Sponsored by Dr. Peter Chen and Erik Dorthe, Shiley Center for Orthopedic Research

Cellxercise Machine:

Growing Synthetic Musculoskeletal Tissues

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What Is Needed?

- Provide ≥ 10% strain
- Run at 1 Hz cycles
- 20 N of force
- Sterilizable
- Easier nutrient feeding

Check Out the Comparison!

Shellpa Pro	**Our Machine**
Tension Loading Only	Tension and Compression Loading
20 N Max Force	41.5 N Max Continuous Force
Disposable Stretchy Silicone Tubs	Affordable Rigid Petri Dishes
Difficult Refeeding	Easy Access Refeeding
Clamps Restricted by Silicon Bed Design	Modular clamp Design

Impact on Society

This project enables researchers to explore novel techniques and breakthroughs in orthopedic repair, more specifically in the formation of tissues. Further applications of this research can result in new surgical procedures with faster recovery times

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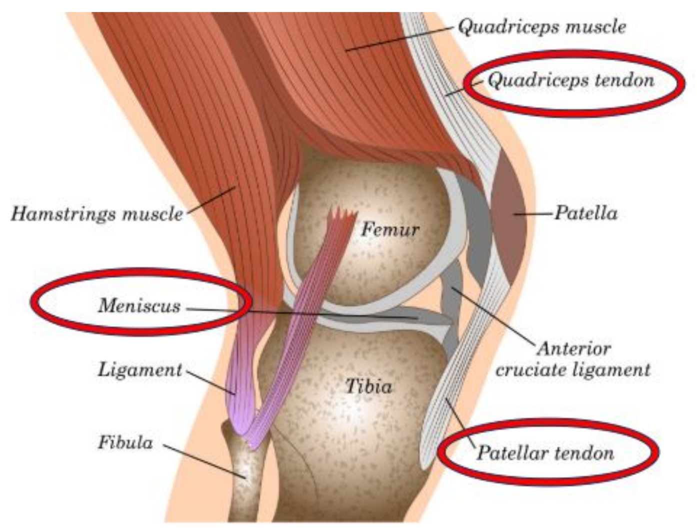
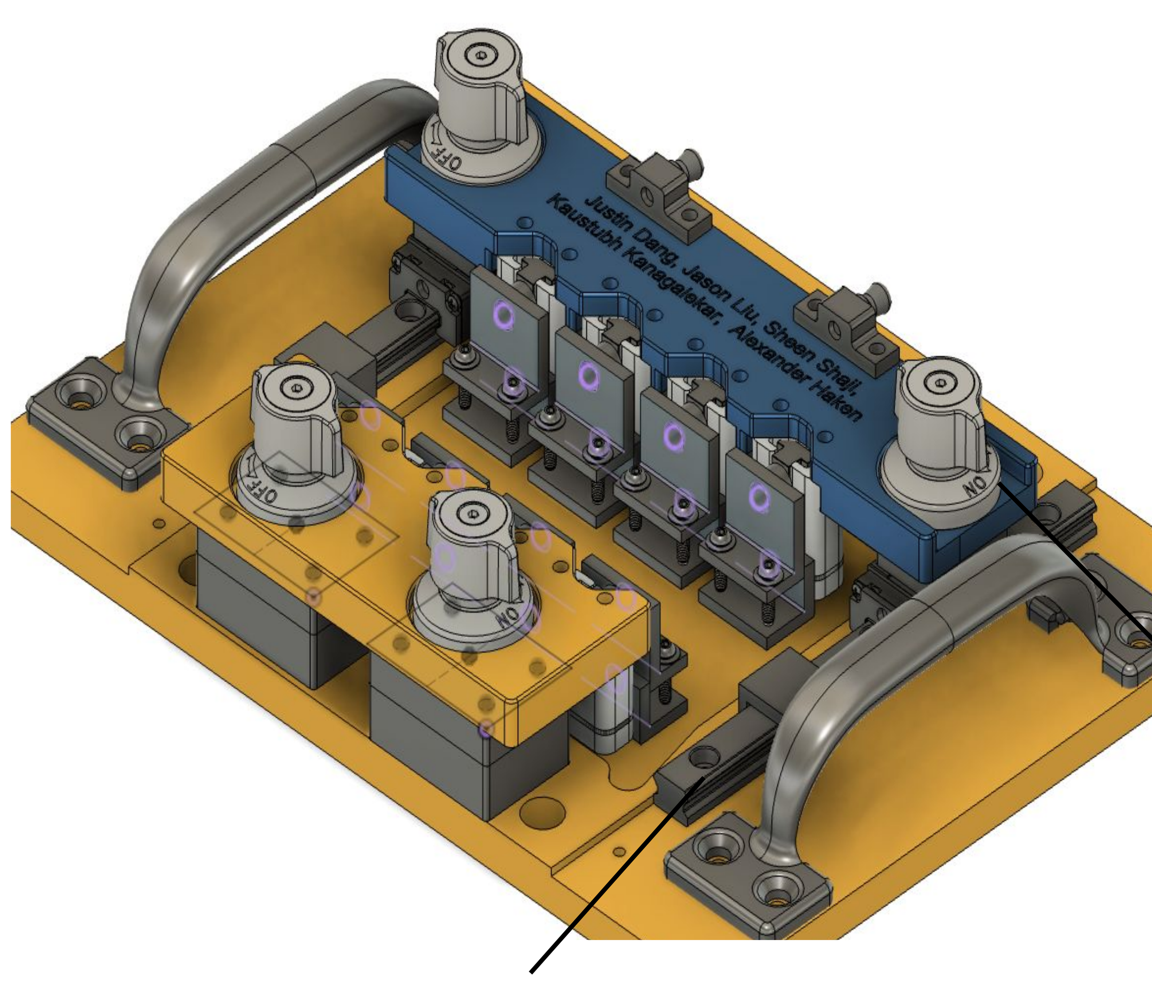
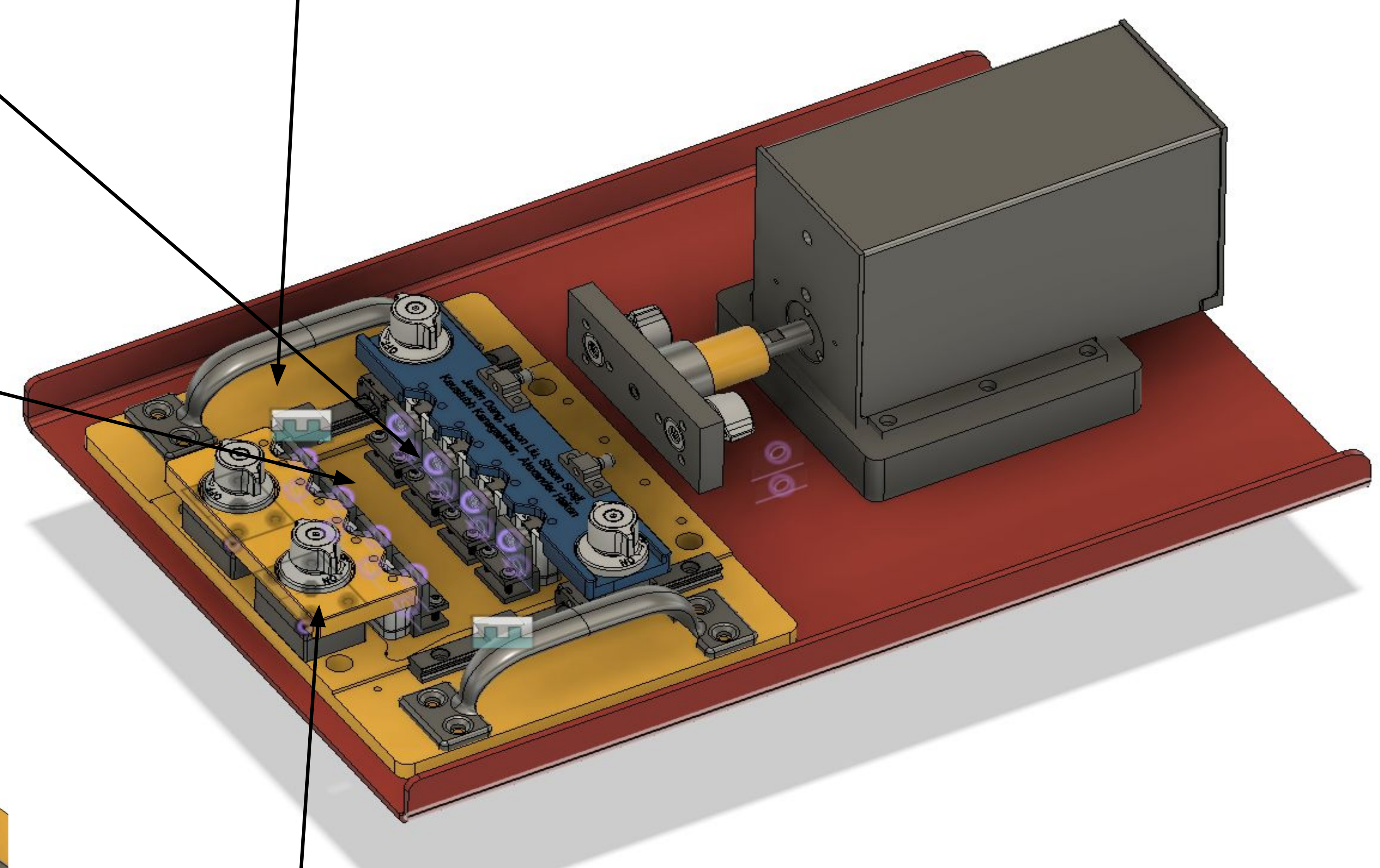
Overview

Dr. Peter Chen and Erik Dorthé from the Shiley Center for Orthopedic Research and Education Lab primarily oversee experiments and research pertaining to musculoskeletal tissue development such as tendons and meniscus tissues. Tendon and/or meniscus tissues that are artificially cultured, which is a big focus of the lab, need cyclic strain to promote growth and alignment of the cells. This is a machine that achieves just that!



Removable Tray





Analysis of Friction between Rails and Carriage

Average collagen sample: 5 mm $\times$ 1 mm

Yield Strength of collagen sample: 2.5×10^6 Pa

Frictional Force: $F_f = \mu F_n$ where F_n is the total load on the bearing

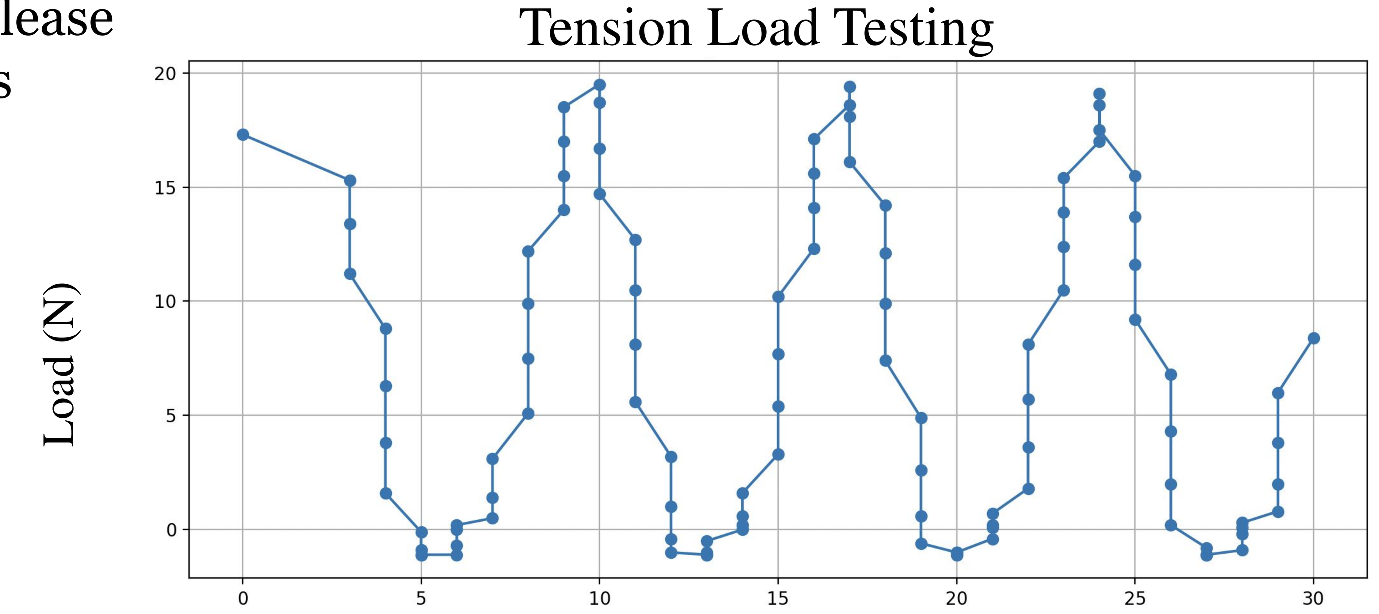
Moment about bearing and rail contact point: 0.009 mm $\times$ 40 N + 0.025 mm $\times$ 40 N = 1.36 Nm in total $\rightarrow$ 0.68 Nm per bearing

Added normal forces of: $\frac{0.68}{0.015} = 45.33$ N

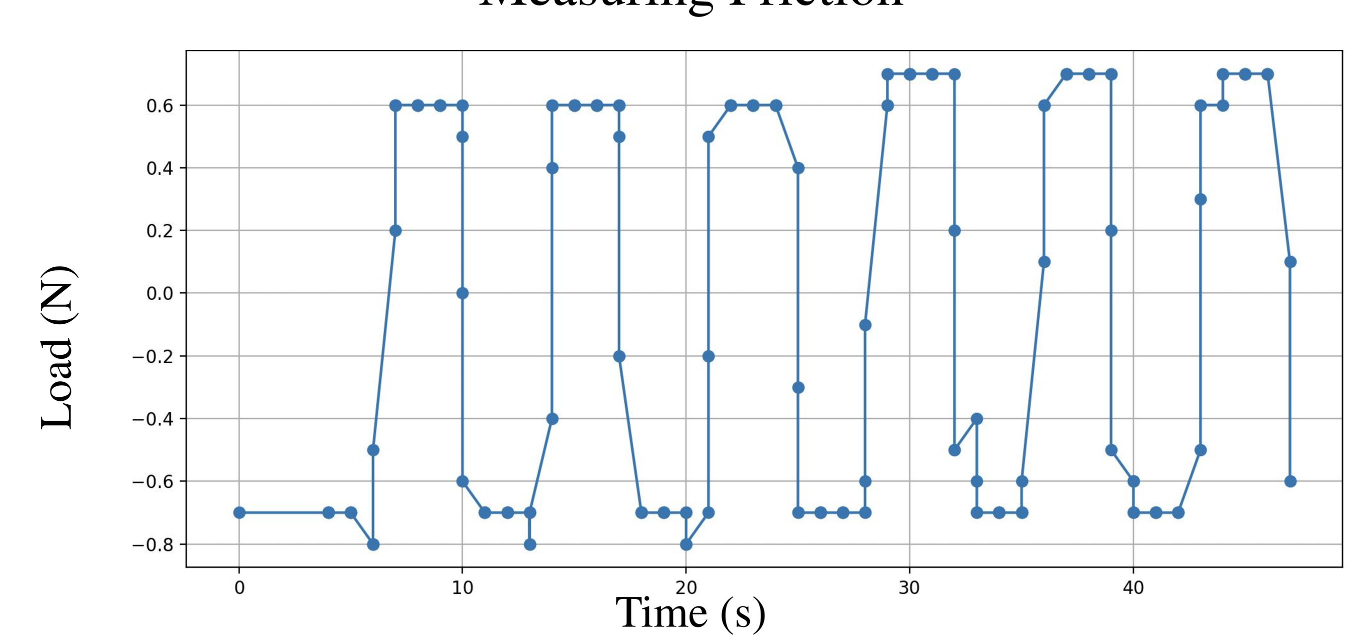
Added bearing friction of 45.33 N $\times 2 \times 0.001 = 0.091$ N

Rails are rated for 9.08 Nm $\geq$ 1.36 Nm as found in theoretical calculations

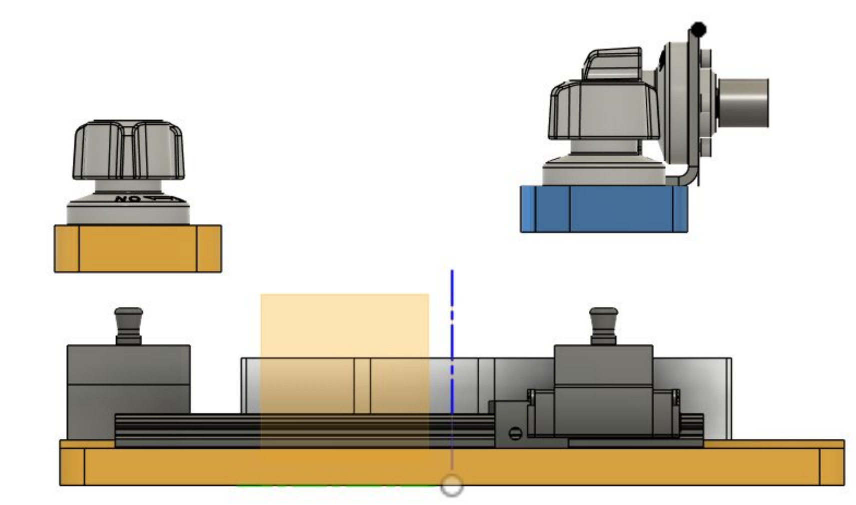
Tension Load Testing



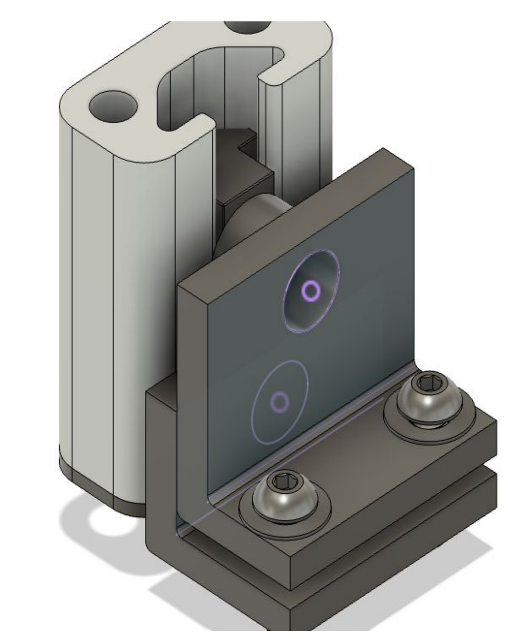
Measuring Friction



Quick Release Fasteners



Tensile Clamp



Experiment Workflow

1. Insert fresh petri dish into tray holder
2. Detach lift plate from actuator
3. Fill petri dish with solution
4. Clamp cell strip, close lid
5. Move to incubator
6. Attach actuator to removable tray
7. Set actuator "zero"
8. Start strain cycle
9. Wait 3 days
10. Detach lift plate from actuator, and move to fume hood
11. Lift lid, and change solution
12. Move back to incubator
13. Re-attach gantry to actuator
14. Re-zero
15. Repeat
16. After experiment concludes, disassemble machine and autoclave clamps, sterilize everything else with ethanol wipes

Future Improvements

- Potential auto-feeding implementation
- Load measurement on individual clamps