Miniature Exercise Device-2 (MED-2)

A Compact Motorized Resistive and Aerobic Rowing Exercise Device

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Outline

- Current ISS exercise hardware
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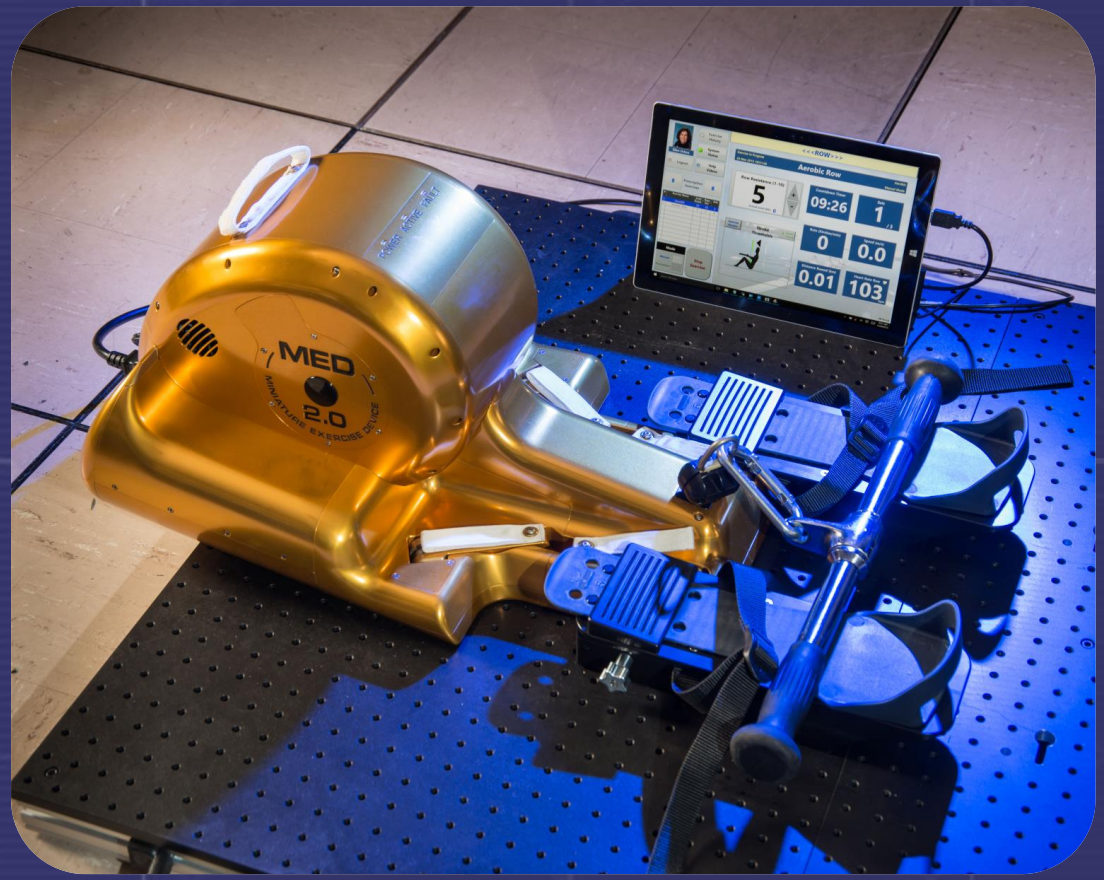


Miniature Exercise Device – 2
with rowing attachments and tablet

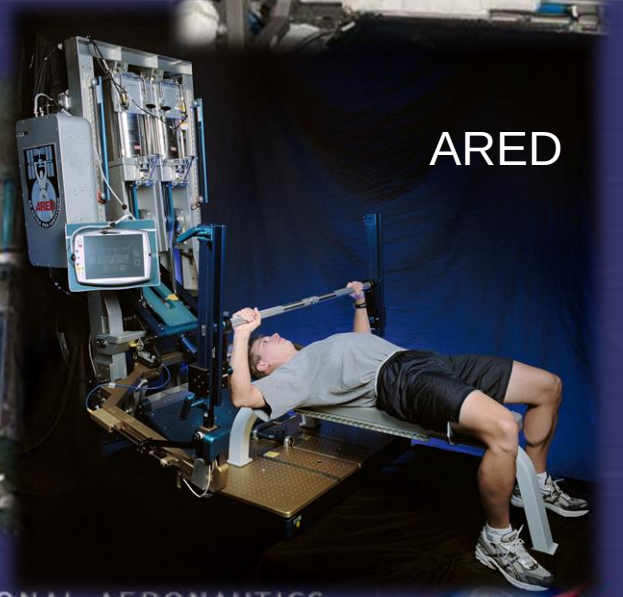
Current ISS Countermeasures (CMS) Hardware

- Two systems provide aerobic exercise, one resistive exercise
  - Cycle Ergometer with Vibration Isolation and Stabilization System (CEVIS)
  - Treadmill (T2)
  - Advanced Resistive Exercise Device (ARED)
- Help maintain crew's musculoskeletal conditioning
- Designed for use on ISS, not exploration missions

CEVIS

T2

ARED



Miniature Exercise Device -1 (MED-1)

- First generation prototype to explore compact resistive exercise device
  - Developed in-house by Software, Robotics and Simulation Division, JSC to address future exercise needs
  - Single cable mechanism to provide resistive exercise
  - Served as a “proof of concept” hardware
- Tested during **Space Environment Analog for Testing EVA Systems and Training (**SEATEST) II
  - Crew exercised and provided feedback
  - Feedback gathered informed future designs

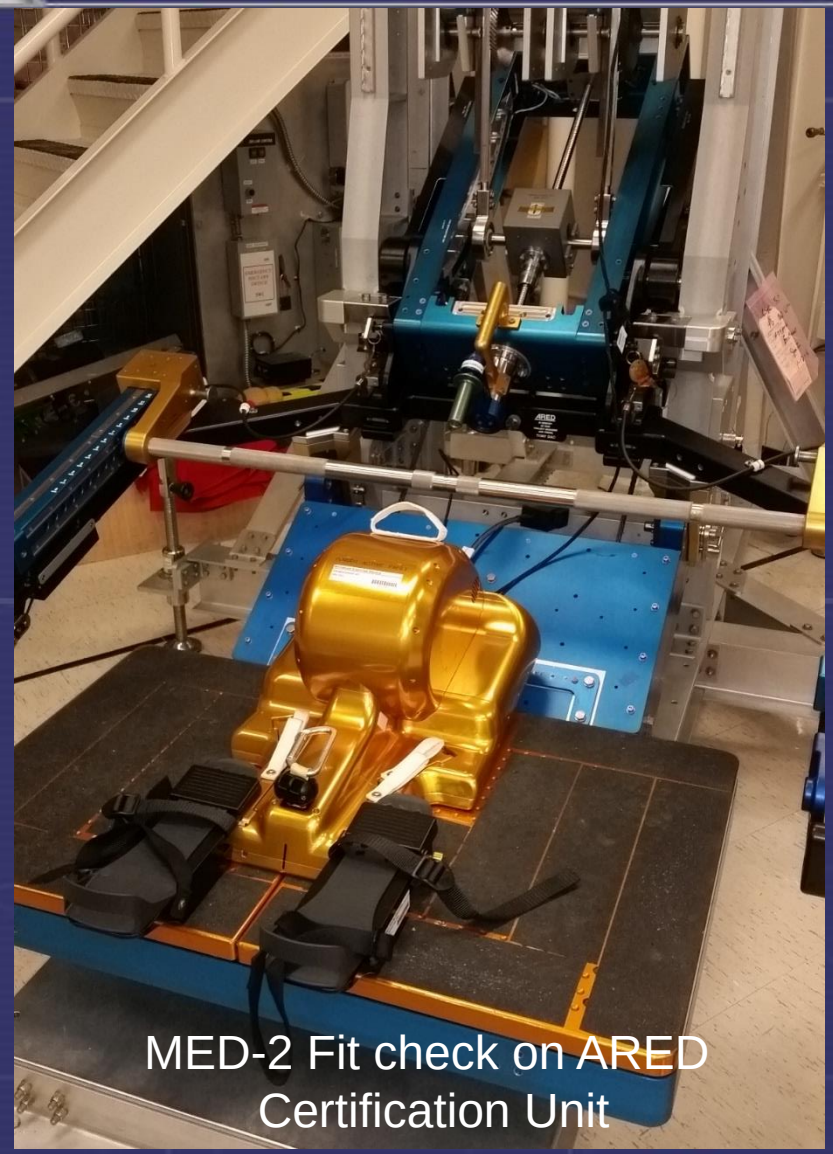
MED-1

Miniature Exercise Device -2 (MED-2) - Overview

- MED-2 is an ISS science payload intended to provide science community evaluation of the usefulness and effectiveness of a small, lightweight resistive exercise device for exploration missions.
  - Developed on a compressed schedule to demonstrate the Class-1E processes and launched in March 2016.
- MED-2 consists of a series elastic motor controlling a pulley, which tensions an exercise cable, to provide resistance as the user pulls against the exercise cable.
  - MED-2 will initially support one aerobic exercise (rowing) and one resistive (deadlift) exercise.
  - Extension capabilities exist beyond the initial technical checkout phase.
  - Results of extended testing, starting with ISS crew in Summer 2016, will inform future design trades.

Miniature Exercise Device -2 (MED-2) - Overview

- MED-2 monitors force applied to the user via the series elastic element
  - Current deployment provides a constant force; force profiles can be varied based on need
  - MED-2 exercise profile can be force controlled or velocity controlled
  - Hardware is able to provide eccentric overload, inertial force profile
- MED-2 has internal energy storage to offset periods of high power demand
- Firmware contains control algorithm and integrated safety checks
  - Rate of change of force limited to prevent unexpected output
- MED-2 attaches to ARED platform for vibration isolation



MED-2 Fit check on ARED Certification Unit

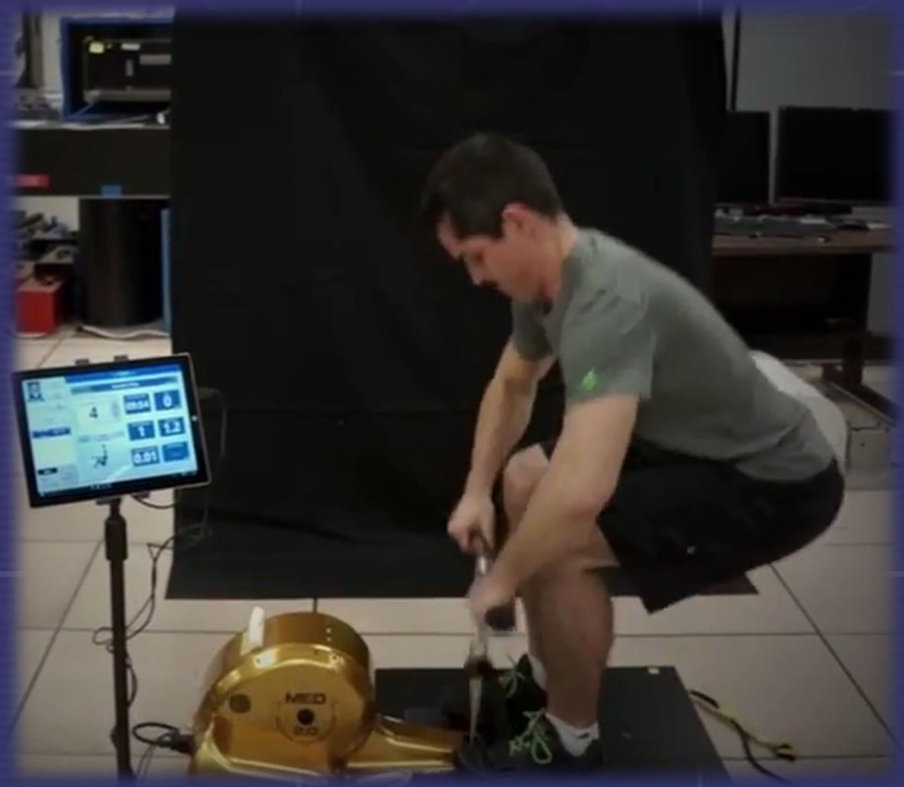
MED-2 Resistive Exercise Mode

- Current MED-2 configuration provides constant force
  - Can be programmed to provide eccentric overload or inertial loading
- Current exercises approved have T-bar attachment
  - Other exercises involving harnesses are being pursued
- Force can be varied real-time by the user
  - Force rate of change limited for safety considerations
  - Force applied throughout the complete range of motion
- MED-2 is able to monitor work and energy expenditure by the operator in addition to repetitions

MED-2 resistive exercise
(bicep curls and goblet squats)

MED-2 Aerobic Exercise Mode

- MED-2 introduces a new modality of aerobic exercise to ISS – Rowing
  - Currently T2 provides running and CEVIS provides cycling
  - Exercise is net energy positive
- User can change settings, similar to ground units
- Software simulates rowing conditions
  - Simulates boat drag, boat weight
  - Other parameters can be adjusted so the rowing experience can be optimized
  - Provides return force for cable to prevent entanglement



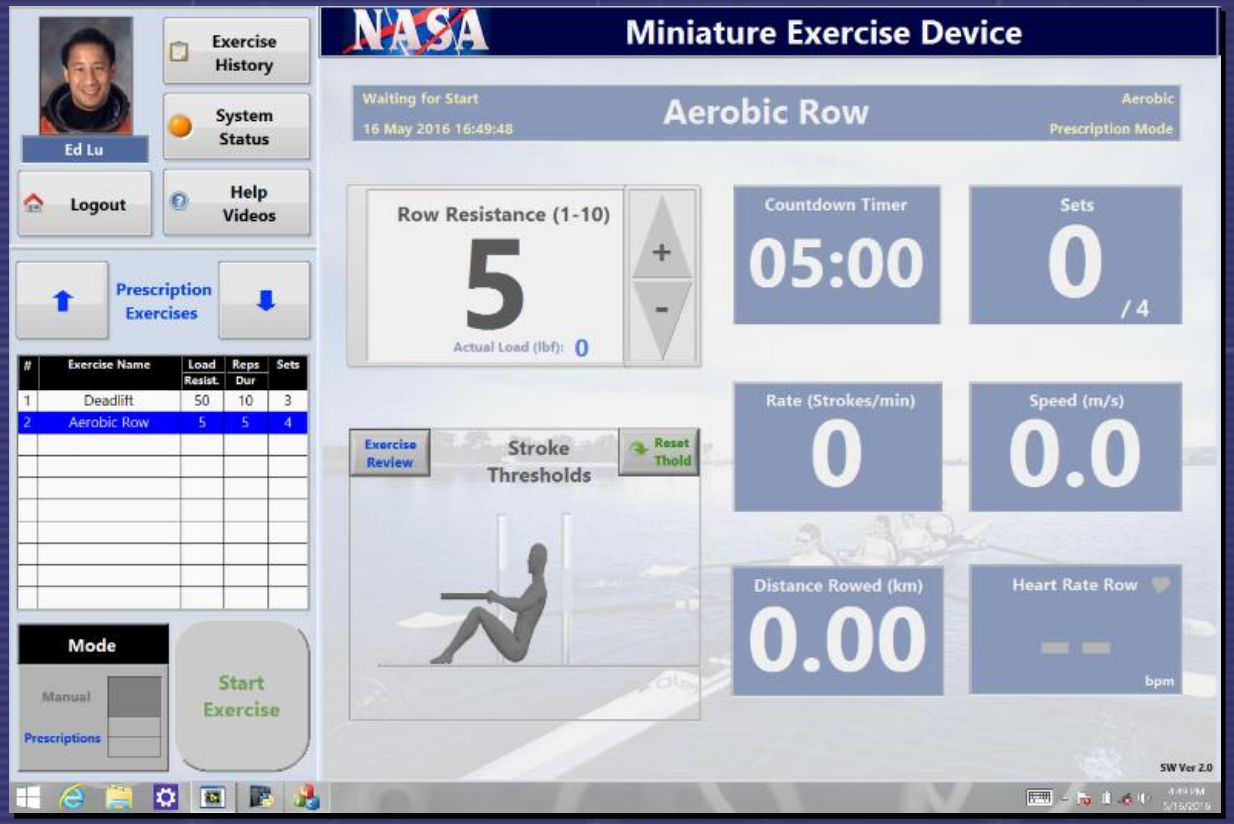
MED-2 aerobic exercise and rowing attachments

MED-2 Graphical User Interface (GUI)

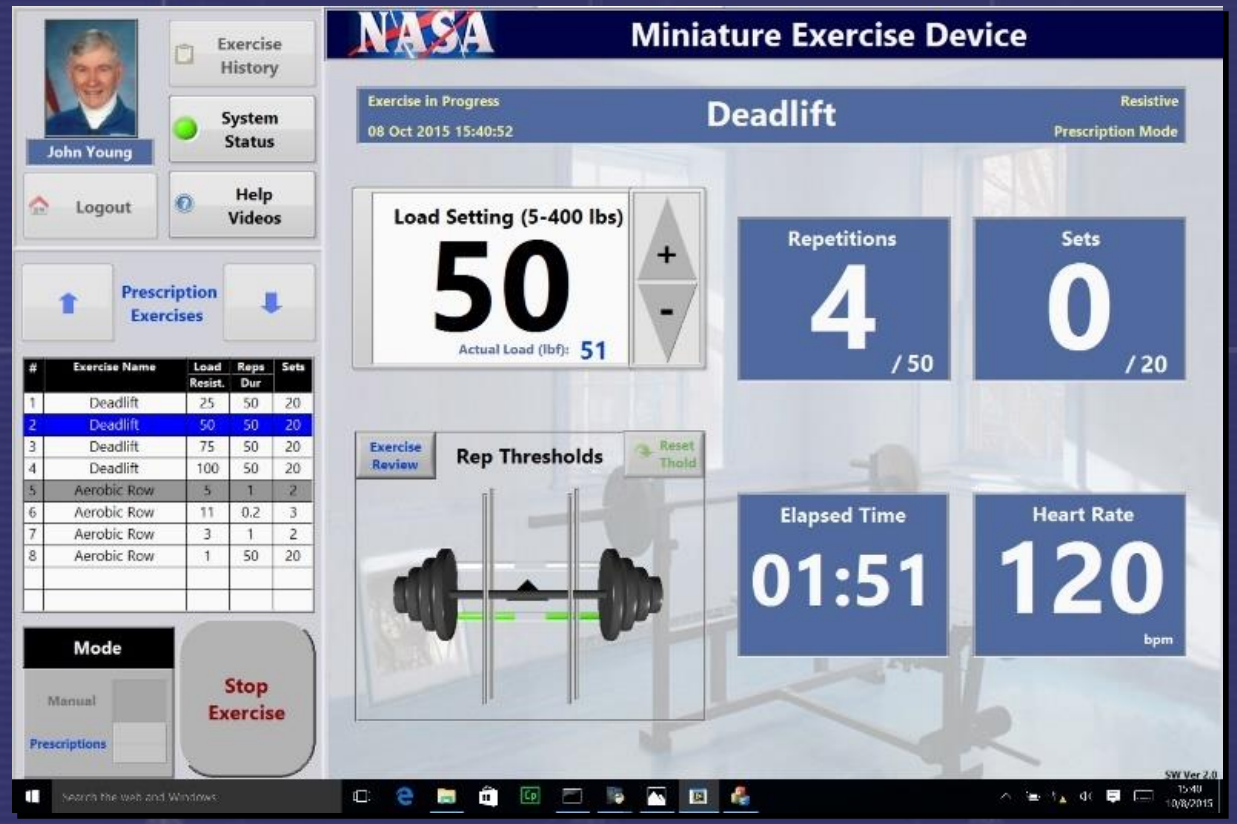
- MED-2 GUI leverages existing CMS software
- Optimized for touch screen format
  - First exercise equipment completely controlled via touch screen
  - Performed iterative user tests on the ground to improve layout
  - Integrated status indications and control features in one layout
- Data transfer does not require crew interaction
  - Reduced workload on the crew
  - Allows ground controllers to upload new exercise prescriptions
- Tablet collects exercise and device data for analysis
  - Integrates Bluetooth Heart Rate Monitor Data

MED-2 Login Screen

MED-2 Graphical User Interface (GUI)



MED-2 Rowing Exercise Screen



MED-2 Resistive Exercise Screen

Summary

- The Miniature Exercise Device -2 is a compact, lightweight exercise device
  - Provides both resistive and aerobic exercise modalities
  - Allows for rowing, new aerobic exercise modality on ISS
- Currently aboard ISS with operations slated to start Summer 2016
  - Initial technical evaluation will satisfy 5x2015 JSC Project goals
  - Subsequent crew study will evaluate efficacy and feasibility of exploration sized exercise device
    - Evaluate touchscreen interface/GUI
    - Evaluate single cable morphology for providing resistive and aerobic exercise