# SPACECRAFT

ENGINEERING HUMANITY'S FUTURE IN SPACE

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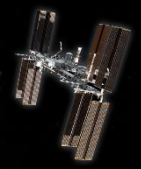
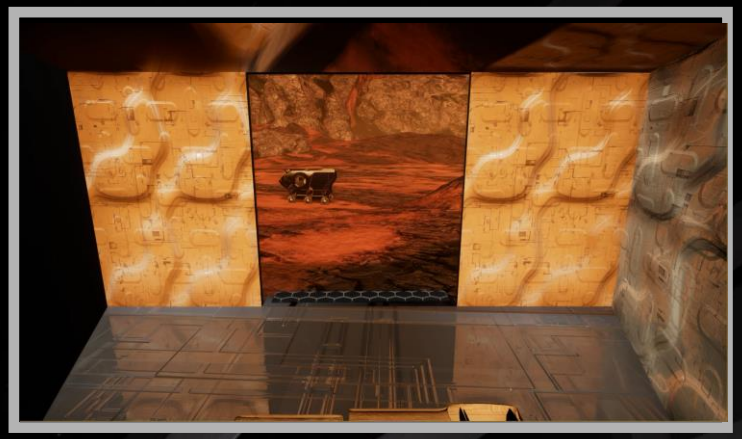
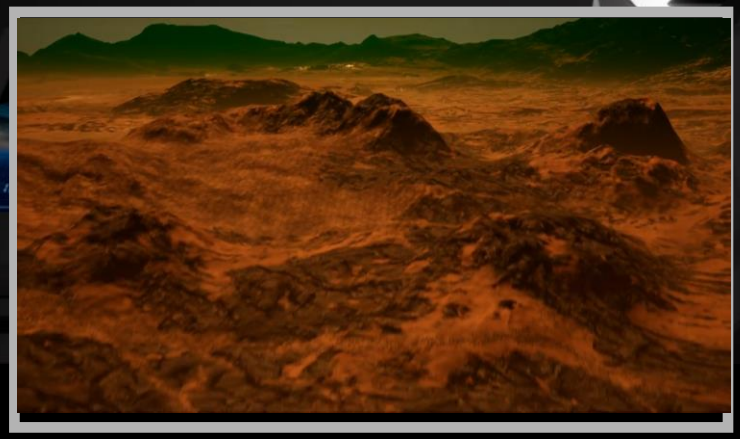
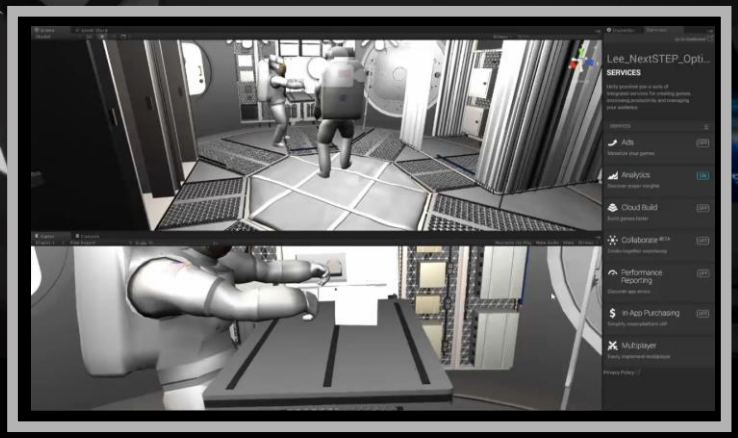









**An open-source, multi-user, VR engineering platform for worldwide collaboration in Space**

# SpaceCRAFT Leadership

**Mauricio Coen**
**Project Manager**
**Graduate Student**

**Neil McHenry**
**Project Manager**
**Graduate Student**

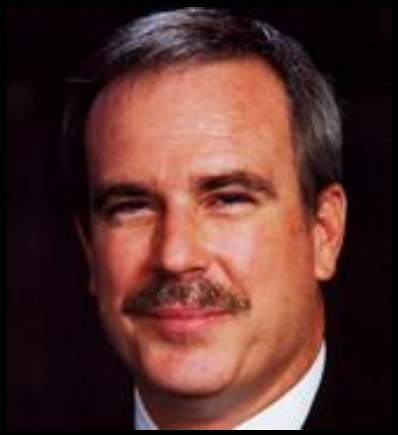
**Robert Hogan**
**Project Manager**
**Graduate Student**

**Tanner Hunt**
**Project Manager**
**Graduate Student**

**Matthew Holub**
**Project Manager**
**Graduate Student**

**Greg Chamitoff, PhD**
**Professor of Practice**
**Instructor**

**Naz Bedrossian, PhD**
**Systems Engineering**
**Advisor**



**George James, PhD**
**Technical Advisor**
**NASA**

**Eddie Paddock**
**Technical Advisor**
**NASA**


NASA


ВОЛКОВ • КОНОНЕНКО
REISMAN • CHAMITOFF
ISS-17


STS-124
GARAN KELLY
HAM NYBERG
FOSSUM HOSHIDE
CHAMITOFF
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ISS-17

National Aeronautics and Space Administration

NASA

Space Flight Awareness

СОЮЗ

FINCKE ЛОНЧАКОВ CHAMITOFF MAGNUS 若田

XVIII

E. MICHAEL FINCKE | YURY LONCHAKOV | GREGORY CHAMITOFF | KOICHI WAKATA | SANDRA MAGNUS

# EXPEDITION 18

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# What is SpaceCRAFT?

- A System for Planning Humanity's Future off Earth
- An Open Source Engineering VR Collaboration Platform
- A New Approach to Space System Design
- A Human-in-the-loop Interactive VR Simulator
- A Complete Mission Design and Analysis Program
- A Detailed Model of the Space Environment
- A Tool for Integrating and Evaluating Space Systems
- A Limitless VR Environment for STEM Education
- A Texas A&M Project with NASA/JSC Advisors

# What is SpaceCRAFT?

SpaceCRAFT is a new concept for collaborative space system and mission design. It is a Virtual Reality (VR) 'Sandbox' environment designed to enable students, government and commercial entities to collaborate, design, evaluate and experience the technology for future operations in Space. SpaceCRAFT aims to enable any person or institution to contribute to humanity's future in Space.

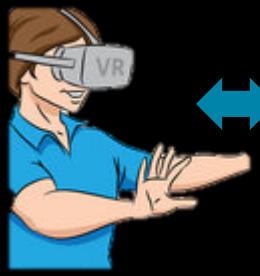
Future missions of exploration and settlement in Space will involve many systems and capabilities working together on a solar-system scale. This includes spacecraft, habitats, rovers, robots, satellite constellations, communication arrays, space suits, landers, science instruments, life support systems, and tools such as teleoperation and advanced autonomous systems for robotic construction and other remote operations. At present, it is essentially impossible to test a complete Space mission architecture in any integrated fashion, especially one with components designed and developed at different institutions worldwide. Quite frequently Space operators are required to work around system deficiencies or to execute missions with suboptimal or degraded capability due to oversights in the initial design or integration. An important lesson learned from past Space operations is that the integration of operational concepts should occur early in the mission and technology design process.

SpaceCRAFT provides the capability for system design and scenario-based operational testing of integrated mission concepts in the actual intended environment using detailed physics and engineering models in VR.

For students of any age, it offers the opportunity to explore and participate in the universe of future possibilities, such as visiting other planets, piloting spaceships, controlling robots, exploring deep space habitats, spacewalking, building your own colony or designing a mission.

# High Level SpaceCRAFT Architecture

Database of User Models & Sims




Graphics Engine and User Interface

Simulation Core

Physics Engine

Plug-In Interfaces

Matlab

CAD

FEA

GIS

Models

# User Experience

- Login via SpaceCRAFT website
- Experience VR Space Mission / Environment Demos
- Join an Ongoing Space Simulation
- Upload User Created Models – CAD, Analytical etc…
- Browse/View/Use Shared Models
- Download/Modify/Improve/Customize Existing Models
- Build Space Missions, Systems, Scenarios
- Run VR Space Simulations
- Invite Others to Join in Multi-User Simulations
- Share Comments/Blogs/Ratings for Shared Models
- Collaborate on Mission & System Designs
- Visit Worlds, Explore Habitats and Join Missions Created by Users

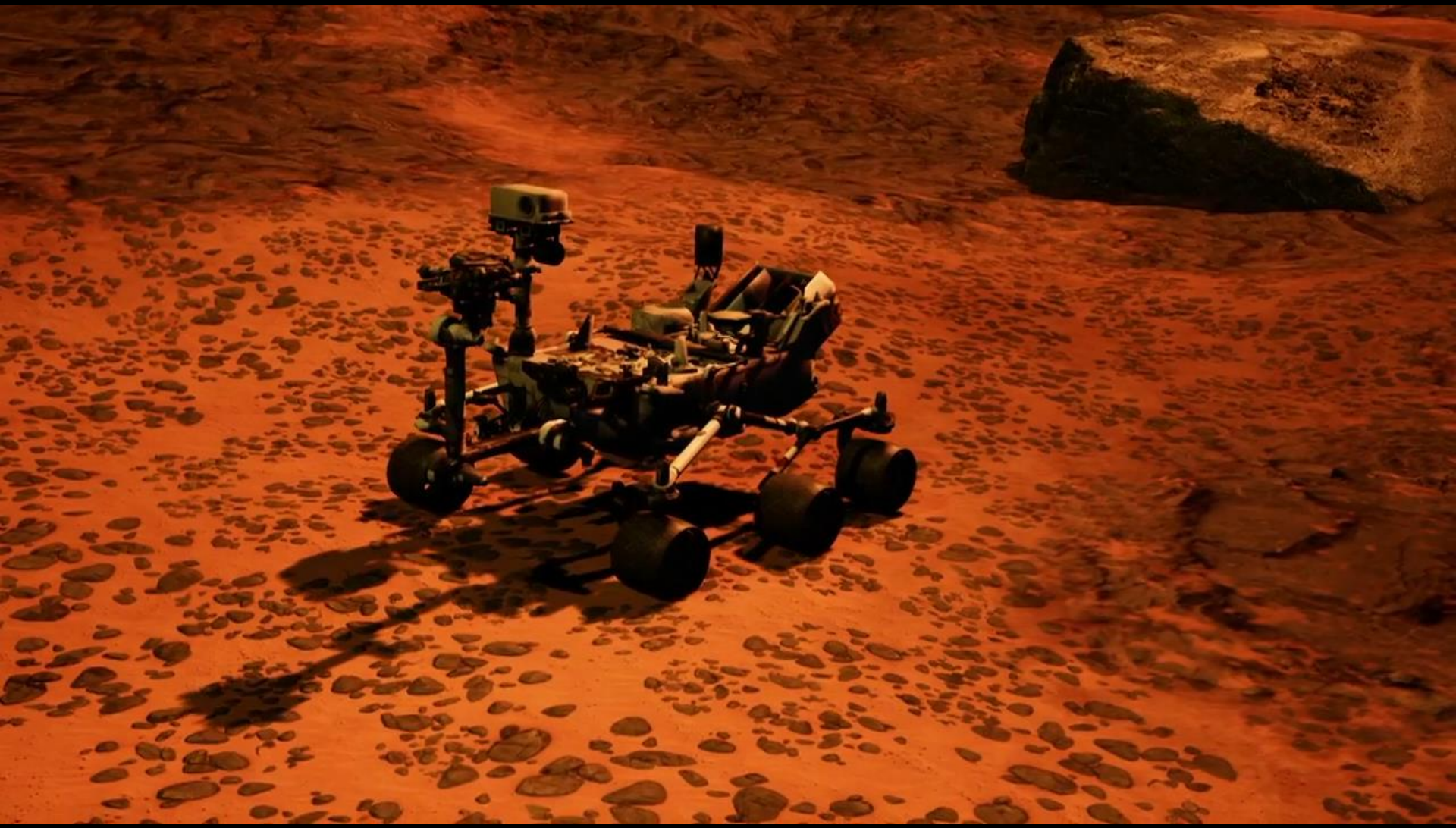
# SpaceCRAFT Core Features

**Solar system model based on the latest exploration data**

# SpaceCRAFT Core Features

Detailed and ‘best available’ surface models

# SpaceCRAFT Core Features

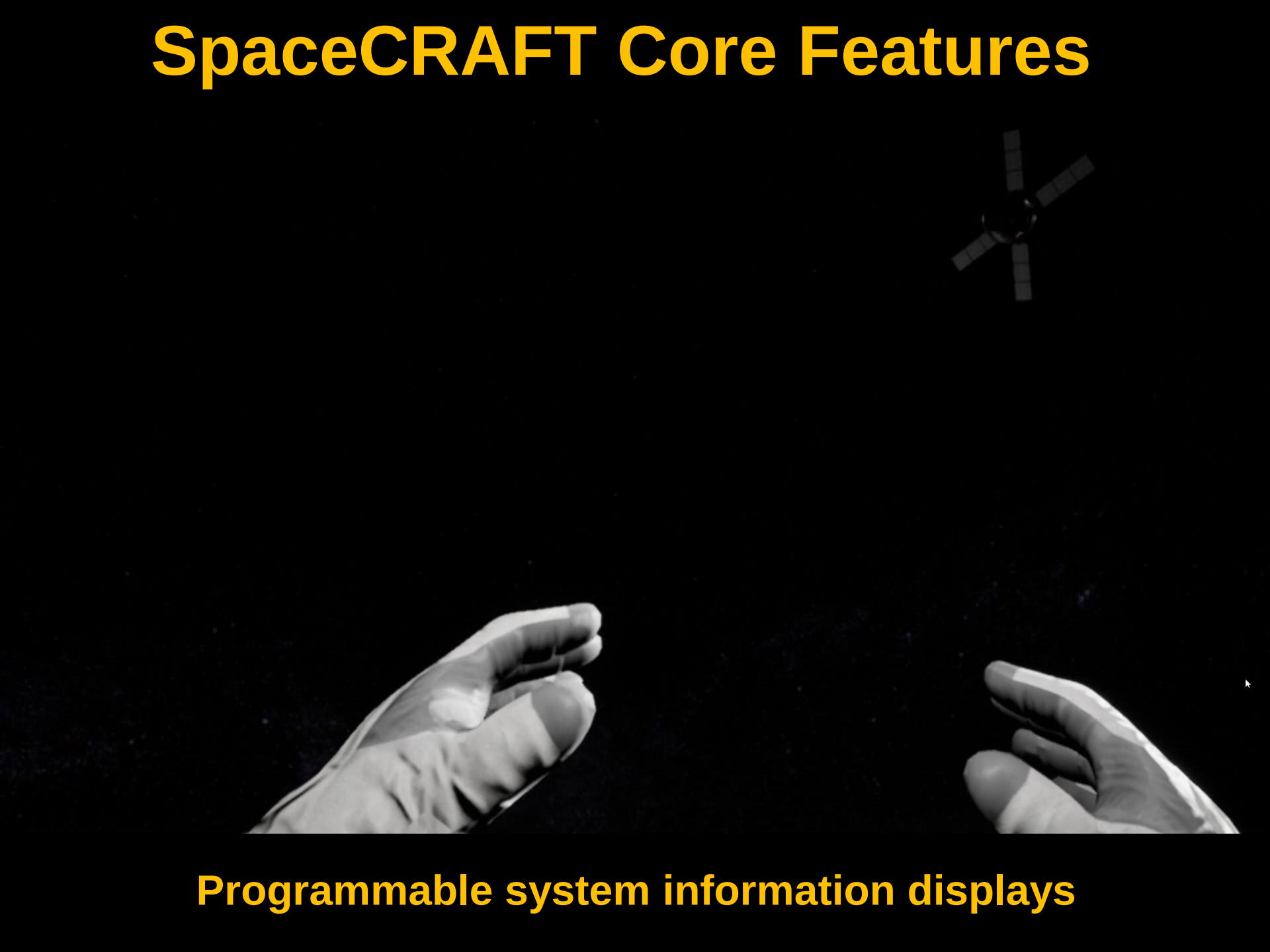


**Model templates for countless space systems**

# SpaceCRAFT Core Features

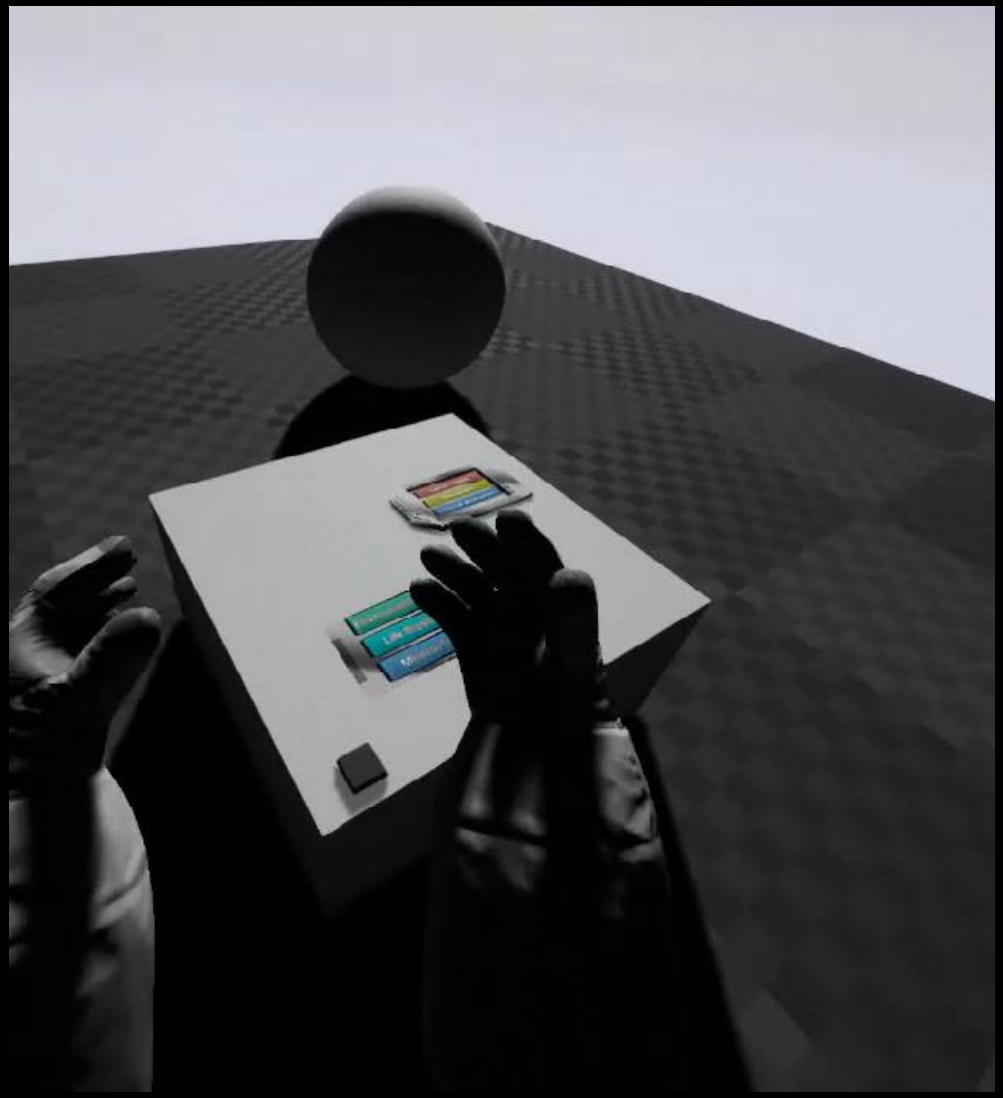

**Analytical functions for system operations and control**

# SpaceCRAFT Core Features



Programmable system information displays

# SpaceCRAFT Core Features

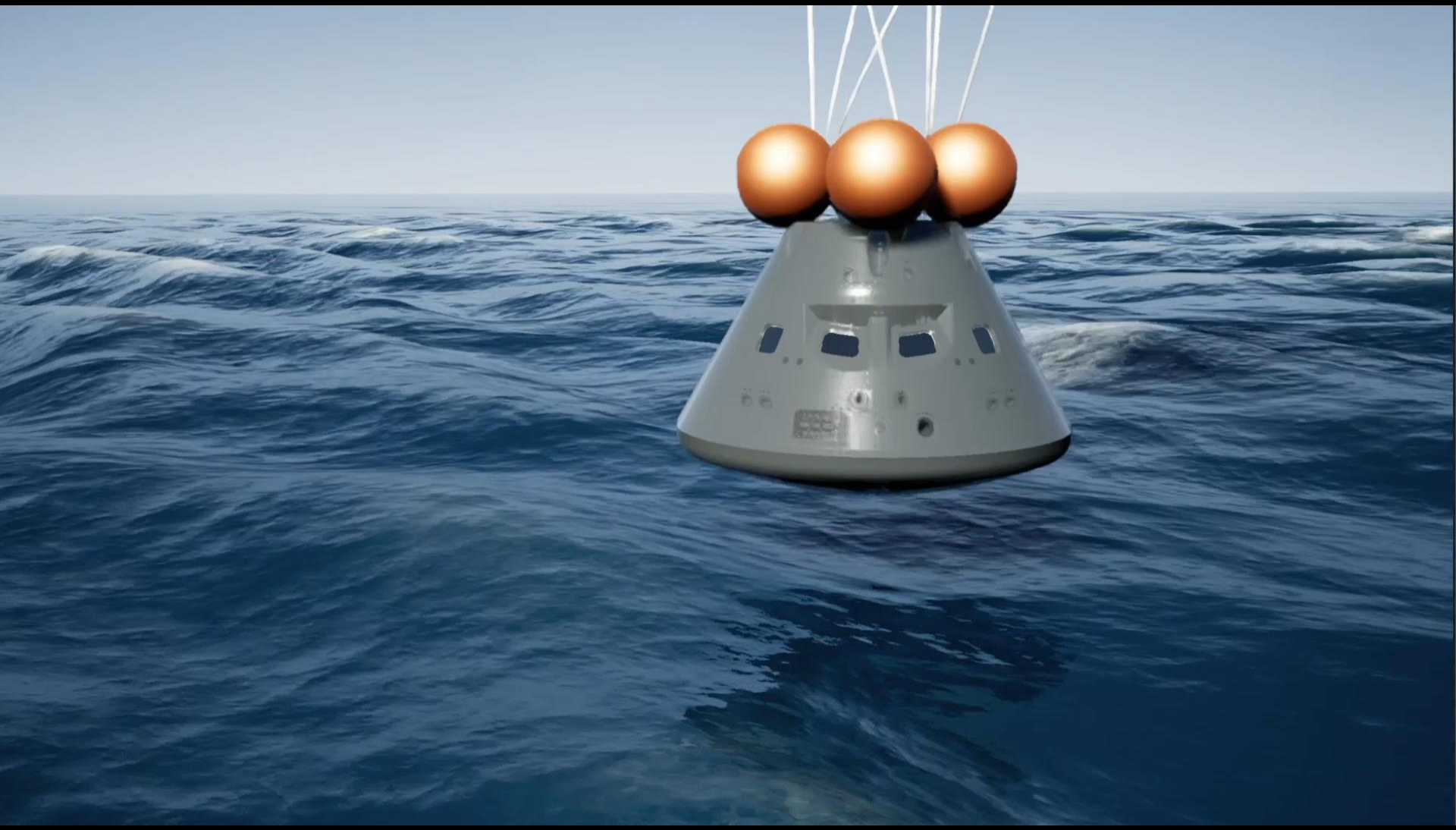


**Customizable simulation controls and menus**

# SpaceCRAFT Core Features

**Human-in-the-loop multi-user scenario-based simulation**

# SpaceCRAFT Core Features

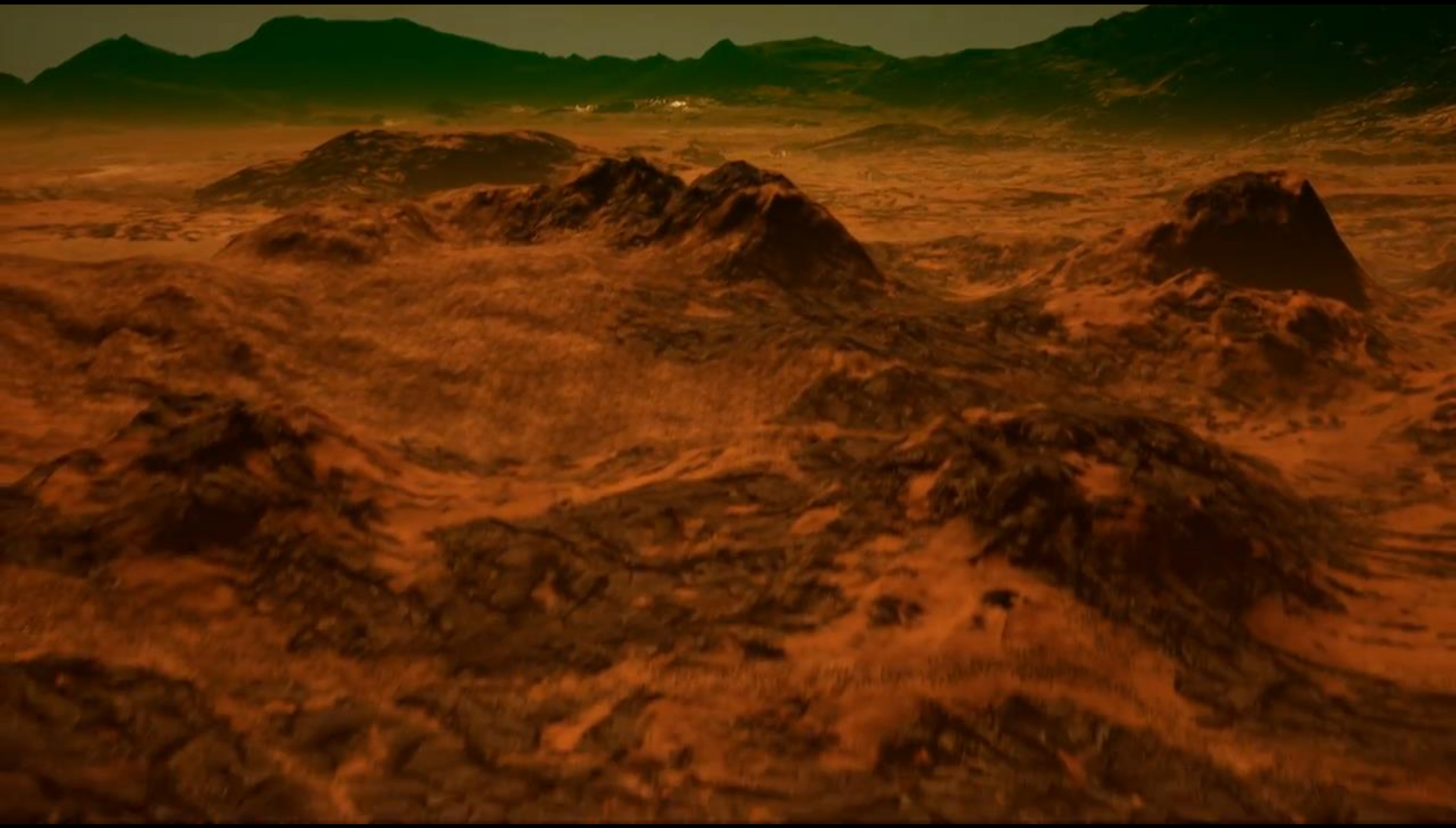


**High fidelity environment models, such as oceans, atmospheres, radiation, gravity etc.**

# SpaceCRAFT Core Features

**Interactive model/system evaluation**

# SpaceCRAFT Core Features



**Integrated analytical and physical models**

# SpaceCRAFT Capabilities

- Seamless API's with common design and analysis packages (Blender, 3dsMax, SolidWorks, Matlab, C++, etc)
- NASA TRICK & Matlab Simulation API
  - for high fidelity engineering model simulation
- Commercial Applications
  - Open-source at the model sharing/sim level
  - Private/protected models and simulations are possible
  - Marketplace for high fidelity/custom models
  - Commercial worlds, simulations, games can be hosted utilizing all tools and capabilities of the SpaceCRAFT platform
- Public Model Library – Validation, Blogs, Ratings, Updates
- Goal of Independence from VR Platforms (UE4, Unity)

# SpaceCRAFT Milestones

- October 2017
  - ✓ SpaceCRAFT goes public – IAC papers, Digital Hollywood
  - ✓ Website deployment – demo videos
  - ✓ Internal application to NASA challenge projects
  - ✓ Engineering/API/GUI/Core development teams progress
- December 2017
  - ✓ Mars Mission Architecture demo
  - ✓ 'Mars City Design' competition winning design demos
  - ❑ 2nd Website deployment – Mars City exploration VR demo
- February 2018
  - ❑ 3rd Website deployment
    - ❑ User/SuperUser accounts
    - ❑ Multi-user VR capability & demos
    - ❑ User sim control features
  - ❑ Basic analytical/physical model integration complete

# SpaceCRAFT Milestones (2)

- April 2018
  - Model management - upload/download/browse/view
  - Model integration – data/communication/prioritization
  - Standalone VR simulation (initial conditions, execution)
  - User interface tools (customizable displays & controls)
  - Core environment models available
    - planetary surfaces, gravity, radiation, atmospheres, oceans, orbital mechanics etc…)

- June 2018
  - Multi-user custom VR simulation
  - Engineering/dynamic (C++) model integration
  - Model blogs/ratings/comments
  - Advanced model templates
    - provides cut & paste & customize models

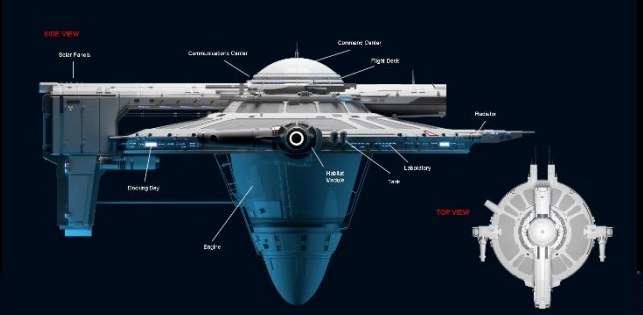
# SpaceCRAFT Milestones (3)

- September 2018
  - Advanced Engineering Model Integration
    - Full Matlab & TRICK analytical models
  - Augmented Reality features (AR in VR)
    - Ex: flow field, power, comm, data visualization
  - Advanced environment models
    - Ex: wind, waves, dust storms, etc
  - Beta-user documentation (initial)

- December 2018
  - Advanced engineering/dynamic model integration
  - Mission scenario design tools
  - Mission analysis tools
  - General-user documentation

# SpaceCRAFT Partners

- NASA Johnson Space Center
- TAMU Ocean Engineering
- TAMU Architecture (Visualization)
- Mars City Design
- Digital Hollywood
- Dell Computers
- Space Odyssey
- Hewlett Packard?





NEIL DEGRASSE TYSON presents

# SPACE ODYSSEY

# SpaceCRAFT Teams

1. SpaceCRAFT Core Systems - Eric
2. Model Integration and Templates - Tanner
3. Control Inputs & Display Outputs - Austin
4. External Software Interfaces (API's) - Nishaank
5. User Interfaces – Website, Executable - Karl
6. Physics, Planetary Systems, Scaling - Connor
7. Space Environment Models - Matthew
8. Space System Models & Animation- Daniel
9. CAD Artwork - Alex
10. Promotion, Media, Demos - ?

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# STS-134 Mission Video