FAMU-FSU College of Engineering

# Team 501
# Tribometer in Spacelike Conditions

VDR1 231017

# Team Introductions

**Branham Channell**
Materials Engineer

**Cobi Johnson**
Systems Engineer

**Madison Retherford**
Mechatronics Engineer

**Javier Ibanez**
Structural Engineer

**Joshua Wesley**
Computer Hardware Engineer

FAMU-FSU College of Engineering

# Sponsor and Advisor

Dr. Brandon Krick

3M Science. Applied to Life.™

Dr. Shayne McConomy

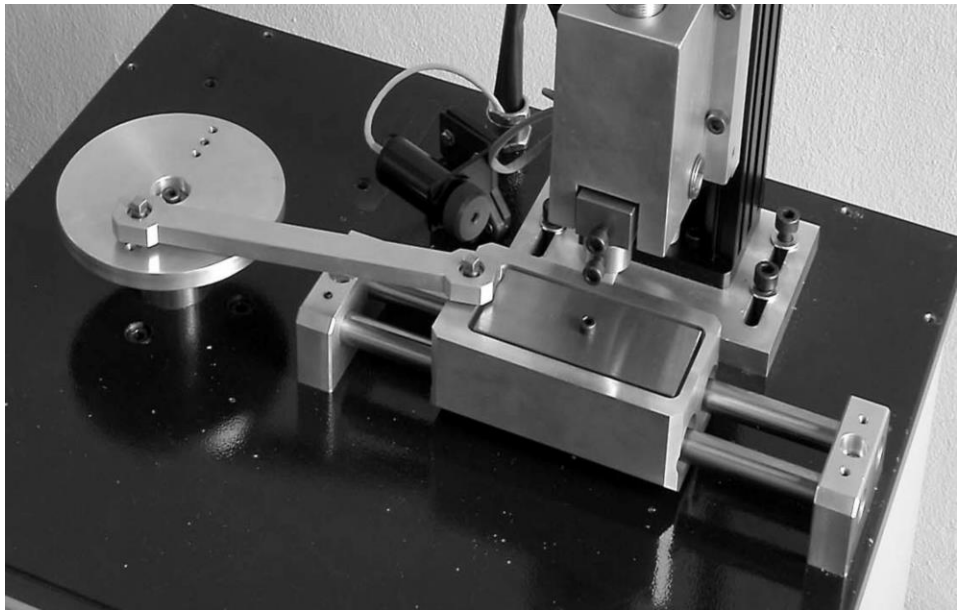
FAMU-FSU College of Engineering

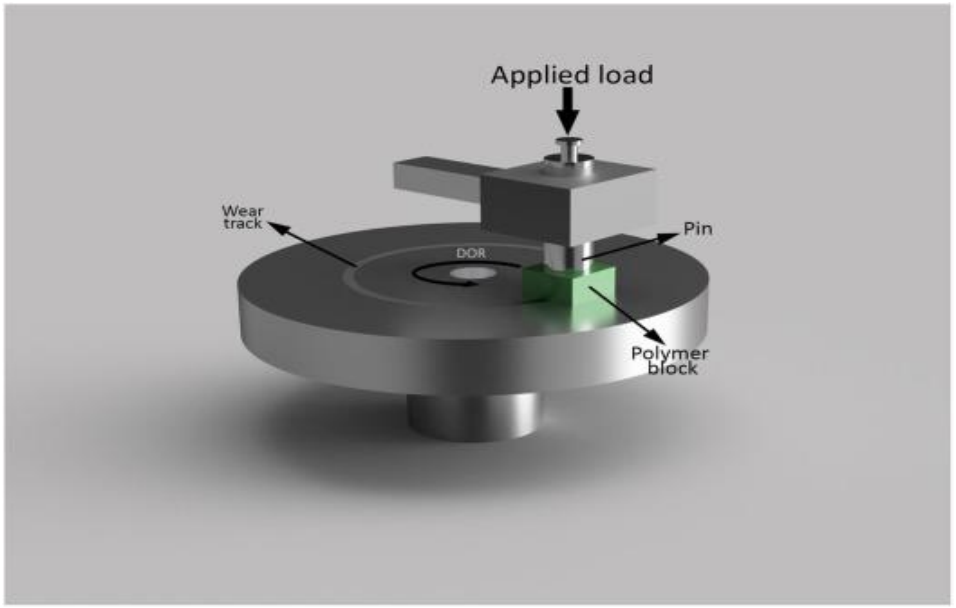
# Objective

The objective of this project is to design, develop, and implement a system that enables the simultaneous testing of multiple samples within a vacuum chamber using a tribometer. This system aims to increase testing throughput and enhance overall efficiency while maintaining prior accuracy and control.

# What is a Tribometer?

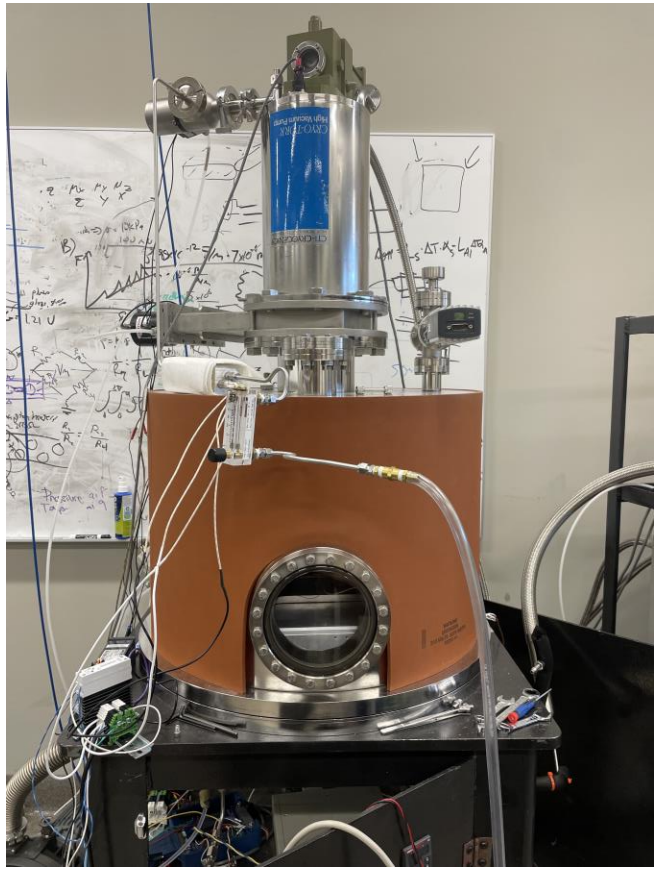
Tribometers measure quantities such as coefficient of friction, friction force, and wear volume on two surfaces in contact by simulating friction in controlled conditions.





# AME's Vacuum Chamber

- Vacuum chambers work by removing air and gas from a vessel using a pump.
- The lab's is a bell-style high-vacuum chamber.
- It can reach pressures as low as $1.5x10^{-6}$ mbar.





FAMU-FSU College of Engineering

# Steps to High-Vacuum

**Step 1**

- Roughing pump pulls initial vacuum on system.
- This "rough vacuum" is around $10^{-1}$ to $10^{-2}$ mbar.

**Step 2**

- Switched to the much stronger cryo-pump.
- Takes vacuum down to $10^{-5}$ mbar quickly.

**Step 3**

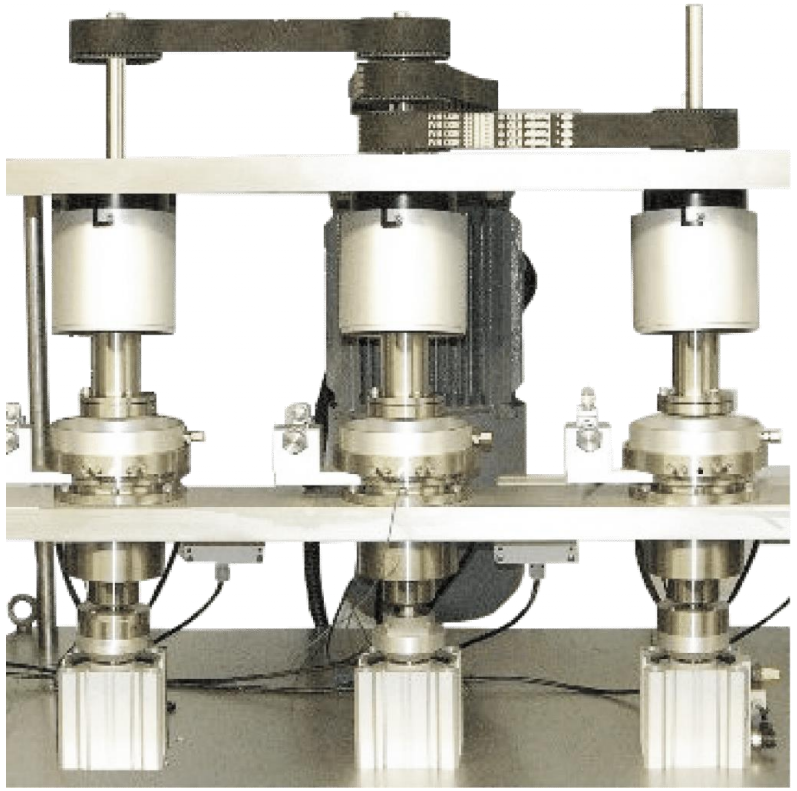
- Let sit overnight (or at least 12 hours).
- Achieves $10^{-6}$ mbar range.



FAMU-FSU College of Engineering

# Key Goals

- **Test multiple samples**
- **Control parameters**
- **Operate in specific conditions**





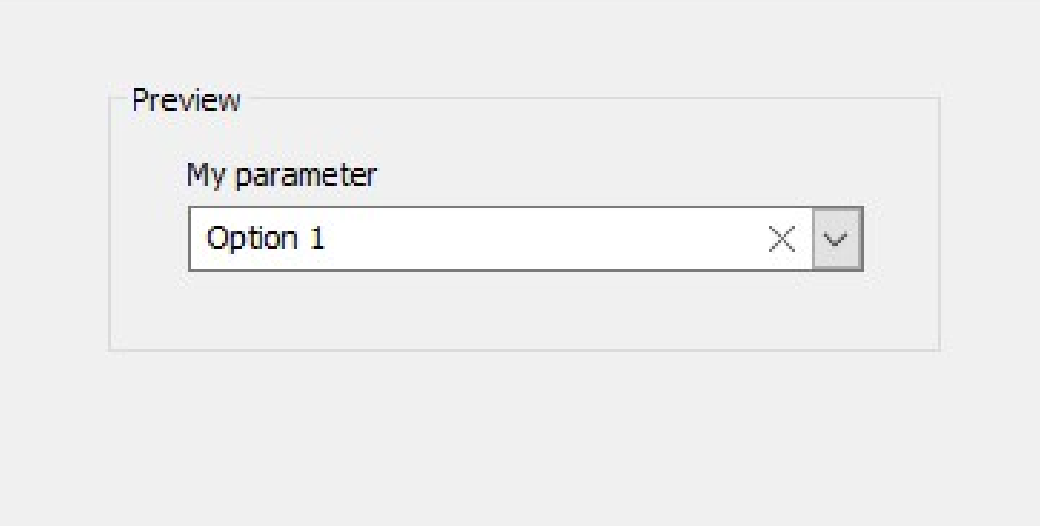
FAMU-FSU College of Engineering

# Key Goals

Test multiple samples

**Control parameters**

Operate in specific conditions



# Key Goals

- Test multiple samples
- Control parameters
- **Operate in specific conditions**

# Primary Market

LOCKHEED MARTIN

BOEING

NASA

# Secondary Market

Sandia National Laboratories

surface technology

REDWIRE

QUALITY CONTROLS CORPORATION

# Tertiary Market

**Dr. David Larbalestier**
Chief Materials Scientist of the National High Magnetic Field Laboratory

**Dr. Lance Cooley**
Director, Applied Superconductivity Center

# Assumptions

Test will be run by individuals with proper training.

Materials that will be tested are polymers and coating.

High-vacuum chamber will be provided.

Applied load and temperature will not be tested outside of the established range.

# Stakeholders - Sponsors

3M Science. Applied to Life.™

# Stakeholders - Manager

**Dr. Brandon Krick**

# Stakeholders - Experts

Dr. Mark Vanderlaan

Dr. Brandon Krick

Dr. Camilo Ordóñez

# Stakeholders - Operators

**Adam Delong**

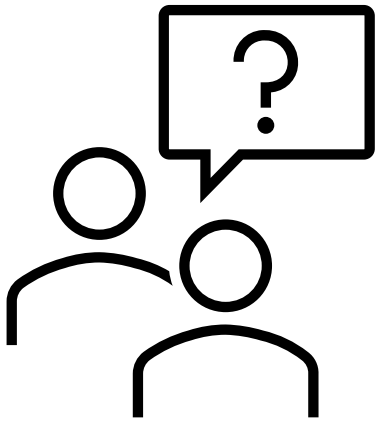
**Kylie Van Meter**

# Stakeholders – General Readers

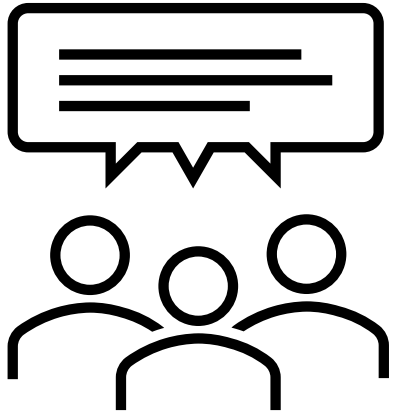
Entec Polymers

Amco Polymers

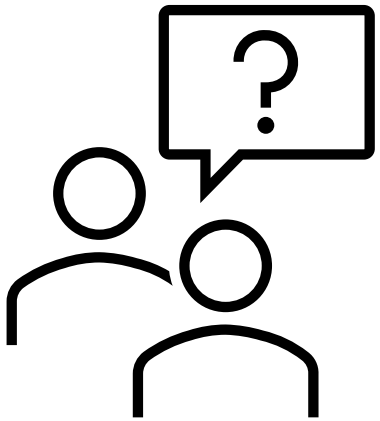
# Customer Needs



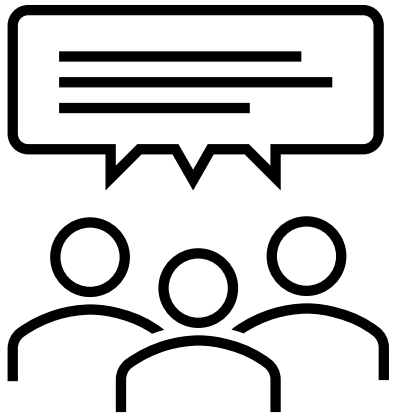
What do you want?



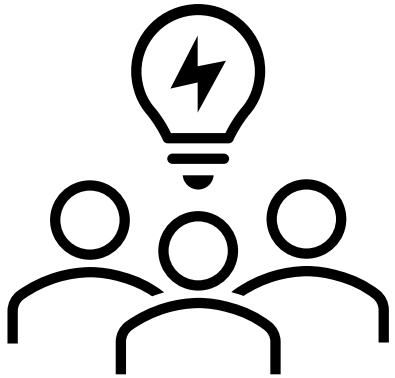
# Customer Needs



To be able to test multiple samples.

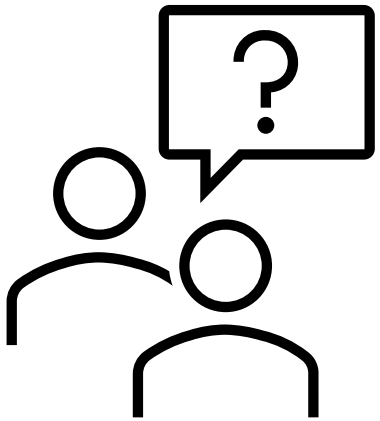


# Interpretation

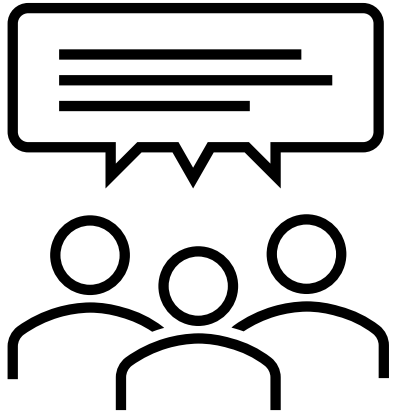


The system tests multiple samples simultaneously.

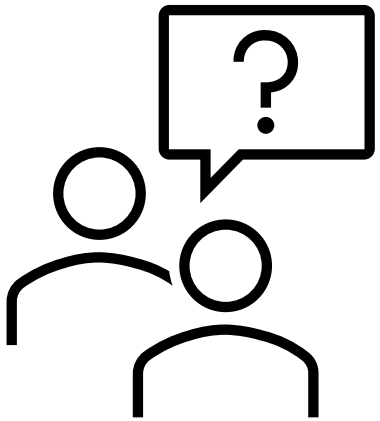
# Customer Needs



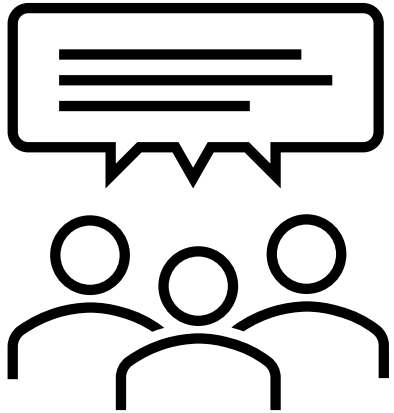
What inputs should the system accept?



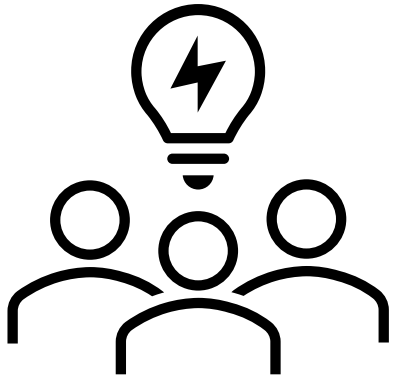
# Customer Needs



Temperature, contact stress, displacement of sample during slide, and number of samples tested.



# Interpretation

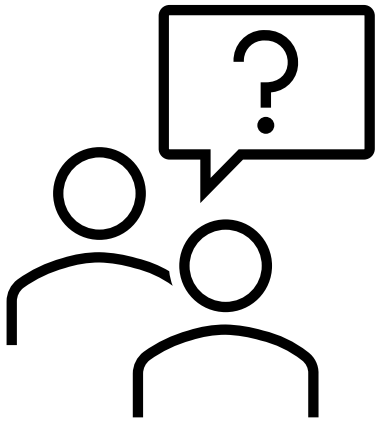


The system reads in and store inputs.

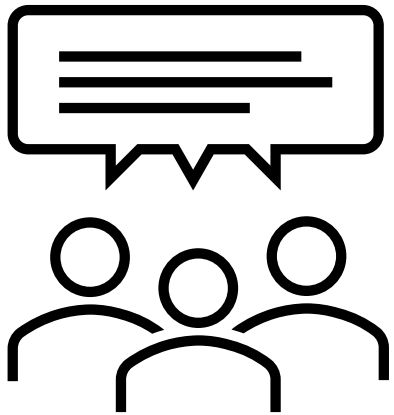


FAMU-FSU College of Engineering

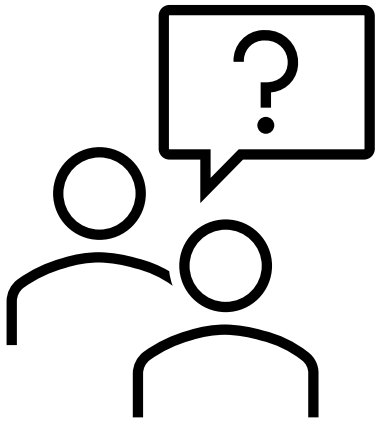
# Customer Needs



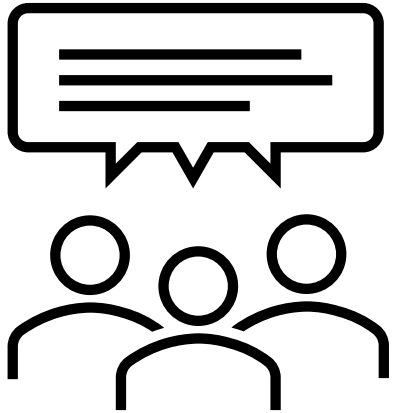
What would you like the system to determine for you and output?



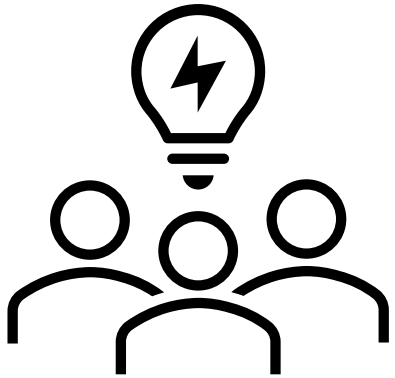
# Customer Needs



Temperature, contact stress, displacement of sample, coefficient of friction, and wear rate.

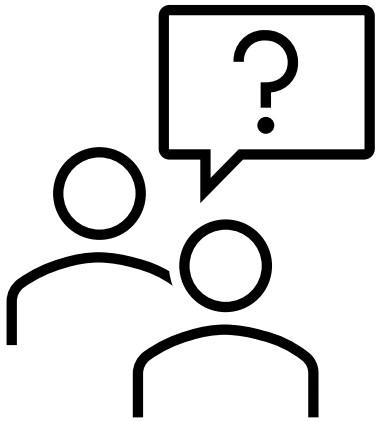


# Interpretation

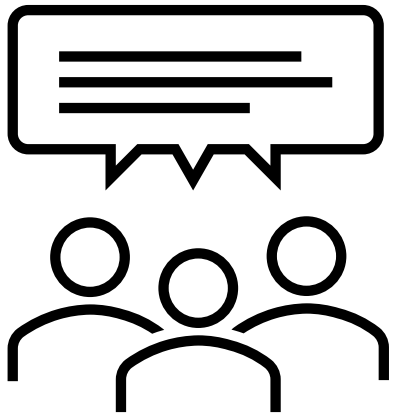


The system returns outputs and critical targets from test results.

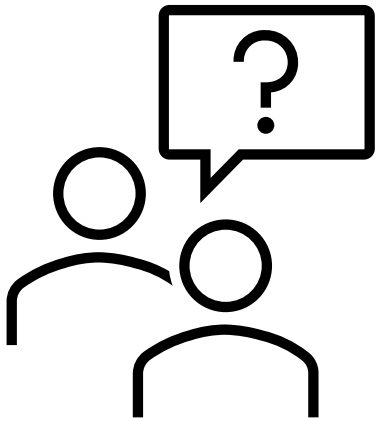
# Customer Needs



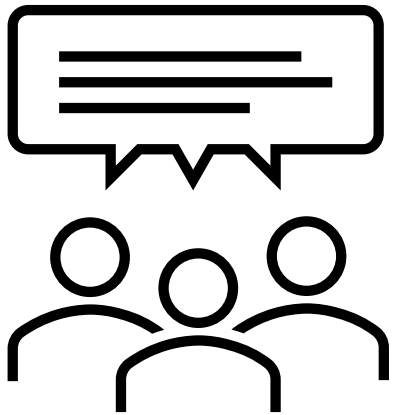
Do you want a visual display returned along with the parameter outputs?



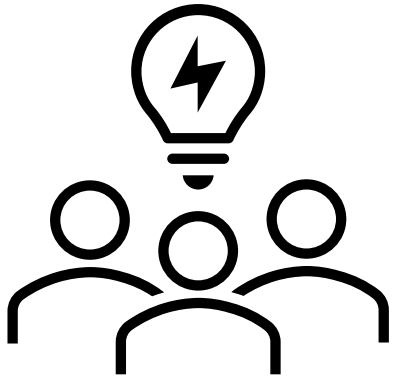
# Customer Needs



A graphical user interface (GUI) exists in MATLAB, design should be compatible with this GUI.

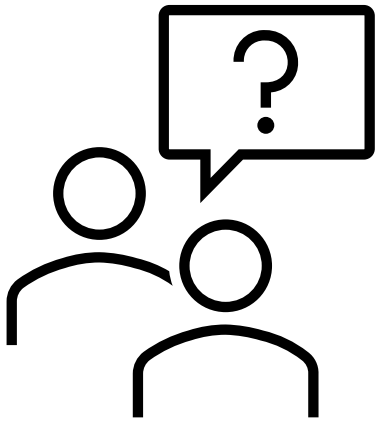


# Interpretation

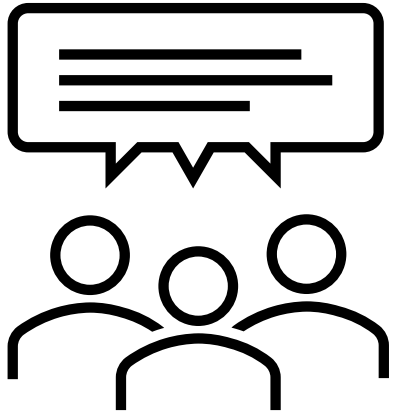


The system is compatible with the previous graphical user interface.

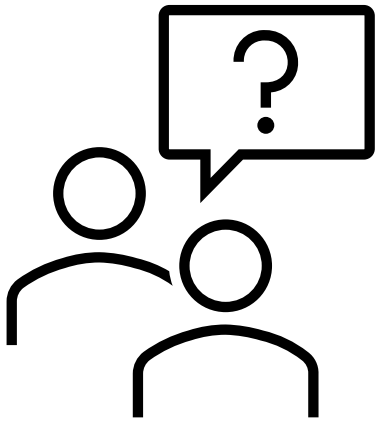
# Customer Needs



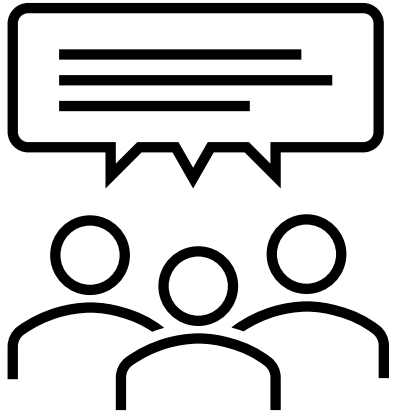
Where will this system need to work?



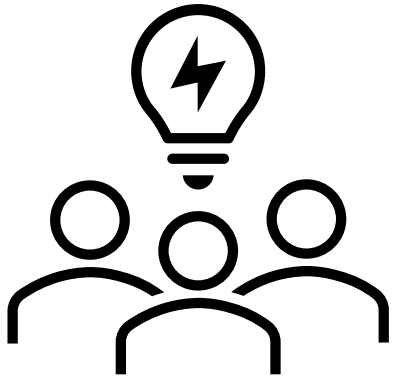
# Customer Needs



Our chamber will only reach high-vacuum.

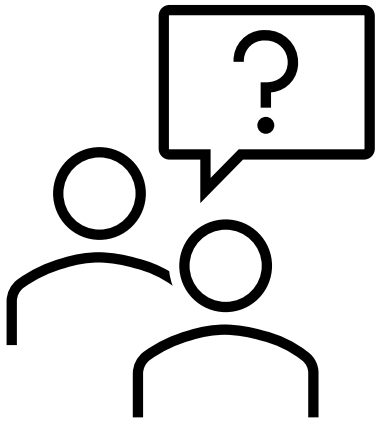


# Interpretation

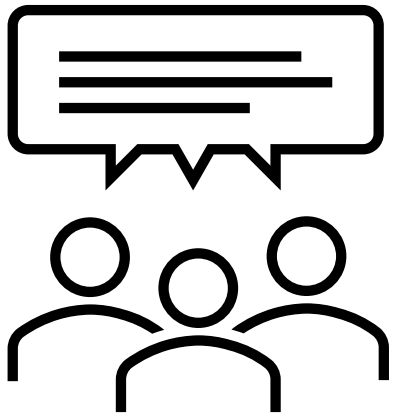


The system can operate under high-vacuum conditions.

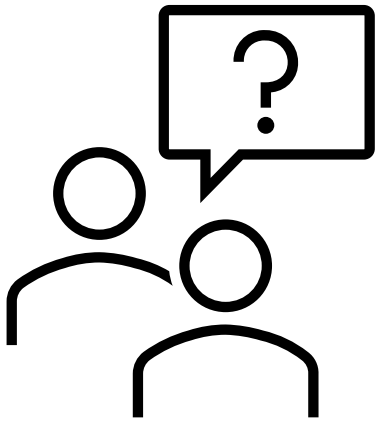
# Customer Needs



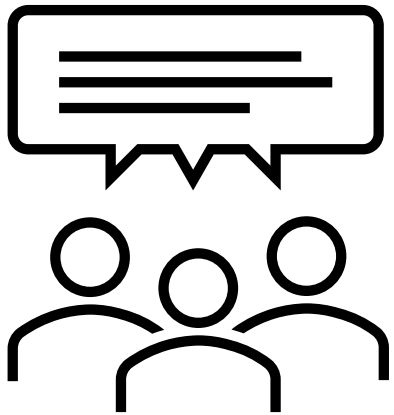
Do we need to modify the vacuum chamber?



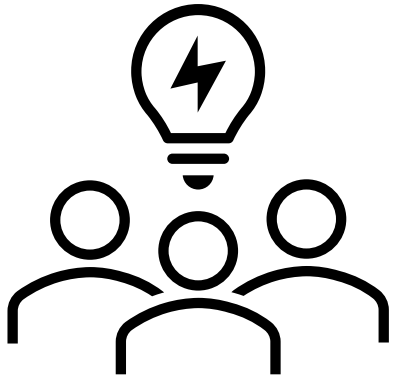
# Customer Needs



No, the system only needs to fit in the vacuum chamber and work under its pre-set conditions.

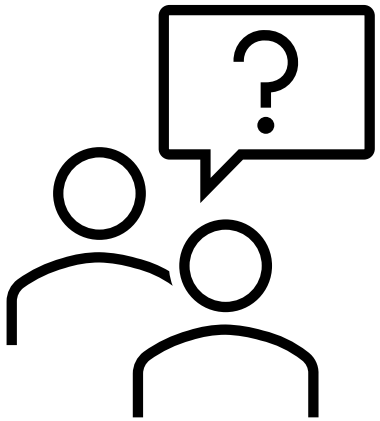


# Interpretation

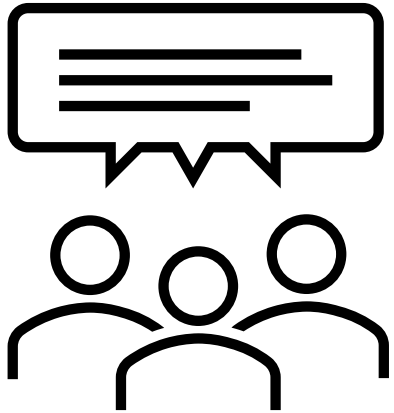


The chamber needs no modification.

# Customer Needs



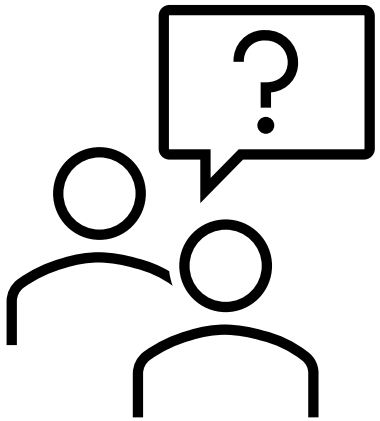
Do the different samples need their own inputs?



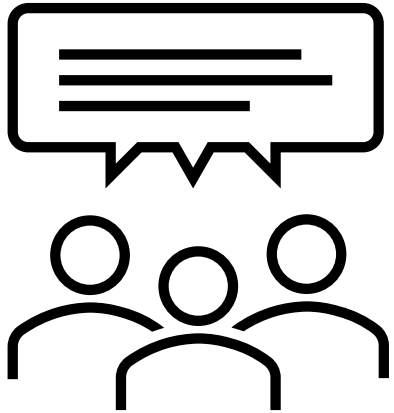


FAMU-FSU College of Engineering

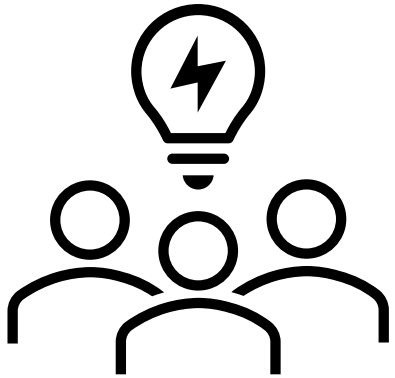
# Customer Needs



To test the same material under different conditions, different contact stresses must be applied to each sample.

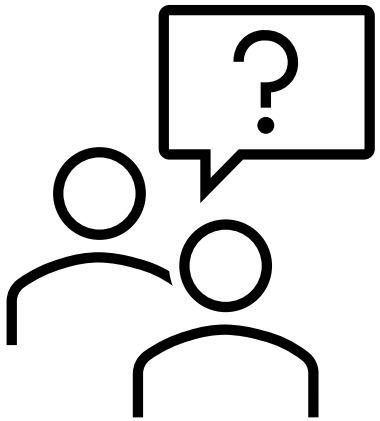


# Interpretation

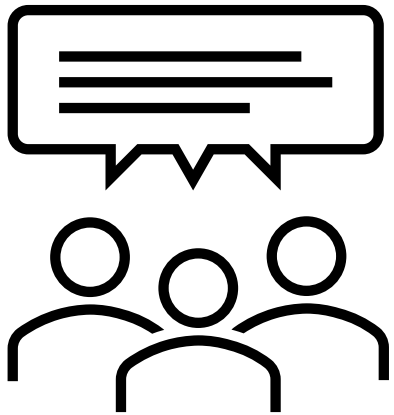


The system can apply different inputs to different samples.

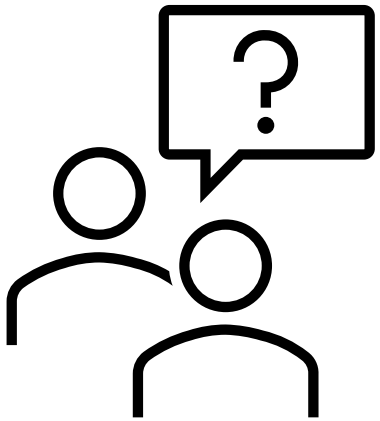
# Customer Needs



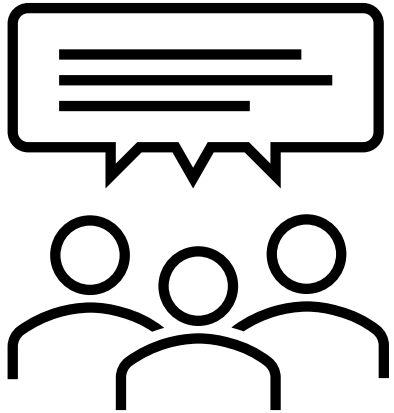
What do you consider a success for this project?



# Customer Needs



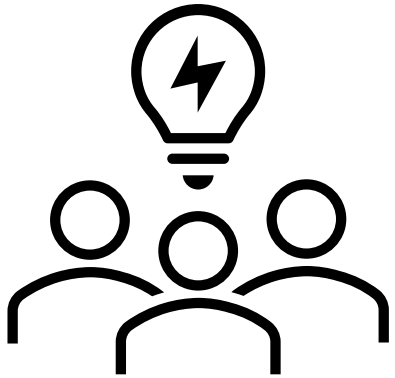
Minimum: single sample prototype that can be expanded in the future. Great success: functional model that can test four to six samples.





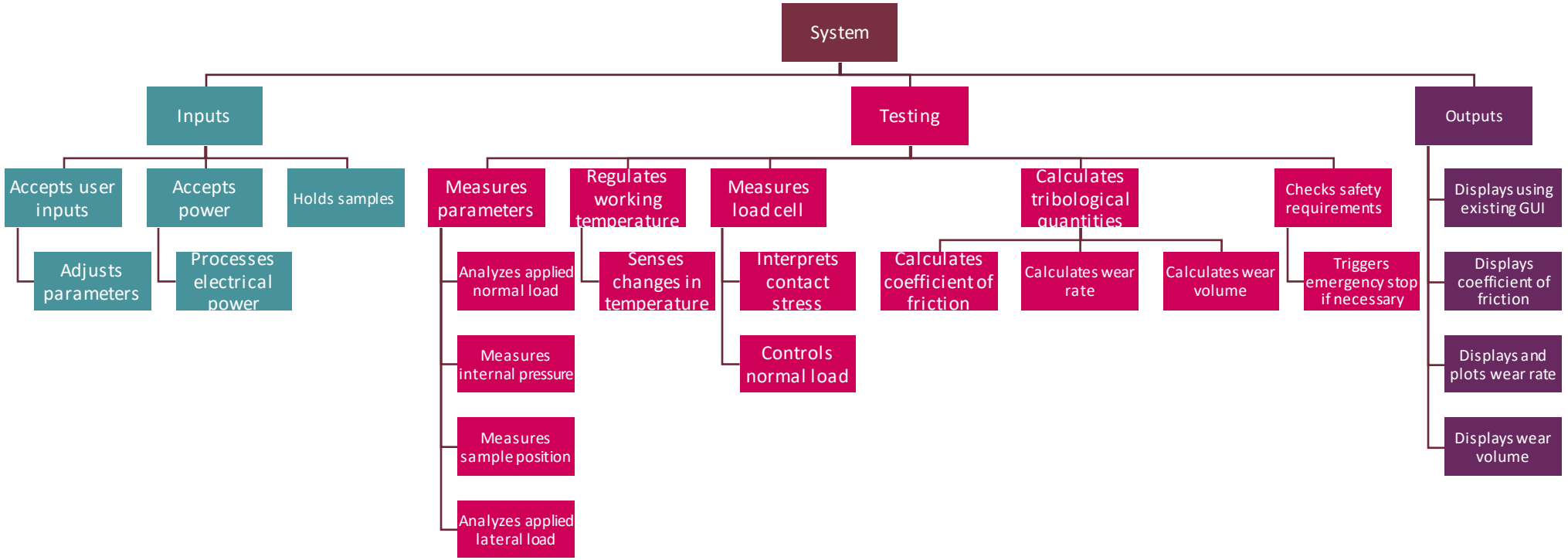
FAMU-FSU College of Engineering

# Interpretation



The system can test at least one sample, but ideally four to six.

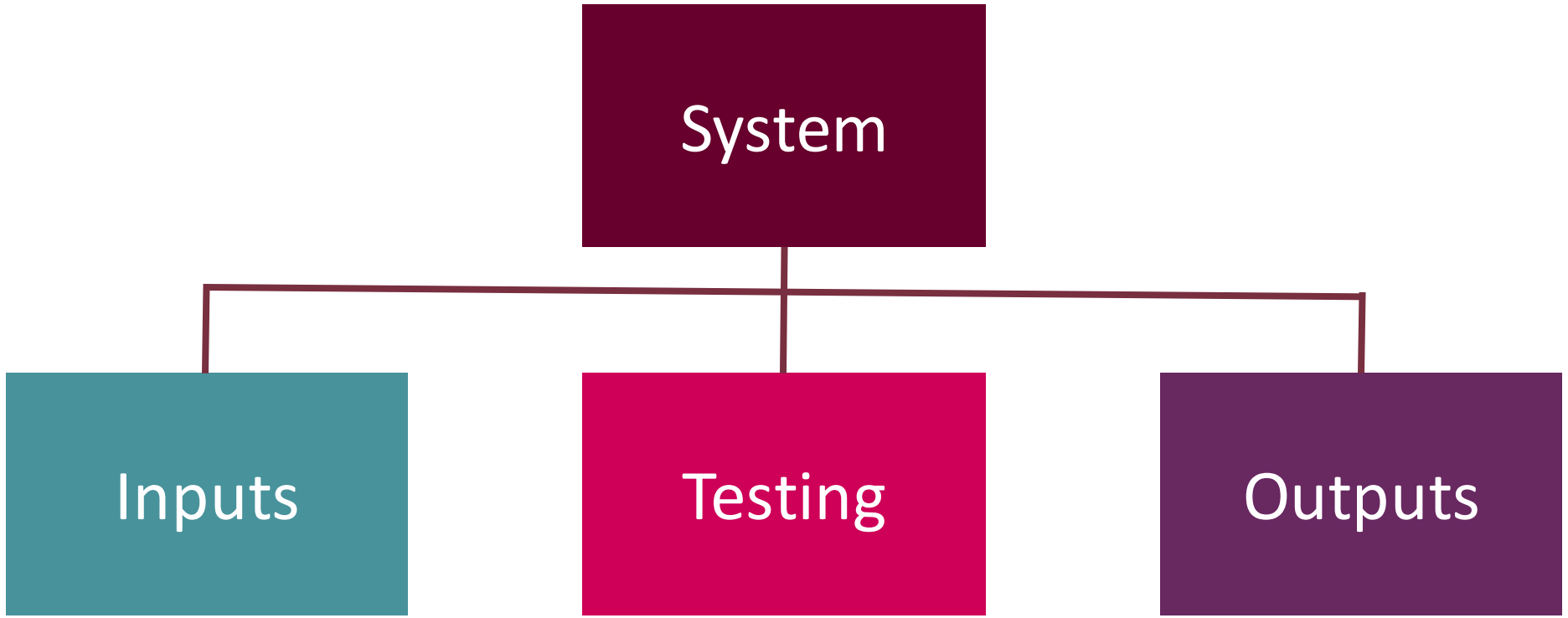
# Functional Hierarchy Chart






FAMU-FSU College of Engineering

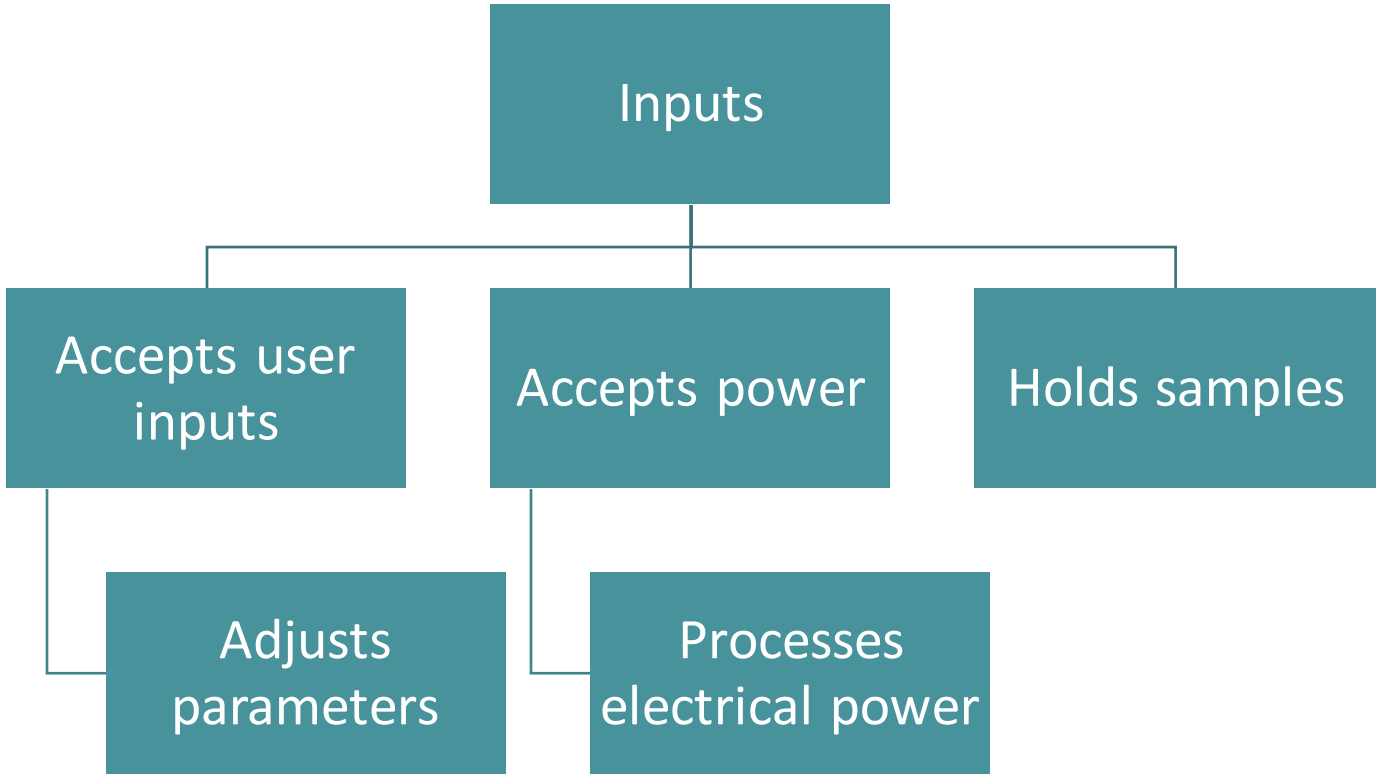
# Functional Hierarchy Chart






FAMU-FSU College of Engineering

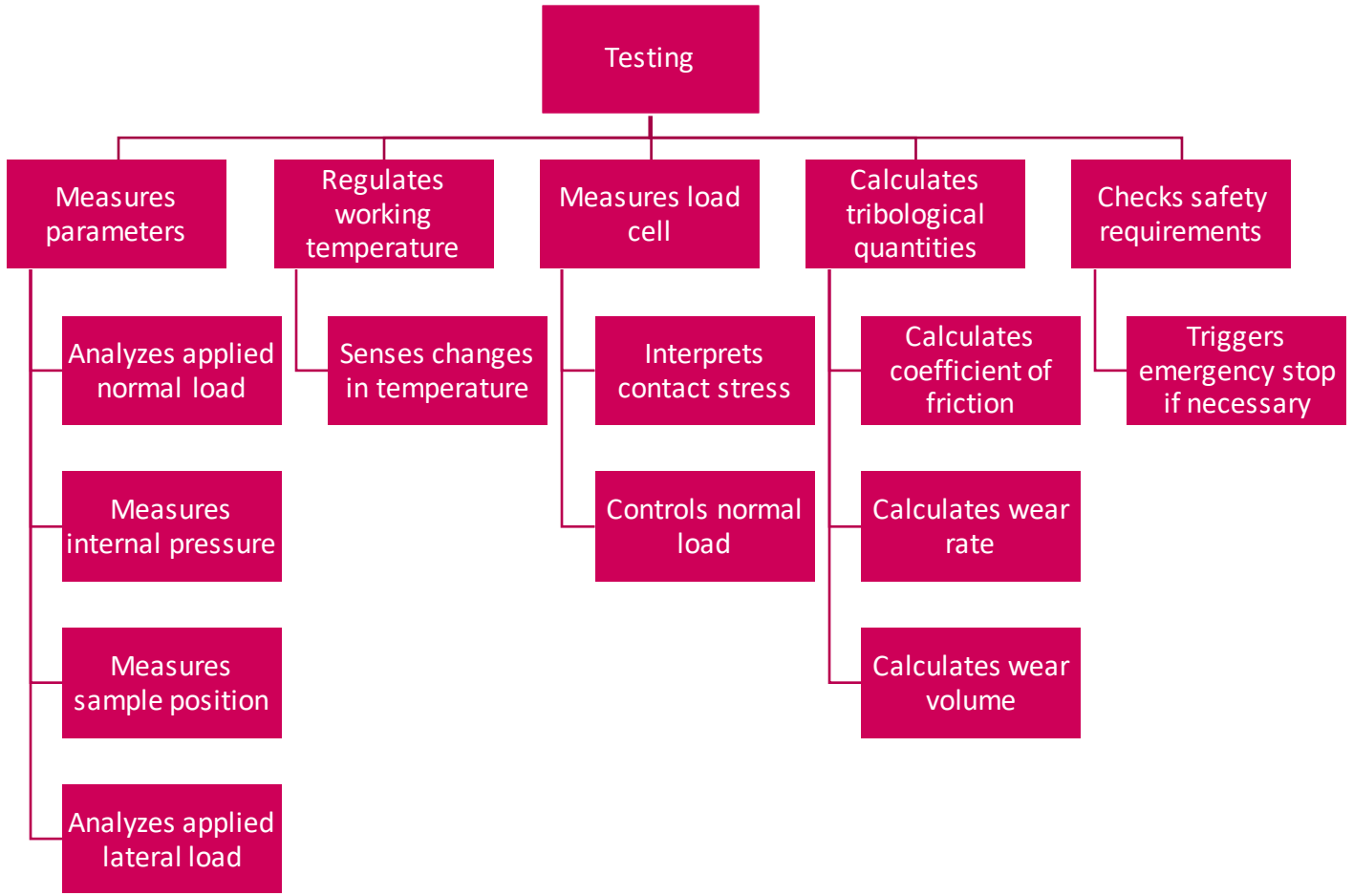
# Functional Hierarchy Chart






FAMU-FSU College of Engineering

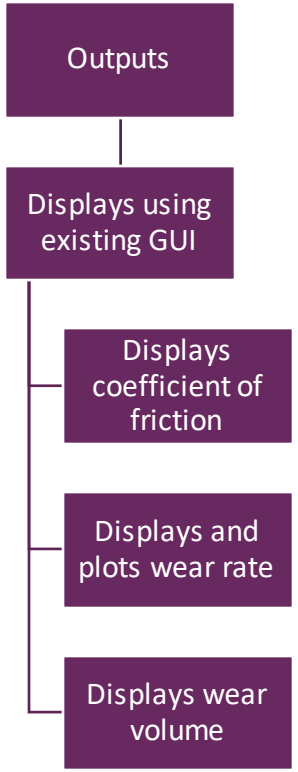
# Functional Hierarchy Chart






FAMU-FSU College of Engineering

# Functional Hierarchy Chart

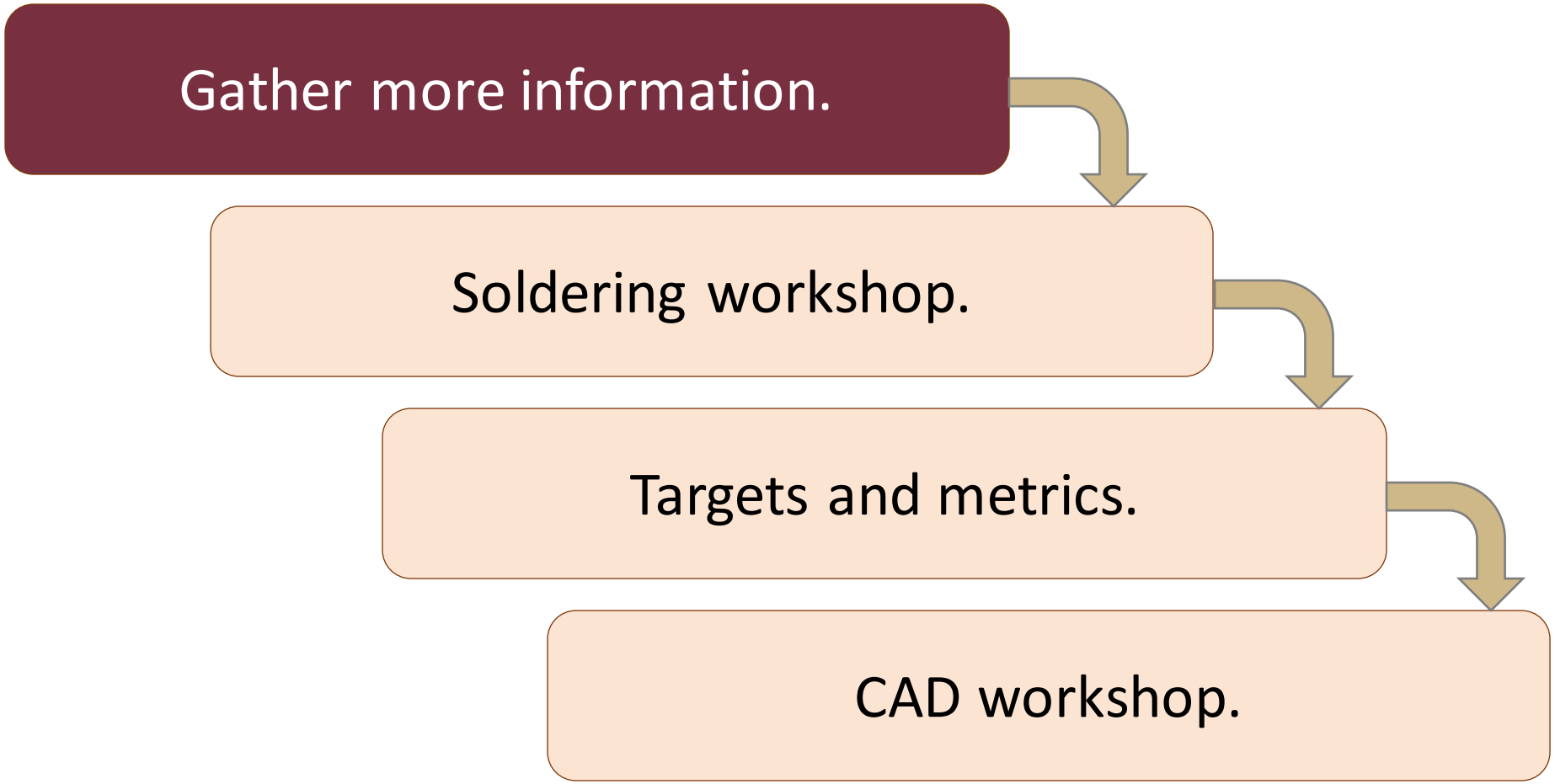




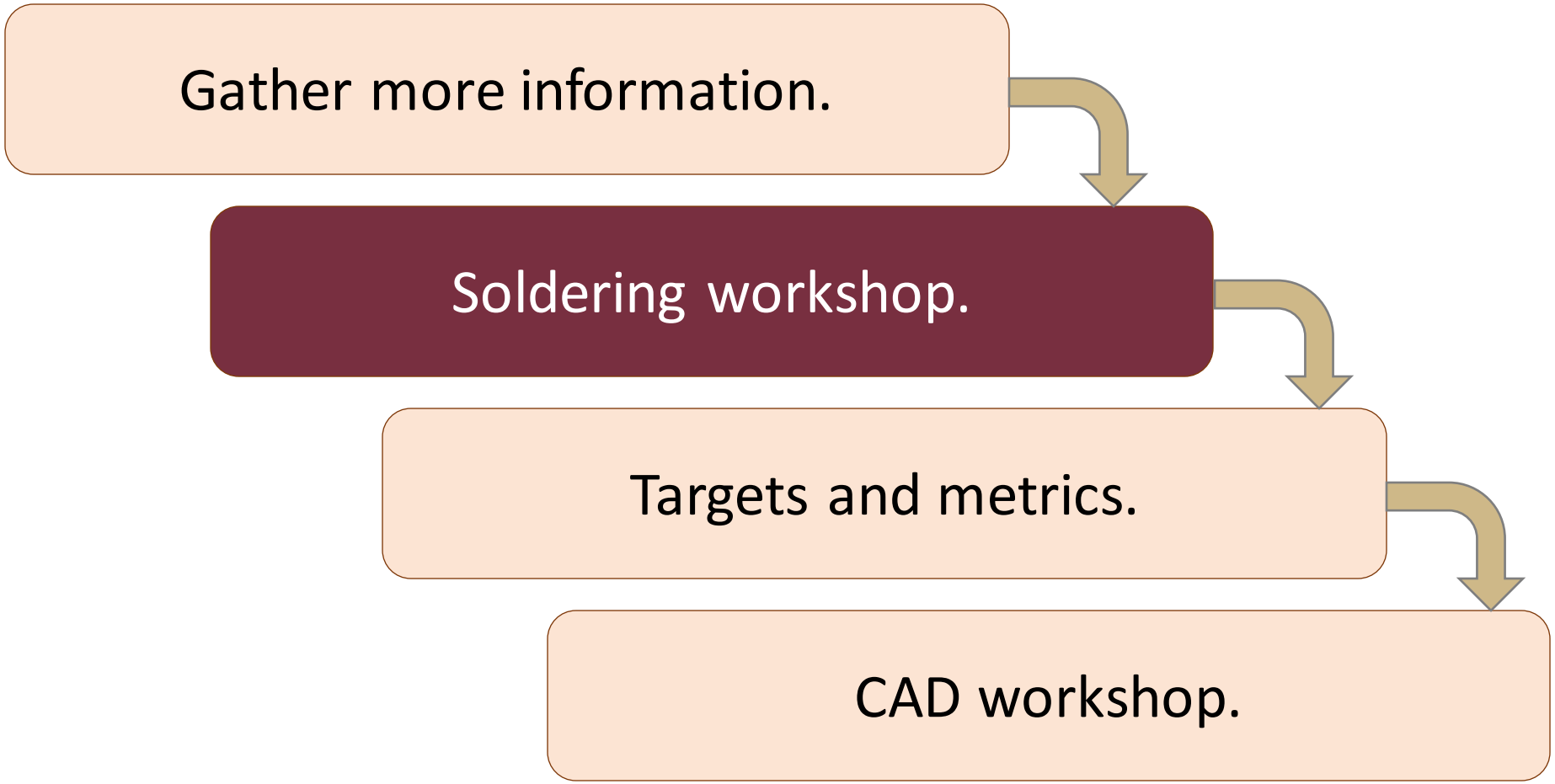

FAMU-FSU College of Engineering

| Functional Cross-Reference | Inputs | Testing | Outputs |
|---|---|---|---|
| Accepts user input. | X | X | |
| Accepts power. | X | X | |
| Holds samples. | X | X | |
| Measures parameters. | | X | X |
| Regulates working temperature. | X | X | X |
| Measures load cell. | X | X | |
| Calculates tribological quantities. | | X | X |
| Checks safety requirements. | X | X | X |
| Displays using existing GUI | | | X |

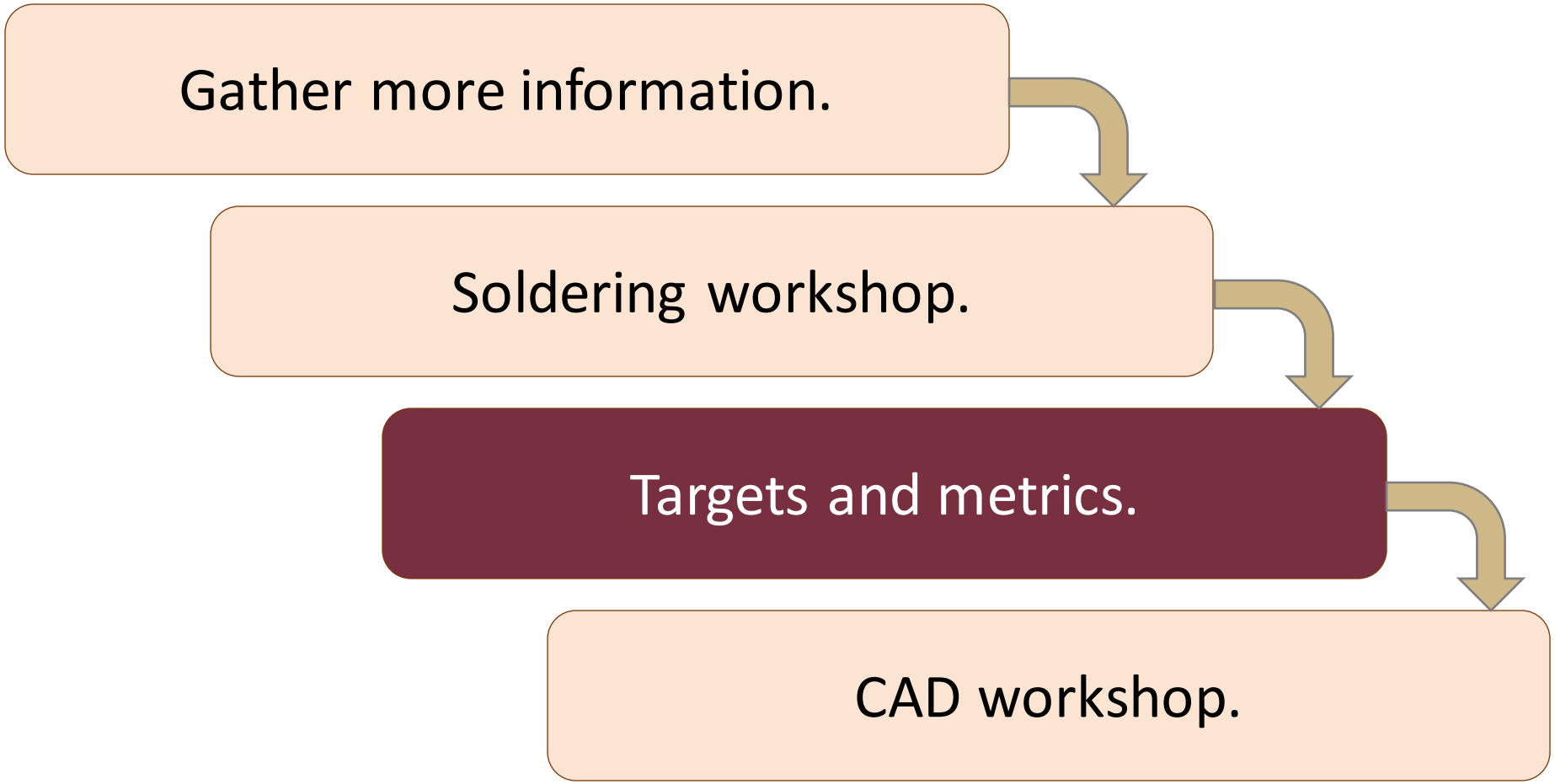
# Future Work


Gather more information.
Soldering workshop.
Targets and metrics.
CAD workshop.

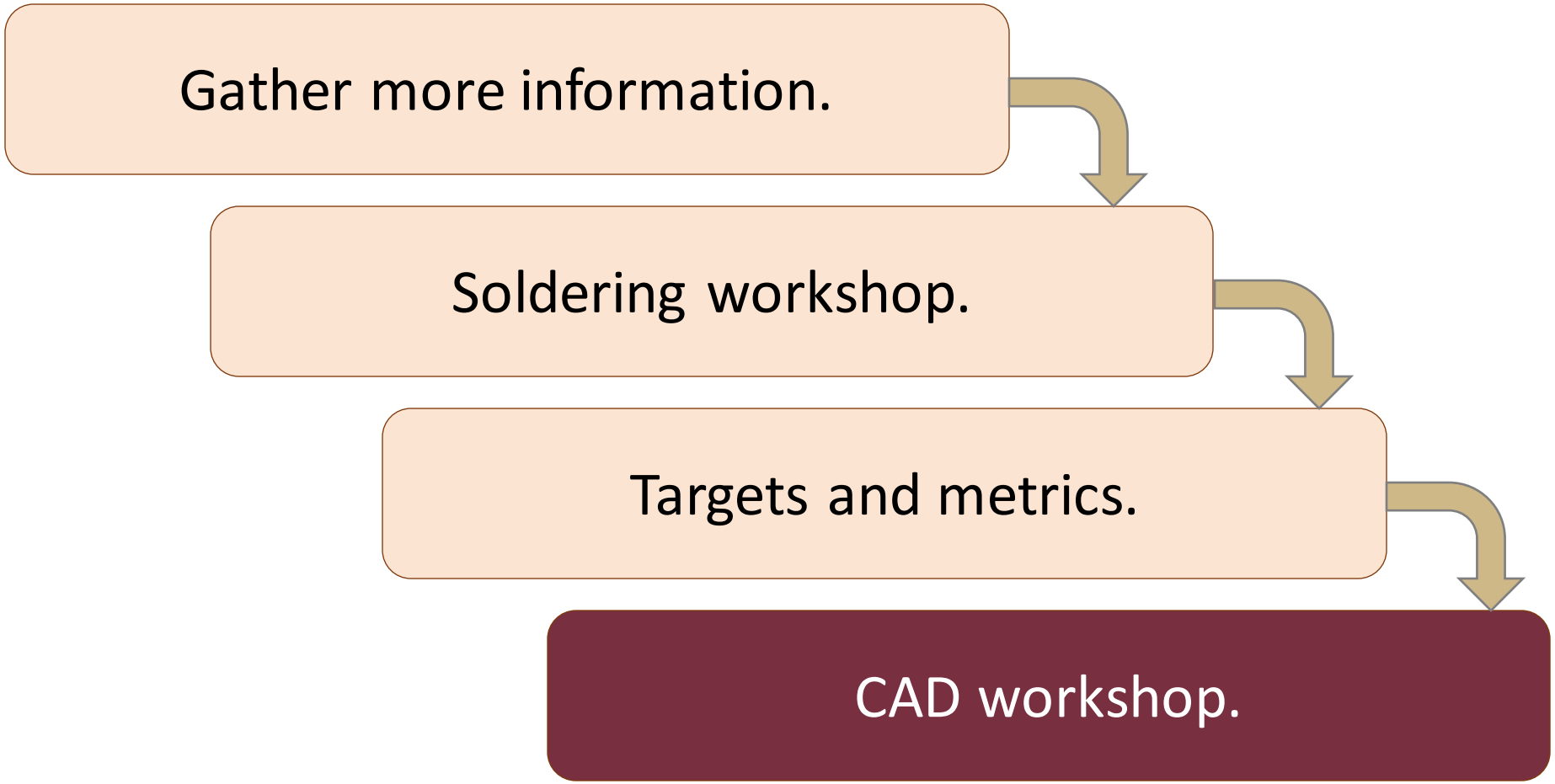
# Future Work


Gather more information.
Soldering workshop.
Targets and metrics.
CAD workshop.

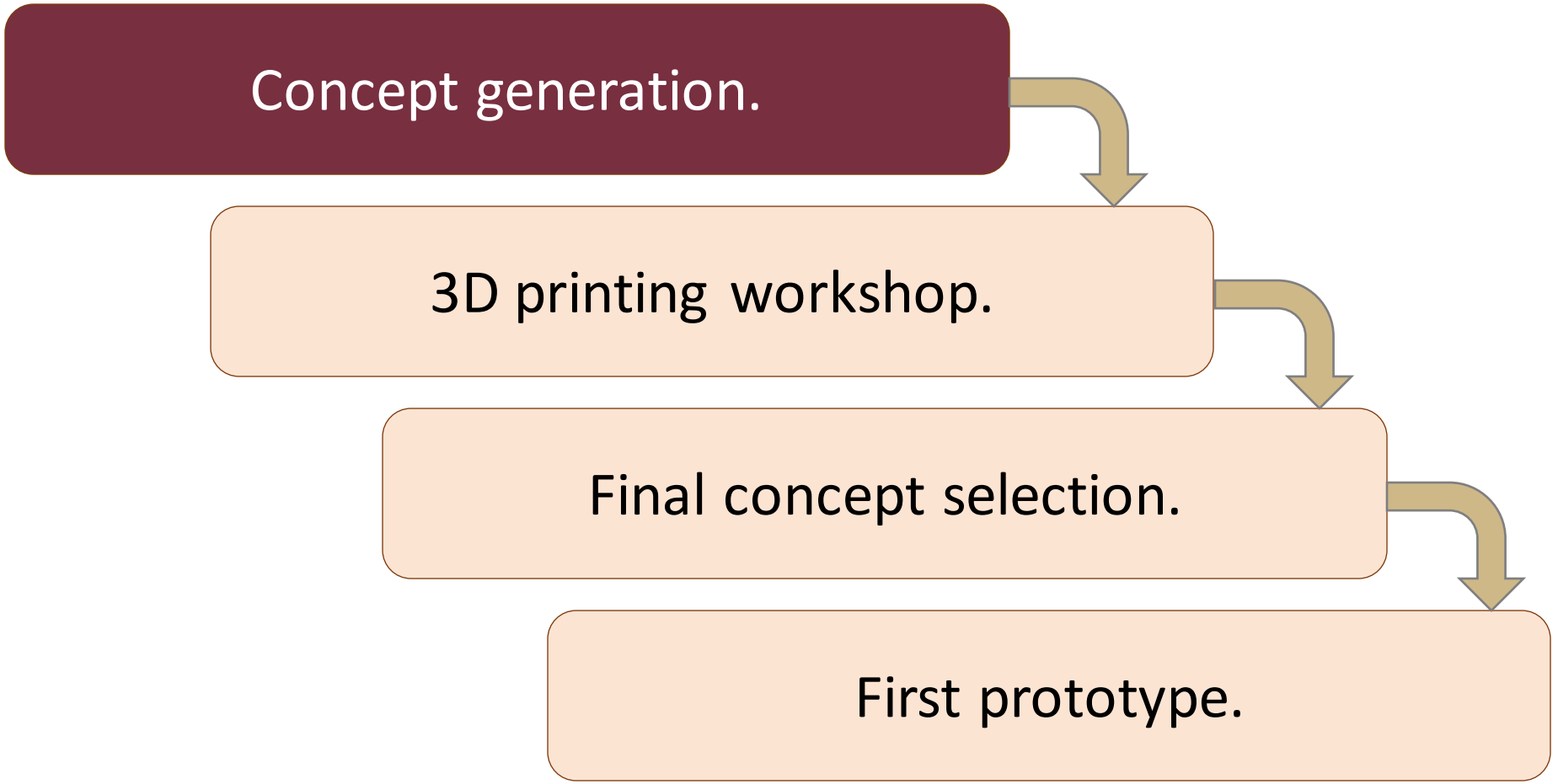
# Future Work


Gather more information.
Soldering workshop.
Targets and metrics.
CAD workshop.

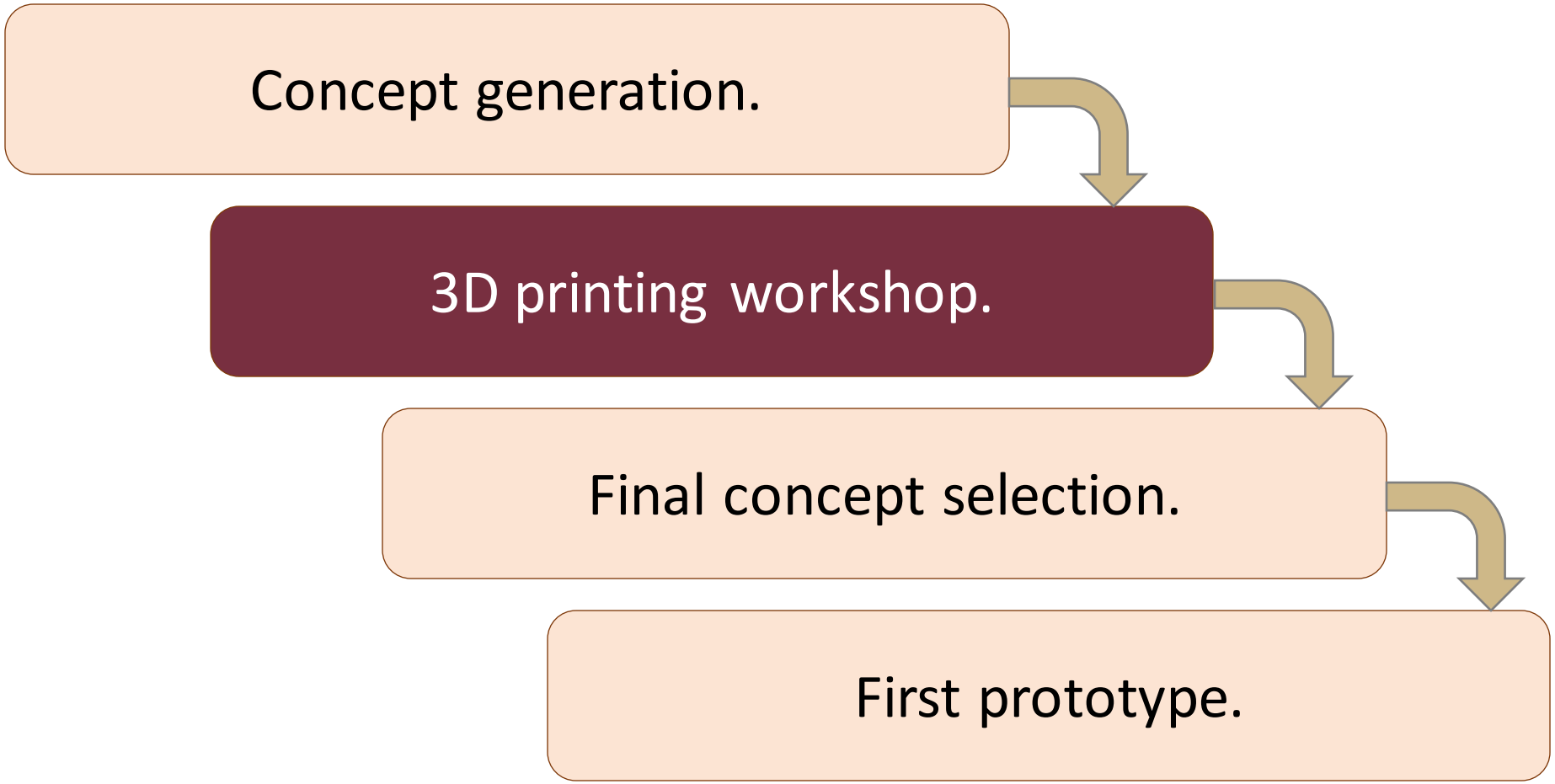
# Future Work


Gather more information.
Soldering workshop.
Targets and metrics.
CAD workshop.

# Future Work


Concept generation.
3D printing workshop.
Final concept selection.
First prototype.

# Future Work


Concept generation.
3D printing workshop.
Final concept selection.
First prototype.

# Future Work

Concept generation.

3D printing workshop.

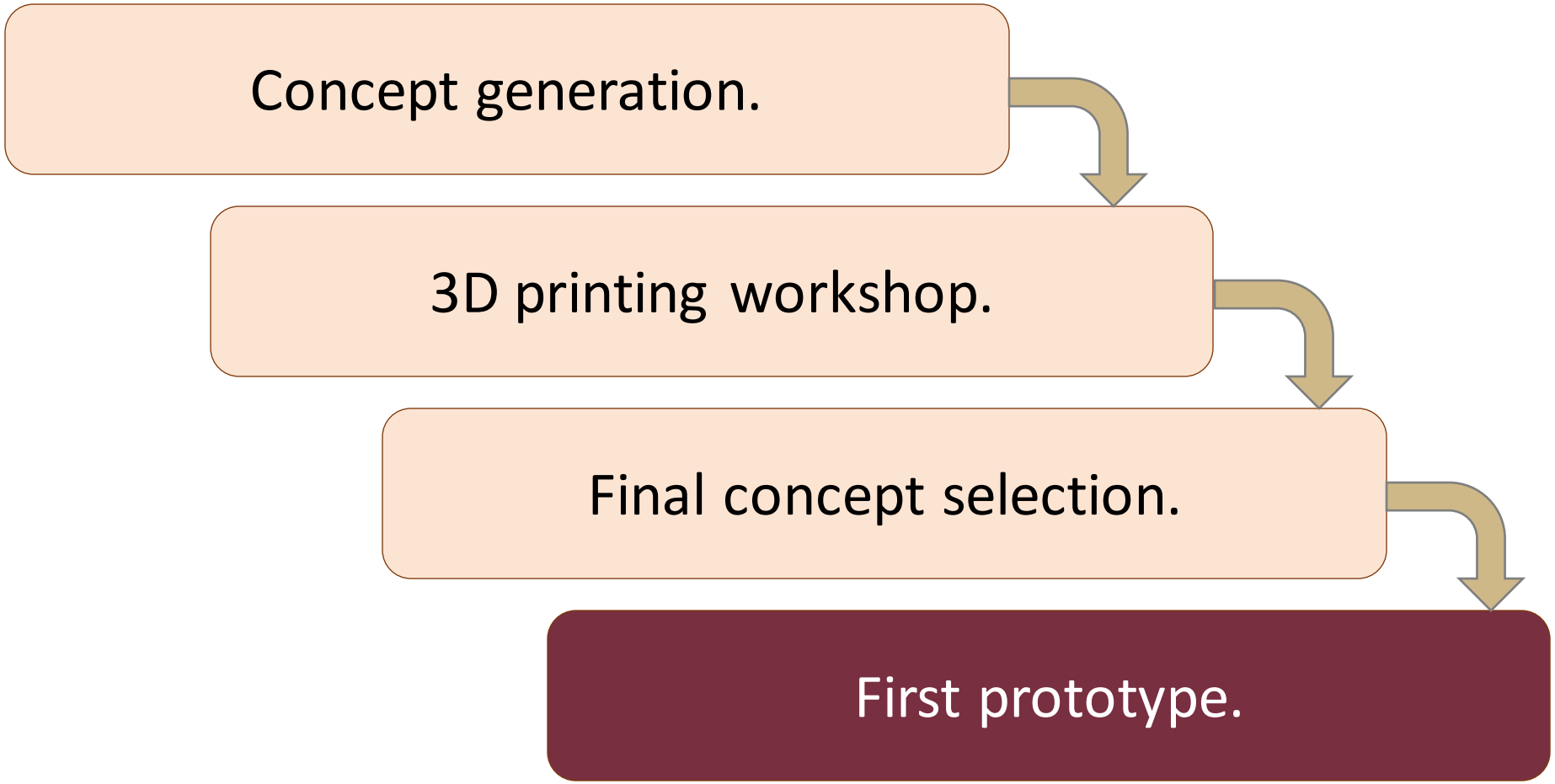
Final concept selection.

First prototype.



FAMU-FSU College of Engineering

# Future Work


Concept generation.
3D printing workshop.
Final concept selection.
First prototype.