Student Initiated 3D Printing Prosthetics Course Made Possible by Makerspace Infrastructure at University of Maryland

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Introduction

ENME 289P: Additive Manufacturing for Prosthetic Design is a student initiated and facilitated course within the Mechanical Engineering Dept. at the University of Maryland. This project-based course gives students hands-on experience with 3D printing and prosthetic design, allowing them to apply mechanical engineering and biomechanics concepts to their designs and test their ideas with prostheses they design. This course was made possible by the makerspace infrastructure within the Clark School of Engineering. Through the technical and social infrastructure existing within Terrapin Works, the students were able to gain the skills needed to ideate, execute and ensure longevity for the course, now preparing for its third year of being offered.

Research

Creating and maintaining this course was a group effort by many members of the University of Maryland (UMD) staff.

A. *ENME289P*

The course is taught in two dimensions: prosthetic design and 3D printing. Students enrolled in the course learned basic biomechanics and traditional prosthetic design from an prosthetists who partnered with the course. The authors of this paper served as Teaching Assistants (TAs) in collaboration with the prosthetists and led lectures and labs covering the nuances of 3D printing and digital fabrication. The authors also guided students in designing a 3D printed prosthetic foot for a fictitious amputee patient. The authors also designed and built a testing apparatus for the students' designs.

B. *Terrapin Works*

Terrapin Works, a collection of digital design and manufacturing resources at UMD, provided the authors with the technical skills and access to resources such as staff, space, tools, and 3D printers necessary for the creation of this course. The development of the authors' expertise was facilitated by structured trainings, peer mentorship and staff mentorship. Terrapin Works was able to create a constructive environment for students who show interest and initiative to expand their impact on the community through self-motivated projects such as this course.

C. *Students*

Students in the course were able to collaborate small teams to enhance their design skills and develop their technical acumen in 3D printing and design as a result of the course. Gaining the knowledge of the nuances of 3D printing in addition to eclectic skills brought by guest lecturers, the students were able to bring their designs to life with access to spaces made possible by Terrapin Works. Several students were hired by Terrapin Works after taking this class and even more have expanded to other companies in the industry because of their knowledge and experience gained in this course.

Results

A. *Exceptional Student*

One student has designed a prothesis that is undergoing review for the patent process. His low-cost, high strength 3D printed prosthetic foot utilized Finite Element Analysis to minimize the stress caused by the high loads resulting from the gait cycle. The student was able to leverage the content from the course with his own background in 3D printing to create an extraordinary modular multi-material device whose geometry promotes a smooth gait, increased energy return and high strength. The design for this foot will be open source, allowing for the drastic decrease in price of this prosthetic foot compared to those currently on the market in conjunction to have a wider impact worldwide, especially in developing nations. While this design is undergoing further testing, it is a prime example of how resources that Terrapin Works and the Clark School of Engineering offer can multiply the efforts and successes of UMD students by providing the requisite resources and support to those taking initiative.

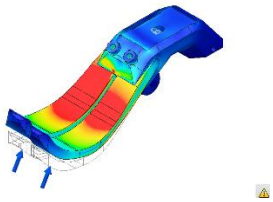

Fig.1 Example design undergoing FEA.

B. *Connections*

This course has allowed a large network of collaboration to take place that incorporated several professionals from industry and research alike. Those include but are not limited to: The Food and Drug Administration (FDA), Enable the Future, Dankmeyer O&P, Knoll Medical Center Annapolis MD, Bioinspired Advanced Manufacturing Lab UMD, and Medical Robotics & Equipment Lab UMD. These connections were all made possible by the Terrapin Works network, available to students and staff.

Conclusion

Terrapin Works continues to enable the UMD community to expand and create a knowledge base of additive

manufacturing that encourages a positive impact continuing to flourish through the course sponsored by the Mechanical Engineering Department of additive manufacturing through prosthetic design.

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