Data Imaging and Visualization Analysis

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Librarian: Dr. Kelley O'Neal

Overview

- Background
- Past Research
  - 2-D maps → 3-D maps
  - Our solution: Virtual Reality
- Research Questions
- Methodology (3 Phases)
  - Product Development (current)
  - Product Improvement
  - Product Evaluation

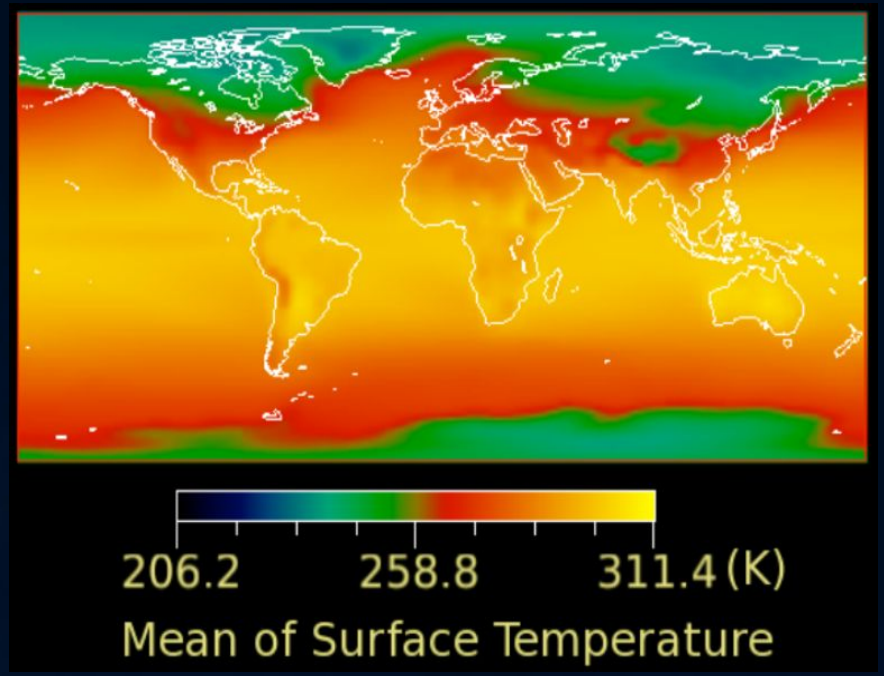
Motivation for Our Project


(NASA, n.d.)

- Terabytes of climate data
- Current visualization and analysis methods are inadequate and not interactive
- Difficult to…
  - View multiple variables
  - Observe correlations
  - Zoom in on areas of interest

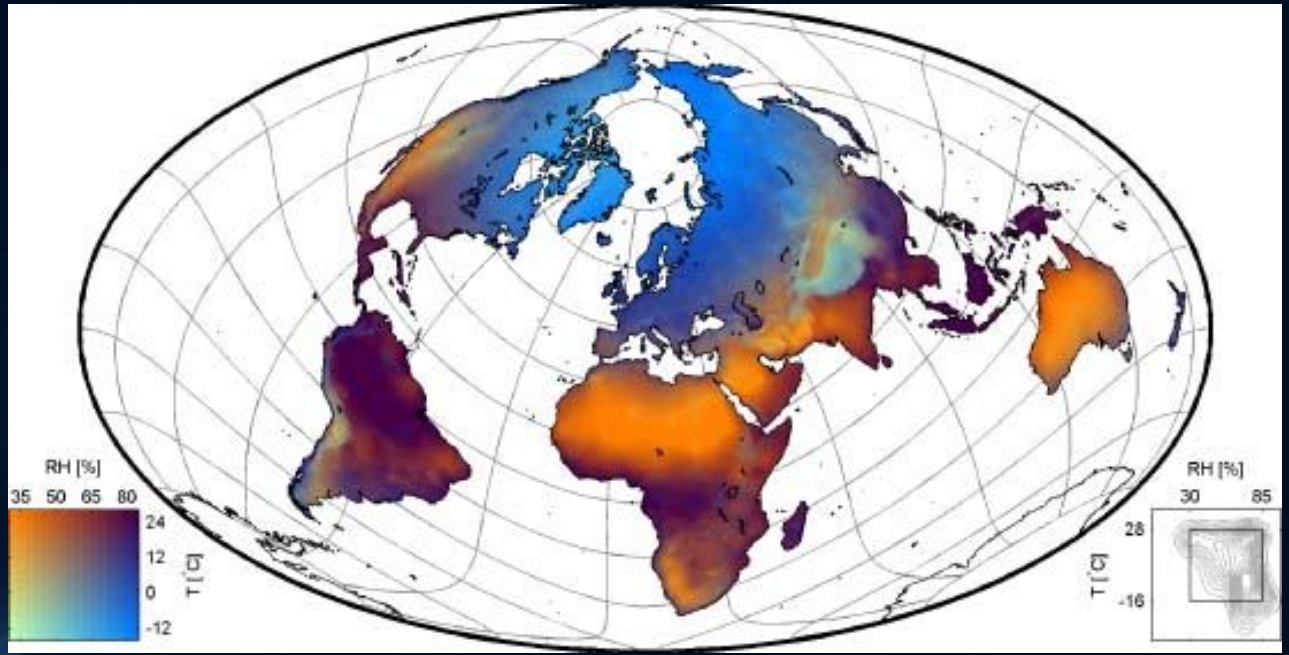
Past Research: Current Visualization Methods

2-D Color Maps



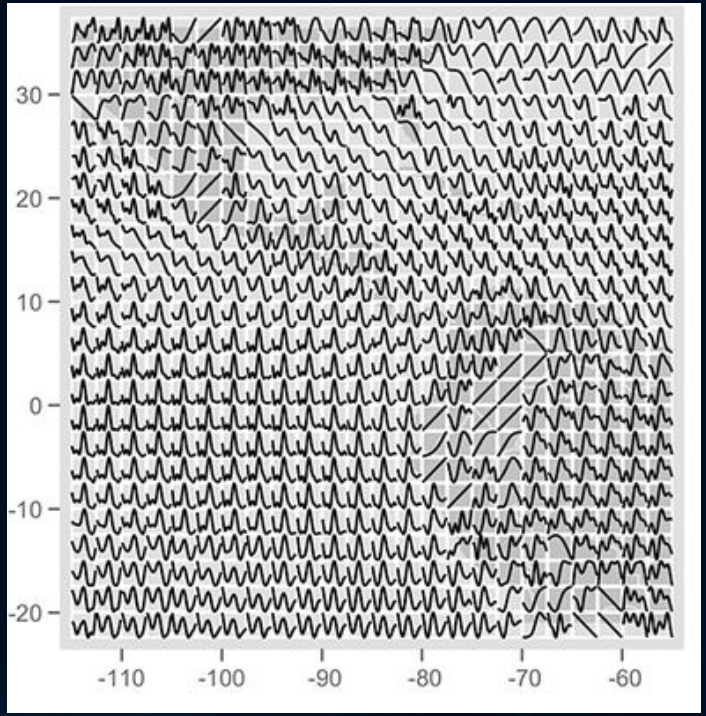
Mean Surface Temperature. TImeframe unknown (Potter at al., 2009).

Two-variable Colored Maps



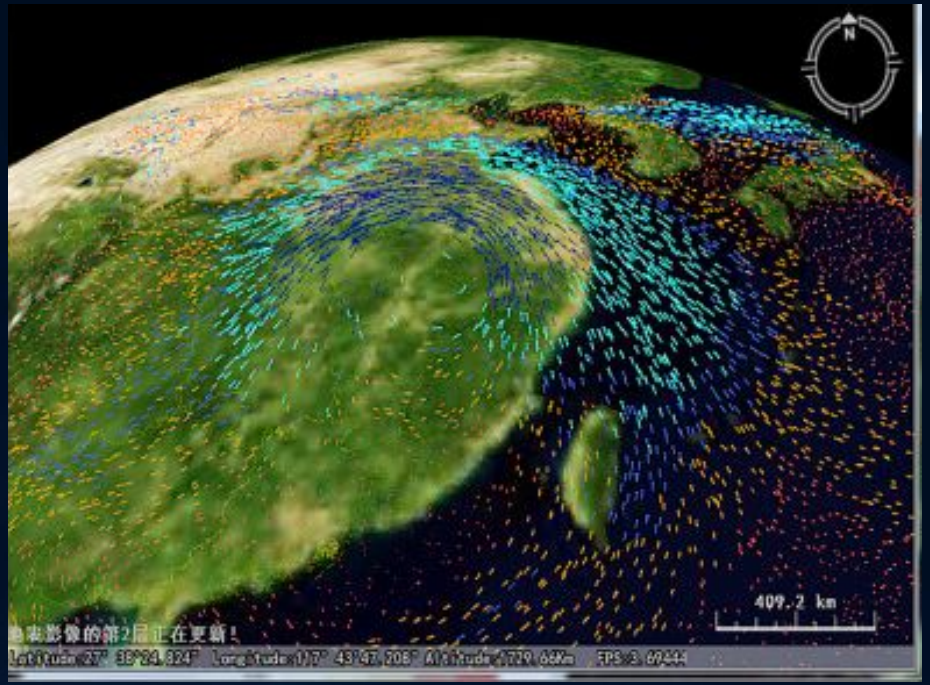
2-D map of relative humidity and temperature (Teuling et al., 2011).

Glyph Maps



Glyph map of temperature across a region (Wickham et al., 2012).

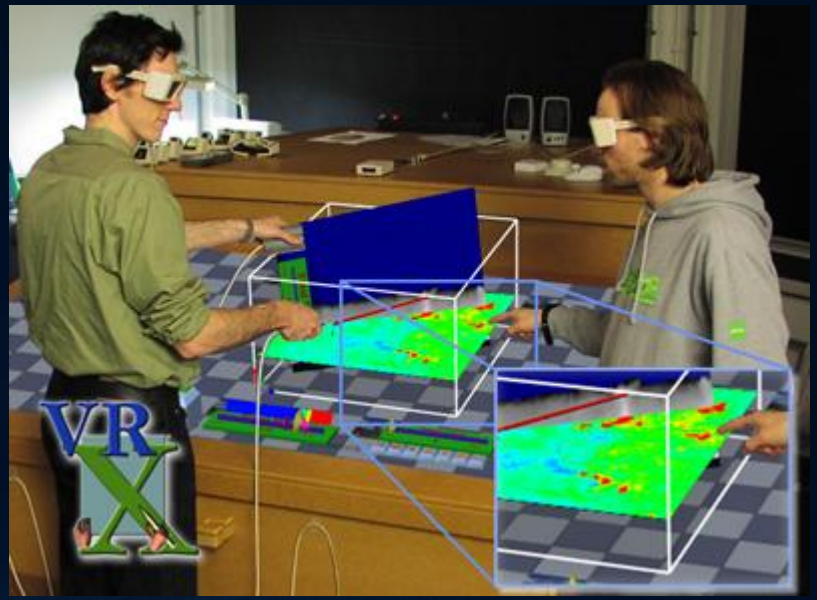
3-D Globes



Tropical cyclone visualized in World Wind globe API (Liu et al., 2015).

Solution

Visualize and Analyze Data with Virtual Reality (VR)



(Koutek, M., & Post, F., n.d.)

Research Questions

Research Questions

- In terms of computation time, feature selection, and storage, how can we most effectively design and create a Virtual Reality climate data visualization tool?

- What are the most user-friendly, aesthetically pleasing and informative ways for scientists and the general public to visualize climate data through VR?

Methodology

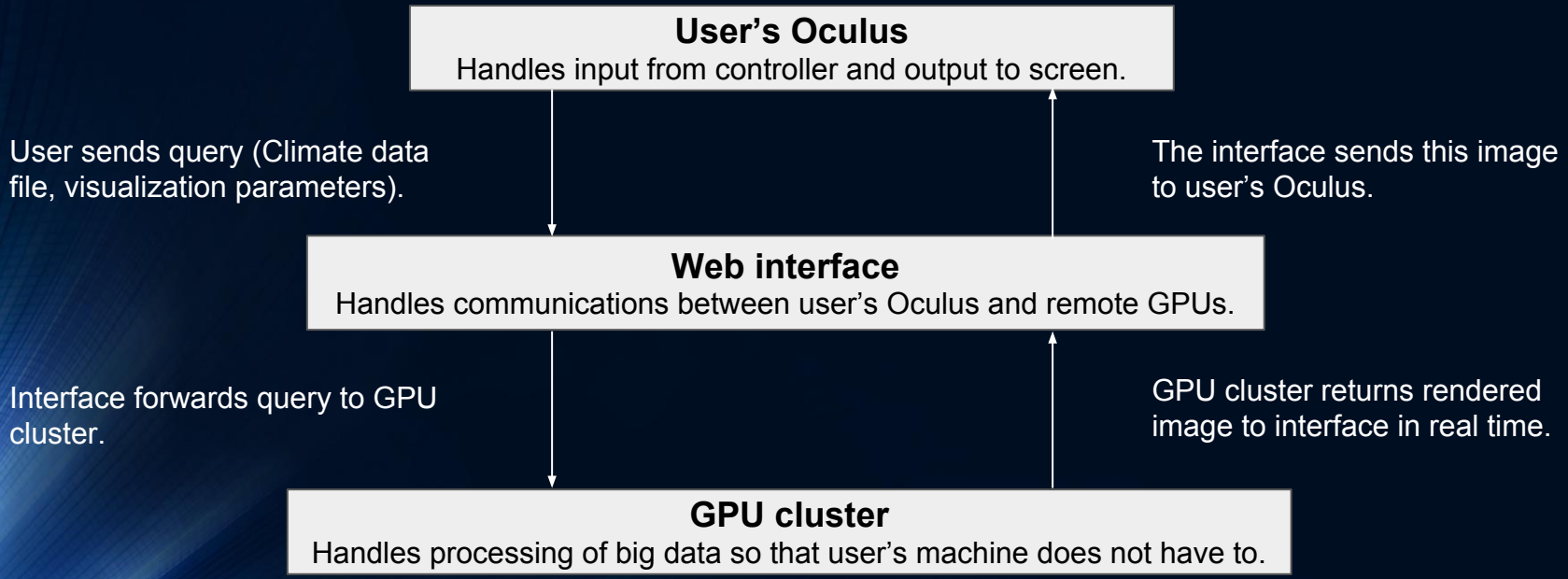
Phase I - Product Development: Oculus Rift Overview

- Most widely used VR device with cutting-edge capabilities
  - Head- and Position-tracking
- Enhanced interactivity of Oculus Touch
- Available in the MakerSpace in McKeldin

(Turbosquid,. 2015)

Phase I - Product Development: System Overview

Control Flow for Cloud-based Climate Data Visualization Tool

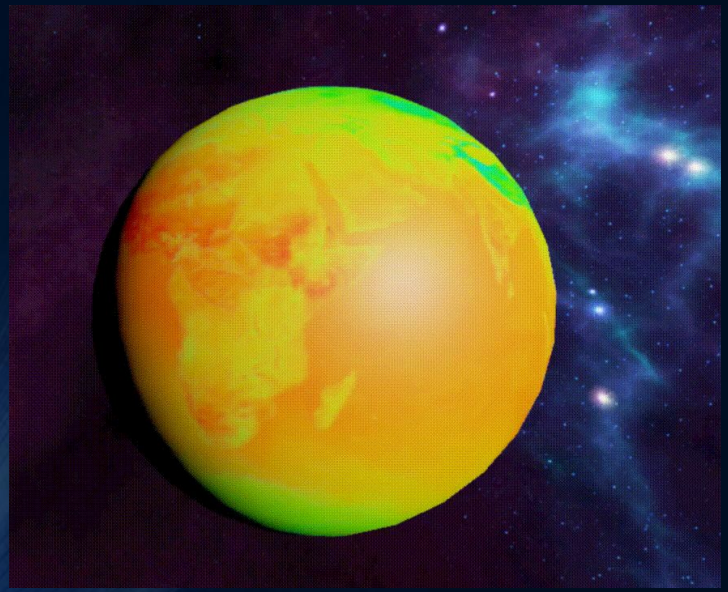


Unreal Engine 4 Overview

- Uses unmodified C++
- Advantages:
  - netCDF library written in C → simple integration
  - More potential for better graphics in visualization
  - “Blueprint” mode
- Disadvantages:
  - Resource intensive - especially processor speed and graphics

Phase I - Product Development: Current Progress

Current Progress



Able to read in and display an entire netCDF file of one variable

Future Goals

- Ability to display multiple variables
- Volumetric 3D rendering for height fields
- Tools to identify meaningful correlations among data
- Interface with maps and GIS data from library resources
- Adjustable color schemes

Phase II - Product Improvement: Focus Groups

First Focus Group

Who

5 graphics experts from UMD faculty

Goal

To refine aesthetics and user interface

Second Focus Group

Who

30 students from UMD

Broken into 5 groups of 6

Goal

To get broad feedback on usability

Third Focus Group

Who

10 climate experts from NOAA/NASA and UMD

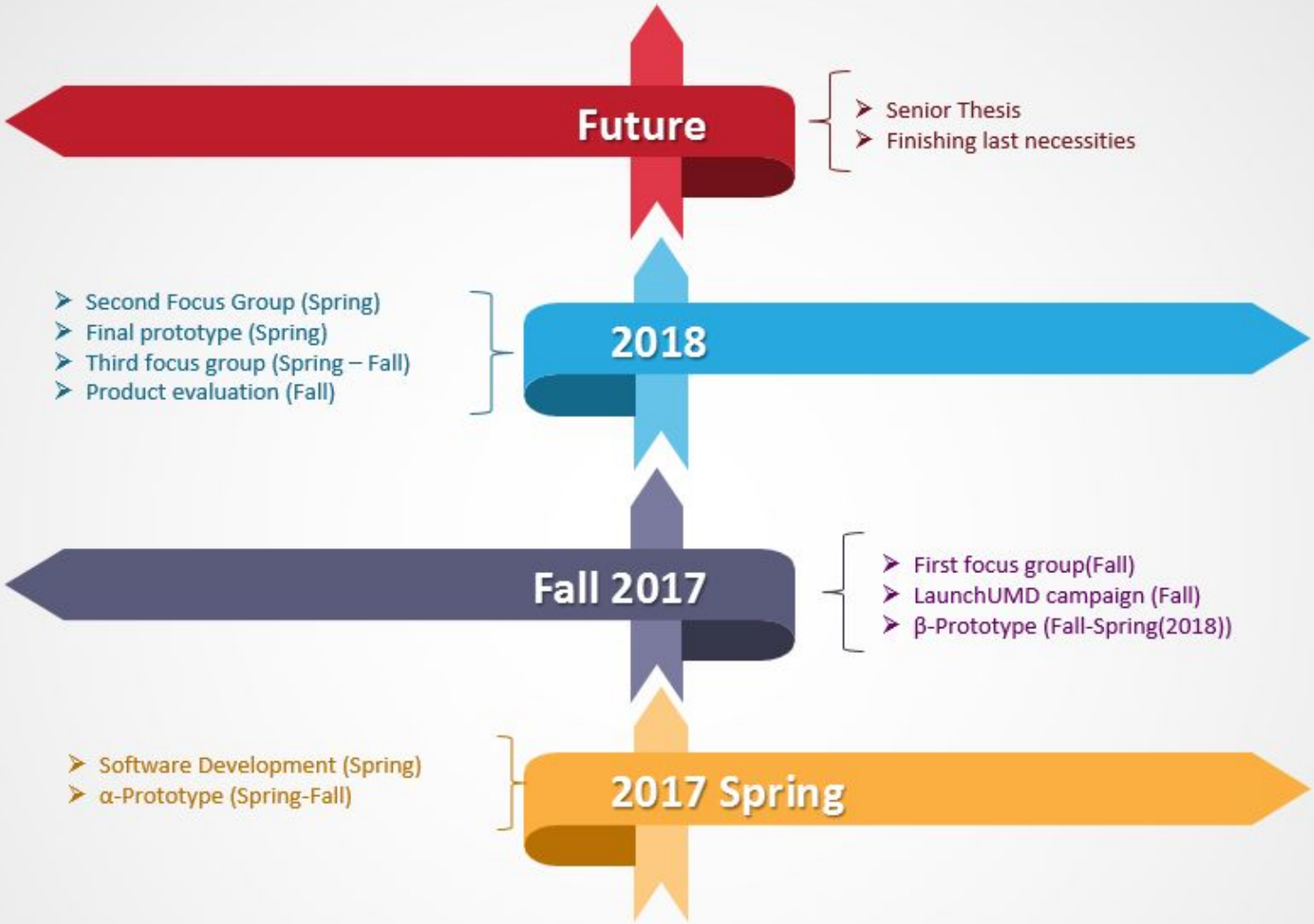
Goal

To get feedback with respect to climate visualization

Phase III - Product Evaluation: Individual Surveys

- Convenience Surveys: Rate our product compared a traditional visualization
  - 50 new participants from the general public
- Targeted Surveys: Given a specific task, record time required
  - 10 research experts

Future Plans


Future
Senior Thesis
Finishing last necessities
2018
Second Focus Group (Spring)
Final prototype (Spring)
Third focus group (Spring – Fall)
Product evaluation (Fall)
Fall 2017
First focus group(Fall)
LaunchUMD campaign (Fall)
β-Prototype (Fall-Spring(2018))
2017 Spring
Software Development (Spring)
α-Prototype (Spring-Fall)

Acknowledgements

Dr. Stephen Penny (Mentor)

Dr. Kelley O’Neal (Librarian)

Dr. Kristan Skendall, Dr. Frank Coale, Vickie Hill (Gemstone Staff)

The Library Spaces at UMD

Questions?

(Turbosquid, 1. 2015)

References

Image Sources:

Koutek, M., & Post, F. (n.d.). Virtual Reality for Data Visualization. Retrieved November 06, 2016, from http://graphics.tudelft.nl/~michal/vr_demos/

Liu, P., Gong, J., & Yu, M. (2015). Visualizing and analyzing dynamic meteorological data with virtual globes: A case study of tropical cyclones. Environmental Modelling & Software, 64, 80-93.

NASA (n.d.). Retrieved November 06, 2016, from http://climate.nasa.gov/nasa_science/missions/

Potter, K., Wilson, A., Bremer, P. T., Williams, D., Doutriaux, C., Pascucci, V., & Johhson, C. (2009). Visualization of uncertainty and ensemble data: Exploration of climate modeling and weather forecast data with integrated ViSUS-CDAT systems. In Journal of Physics: Conference Series (Vol. 180, No. 1, p. 012089). IOP Publishing.

Teuling, A. J., Stöckli, R., & Seneviratne, S. I. (2011). Bivariate colour maps for visualizing climate data. International Journal of Climatology, 31(9), 1408-1412.

Turbosquid. (2015). Oculus Rift and Touch. Retrieved November 06,2016, from http://www.turbosquid.com/3d-models/3ds-max-oculus-rift-touch/94267

Wickham, H., Hofmann, H., Wickham, C., & Cook, D. (2012). Glyph-maps for visually exploring temporal patterns in climate data and models. Environmetrics, 23(5), 382-393.

	Name	Unit Price	Quantity	Costs	Date
Expenses					
	Oculus VR Device (w/Oculus Touch)	$ 800.00	1	$ 800.00	Spring 2017
	Oculus VR Device (w/Oculus Touch)	$ 800.00	1	$ 800.00	Fall 2017
	Graphic Designer Focus Group Refreshments	$ 30.00	1	$ 30.00	Fall 2017
	Student Focus Group Refreshments	$ 5.00	5	$ 25.00	Fall 2017 / Spring 2018
	Student Focus Group Compensation	$ 15.00	30	$ 450.00	Fall 2017 / Spring 2018
	Climate Expert Focus Refreshments	$ 30.00	1	$ 30.00	Spring 2018 / Fall 2018
	Student Survey Refreshments	$ 2.00	50	$ 100.00	Fall 2018
	Student Survey Compensation	$ 5.00	50	$ 250.00	Fall 2018
	Travel Expenses / Conferences**	$ 800.00	4	$ 3,200.00	Spring 2019
Total				**$ 5,685.00**	
Revenue					
	Library Award	$ 1,000.00	1	$ 1,000.00	Spring 2017
	Launch UMD**	$ 3,500.00	1	$ 3,500.00	Fall 2017
	Gemstone Funding*	$ 600.00	1	$ 600.00	Fall 2016
	Gemstone Funding*	$ 600.00	1	$ 600.00	Fall 2017
	Gemstone Funding*	$ 600.00	1	$ 600.00	Fall 2018
Total				**$ 6,300.00**	
	*** Goes away after every school year**				
	****Very rough estimate**				