32nd Annual INCOSE international symposium

hybrid event

Detroit, MI, USA

June 25 - 30, 2022

# Digital Twins for Space Exploration

Paper 67

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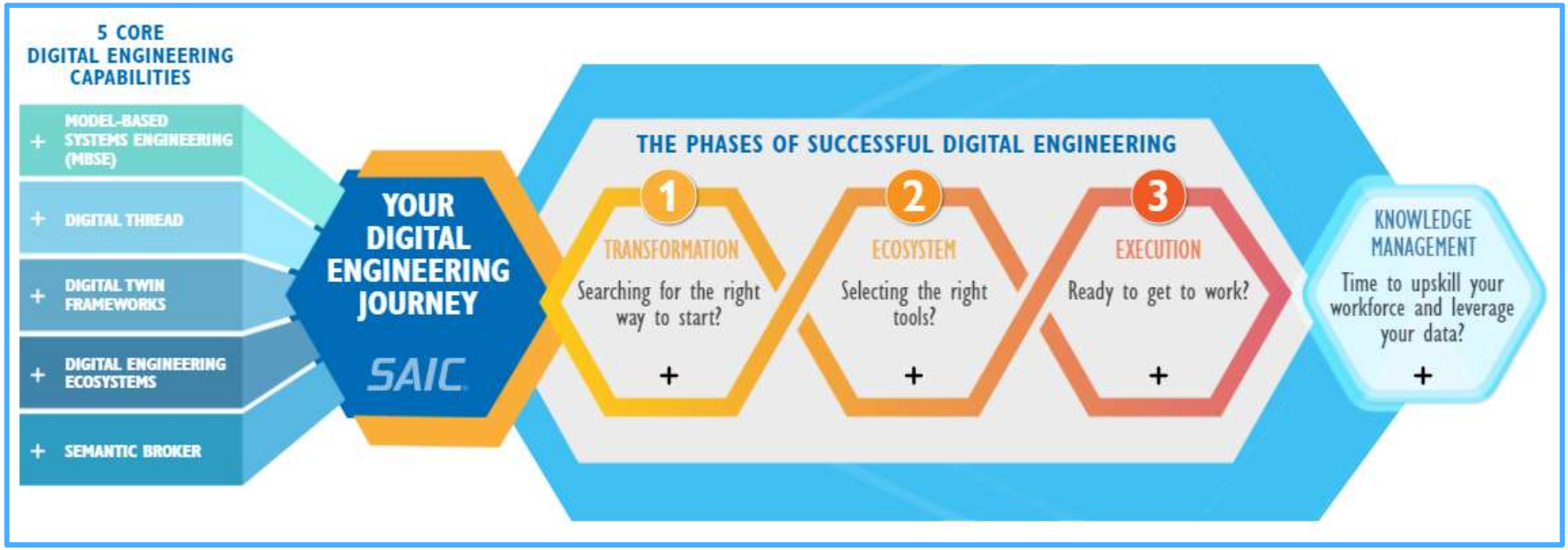
# Overview

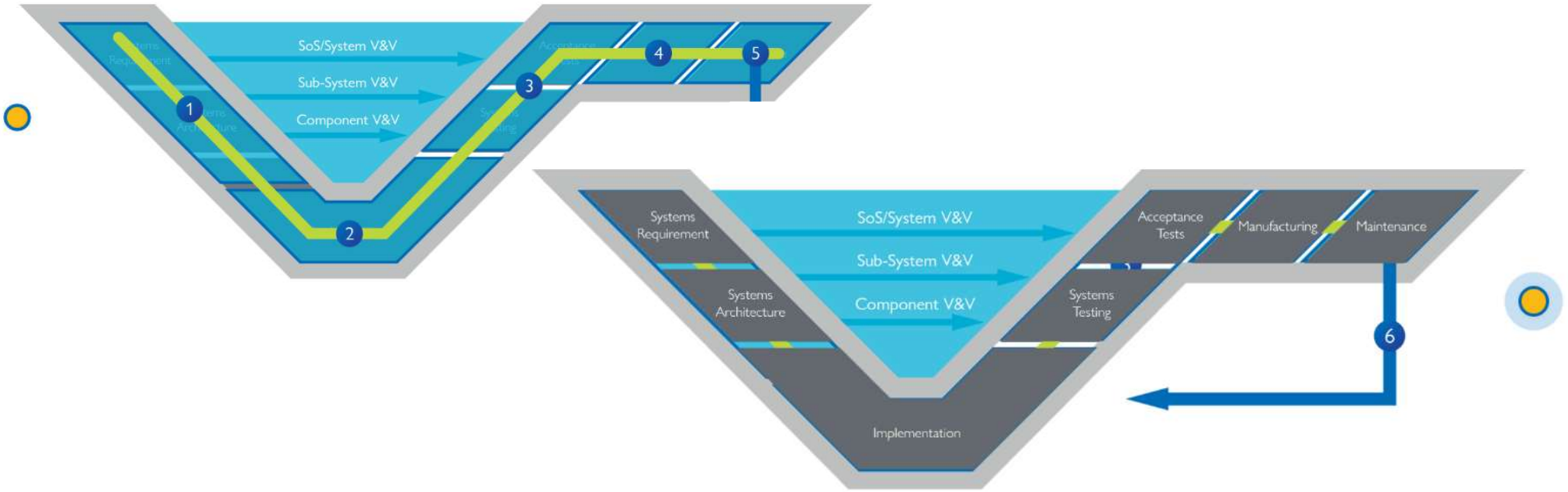
- Digital Engineering and SAIC's Engineering Innovation Factory offerings
- The Lunar Landscape Lighting demonstration project
- Future Work

# Digital Engineering at SAIC



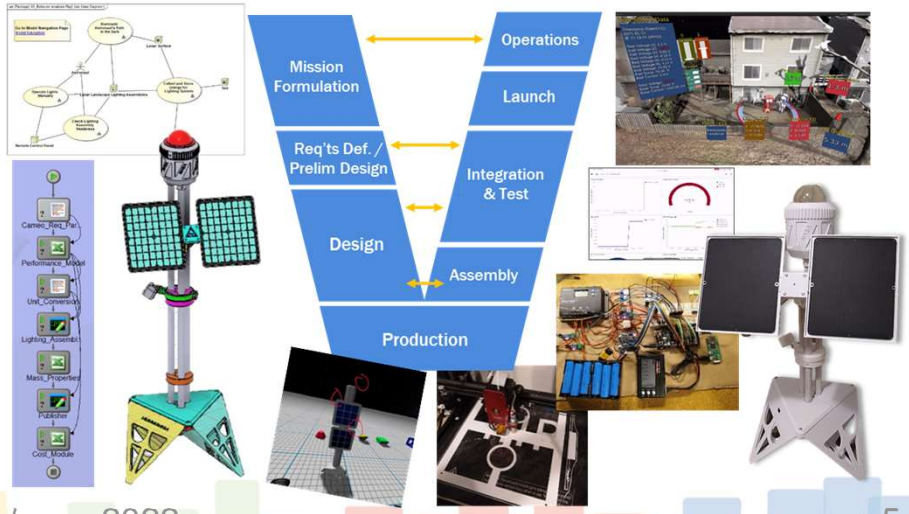
# Engineering Innovation Factory

- Covering the entire lifecycle of system development and deployment



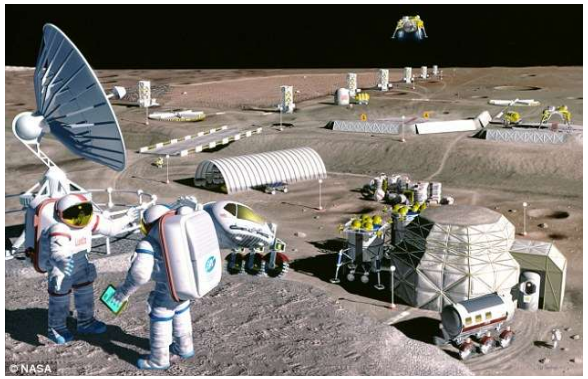
# Lunar Landscape Lighting (Tri-EL) Project

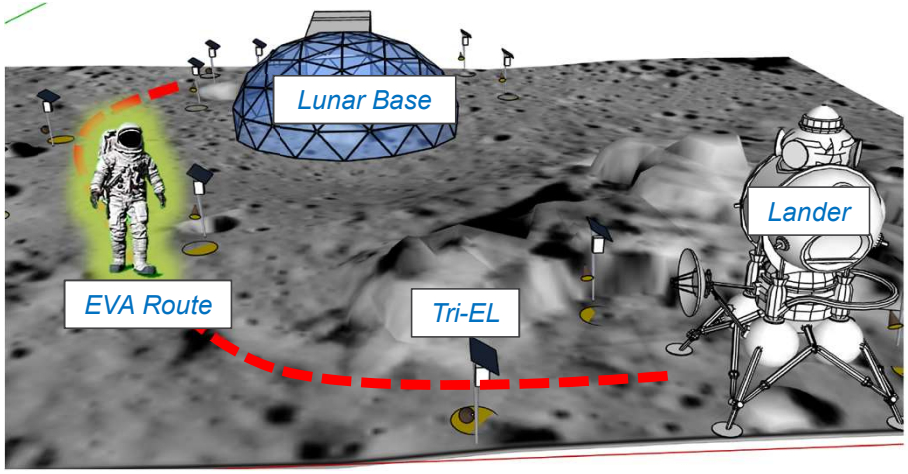
- Demonstration effort showcasing DE capabilities and applicability to NASA program opportunities
- DE offerings developed as part of DoD Digital Engineering Strategy evolution
- Several integrated demos with a collaborative and geographically distributed team

# Tri-EL Project Concept Overview

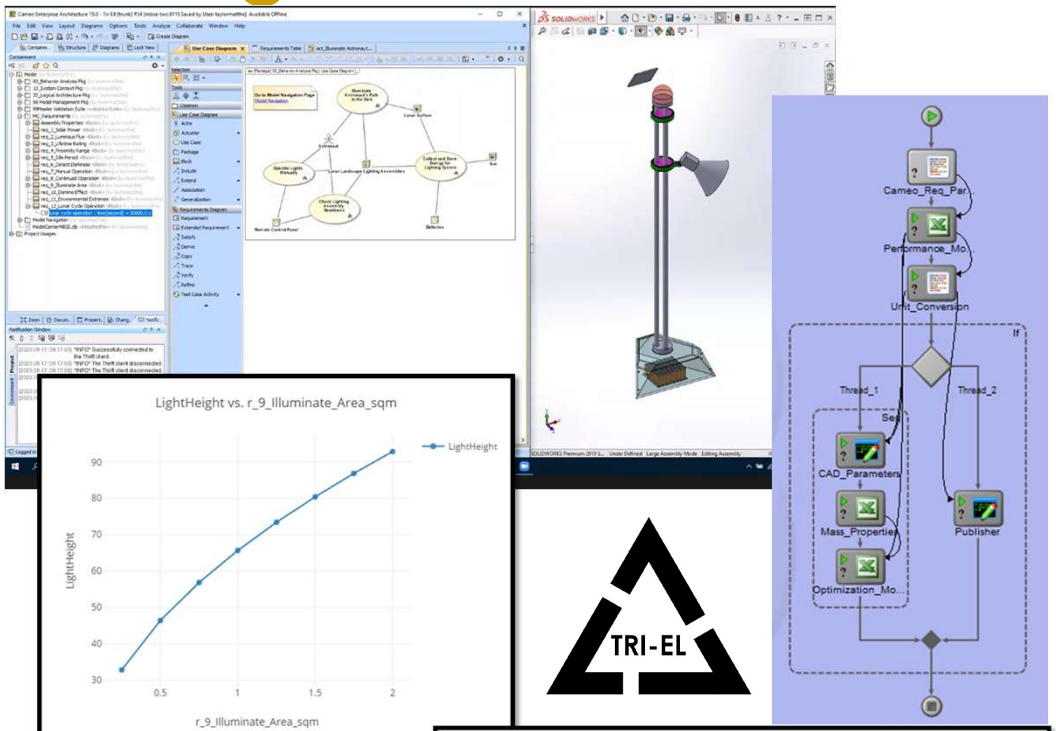
- As NASA looks to return to the moon, and establish a permanently manned base, astronauts will benefit from repositionable lighting for EVA excursions during the 14 day lunar night.
- A set of 11 core requirements for the system function were established as stakeholder requirements for the project



# Tri-EL Systems Engineering

- Center of MBE for Tri-EL
- Cameo System Model maintained authoritative source of truth for requirements and DOE results
- Automated report generation demonstrated push button artifact generation
- Phoenix ModelCenter connected analyses with descriptive model and other engineering domains
- Validation Suites ensured consistency and completeness of model content through project lifetime

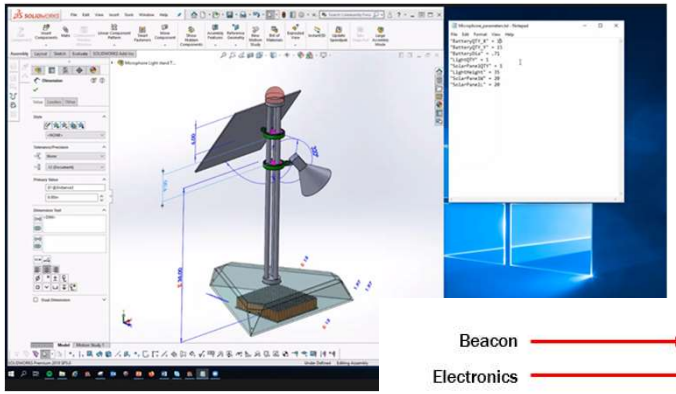


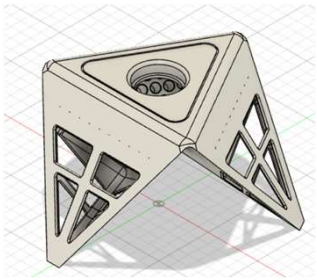

**Use Case Table**

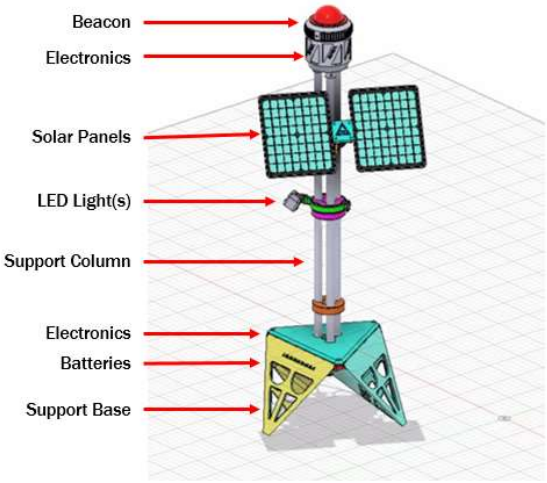
| Name | Documentation | Actors |
|---|---|---|
| Check Lighting Assembly Readiness | Determine that all Tri-Ell components are functional and ready or that manual backups are in place. | Remote Control Panel<br>Lunar Landscape Lighting Assemblies<br>Astronaut |
| Collect and Store Energy for Lighting System | Pre-Conditions: Lights are installed correctly, light system is properly functioning.<br>Goals: Store enough energy to illuminate Astronaut's pathway for two weeks | Sun<br>Lunar Surface<br>Batteries<br>Lunar Landscape Lighting Assemblies |

# Tri-EL Design Engineering

- Mechanical design in Solid Works
- Analysis in Excel, MatLab
- Connected with Phoenix Model Center
- Design tools added or changed throughout Tri-EL to demonstrate tool agnostic DE approach to solution

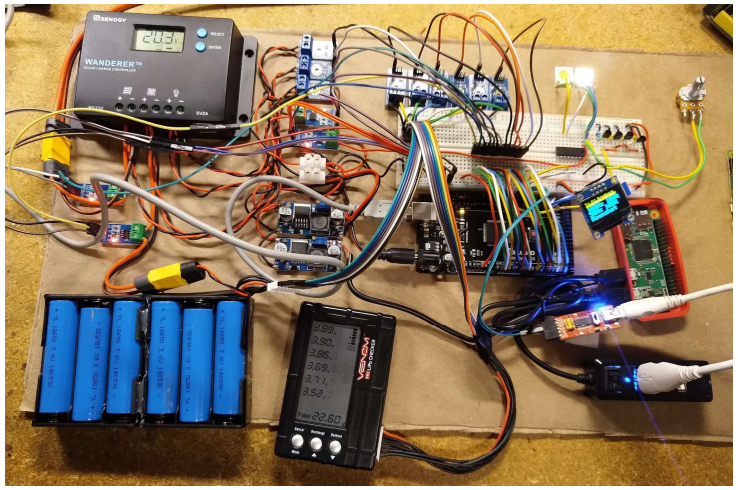




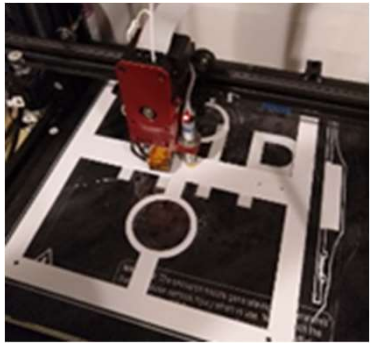


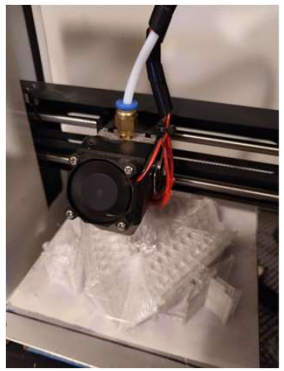
# Tri-EL Prototyping and Evaluation

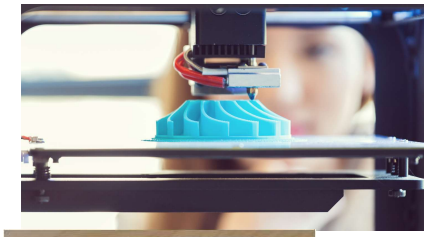
- Breadboards utilized for electronics verification
- 3D printing for rapid prototyping and proof of manufacturing concept
- Distributed capabilities employed across the geographically diverse team

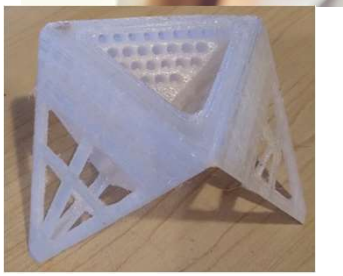






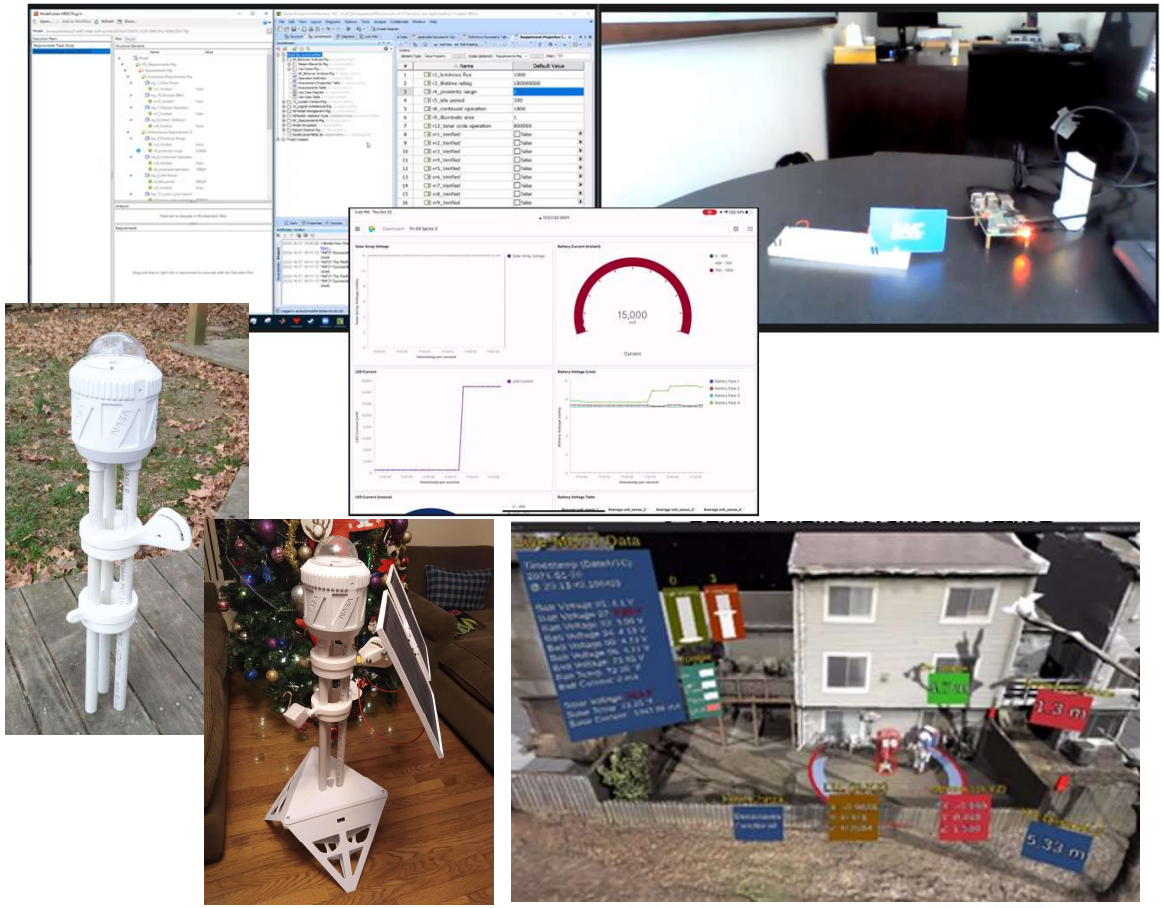






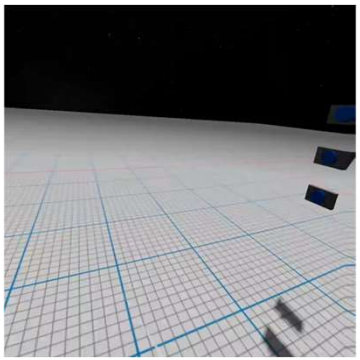
# Tri-EL Digital Twin

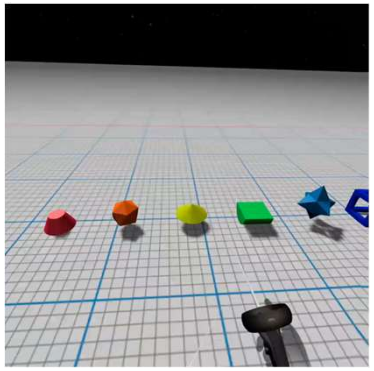
- Utilize tabletop physical system with Digital Twin to validate models with data and use feedback mechanisms as proof of concept
- Establish IoT board that reports results from the physical “twin” setup and compares to the digital twin for monitoring
- Move to larger scale demonstration
  - When you have someone willing to donate their backyard
  - Prototypes make great holiday gifts!
  - Accurate measuring helps for property assessments

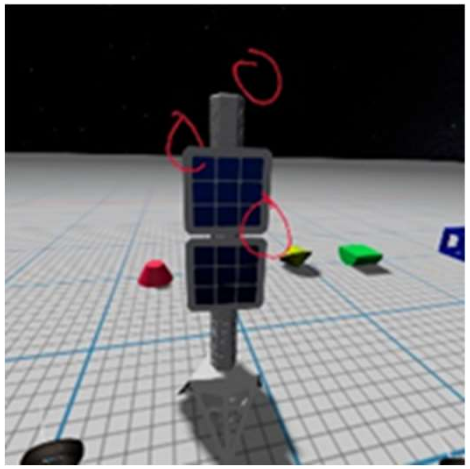


# Tri-EL Virtual Reality

- Utilize VR for virtual prototyping in development
  - Can be more efficient for geographically diverse teams
  - Can be more cost and schedule effective for quick turn iterations over rapid prototyping
- VR also enables development of manufacturing, assembly, sustainment and operations needs ahead of material implementation
  - Can address simulating alternate gravity forces (such as lunar surface) in ways that are challenged or expensive on Earth







# Future Work

- Rapidly deployable digital engineering ecosystem
- Engineering Innovation Factory Lab in Reston, VA
- Applying the concepts on new programs and contracts

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