Materials VR Incorporated
A VR Materials Characterization Laboratory

By Joseph Tracey

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Project Goals:

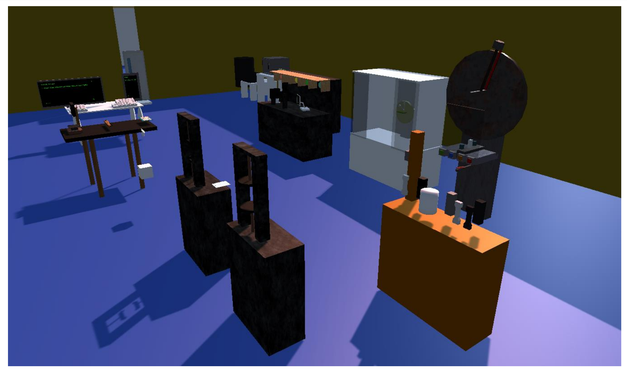
In Materials Science and Engineering, we rely on a myriad of testing stations to aid us in our career. However, hands on time using these tools in school is limited, as such tools are available only for use on required projects.

A simulation of a lab could be an ideal place to allow prospective students of the major to learn the basics, without access to a lab or professionals. Here the fundamental test stations within a materials lab are simulated in VR with a set of sample problems which require the use of these stations to solve.

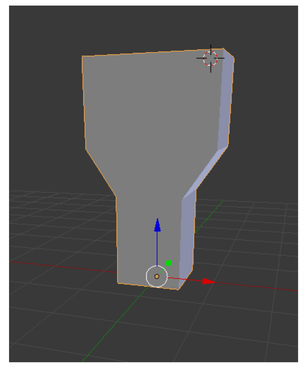
VR simulations could be used to open educational opportunities up for those who otherwise do not have access to it.

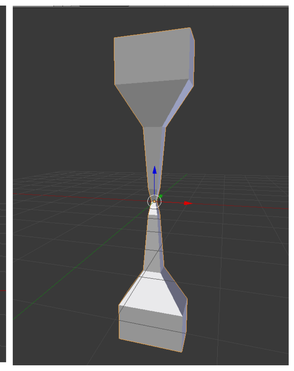
Unity & C#:

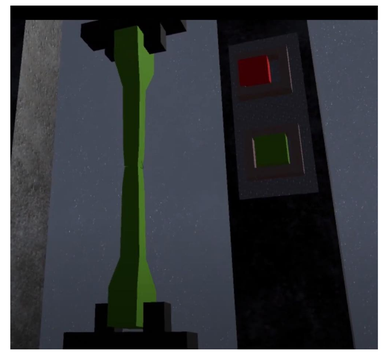
The VR simulation is run using Unity, a free platform for 3D development. Much of the Lab Environment and textures came from Unity's Marketplace, while testing stations, sample and question management, and UI had to be designed and programmed using C#.



An early example of the lab testing stations before any textures were applied.





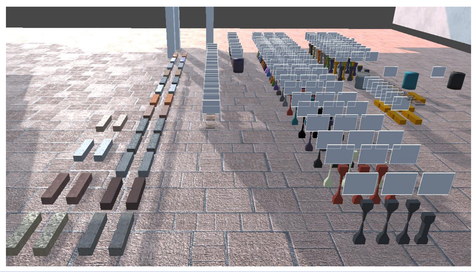


Blender & ShapeKeys:

Complex shapes and transformations cannot be easily generated using just Unity, so tensile and compression deformation was modeled first in Blender. Various deformations were formed and saved as 'ShapeKeys'. Any shape between the original shape and a 'ShapeKey' may then be rendered on the fly, in order to create a wide variety of different types of deformations.

Beauty of Open-Source:

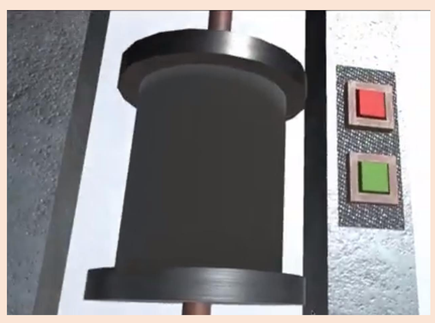
The code for this project is being made open source. The benefit of an open source release is not just that the program will be available to people without the hurdle of a paywall, but that any interested user can open up the source code and modify the project to suite their own needs. Now that a base project is in place, it is simple to modify the lab to either add new lessons with the existing tools, or to add new tools that serve different functions.



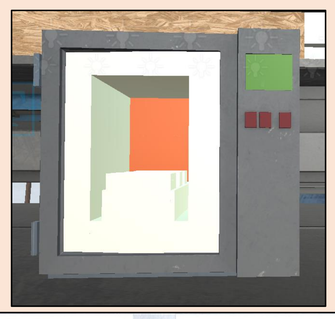
Testing Stations:

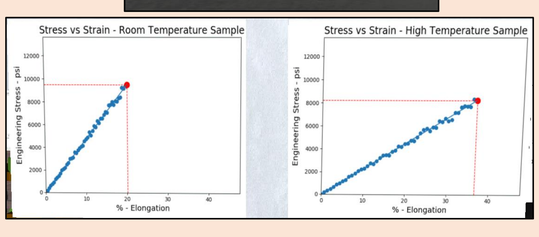
Conductivity Tester:
Users learn basics of electrical properties, such as Ohms Law

Tensile Tester:
Tensile test dog-bone samples and read their stress strain charts

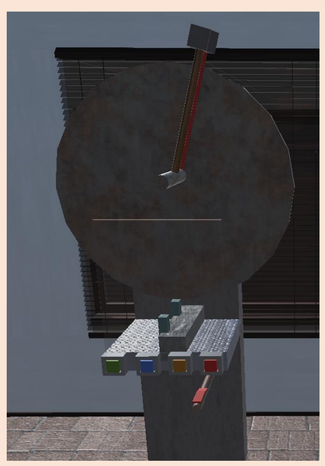


Compression Tester:
Compression test samples to determine how their properties change under compression





Furnace/Liquid Nitrogen:
Heat or cool samples to modify the results of tensile and Charpy tests



Charpy V-Notch:
Use a physics based Charpy tester to compare sample toughness

XRD:
Use X-Ray Powder Diffraction to compare crystal structure of samples

Current State of VR:

VR is becoming increasingly accessible to the average person. While most individuals use VR for recreation, it is also used for industrial purposes, such as military training. VR gives a first person-hands on perspective where users can use tools and interact with the environment. Tools such as rulers, calculators, scales, and even the hand brake on a Charpy tester demonstrate very simple yet diverse tools which help enhance the VR experience.

Future Possibilities and Reflection:

This project covered a lot of ground, but still leaves a lot of room for growth. One of the hardest things about working on such a large project alone was troubleshooting. There is still a laundry list of technical issues which would require fixes for a more retail style of release. The Charpy V-Notch has been a more troubling aspect of the project, due to the multitude of physics elements at play. My future endeavors into simulation-based projects will be taken with a more focused scope. With the project's open source status, it may provide the foundation for other works to build upon and take advantage of the systems implemented so far.

Funding, Acknowledgements, & Links:

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Link to YouTube Video: https://www.youtube.com/watch?v=6jgGbGefXSc

Download Link for Unity Project:
https://drive.google.com/drive/folders/14M8h-opyK6cErIQPC5soAWYS9R3UKLHn?usp=sharing