BACKGROUND
Exercise is a major mitigation to many deleterious physiological effects of spaceflight and is required for crewed missions. In particular, treadmills have been critical in providing multiple physiological benefits to crewmembers for missions greater than approximately 30 days, including reduced degradation of:

1. Bone structural strength of lumbar spine, pelvis, femoral neck and trochanter (due to the ground reaction forces of approximately 2-3 times the person’s body weight that are reacted by the bones and muscles of the lower body)
2. Cardiovascular fitness (due to the increased heart rate from aerobic exercise)
3. Sensorimotor control system, which is the integration of sensory input from vision, proprioception and the vestibular systems to maintain balance (due to the coordination and balancing of body motions while ambulating under a vertical load up to the person’s body weight)

Each of these physiological benefits helps enable the crewmember to function and recover in a more effective and coordinated manner with reduced risk of injury upon their return to a gravity or partial gravity environment.

Unfortunately, treadmills require significant mass (>300 lbs), volume (>100 ft³ total, including both device volume and user operational volume) and power (>900W for speeds >10MPH) when implemented within space vehicles. Although these needs can be accommodated on a large vehicle such as ISS, they will be severely constrained on the future exploration crewed vehicles that have been conceived for future exploration missions. In order to enable long duration exploration missions, including going to Mars, new approaches for keeping the crew healthy are required.

PROBLEM/DESCRIPTION
Design innovative, non-treadmill concepts that can deliver the treadmill’s physiological benefits in a microgravity environment in a manner that requires fewer resources than today’s spaceflight treadmills. The objective criteria in descending priority are:

1. Provide the 3 identified physiological benefits
2. Minimize device mass (target is <100 lbs)
3. Minimize total volume (target is <50 ft³ total, including both device volume and user operational volume)
4. Minimize power consumption (target is <500W)
5. Provide a zero-g crew restraint system during running

DELIVERABLES
Deliverable will be in the form of CAD models, mockup, parts list, physiological benefits the device provides and how; notional estimates of mass, device volume, user operational volume, and power.

DESIGN TEAM PROFILE

<table>
<thead>
<tr>
<th>NASA MENTOR:</th>
<th>Phillip Callen</th>
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<tbody>
<tr>
<td>LEVEL:</td>
<td>Upper Division Students [JR/SR]</td>
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<tr>
<td>MAJOR / DISCIPLINES:</td>
<td>Multidiscipline team (ME, EE, CompSci, Biomed, Human Physiology, etc.)</td>
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<td>TEAMS:</td>
<td>Two teams</td>
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<td>DURATION:</td>
<td>One or Two-Semester Project</td>
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