

ABSTRACT

Long duration spaceflight has a negative effect on the human body, and exercise countermeasures are used on-board the International Space Station (ISS) to minimize bone and muscle loss, combatting these effects. Given the importance of these hardware systems to the health of the crew, this equipment must continue to be readily available. Designing spaceflight exercise hardware to meet high reliability and availability standards has proven to be challenging throughout the time the crewmembers have been living on ISS beginning in 2000. Furthermore, restoring operational capability after a failure is clearly time-critical, but can be problematic given the challenges of troubleshooting the problem from 220 miles away.

Several best-practices have been leveraged in seeking to maximize availability of these exercise systems, including designing for robustness, implementing diagnostic instrumentation, relying on user feedback, and providing ample maintenance and sparring. These factors have enhanced the reliability of hardware systems, and therefore have contributed to keeping the crewmembers healthy upon return to Earth. This paper will review the failure history for three spaceflight exercise countermeasure systems identifying lessons learned that can help improve future systems. Specifically, the Treadmill with Vibration Isolation and Stabilization System (TVIS), Cycle Ergometer with Vibration Isolation and Stabilization System (CEVIS), and the Advanced Resistive Exercise Device (ARED) will be reviewed, analyzed, and conclusions identified so as to provide guidance for improving future exercise hardware designs. These lessons learned, paired with thorough testing, offer a path towards reduced system down-time.