# THE UNIVERSITY WISCONSIN MADISON

# TISSUE BIOREACTOR

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# 357 357 371

Budget

Statement of Accounts (BME-Spring 2007)

4,744.00

4,544.00

4,512.35

3,801.35

3,785.21

3,785.21

3,781.10

3,776.88

3,770.56

3,769.10

3,767.74

3,766.38

3,764.37

3,758.05

3,754.58

3,750.44

3,750.00

3,746.90

3,741.92

3,720.82

3,719.81

-16.14

Starting Amount

Function Generator

Power Amplifier

Electromagnetic Voice Coil Actuator

Actuator Rods (Pipettes)

Low Mass Vibrational Bar

Metal Screws with Plastic Caps

Plastic Screws with springs

Flat Spring Rollers

Hex Bolts

Dropcloth 9x(12.5mil)

Solid Brass Bar 1x(3/64")

Paint Brushes

Duct Tape

Lock Nuts

Wing Nuts

Metal Short Screws

Grip Cloth

16-Mar-2007

16-Mar-2007

17-Mar-2007

17-Mar-2007

17-Mar-2007

18-Mar-2007

10-Apr-2007

12-Apr-2007

21-Apr-2007

21-Apr-2007

22-Apr-2007

22-Apr-2007

27-Apr-2007

27-Apr-2007

27-Apr-2007

29-Apr-2007

30-Apr-2007

30-Apr-2007

30-Apr-2007

2-May-2007

2-May-2007

#### Abstract

Develop an improved bioreactor for researching vocal fold tissues. The bioreactor needs to best simulate the environment of the vocal folds by distributing equal vibration across the cell-seeded strips while the strips are coming into contact. A design of one single-sided vibration bar with two pairs of cell-seeded strips was selected, which largely improves the extent of vibration.

#### Problem Statement

Current design of the bioreactor does not properly simulate the human vocal fold motion. The primary goal is to evenly distribute the vibration along the contacting cell-seeded strips. This will be performed by building a bioreactor with increased vibration distribution along the cell-seeded strips, and also making even contact between the vibration strips.

#### Motivation

The client is interested in researching the vibrations and tensile stress of the human vocal folds with bioreactors. The current bioreactor could only mimic vocal folds activities to a certain extent, therefore a device with a better vibration distribution and strip contact needs to be developed.

# Background

A bioreactor is a device that supports a biological system by simulating an active environment. The simulated system will be the human vocal folds, which are two pieces of stretchable tissue located inside the throat that mainly consist of connective tissues. This device will be operated under constant and adjustable vibration and tensile stress to fully simulate the actual environment.

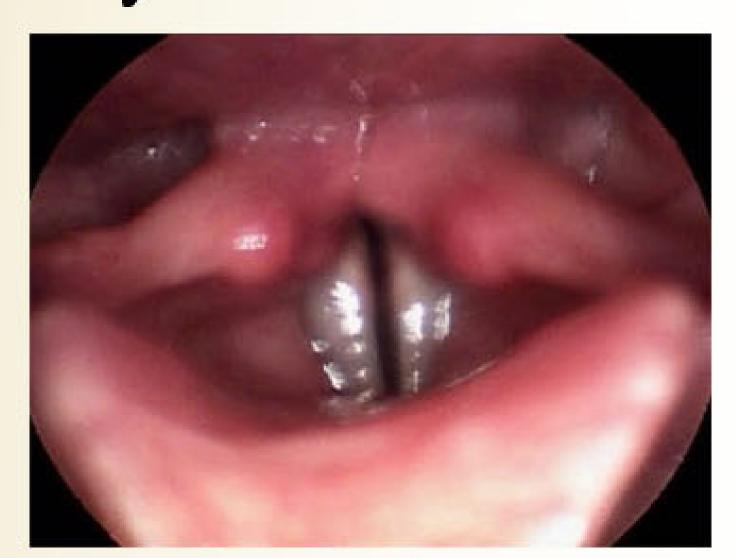


Figure 1: A pair of healthy vocal folds. The vocal folds come into contact during voicing and vibration occurs. The tension of the vocal folds is adjusted to control the pitch of the sounds.

## Design Criteria

This device must be able to distribute uniform vibration and tensile stress across the cell-seeded strips. During vibration, the cell-seeded strips must come into contact. Moreover, components of this device such as the T-flask and Tecoflex strips must be disposable and the screws and actuator rods need to be replaceable.

### Design

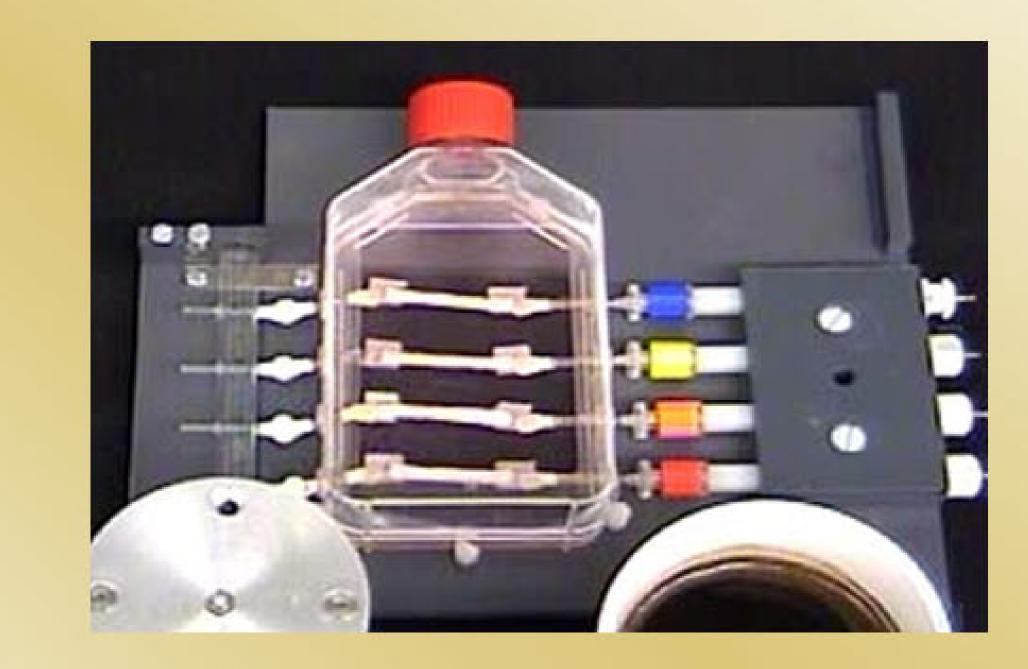


Figure 2: Previous design of bioreactor. The vibration of the actuator rods is very limited because they are larger in size, which will lead to loss of vibration during energy transmission.

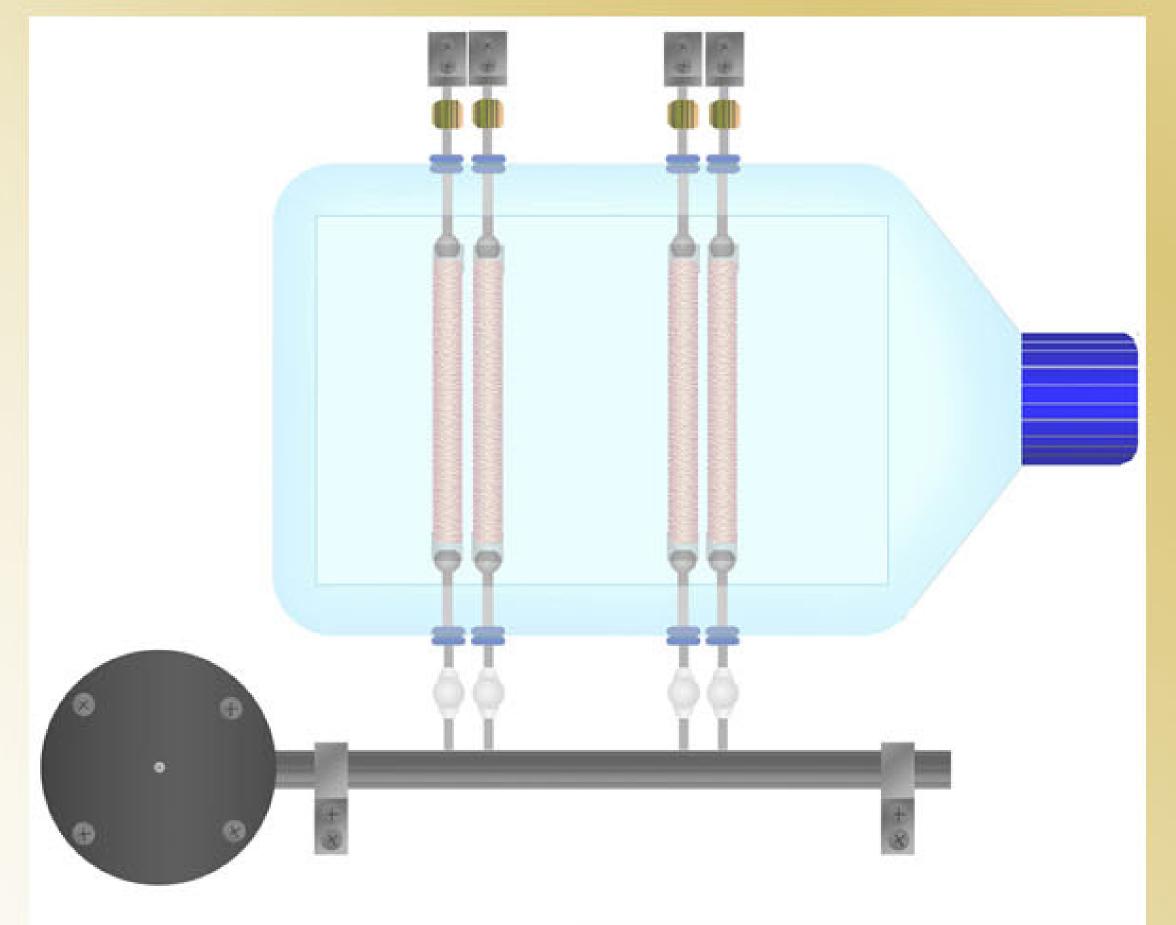


Figure 3: Final design that is favored by the ratings of the design matrix. This device consists of a single-sided vibration bar and 2 pairs of parallel strips. The single-sided vibration will distribute a constant vibration across all 4 strips, and the individual pairs will come into contact.

## Future Work

A computer-monitored vibration system could be implemented for enhancing the distribution of vibration. Also, a better testing method needs to be developed in order to measure the acutal vibration distribution and reliable testing data for analysis. Another improvement could be made by replacing the Tecoflex strips with other materials, since Tecoflex is not the best cell-adhesive strip.

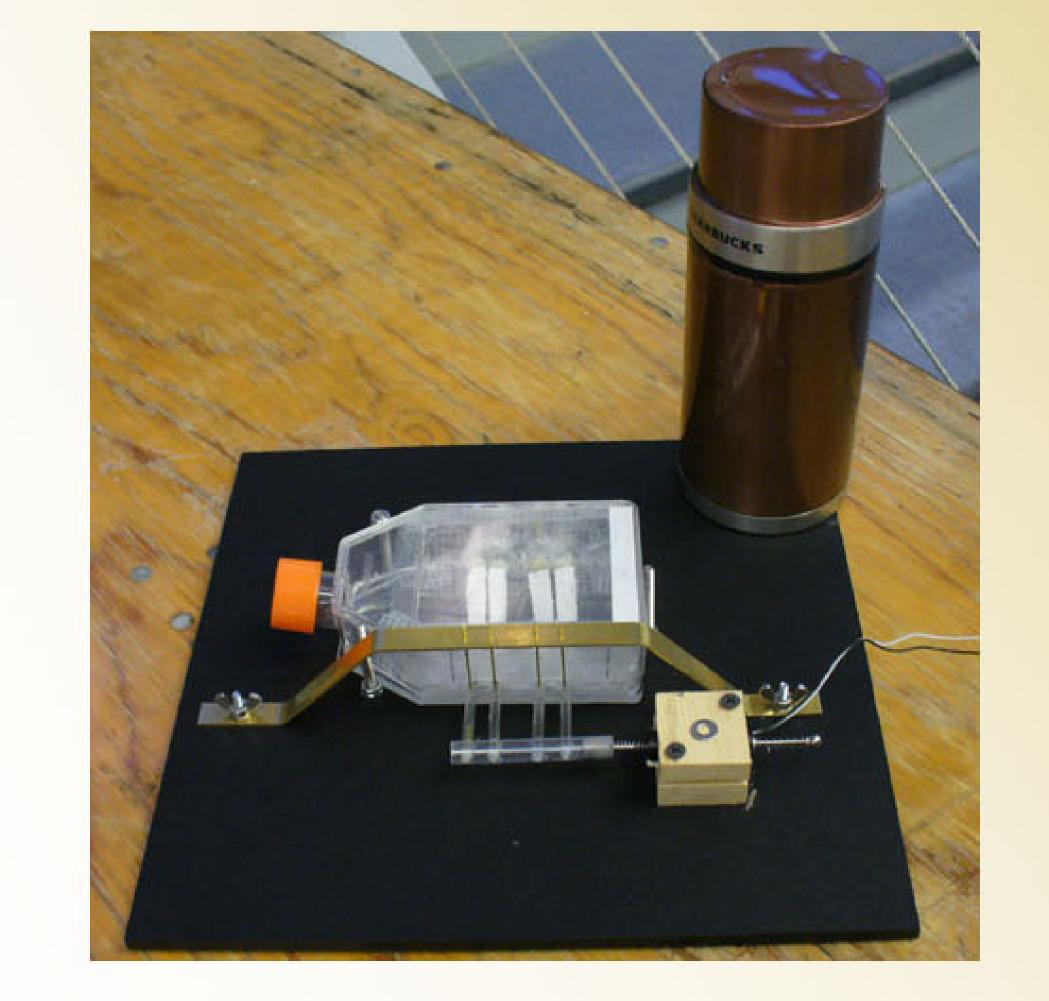


Figure 4: Working prototype of an improved bioreactor. T-flask in the center of the black actuator has a clear plastic cover, and the Tecoflex strips are stored inside the flask. The brass bridge pins down the actuator rods to prevent the vertical motion of the rods, and the 3 metal screws fix the flask in place, which also prevents translational motion. The wooden block in the bottom right keeps the actuator in position, and the barbell assists the movement of the actuator rod.

#### References

Altman, K. W. (2002). Vocal fold histology. Retrieved March 3, 2007 from http://www.voice.northwestern.edu/vfhisto.html
Hitchcock, Robert. Personal Interview 7 Mar. 2007.Personal Interview 2 Mar. 2007.
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Titze, Ingo R., et al. "Design and validation of a bioreactor for engineering vocal fold tissues under combined tensile and vibrational stresses."

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