2020 Status Report

The Methodology Lab is an exploratory 3D-printing research lab in service to the TTUHSC community. The program originated in 2016 with one 3D-printer, in four years the lab has grown into an interdisciplinary facility with twelve 3D-printers and is part of the TTUHSC SOM curriculum. In this time, the program has developed into a relevant asset. Since 2016, the lab has printed 2,497 objects that have resulted from 257 projects requested by the HSC faculty and students. Sixty-seven percent of these projects have been used to support medical education, such as customized teaching aids or suturing devices for residents. For example, to help students learn cardiac ultrasound techniques, a heart model generated from medical imaging was customized to represent the parasternal long axis.[1] In addition, fifty-four percent of our 3D-modeling work is created and designed by The Methodology Lab staff using a process to convert medical imaging into 3D-printed models: a process called segmentation.[2] And fifty-seven percent of these creations are sources of research that supports faculty and staff to find new ways to use 3D-printing to enhance medical curricula.[3] In addition to supporting research, The Methodology Lab has been supporting the health sciences curriculum by offering courses and workshops.[4] As a result, sixty-seven percent of our projects have been related to students and faculty interested in understanding the relationship between 3D-printing and the health sciences. The Methodology Lab has a 3D-printing course embedded in the School of Medicine curriculum as a fourth-year elective: *Thinking in 3D: An Introduction to Medical Imaging 3D-printing*.[5] Since the 2018-19 academic year, MISD 8420 has enrolled thirty-eight medical students. These students have gone on to place in residency programs such as Internal Medicine (29%) to Neurology (4%). Starting in 2017, we have offered a 3D printing module for the School of Health Profession Occupational Therapy (HPOT 5317), here over fifty graduate students have learned the benefit of using 3D-printing to customize assistive devices for clients with disabilities. Finally, in March of this year the HSC transitioned to working remotely. Rather than allowing the 3D printers to remain idle, the Methodology Lab was able to support the West Texas Consortium by printing COVID related PPE to keep our health care workers safe during critical PPE shortages. From April to July of 2020, ML staff printed 1050 brims and ear savers on 3D printers situated in our living rooms.

In summation, The Methodology Lab offers a 3D-printing service as well as a teaching curriculum for the TTUHSC community. Over the past four years, we found innovative ways to make 3D-printing relevant by generating 3D models from medical imaging, developing medical teaching devices (like foot models with removable ligaments), and generating ultrasound teaching models. We found effective ways for 3D- printing to play a role in medical education and simulation. While the future is uncertain, we must be certain in the value of experimentation and research into practical applications with new technology.

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[1] See Abstract I. Kate M. Serralde, Vaughan H. Lee, and Gregory L. Brower. "Bad Reputation: Using Three-dimensional Printed Heart Models to Supplement Cardiac Ultrasound Training for Undergraduate Medical Students."

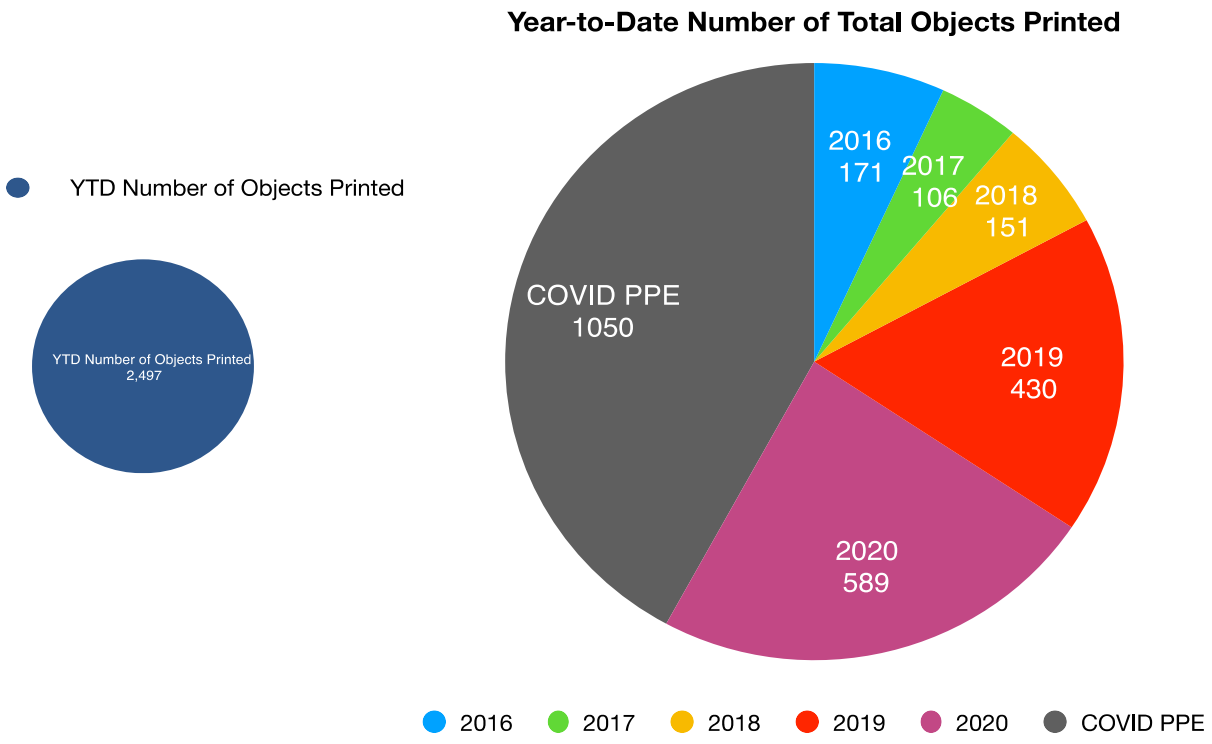
- Presentation Medical Librarian Association, 2020 Annual Meeting, August 2020.
- Presentation at John Hopkins, 2020 Institute for Excellence in Education, March 27-29, 2020.
- Presentation at South Central Chapter of the Medical Library Association, SCC/MLA 2019 Annual Meeting. October 10-14, 2019
- Presentation at World Congress of Ultrasound in Medical Education | University of California, Irvine, School of Medicine. September 10-14, 2019.

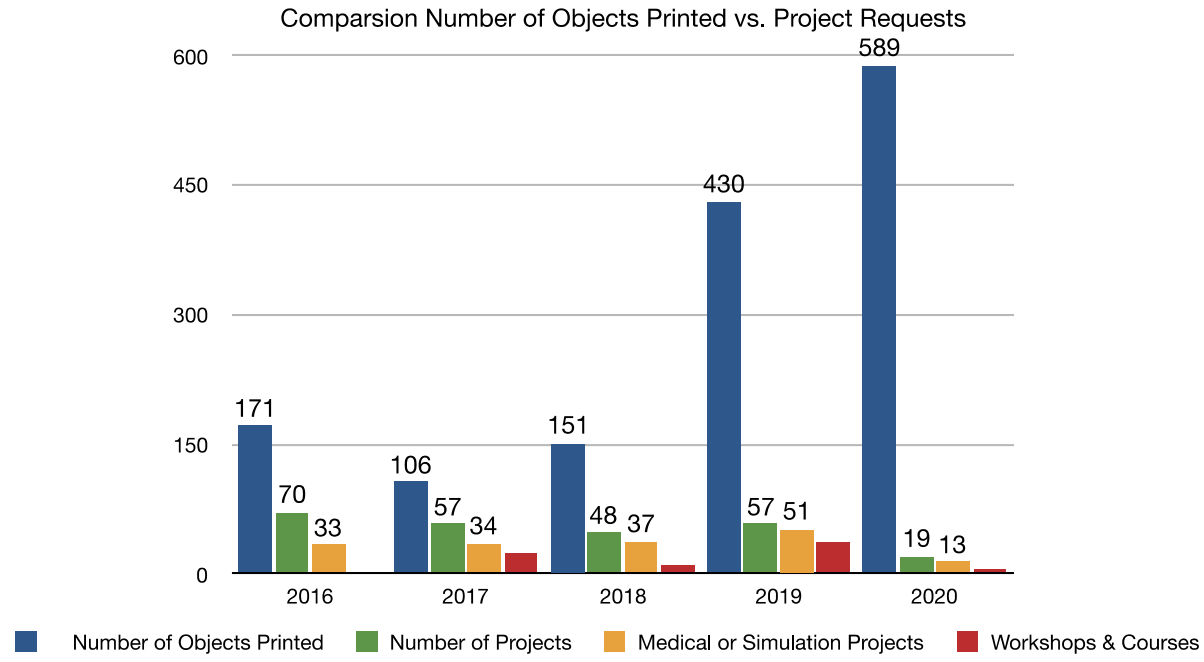
[2] Segmentation is the process of extracting volumetric data from medical imaging. To isolate and 3D-print a region of interest, your medical imaging data needs to be in the format of a dicom series or image stack. A segmentation software like 3D Slicer provides a set of automatic and manual editing tools that isolate pixels of a similar threshold. The quality of your model largely depends on the resolution quality of your medical imaging, type of 3D printer, and material quality. A low resolution scan can obsure anatomical feature boundaries and limit the articulation of your idea.

[3] See Abstract II. Kate Serralde, Jennifer J. Mitchell, and Jaime Diaz. "Having my cake and eating it too: Using 3D printing to enhance Medical Curricula in the Time of COVID." Presented at South Central Chapter of the Medical Library Association, SCC/MLA 2020 Annual Meeting. October 28, 2020.

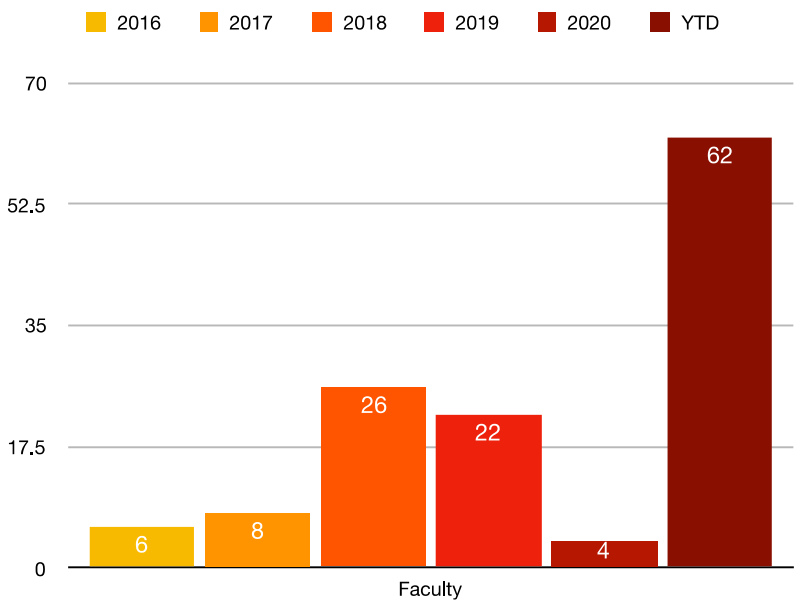
[4] For information regarding types of courses and workshops see: https://ttuhsc.libguides.com/c.php?g=445439&p=7226638.

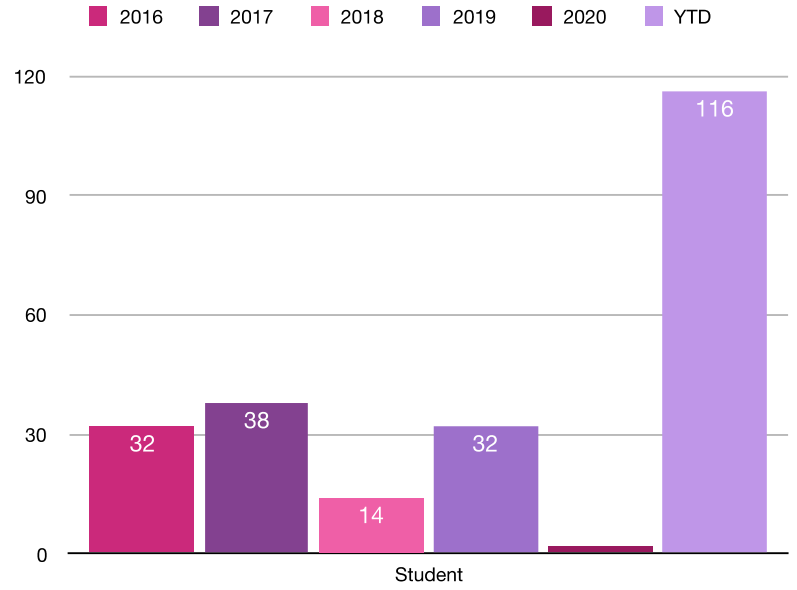
[5] Some 3D-Printing courses offered within some medical institutions: University of California San Francisco offers course on segmentation: **Anatomy 170.01**. The Medical University of South Carolina offer a **Human Centered Design Program** for their Department of Surgery. The University of Gdansk offers *a **3D printing in Medicine elective***.

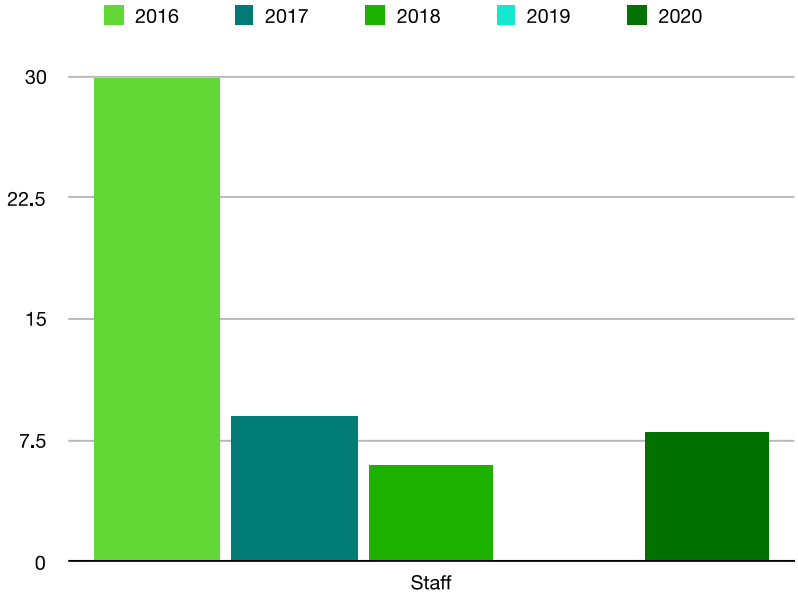

Year-to-Date Number of Total Objects Printed
YTD Number of Objects Printed
YTD Number of Objects Printed
2,497
2016
171
2017
106
2018
151
2019
430
2020
589
COVID PPE
1050
2016
2017
2018
2019
2020
COVID PPE

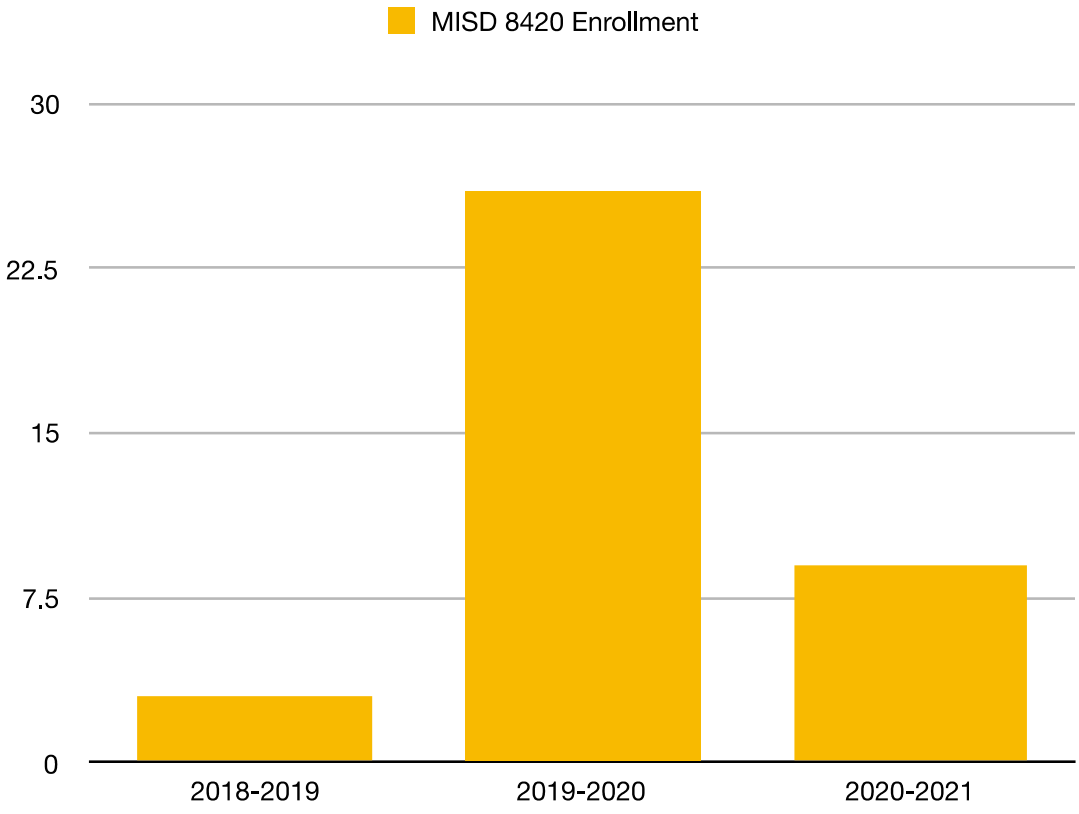

Comparsion Number of Objects Printed vs. Project Requests
600
450
300
150
0
171
70
33
106
57
34
151
48
37
430
57
51
589
19
13
2016
2017
2018
2019
2020
Number of Objects Printed
Number of Projects
Medical or Simulation Projects
Workshops & Courses

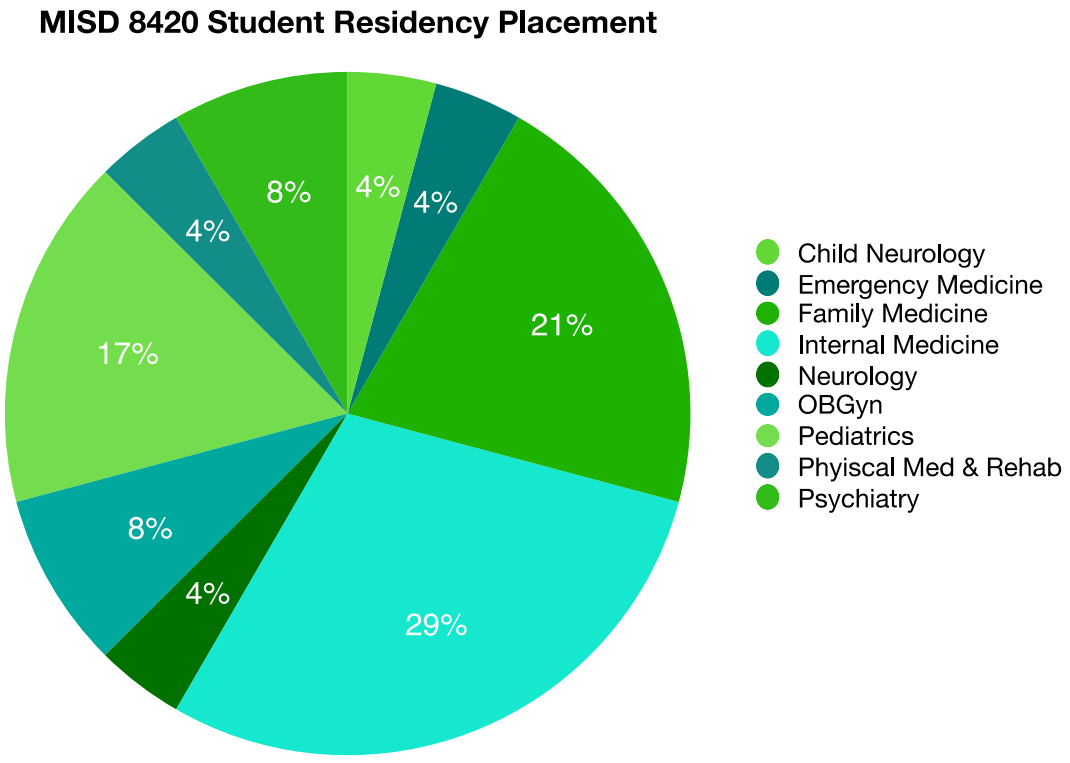
Patron Distribution 2016-2020








MISD 8420 Enrollment
30
22.5
15
7.5
0
2018-2019
2019-2020
2020-2021


MISD 8420 Student Residency Placement
4%
4%
21%
29%
4%
8%
17%
4%
8%
Child Neurology
Emergency Medicine
Family Medicine
Internal Medicine
Neurology
OBGyn
Pediatrics
Phyiscal Med & Rehab
Psychiatry

Abstract I

Bad Reputation: Using Three-dimensional Printed Heart Models to Supplement Cardiac Ultrasound Training for Undergraduate Medical Students.

Kate M. Serralde, Vaughan H. Lee, and Gregory L. Brower

Abstract

What is the point of a 3D printed model of a heart? On the surface, this seems like a pretty basic question. But 'what's the point' questions are anything but basic. This is a statement that our heart has no inherent purpose. And it makes me wonder: how has our heart earned such a bad reputation? Did it spend too much time smoking in the bathroom? In many ways, our heart has earned this reputation. Like its closely related cousin, the art object, the 3D printed model is essentially non-utilitarian. Our heart lacks a definite function like a hammer or stethoscope and for the most part it is simply meant to be regarded. Through a collaboration with the medical education department, we answered this question when we tested the effectiveness of incorporating 3D printed heart models into novice sonographers' educational practices.

Study: Undergraduate medical students struggle with visualizing dynamic aspects of cardiac anatomy and physiology when learning ultrasound. Three-dimensional (3D) printing is an emerging technology used to produce accurate anatomical models. However, this technology has not as yet been evaluated as an adjunct in teaching first-year undergraduate medical students integrated Point of Care Ultrasound. The goal of this study was to determine if 3D heart models are effective to aid students in acquiring and interpreting normal cardiac images obtained using B-mode ultrasound. Methods: 3D cross-sectioned models depicting both halves of a human heart cut along the parasternal long axis (PLAX) plane were created using computed tomography (CT) DICOM data. Through segmentation, this data set, was used to create a model in stereolithographic file format to generate the 3D print. The heart models were made available to first-year medical students (total n=196) completing a cardiac POCUS activity in the Structure and Function of Major Organ Systems block at XXXX School of Medicine. Each student had to acquire and submit a PLAX image for a grade. Results: The in-house printing of 3D cardiac models was $64. This is considerably less expensive than commercial models. Students found the PLAX cardiac heart models to be useful for orienting themselves during cardiac ultrasound training. Conclusion: Our experience incorporating 3D printed heart models in medical anatomy and physiology education, provides evidence that 3D printed cardiac models help novice sonographers better understand relevant surface and cardiac anatomy. Accordingly, in-house printing of 3D cardiac models is a cost-effective approach to facilitate development of clinical skills in first-year medical students.

Abstract II

Having my cake and eating it too: Using 3D printing to enhance

Kate M. Serralde, Jennifer Mitchell, MD, FAAFP, FAMSSM, & Jaime Diaz

Medical Curricula in the time of Covid

When social distancing went from a suggestion to an imperative; replacing face-to-face interaction with screen to screen interfacing – all of us were presented with a new set of challenges. There was the challenge in moving my 3D-printing library service into my living room and teaching curricula to a total virtual setting. But Jennifer Mitchell, MD, Professor of Family Medicine, had a more complicated problem: How to teach students to set an arm in a short arm cast in a virtual setting. Her solution? Mail each student a 3D-printed arm model and organize a virtual workshop to teach the techniques of applying a short arm cast. While still sequestered in our homes, my staff and I had three weeks to design, print, assemble and paint twenty-one adult size arm models to ship the homes of third-year undergraduate medical students. A piece of cake, right? Actually, it was. This project serves as an excellent example of how 3D printing can play a key role within everyday medical practices and medical curriculum, especially in the time of Covid-19. While the future is uncertain, we must be positive in the value of experimentation and research into practical applications with new technology.

Keywords: 3D printing, segmentation, medical education, medical library service; Covid-19

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