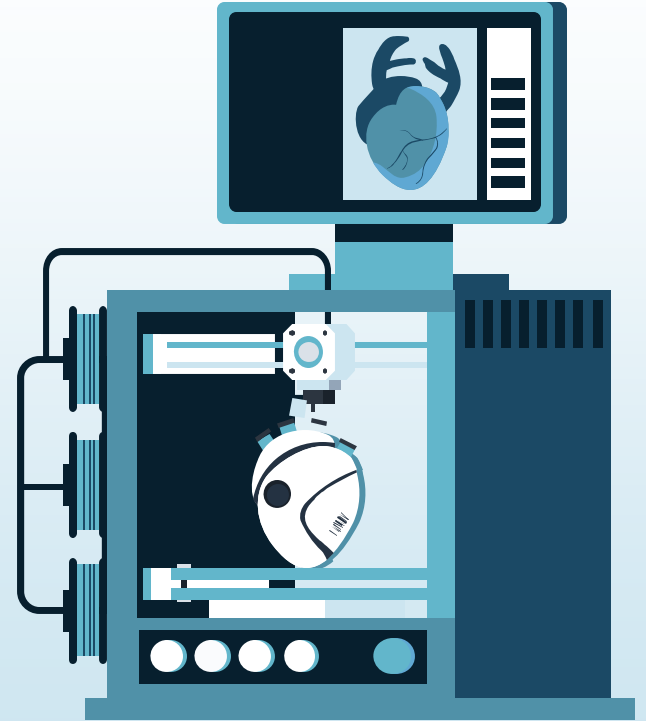


# Recycling for 3D Printing at UNAM

Cassidy Choquette, Tobias Enoch,  
Jacob Saunders, Nikesh Walling



# Presentation Roadmap



**01**

Project Overview

**03**

Results

**05**

Future Work

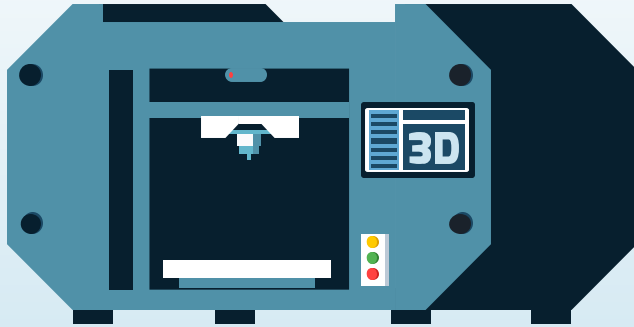
**02**

Methodology

**04**

Discussion

# Useful Terms



FDM 3D Printing



Filament



CAD

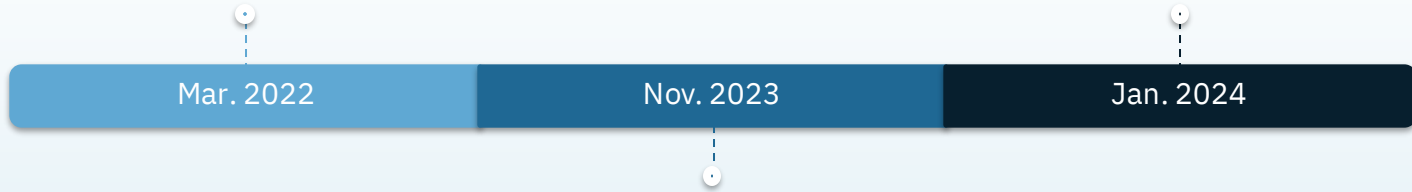
# *Project Overview*

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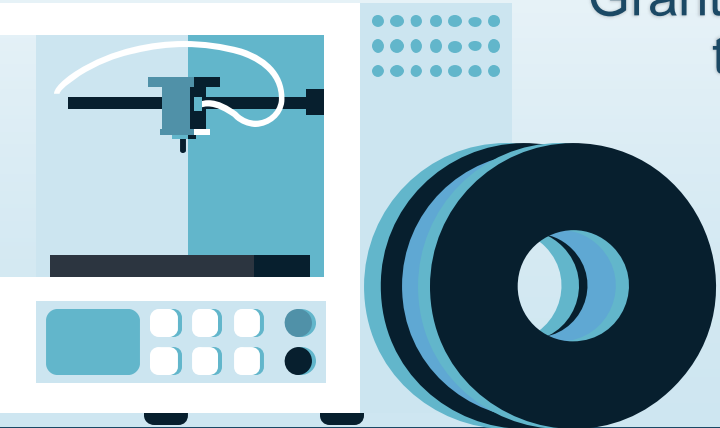


UNAM's grant from Dirsana+ starts the Forge 3D Lab

Start of our IQP to provide a supply of filament



Grant ends, leaving no funding to purchase filament





# Objectives

Create a renewable supply of filament from waste plastic for the Forge 3D Lab.



# Objectives



## Assess

Assess the use of and need for 3D educational aids at UNAM.



## Identify

Identify ethical considerations in medical education in Southern Africa



## Construct

Construct a filament extruder and create a renewable source of filament



# *Methodology*

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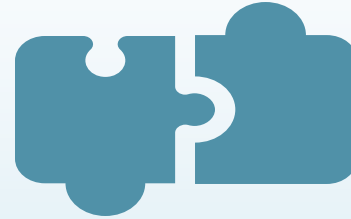


# Mixed Methods Approach



## Qualitative Data Collection

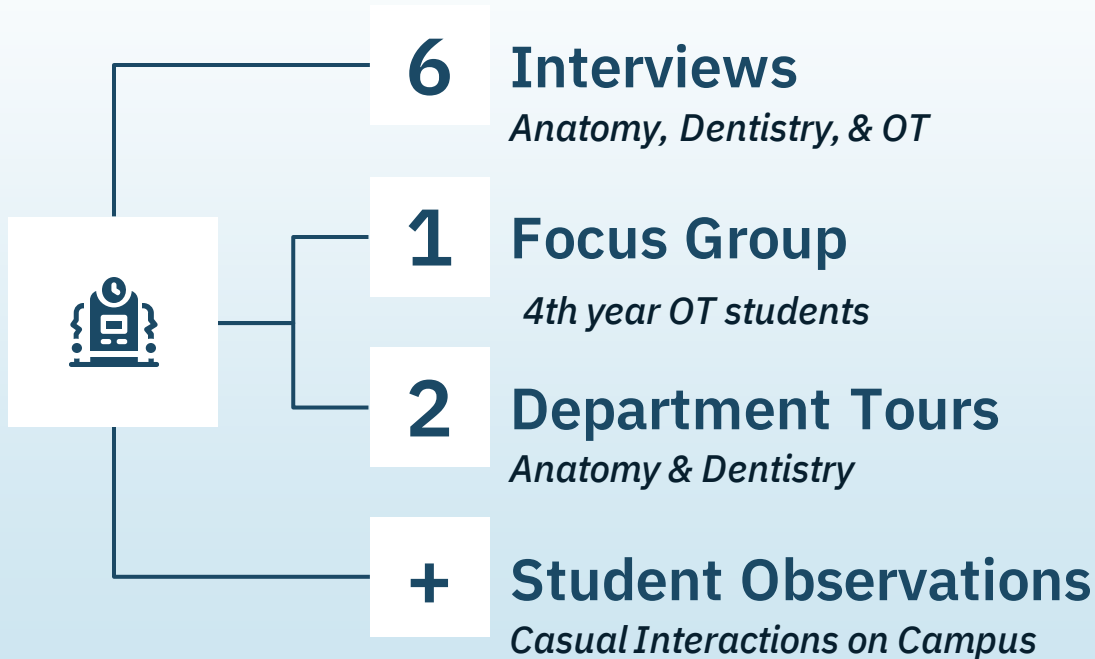
Focus group with UNAM students  
In-depth interviews with UNAM staff



## Technical Engineering Work

CAD models and sourcing  
Construction of filament production set-up

# Qualitative Data Collection Methods



# Qualitative Data Collection

Participant	Date of Interview	Duration	Profession
Participant 1	March 19th, 2024	1 hour, 41 minutes	Anatomy Professor
Participant 2	March 27th, 2024	59 minutes	Dentistry Technician
Participant 3	March 27th, 2024	52 minutes	OT Professor
Participant 4	April 4th, 2024	39 minutes	Anatomy Professor
Participant 5	April 5th, 2024	33 minutes	Anatomy Technician
Participant 6	April 5th, 2024	42 minutes	Anatomy Technician
Focus Group	April 5th, 2024	40 minutes	4th-Year OT Students

# Data Analysis & Coding

## Primary Code

*Derived from overarching topics*

## Secondary Code

*Reflect arguments within primary themes*

Ethics

Cultural Rights

Legal Precedent

“Bridging the Gap”

2D to 3D

Multimodal Learning

Teaching Models

Material Lifespan

Availability

Cost

Funding

Revenue Stream

“Patient Individuality”

Time Cost

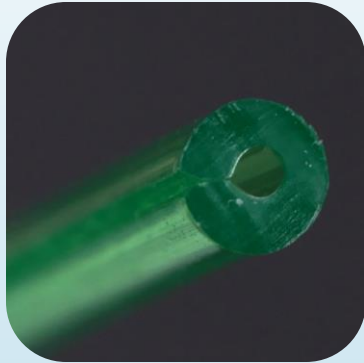
Personalization

# Technical Methodology: Filament Creation

Bottle  
Cutting



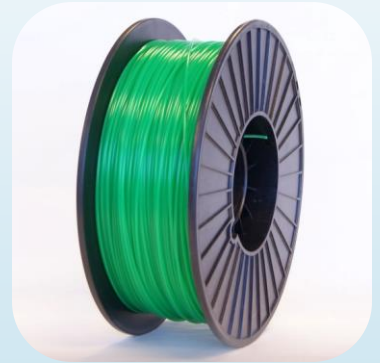
Pulltrusion



Pelletization



Extrusion



# Results

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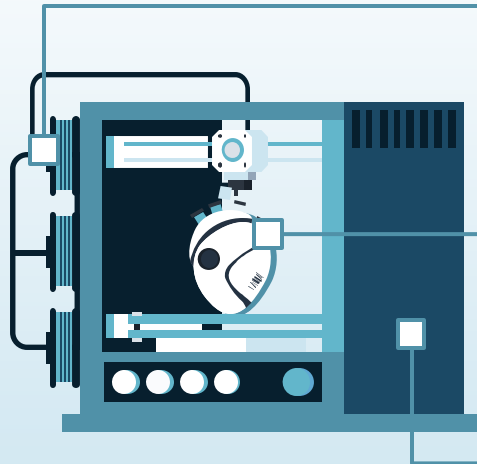
UNAM  
UNIVERSITY OF NAMIBIA  
Hage Geingob  
Campus

# Objective #1

To assess the use of  
and need for  
educational aids at  
UNAM



# Common Themes: Interviews



4/6

## 3D Learning

Stressed importance in anatomy

4/6

## "Bridging the Gap"

Finding a method in between 2D and cadavers

3/6

## Multi-Modal Learning

Emphasized the importance of various study tools



# Anatomy:

## “Bridging the Gap”

---

"If I scan the thing, I have a 3D model that I can show the students on screen in three dimensions that **bridges the textbook with paper...**"

**- Participant 1**



“You go to the lab, and they put a sticker on a specific part, either an organ or skull muscle and then they will ask you what that is. But, at home you are only studying from a textbook, not a 3D.”

- 4th Year OT Student:





# Dentistry

## Traditional vs. Contemporary Methods

"For me, the digital system is, it's kind of like an add-on ... It's basically supplementary to the conventional methods - It's really important that [dentistry students] grasp the concept fundamentally from the conventional method."

- Dentistry Tech.

# Occupational Therapy

## Personalization and Time

---

“Physical Therapists teach you how to **walk**, Occupational Therapists teach you how to **dance**.”

“It can take up to **two to three hours** to make one splint”

**- Participant 3**

<https://captionsswapde.blogspot.com/2021/03/picture-of-splint.html>



# Objective #2

To identify ethical considerations in medical education in Southern Africa



# Ethical Considerations in Anatomy



## Identifiability

Patient privacy when publishing



## Cultural Traditions

Respecting the life before the cadaver

## 3D Models

Consent to reproduce materials



# Ethical Considerations in OT

- Assistive devices toward **occupational justice**
- Personalization takes time away from others



# Ethical Considerations in Dentistry

- **Biocompatibility concerns** limits using FDM 3D printing in dentistry
- **Unethical** to use non-biocompatible or expired material

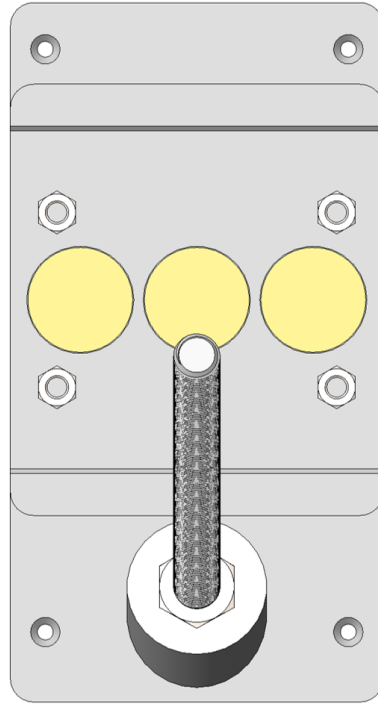
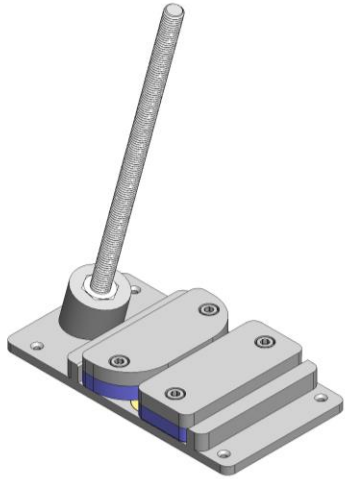




*Objective 3:  
Technical  
Results*

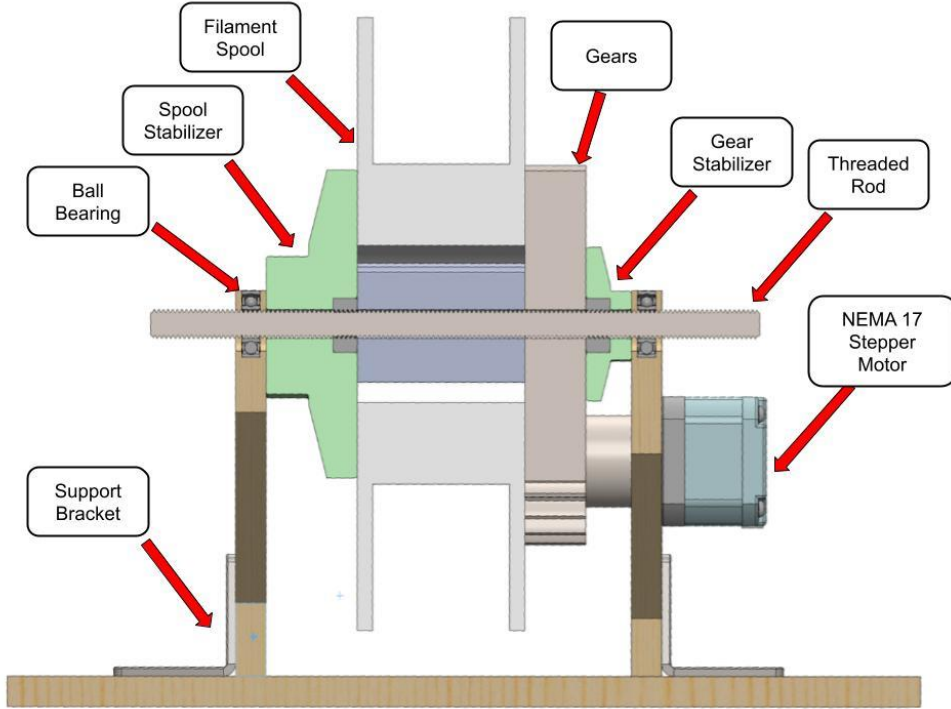
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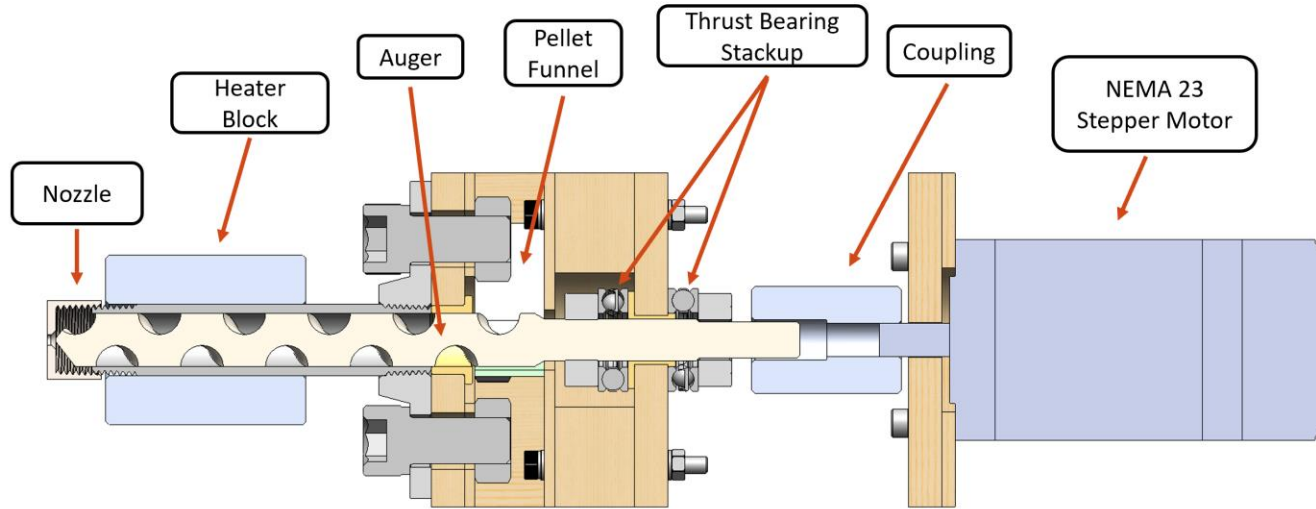
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***Technical  
Design:  
Bottle  
Cutter***



# *Technical Design: Filament Winder*

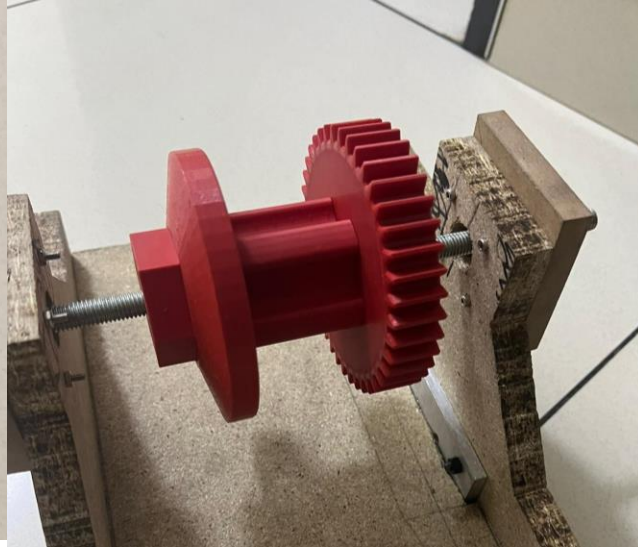
# *Technical Design: Filament Extruder*





# *Design and Sourcing*

- Entire design made to use inexpensive materials that are easily replaceable.
- Mostly sourced in Namibia
- Modular design allows for easy modification



***Current Progress***

A man with a beard and safety glasses is working at a band saw in a workshop. He is focused on cutting a piece of yellow material. The background shows various workshop equipment and tools.

# *Discussion*

---

Is 3D printing a possible solution?

# Results Summary

Medical education requires a mixed methods approach, but some methods, like cadaver dissection, are controversial.

As a public university funded by the government, UNAM suffers from a severe lack of funding.

3D Printing sits in a moral gray area; everyone disagrees on what human remains can and cannot be reproduced.



# Anatomical Models

- Students could bring home 3D printed anatomical models for study
- Ethical considerations regarding replicating cadavers may slow down this process



# Biocompatibility



- Dentistry students can practice 3D modeling and print preparation using the resin printers in the Forge3D lab.
- Less of the expensive, proprietary dental resin will be needed for teaching.

# Assistive Devices

- With 3D printing, OTs could modify 3D CAD files to quickly make personalized assistive devices.
- With 3D printing, a single OT can see more patients while assistive devices are made automatically by a machine.



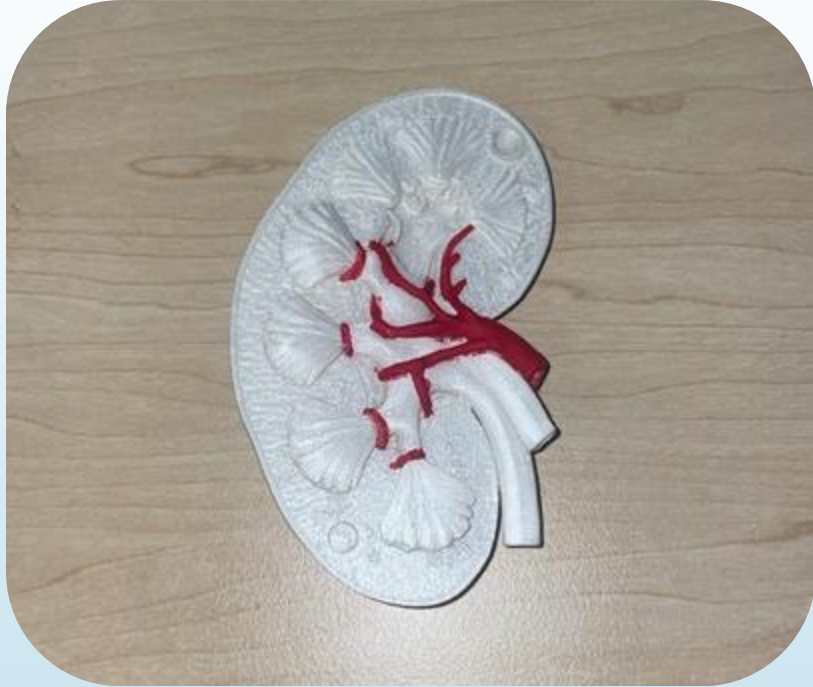
<https://bitfab.io/blog/3d-printed-splints/>

# Technical Progress

- Bottle Cutter ~ 70% Complete
  - Cutter tested and Rev. 2 will be manufactured.
- Filament Winder ~90% Complete
  - Assembled, waiting for electronics.
- Filament Extruder ~50% Complete
  - Nearly all parts manufactured.
  - Tuning and electronics required.



# Conclusions



- **Objective 1: Assess Educational Needs**
  - Many opportunities to use 3D printing in medical education
- **Objective 2: Identify Ethical Issues**
  - 3D printing lies in an ethical grey area in medical pedagogy
  - Technology is currently ahead of the law
- **Objective 3: Construct Device**
  - The device is unfinished, but is in a good state overall

# Future Potential

## Anatomy:

- Professors may print molds to create anatomical models on mass for all students.

## Dentistry:

- Experimentation with silicone molds and advanced resins may lower the cost of practice teeth.

## Occupational Therapy:

- Courses in CAD may allow students to design and build their own 3D printed assistive devices.

## Forge3D Lab:

- 3D printing request service to generate revenue



# Questions?

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