Gradient One

Crewed EVA-Accessible Boom Testbed

A human-rated artificial gravity pathfinder for orbital habitation

Executive Summary

Gradient One is a full-scale artificial gravity demonstrator designed to validate human tolerance to rotational gravity and vertical gravity gradients in orbit. The mission features **three crewed, pressurized habitat pods** mounted at specific radii along a **350-meter rigid boom**, each simulating a different gravity level: **Earth, Mars, and Moon**.

The structure rotates at **~1.6 RPM** to generate 1g at the outermost pod. A counterweight system on the opposite end balances the rotation. Astronauts access each pod via EVA along the truss, entering through individual airlocks.

Gradient One directly supports the development of **Aegis Station** by addressing critical unknowns in rotating environments.

Mission Rationale

Despite decades of spaceflight, no humans have lived in partial gravity or experienced continuous rotational gravity in orbit. All long-term habitation to date has occurred in microgravity, with known physiological degradation.

Only live human subjects can evaluate:

- Coriolis effects
- Gravity gradient perception
- Motion adaptation under spin

Gradient One provides the validation platform needed to bridge this gap for future orbital habitats.

Technical Architecture

Component	Description

Boom Length	350 meters (rigid truss)
Pods	Three pressurized crew-rated modules, 10 m tall × ~2.5 m diameter
Counterweight	Inert or mirrored dummy pods to balance rotational mass

Artificial Gravity Configuration (at 1.6 RPM)

- All three pods are fixed to the **same side** of the boom
- Each pod simulates a different **gravity level** based on radial distance:
  - **Earth (1g)** near boom tip
  - **Mars (~0.38g)** at intermediate radius
  - **Moon (~0.17g)** further inward
- Each pod is **matched** by a counterweight on the opposite side to preserve system balance

Mission Operations

Deployment

- Launch to 500–600 km circular orbit
- Deploy boom, pods, and counterweights
- Spin-up to ~1.6 RPM

Crew Access

- Dock at non-rotating central node
- EVA along boom to reach each pod
- Pressurized entry via pod-specific airlocks

Spin Phase

- Maintain ~1.6 RPM
- 14–30 day nominal habitation cycles

- Continuous monitoring of adaptation and performance

Recovery

- Controlled spin-down
- EVA return to hub
- Crew recovery via reentry capsule

Instrumentation and Research Goals

Focus Area	Implementation
Motion & Balance	Head/eye tracking, Coriolis response, gait analysis
Vestibular	EEG, nausea tracking, spatial orientation tasks
Physiology	ECG, muscle/bone load, fluid shifts
Environment	Airflow, water behavior, particle settling
Performance	Dexterity tests, cognitive latency, coordination tasks
Video Capture	EVA and pod interior video monitoring

Safety and Redundancy

- Emergency spin-down capability
- Redundant power, comms, and ECLSS
- EVA tether systems with guide rails
- Visual boom markers and handholds
- Abort protocols and emergency O_2 in each pod

Upgrade and Reuse Potential

- Expand to 90–180 day missions
- Add internal mobility/ergonomic systems

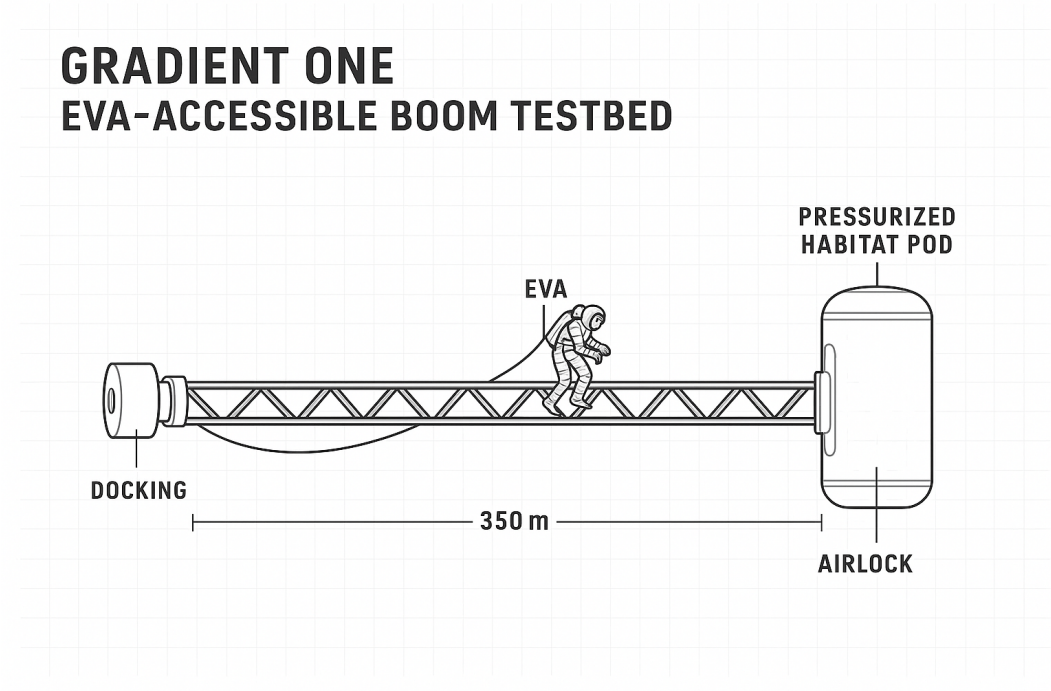
- Integrate with full-scale rotating platforms
- Adapt truss for additional modules or science payloads
- Enable robotic or drone-assisted boom traversal

Strategic Relevance

Gradient One enables:

- Empirical validation of artificial gravity for human habitation
- Confirmation of Aegis Station design assumptions
- Data for Artemis successors and Mars preparation
- A shift in human spaceflight from microgravity to stable orbital life

Gradient One transforms rotational gravity from theory into tested, human-rated infrastructure.



Gradient One pod boom