DEPARTMENT OF MECHANICAL ENGINEERING

GOAL Kit V4: The Heart Valve
Team 41

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Background

Get Outside and Learn (GOAL) Is an **outreach engineering kit program** led by the University of Maryland's **Women in Engineering Program**. The main goal of this program is to provide a hands-on experience in STEM-inspired activities for underrepresented middle and high school students.

Our Challenge

Students will develop their own **heart valve model** and test it in a **dry system** in which rice acts as blood cells through a large tube acting as an artery. Students should be able to observe the **one-way flow** that their valves create when flipping their valve between the "correct" and "incorrect" position which will then cause a blockage.

What Sets Us Apart

Previous GOAL kits focused on traditionally mechanical-engineering designs and quantitative data, our kit is unique with its focus on **bioengineering** and **human health**.

Curriculum

The Scenario

A patient with a heart valve disease is in need of a heart valve replacement. The students, as engineers, will be in charge of designing and building new valves for surgery.

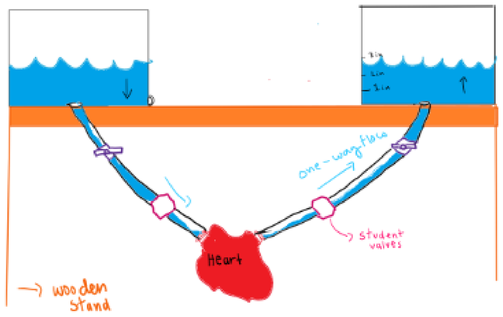
Lesson Plan

Students will be educated on how a heart and heart valves function through a corresponding pamphlet and trifold poster. This media explains both the functions of the heart and valves as well as our challenge.
We have provided various materials inspired by real-life artificial valves such as silicone flaps, rubber balls, and jewelry wire to allow students to create similar or even unique valves. Regardless of what students create, the main learning objective students need to take away is the **one-way flow** of blood.

We also have a **demonstration** of working valves in an inlet-outlet system with a "heart" pump that students can pump to see how a heartbeat creates the flow of blood with the assistance of valves.

FInal Design

Working Heart Valve System Demonstration



- Two water tanks
- Wooden stand
- Hand pump with latex heart cover
- 0.5" tubing
- 4x 3D-printed PLA chambers
  - Interior: working valve on acrylic plate
- Clamps and plumber's tape to secure the chamber with the valve plate

1. The two tanks are filled equally with water
2. The hand pump is squeezed to resemble heartbeats
3. Effective valves that enable *one-way flow* transport the water from one tank to the other
4. The water level in one tank rises as the other falls

Ineffective valves will not transport the water between tanks!

Heart Valve Dry System for Student Testing

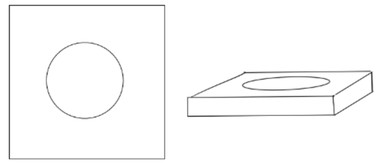
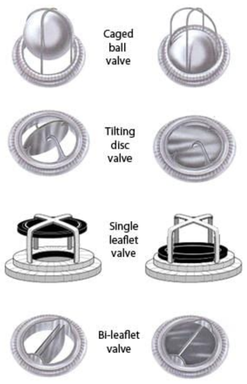


Plate template for students to sketch their heart valve design ideas

Prototyping and Testing

Heart Valve Building

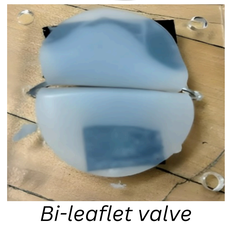
Artificial Heart Valve Types



Source: https://voices.uchicago.edu/grosspathology/thoracic/prosthetic-heart-valves/

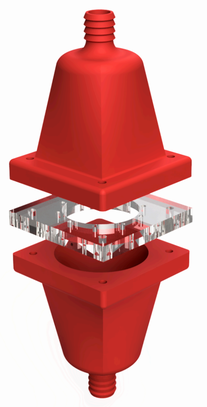
Acrylic laser-cut plate as valve building foundation

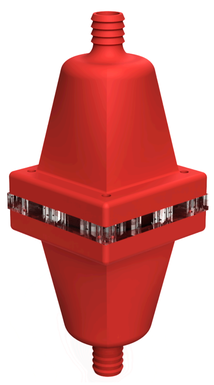
Caged ball valve



Bi-leaflet valve

Heart Valve Testing Chamber (for demonstration)





The 3D-printed valve chamber diverts water flow from the tubing to the valve plate for valve efficiency testing.

Ball valve design within our working valve system demonstration

For the Future

Ideally, we want a system that allows the students to test their valves with water and a pump rather than rice. We had difficulty creating a watertight system that allowed for exchanging valves without leakage which is why we created the dry system. We believe a true test of valves is if they prevent liquid from flowing without the force generated by a pump.