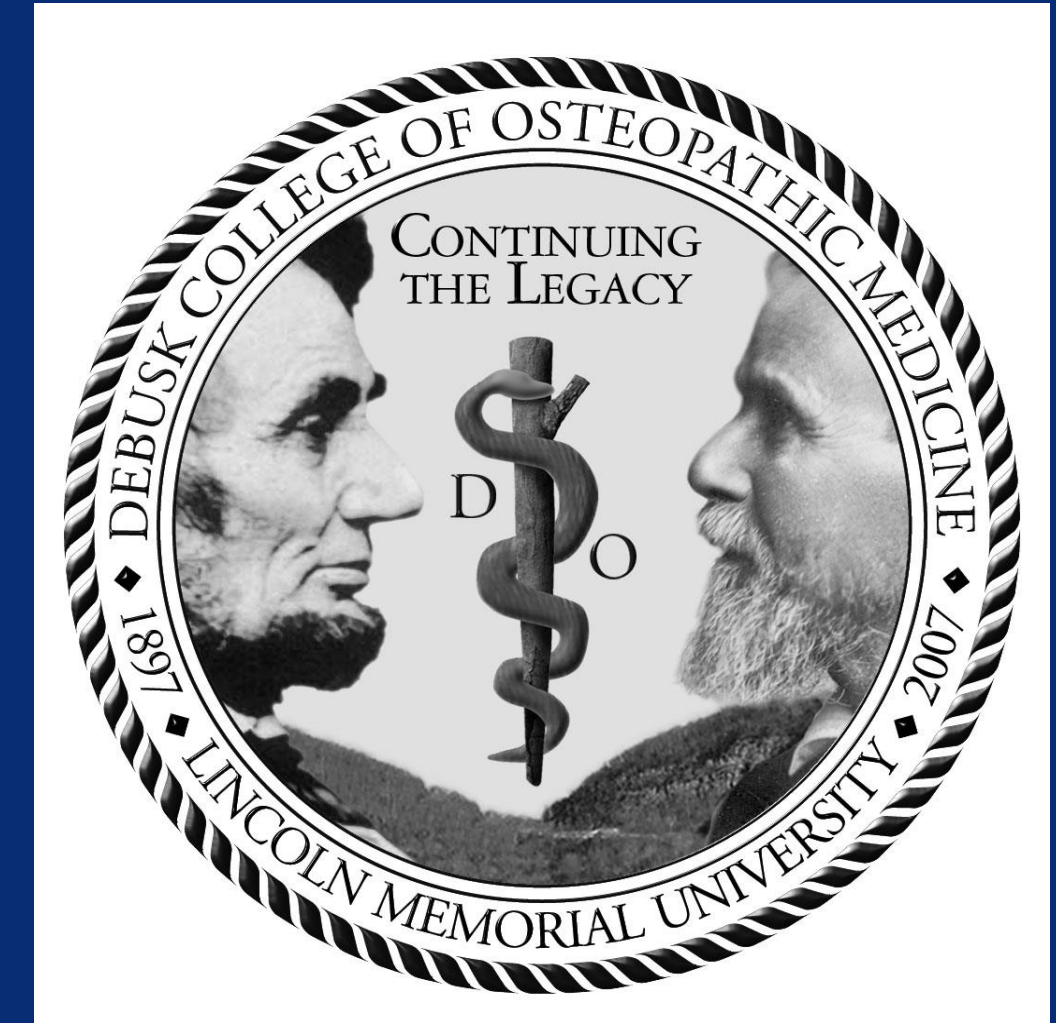


# The Application of Three-Dimensional Printing Technology to Quickly Replace Expensive Anatomical Models Necessary for Use in A Medical Neuroanatomy Course



Erick J. Moberg<sup>1</sup>, Matthew Warren<sup>3</sup>, Ron Wilde<sup>1</sup>, Carson Black<sup>2</sup>, Brent J. Thompson<sup>2</sup>.

<sup>1</sup>DeBusk College of Osteopathic Medicine, Lincoln Memorial University, Harrogate, TN 37752

<sup>2</sup>DeBusk College of Osteopathic Medicine, Lincoln Memorial University, Knoxville, TN 37932

<sup>3</sup>Southeast Kentucky Community & Technical College Innovative, Design, & Entrepreneurship at Southeast (IDEAS Center), Middlesboro, KY 40965

## Introduction

- Due to the high cost of models, frequent shipping delays, and items that are back ordered, it is challenging to quickly order and receive models from commercial companies.
- In this study, we needed to replace damaged models of the ventricles of the brain and sought to answer the question:  
*Can we use Three-Dimensional Printing Technology as a cost-effective method to rapidly produce cerebral ventricle models that are accurate and sufficiently detailed for our teaching needs?*



Figure 1- Broken Ventricle System Model

## Materials/Methods

- A search was performed in the “NIH 3D Print Exchange” opensource DICOM database.
- The desired stereolithography (STL) file was then downloaded and processed in PRUSA Slicer before it was taken to the 3D printer (PRUSA i3 MK3S+).
- We printed our model using flexible thermoplastic polyurethane (TPU) materials.

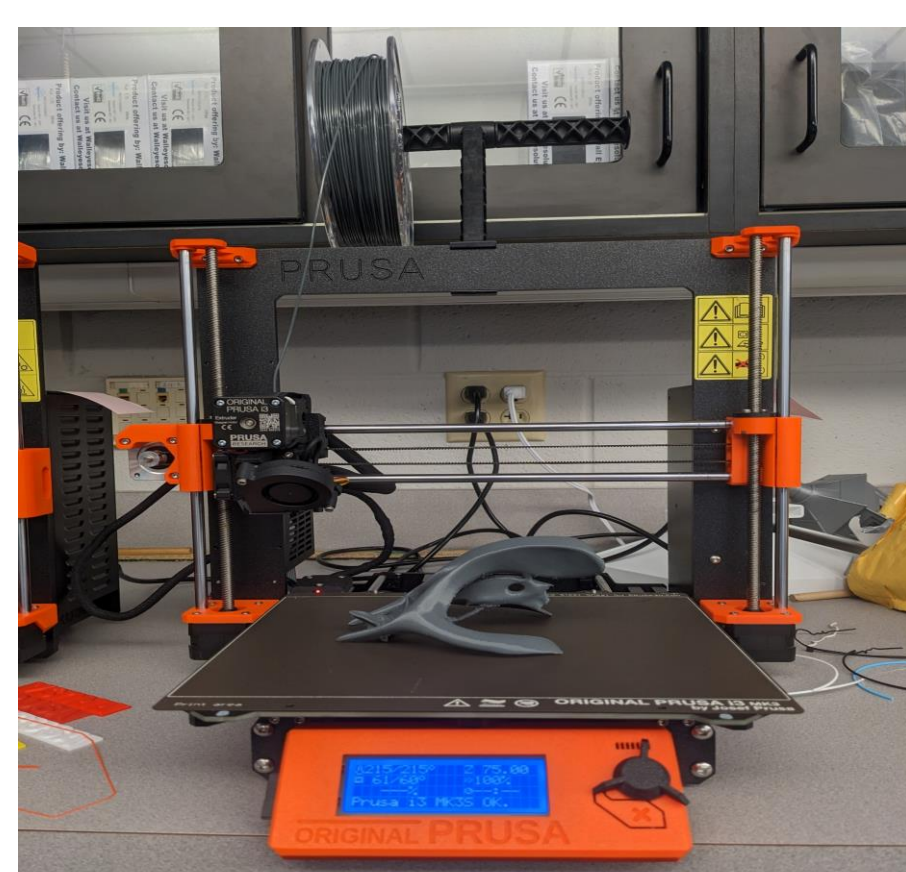


Figure 2- PRUSA i3 MK3S+ 3-Dimensional Printer

## Results

- The replacement ventricle system model was produced in under 8 hours versus 16-29 weeks of shipping.
- The overall cost per model was less than \$3.00 USD for the TPU model compared to commercial products, which are priced at \$137.00 USD.
- Once developed, the model was verified for accuracy using the course textbook, and positive feedback was received from the Anatomy teaching team, who made comments such as “extremely durable” and “very useful for teaching.”

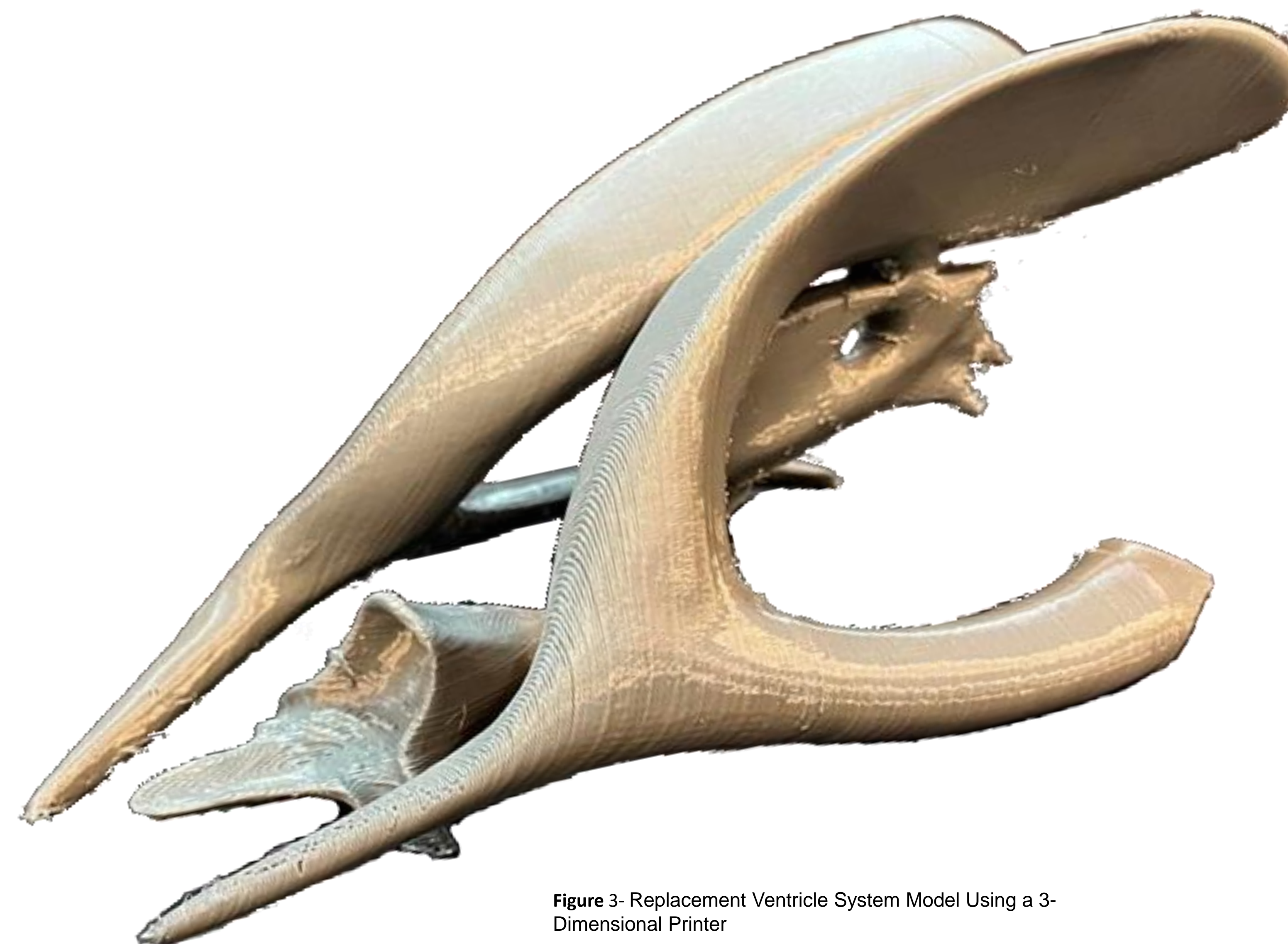


Figure 3- Replacement Ventricle System Model Using a 3-Dimensional Printer

## Discussion

- Due to the prohibitively high cost and long lead time in purchasing and receiving, we sought other options.
- In 8 hours, we were able to replace the damaged commercially produced model with a new 3D printed model for less than less than \$3.00 USD. This saved the department \$134.00 USD.
- This cost-effective option will now allow models to be printed more quickly and less expensively, ultimately making our lab more efficient.

## Significance

- Plastic anatomical models often have a tendency to break.
- Replacing commercially available anatomical models is cost prohibitive and time consuming, sometimes taking several months to receive the new model.
- Using publicly available STL data files and Three-Dimensional Printing Technology, we were able to inexpensively produce models specific to our needs and ensure we have the necessary models available for our students.

## Future Directions

- In the future, the research team plans to formally test the models for quality and usefulness.
- The research team plans to design unique models that supplement 2D images found in the course textbook.
- The research team also plans to experiment with other materials and colors to enhance the models.

## Acknowledgements

We wish to thank the Department of Anatomy, Lincoln Memorial University-DeBusk College of Osteopathic Medicine for their financial support of the study and Southeast Kentucky Community & Technical College, Innovative, Design, & Entrepreneurship at Southeast (IDEAS Center) for their time and materials.