was stamped to create a textured skin look. Once the mold tray was made, Smooth-On Dragon Skin silicone mixture was added and allowed to set until a silicone mold was formed.



Initial photo of desired model

Blender user interface during modeling process

Final stereolithography (.STL) file

Discussion

The future of 3D modeling is promising and doesn't appear to be slowing down anytime soon. Concept art and images from the real-world can be transformed into three-dimensional renders, which can ultimately be printed into a tangible, real-world objects. This allows for the creation of anything one can imagine. As new obstacles occur in medicine, 3D model-making and printing should be considered as potential solutions. This not only provides individualized medicine per patient but can lead to breakthrough advancements in biotechnology and bioengineering.

Additionally, these methods offer significant reductions in cost. Some advanced prosthetic limbs can cost anywhere from $5,000 to $50,000, but the use of 3D printed prosthetics can provide far more affordable options.[3] Traditional silicone skin cutouts can cost well over $100. The functional model created during this project costed less than $30 in total.

One important aspect is the use of 3D models for education. For example, in a study testing the efficacy of 3D models as a tool for teaching congenital heart disease, students "strongly agreed" that the 3D printed models made them more confident in explaining congenital cardiac anatomy to others. The students also recommend the use of 3D models for future educational sessions.[4]

Moving forward, the techniques of creating props and designing 3D models found in many major films should be applied to medicine due to their various uses.[5] With the rapid integration of biotechnology into the field of healthcare and the growing demand for personalized medicine, there is no better time than now to explore 3D modeling as we approach what may very well be the next era of medicine.

Next Steps

The Innovations Lab is planning to design and print anatomical models to continue testing the efficacy of 3D printed models in an academic setting. They will be used in the Development, Structure, and Function (DSF) course during the 2019-2020 academic year.

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Sources

1. Center for Devices and Radiological Health. "3D Printers Are Used to Manufacture a Variety of Medical Devices." U.S. Food and Drug Administration, FDA, 2017, www.fda.gov/medical-devices/3d-printing-medical-devices/medical-applications-3d-printing.
2. Plante, Corey. "How 3D Printing Helped Design the 'Stranger Things' Demogorgon." Inverse, 2017, www.inverse.com/article/37964-stranger-things-2-demogorgon-dog-3d-printing-design.
3. Frost & Sullivan. "3-D Printing to Lower Prosthetic Costs." The Alliance of Advanced BioMedical Engineering, 2018, aabme.asme.org/posts/3-d-printing-to-lower-prosthetic-costs.
4. Smerling, Jennifer, et al. "Utility of 3D Printed Cardiac Models for Medical Student Education in Congenital Heart Disease: Across a Spectrum of Disease Severity." Pediatric Cardiology, U.S. National Library of Medicine, 25 June 2019, www.ncbi.nlm.nih.gov/pubmed/31240370.
5. Paul, Gordon M., et al. "Medical Applications for 3D Printing: Recent Developments" Missouri Medicine, Feb 2019, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6139809/