

# **Construction Informatics and Visualization**

## **Outline**

1. Research Areas and Selected Research Projects
2. Future Research Trajectories

# 1. Research Areas and Selected Research Projects

## 1.1 Virtual Reality (VR)

- Comparing Perceptions of Occupant Flow and Space Functionality in Virtual Reality and an Actual Space

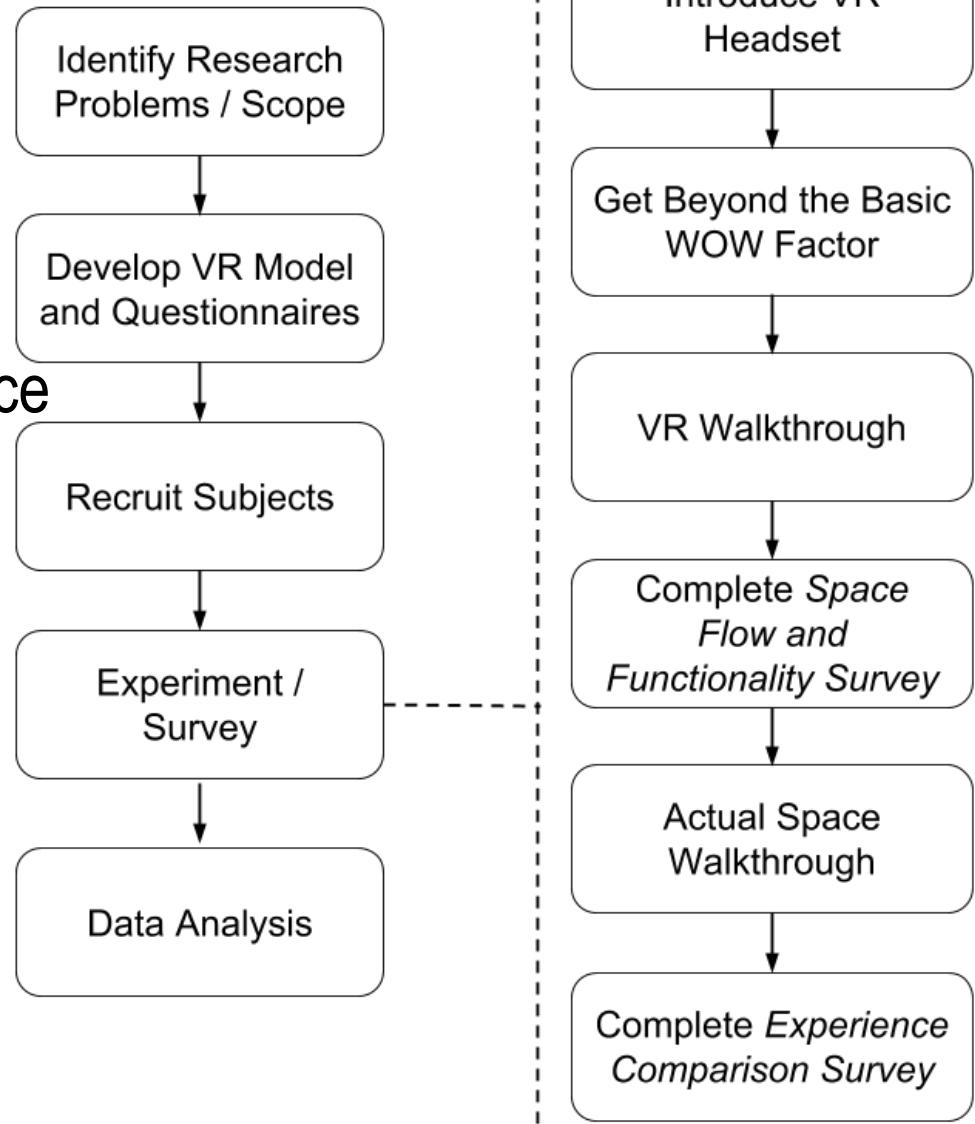
*(Funded by the University Research Council)*

## Problems & Motivation

- Project Goals
  - Gather perceptions of design relating to flow and functionality within a VR experience.
  - Compare the VR experience to a walkthrough of the real space.

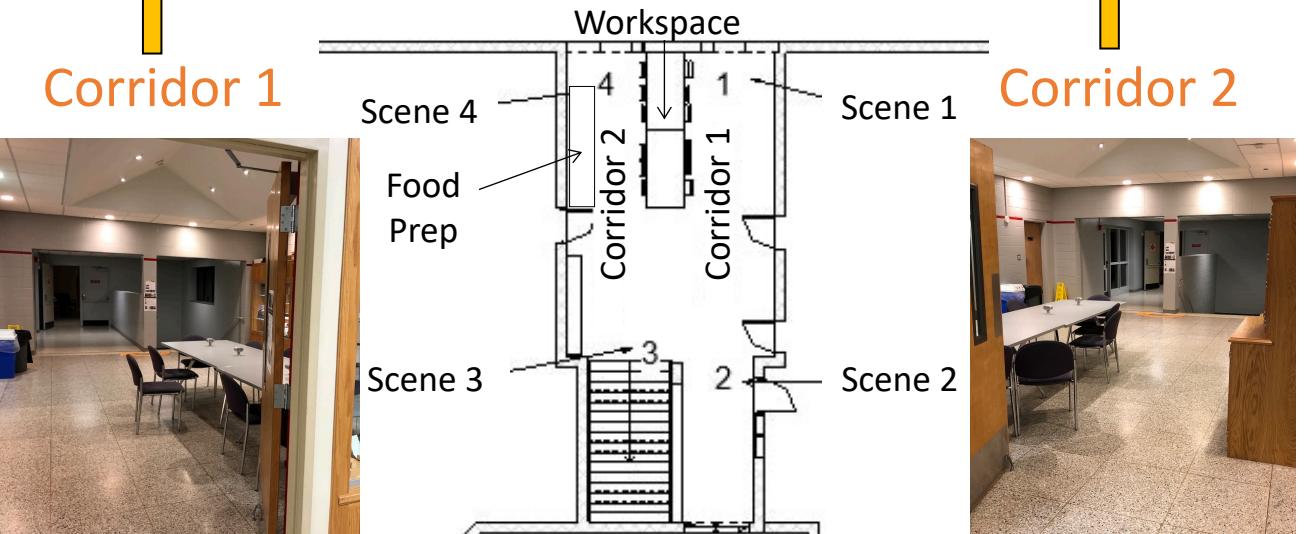
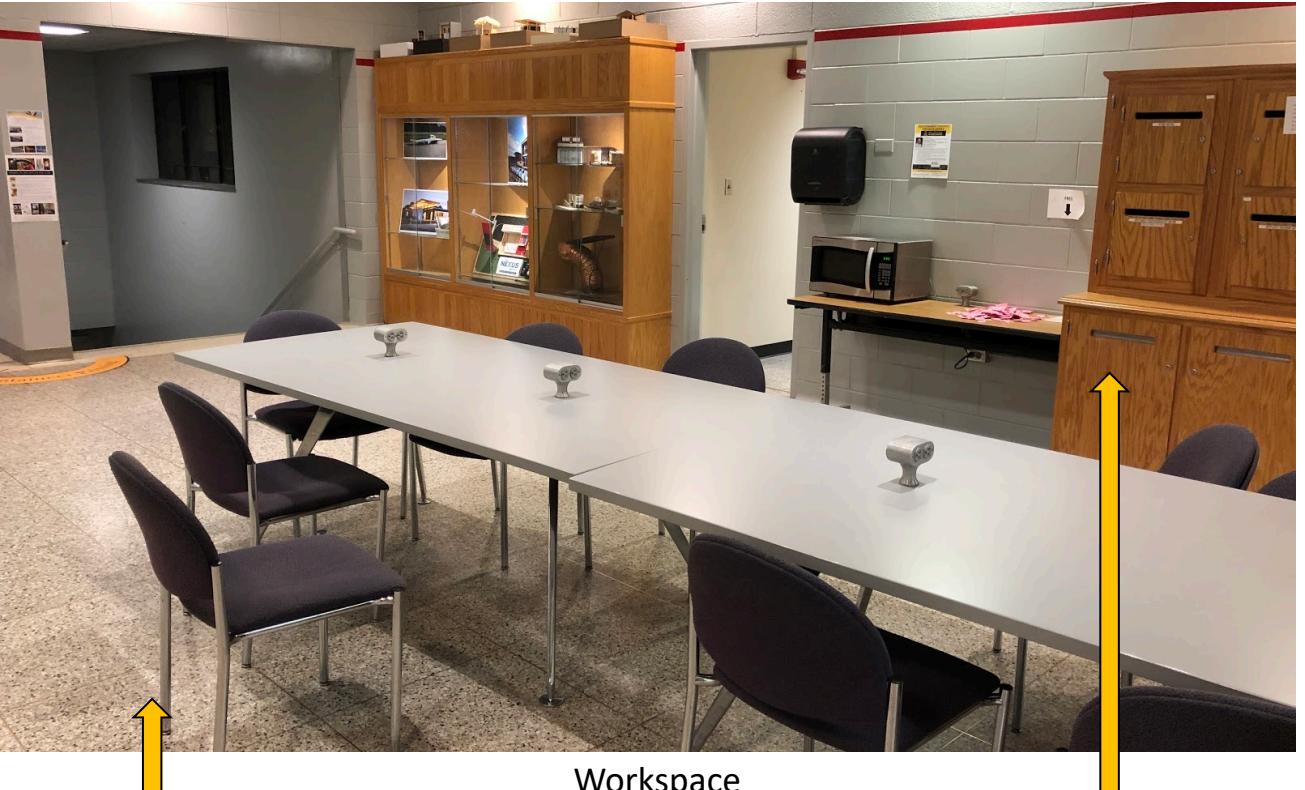
# Early Experimental Design Focal Points

- Define the space and design considerations to test
- Deciding how the subjects will interact with the space
- Software tools
  - Revit → 3ds Max → Unreal Engine



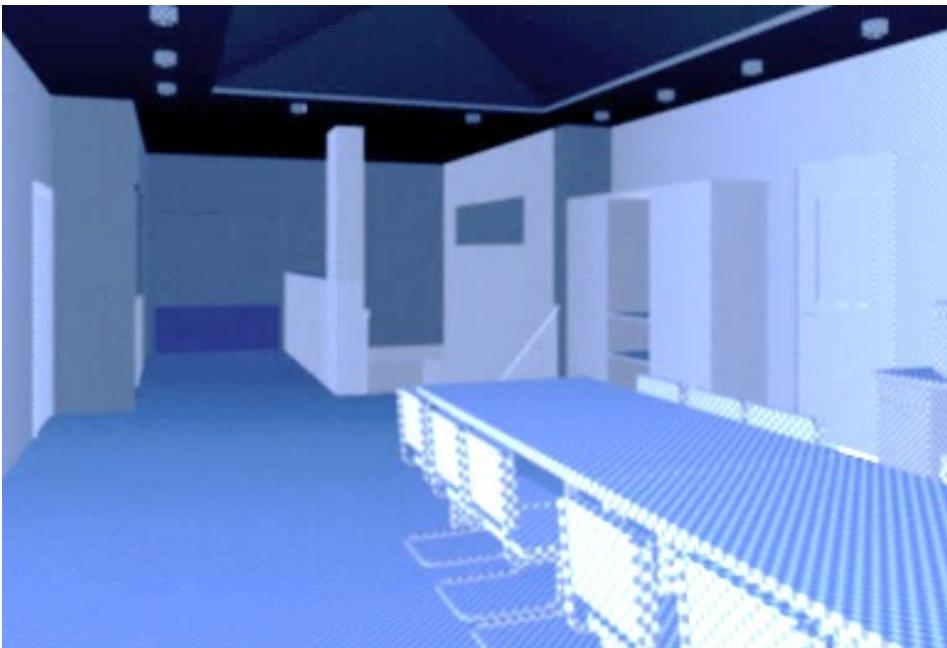
# Space Layout

- Corridor 1
- Corridor 2
- Workspace
- Food preparation
- Mail drop

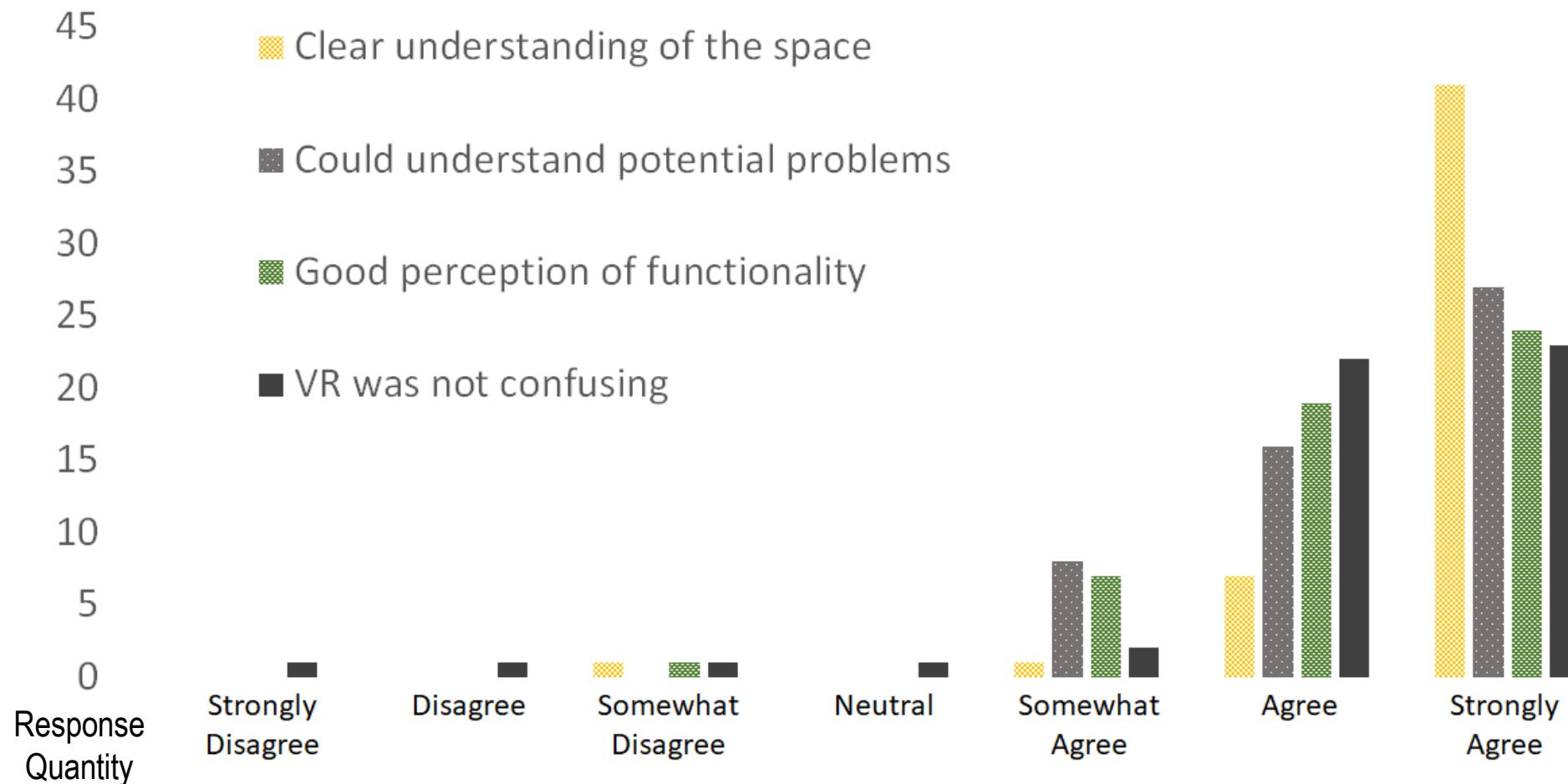


# Space Layout

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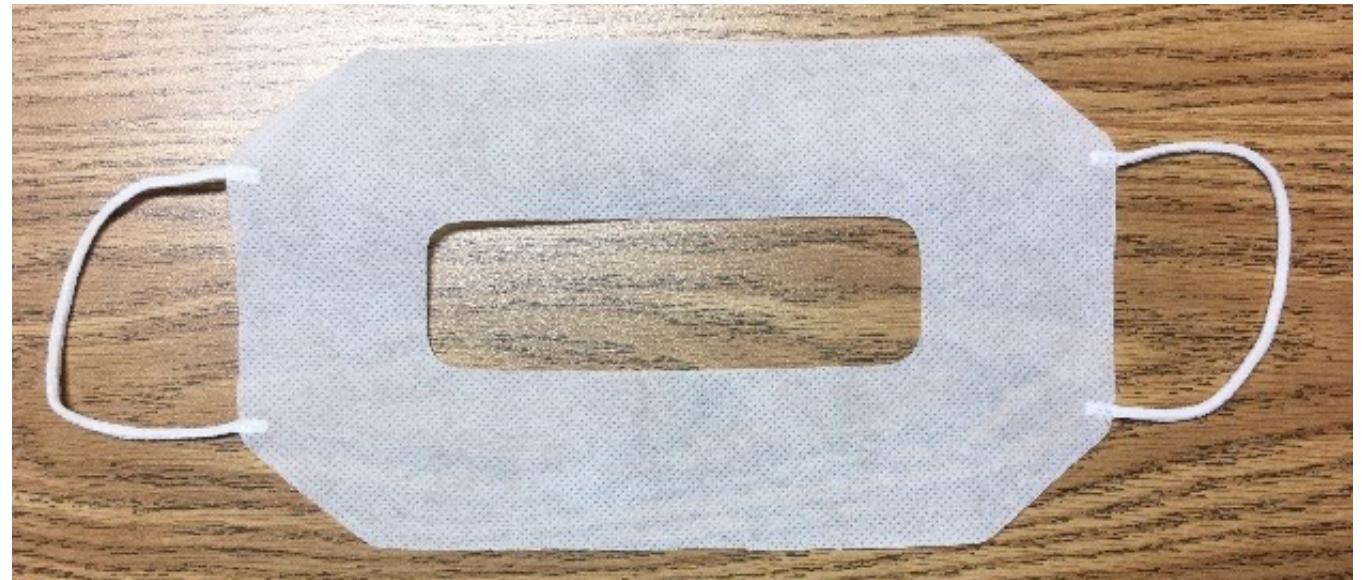


# VR to Walkthrough Experience Comparison



## Limitations

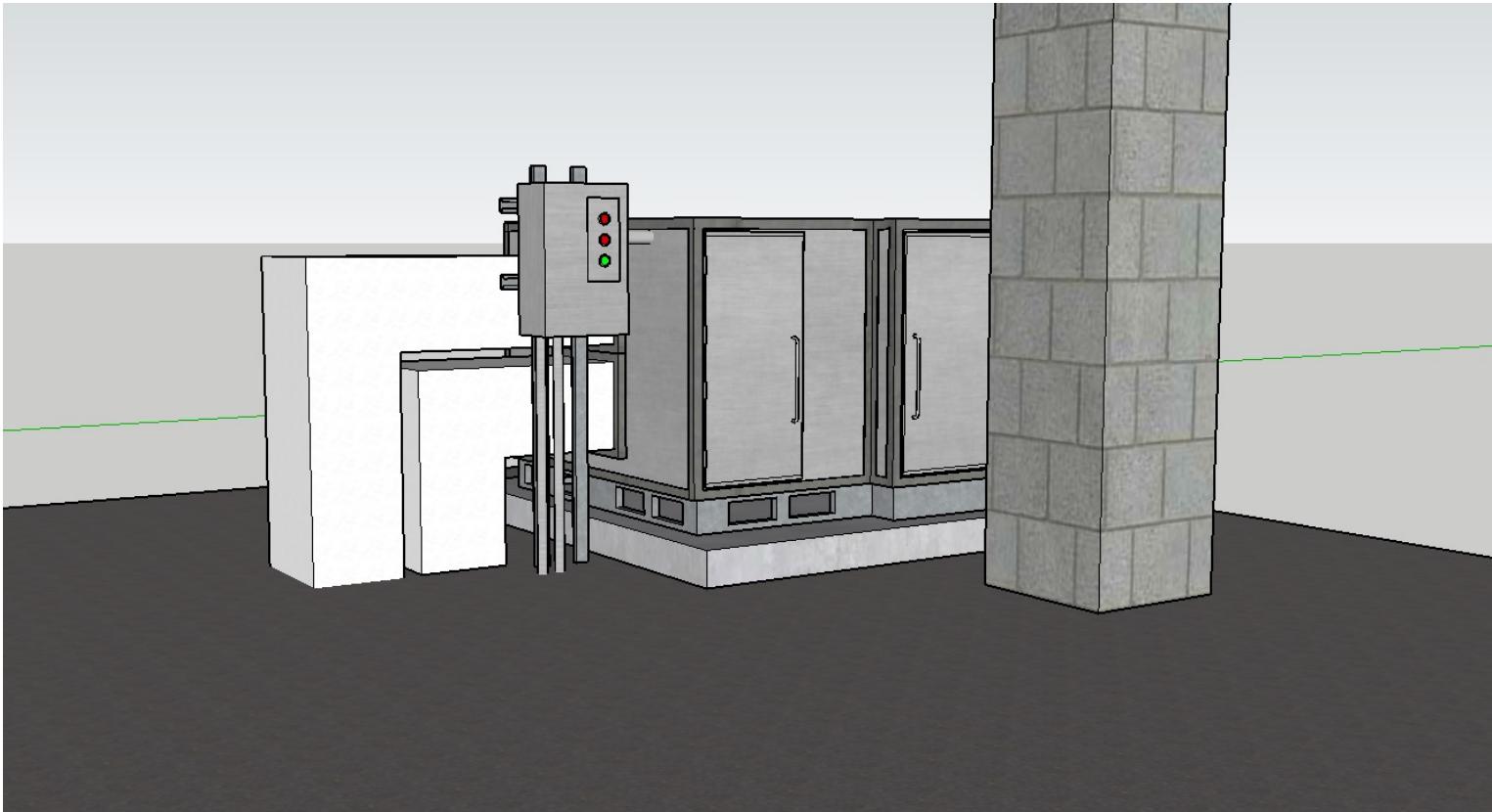
- Bias
- Students vs. Broader population
- Face Guard



## Next Step - Scaling Factors in the Virtual Reality (VR) Environment

- Problem Statement
  - Can virtual environments accurately represent the real-life scale of a building model, as demonstrated by users' ability to determine scale?
- Research Goal
  - To better understand how individuals perceive scales in VR environments

# Next Step - Scaling Factors in the Virtual Reality (VR) Environment



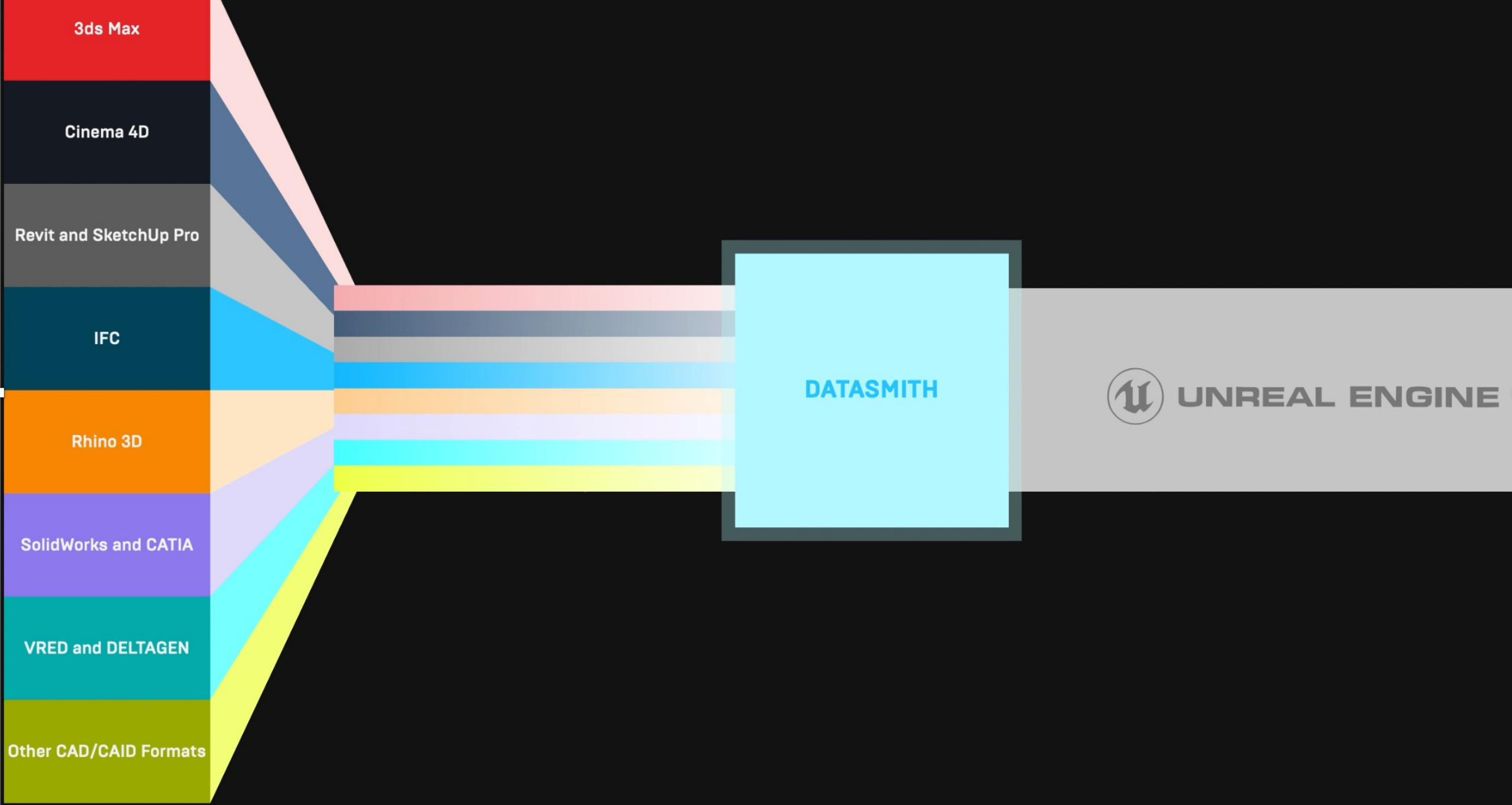
## Next Step - Scaling Factors in the Virtual Reality (VR) Environment



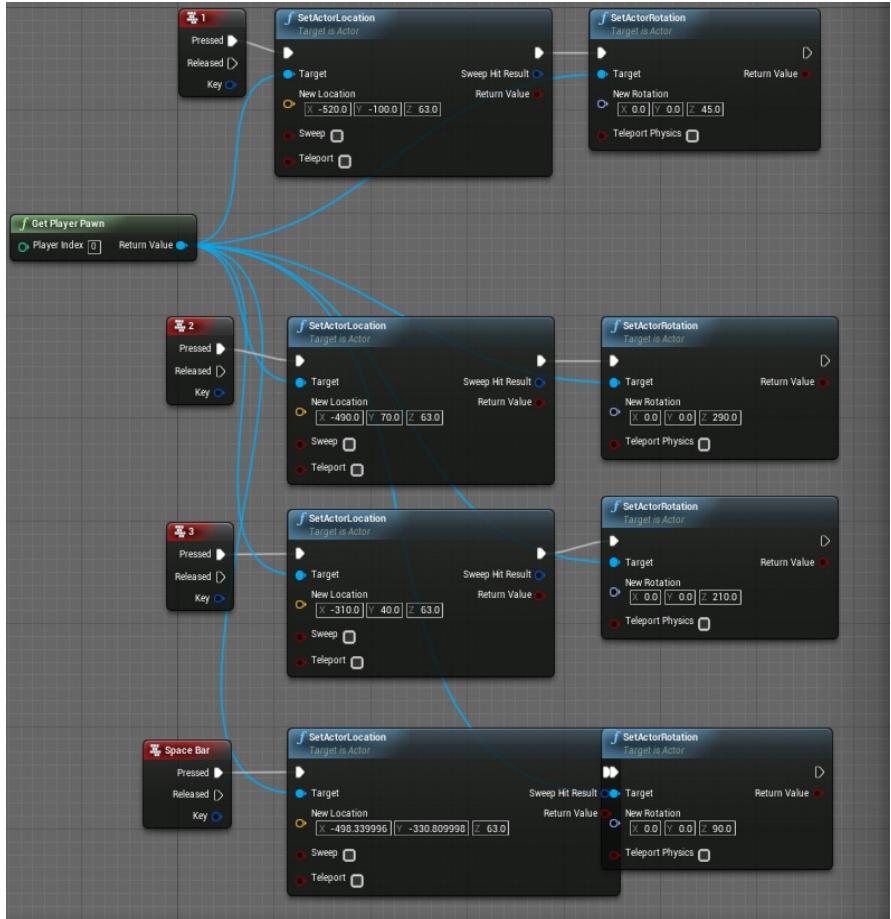
# Next Step - Scaling Factors in the Virtual Reality (VR) Environment



Unreal Game Engine



# Next Step - Scaling Factors in the Virtual Reality (VR) Environment



Blueprints Visual Scripting



## Next Step - Scaling Factors in the Virtual Reality (VR) Environment

Scale	Abbreviation	Condition
Physical Mock-up	Phy.	1:1 Scale; Real-life
Normal	V1	1:1 Scale; Virtual
Small	V2	10% reduced scale; Virtual
Large	V3	10% increased scale; Virtual

# Future Research Topics

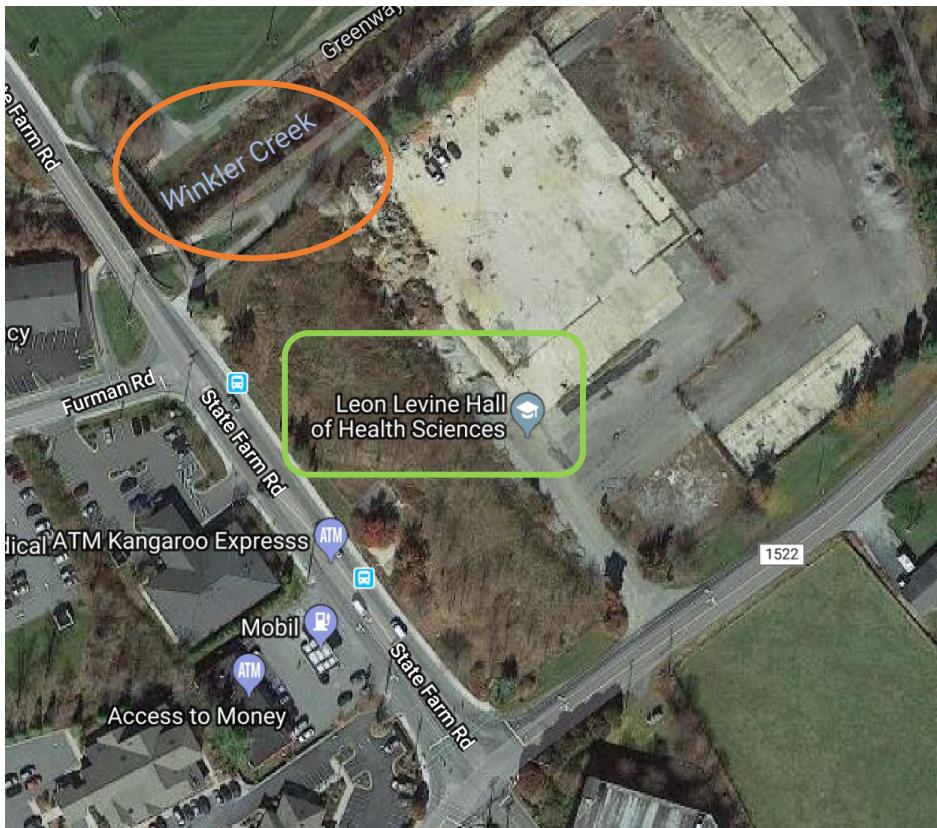
- Lighting Design
  - Evaluation of Exterior Luminous Environment Using Virtual Reality
- Augmented Reality (AR)
  - Use of AR Technology in Design Reviews
  - Scaling Factors in the AR Environment
- Etc.

# 1. Research Areas and Selected Research Projects

## 1.2 Unmanned Aerial Vehicle (UAV) Technology

- Soil Erosion Monitoring Using Unmanned Aerial Vehicle (UAV) Technology  
*(Funded by the University Research Council)*
- Comparative Analysis of Unmanned Aerial Vehicle (UAV) Surveying and Traditional Surveying Techniques  
*(Integrating Research and Teaching)*

# Problems & Motivation



Leon Levine Hall of Health Sciences



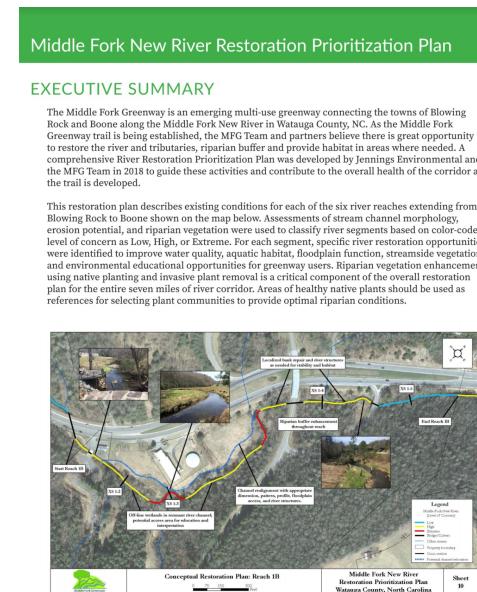
Pictures taken on 10/11/2018 (During Hurricane Michael)

# Research Goal

- To develop an automated approach to assess the rate of soil erosion caused by storm water runoff using the unmanned aerial vehicle (UAV) technology.

Jennings Environmental PLLC

NATURAL SOLUTIONS FOR SUSTAINABLE WATERSHEDS



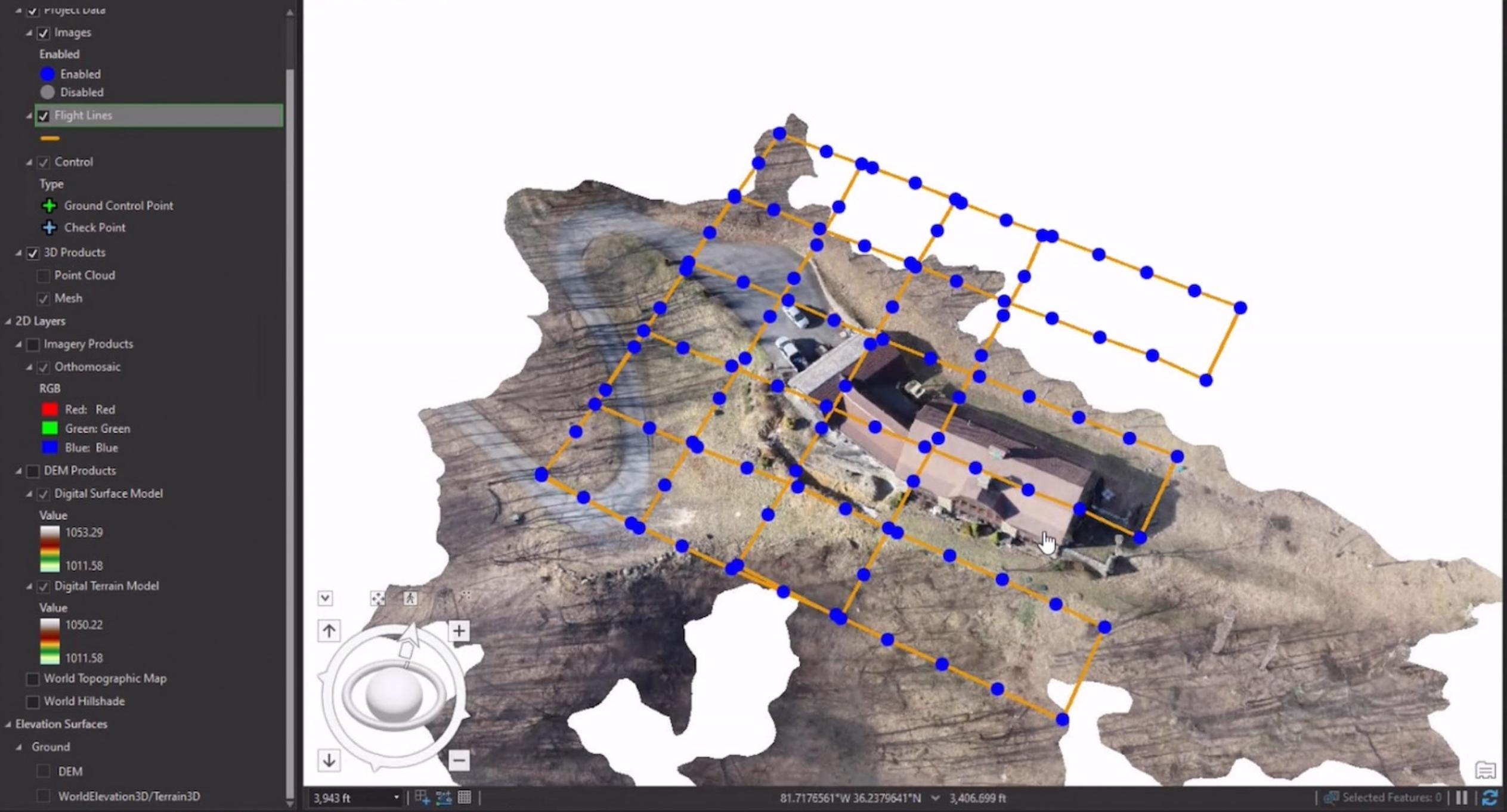
# Project Resources



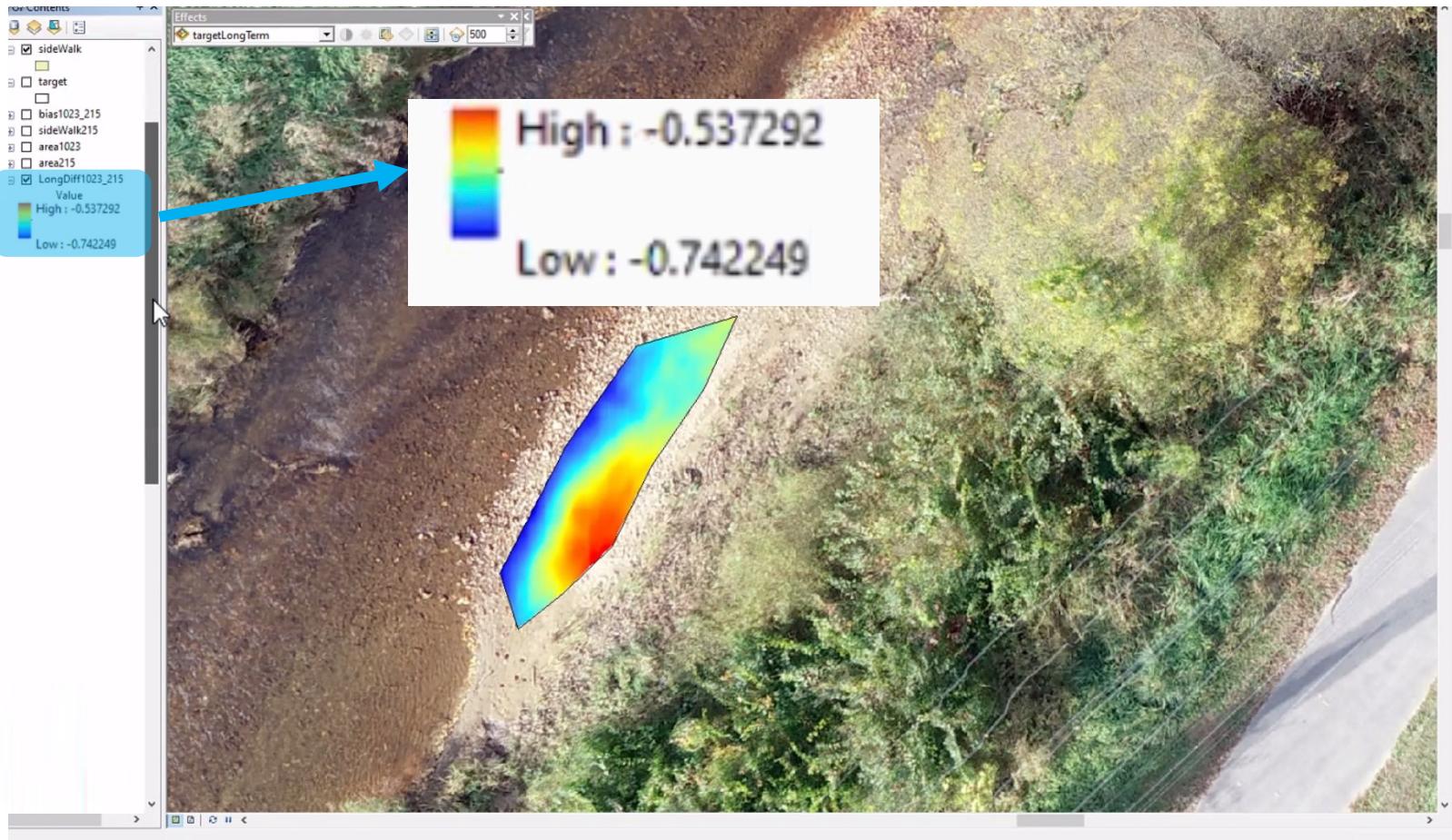
- Drones
  - DJI Matrice 100
  - DJI Phantom 4 V2
- Software
  - DroneDeploy
  - DatuSurvey
  - ArcGIS Drone2Map
  - Pix4Dcapture
  - DatuFly
  - ...
- Collaborating with Department of Geography and Planning, Department of Computer Science

# Project Design





## Result – 02/2019 vs. 10/2020



# 1. Research Areas and Selected Research Projects

## 1.1 Unmanned Aerial Vehicle (UAV) Technology

- Soil Erosion Monitoring Using Unmanned Aerial Vehicle (UAV) Technology

*(Funded by the University Research Council)*

- Comparative Analysis of Unmanned Aerial Vehicle (UAV) Surveying and Traditional Surveying Techniques

*(Integrating Research and Teaching)*

## Research Goal

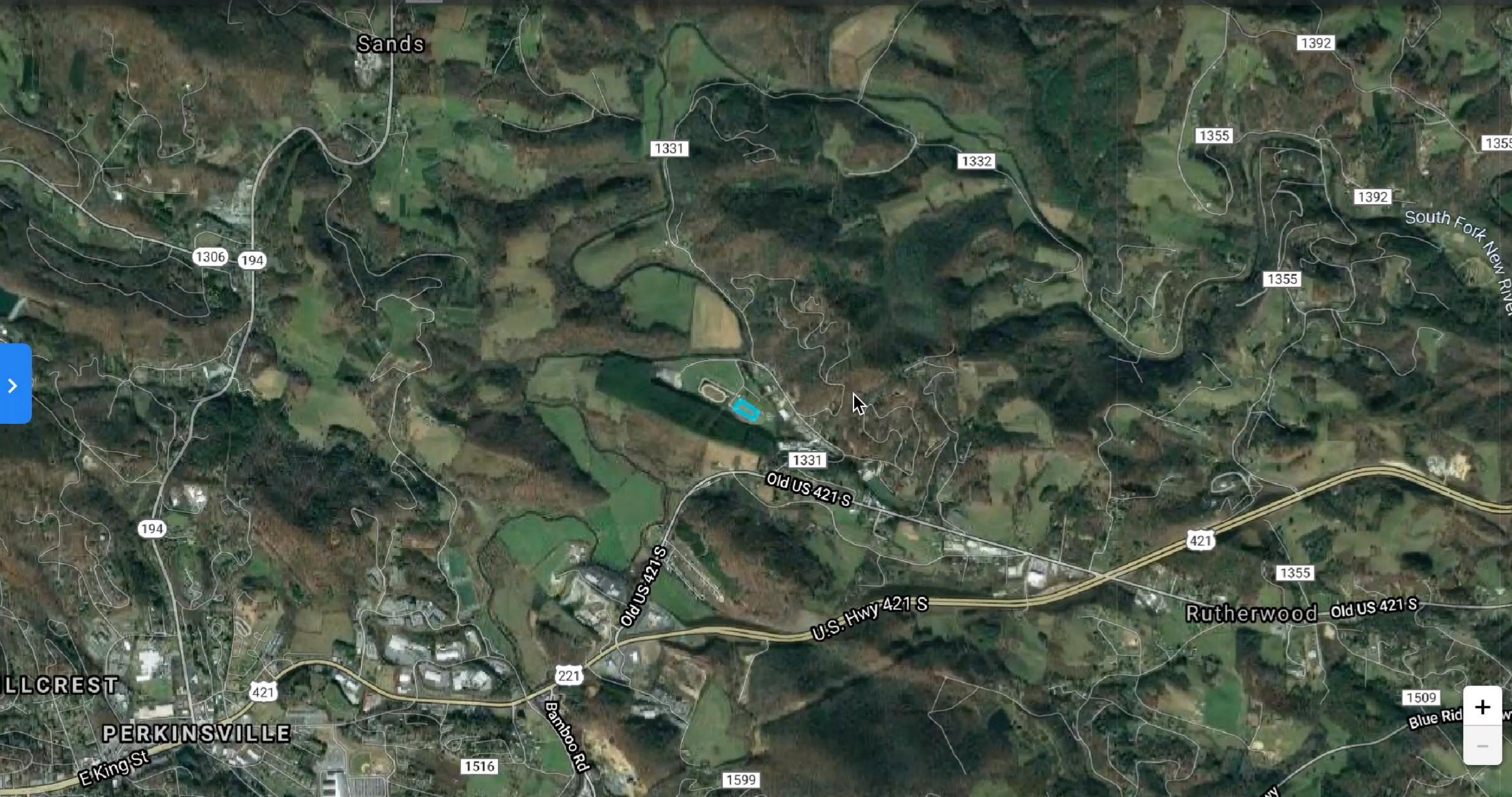
- To create a preliminary comparison of UAV surveying techniques and traditional surveying techniques in terms of the accuracy and required resources



## Research Site

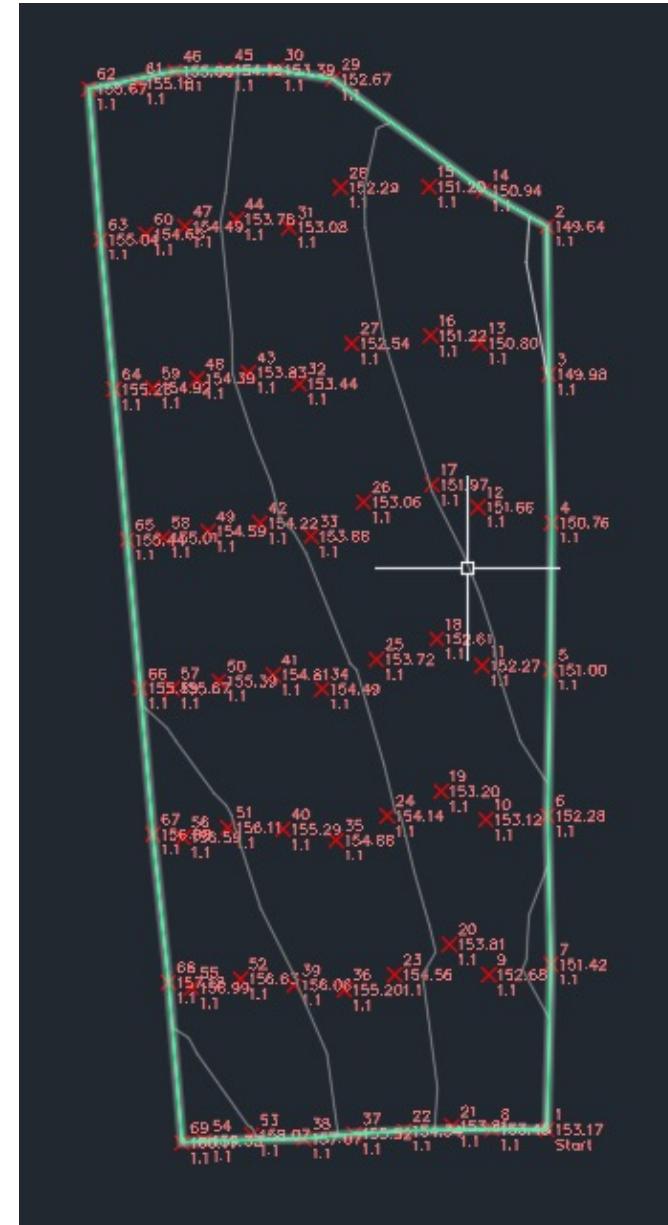
- Location: High Country Fairgrounds
- Area: 1.36 acres (400 ft x 150 ft)





# Site Surveys

- Two site surveys
  - Survey 1: 2 drone flights + traditional survey method (total station)
  - Survey 2: traditional survey method (total station)
- Software
  - DroneDeploy
  - Autodesk Civil 3D



# Result



## Drone flight

- 243 images
- 0.53 hr (20 min setup, 12 min flight)

1.36 acres  
(400 ft x 150 ft)

# Result

	<b>Traditional Surveying</b>	<b>Drone flight 1</b>	<b>Drone flight 2</b>
Active Workers	2	2	2
Data Collection Time (hrs)	4.5	.53 (20 min setup, 12 min flight)	.53 (20 min setup, 18 min flight)
Points / Images	70 points	243 images (thousands of points)	275 images (thousands of points)

## Future Research

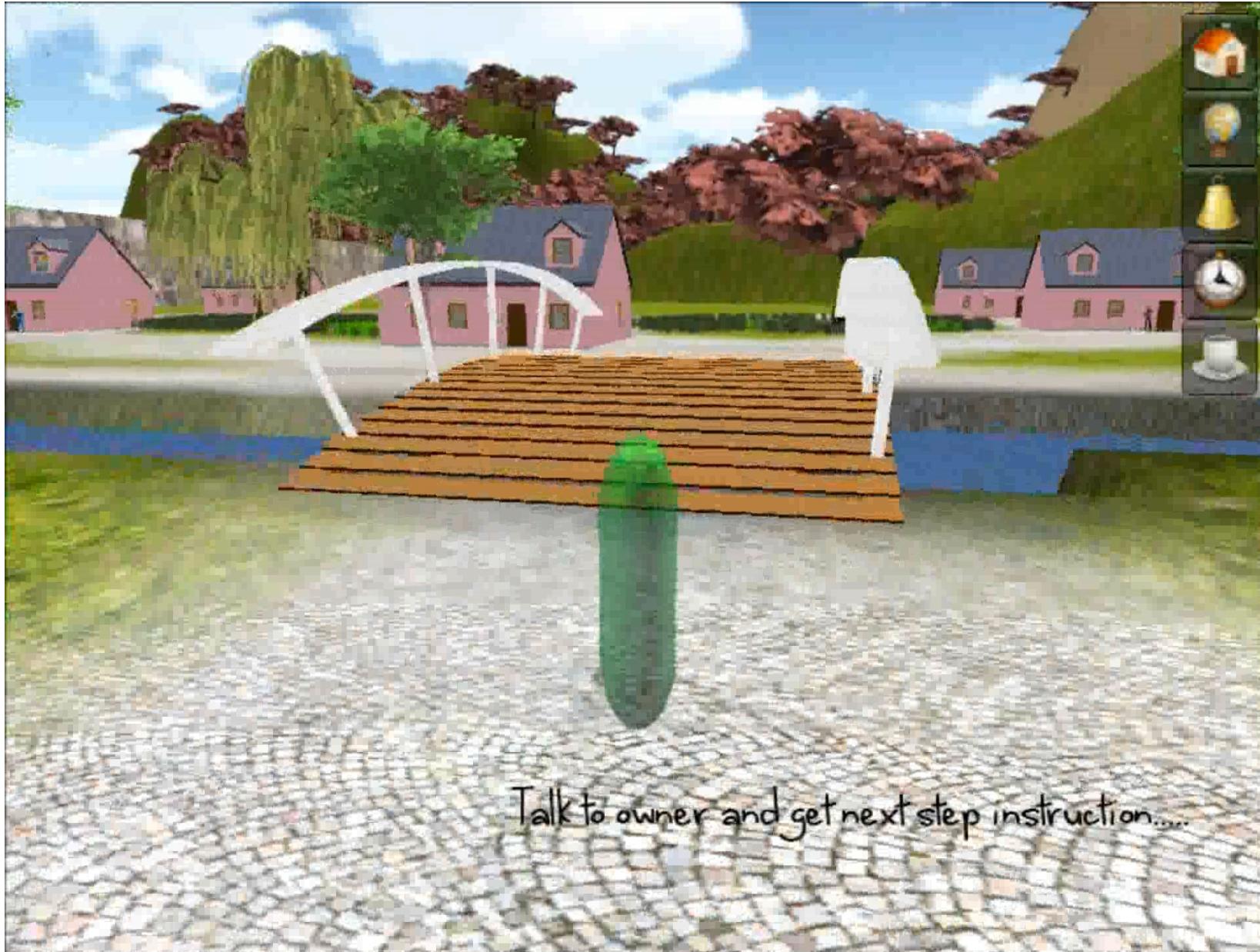
- A UAV Health Diagnostics Approach for PV Panels Using UV Fluorescence (UVF) Imaging Technology
- UAV Technology-Based Construction Progress Monitoring
- Structural Health Monitoring
- Construction Safety Monitoring
- Etc.



# 1. Research Areas and Selected Research Projects

## 1.3 Engineering Education

- Cohort-Based BIM Education
- VR and Safety Training
- Use of Virtual Reality (VR) Technology in AEC Education
- Etc.



Talk to owner and get next step instruction....

LIGHTING NEEDS TO BE REBUILT (4642 unbuilt object(s))

'DisableAllScreenMessages' to suppress



# 1. Research Areas and Selected Research Projects

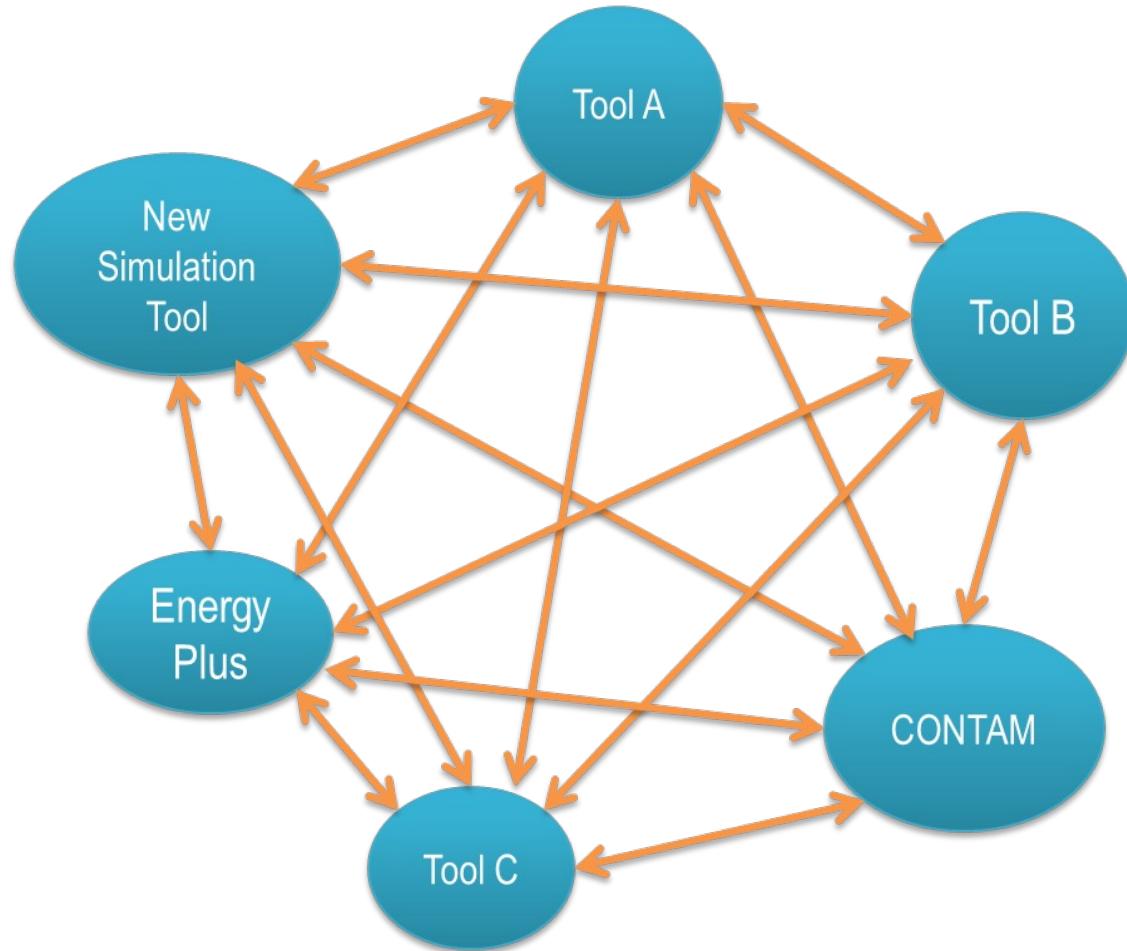
## 1.4 Building Information Modeling (BIM)

- OpenStudio Enhancements

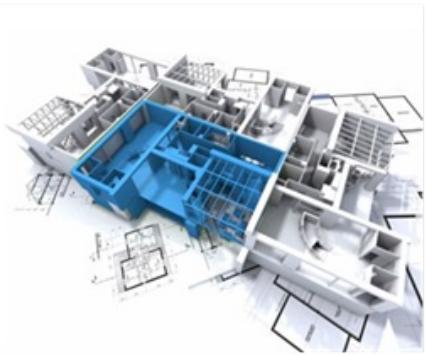


*(Funded by Department of Energy)*

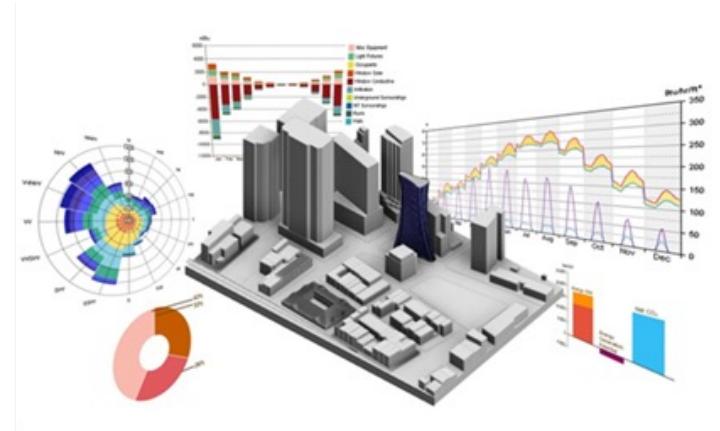
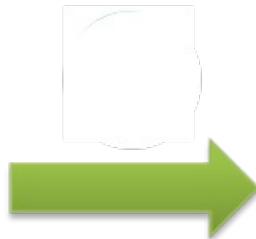
# Problems & Motivation



# Research Scope



BIM Models



Energy Analysis



# 1. Research Areas and Selected Research Projects

## 1.5 Construction Information Systems

- Integrated Change and Knowledge Management in Energy Efficiency Retrofit Projects

*(Ph.D. Dissertation)*



## 2. Future Research Trajectories

- Research Directions
- Potential Funding Sources
- Collaboration Opportunities
- Industry Connections

# Potential Research Topics

- Use of AR Technology in Design Reviews
- Evaluation of Exterior Luminous Environment Using Virtual Reality (VR)
- Use of Virtual Reality (VR) Technology in AEC Education
- Scaling Factors in the AR Environment
- A UAV Health Diagnostics Approach for PV Panels Using UV Fluorescence (UVF) Imaging Technology
- UAV Technology-Based Construction Progress Monitoring
- From Building Information Modeling (BIM) to Building Knowledge Modeling (BKM)
- Etc.