

Directed Acyclic Graph – DAG Narrative

- ❖ **Altered Gravity** across all DRMs includes microgravity, lunar gravity, Mars gravity and Earth Gravity. This affects **Effective Gravity Level** experienced by crew and through that **Musculoskeletal Loads**.
- ❖ **Distance from Earth** determines the mass and volume allocations for vehicle design and suit design, and **Exercise System Design**, and affects the **Effective Mission Duration**.
- ❖ **Isolation and Confinement**, especially over long **Effective Mission Durations** can induce monotony and anhedonia affecting the **Motivation** to perform needed exercise.
- ❖ The central focus of the Muscle and Aerobic Risk DAG is on **Aerobic Fitness** and **Muscle Performance** levels being adequate for crew to do the tasks that are expected of them (**Task Performance**). These directly influence **Individual Readiness** and **Crew Capabilities** for task performance.
- ❖ When these nodes are negatively affected, the performance of EVAs - **EVA (Risk)** - and the performance of post-landing tasks – **Crew Egress (Risk)** are threatened.
- ❖ Aerobic Fitness and Muscle Performance are directly affected by the **Physiologic Changes** that occur at the level of cardiac, smooth, and skeletal muscle throughout the body as a result of the duration of exposure to the spaceflight environment. Aerobic fitness is also directly dependent on the functionality of the Cardiovascular system (**Cardiovascular Risk**).
- ❖ These **Physiologic Changes** are the result of several contributing factors:
 - **Musculoskeletal Unloading** that occurs as a result of the **Altered Gravity** Environment.
 - **Endocrine Factors**, (i.e., **stress hormones**) that are related to the **Isolation and Confinement** experienced. Countermeasures to these include:
 - **Resistive Exercise**
 - **Aerobic Exercise**
 - Medications - **Pharm (Risk)**
 - **Nutrients- Food and Nutrition (Risk)**
 - Other contributing factors can include the **Motivation** to exercise which is impacted by **Fatigue** through the **Sleep (Risk)** and **Food and Nutrition (Risk)**, **Effective Mission Duration** that can induce monotony, design, and maintenance challenges from the **HSIA (Risk)**.
- ❖ The **exercise capability** that protects Aerobic Fitness and Muscle Performance is the result of the Vehicle Design process, the HSIA (Risk), and the fielded Crew Health and Performance System. These define and limit the presence and reliability of the Exercise Hardware that is available in a mission. The **exercise prescription** that can be accomplished by crew is limited by the Schedule, Vibration Isolation System, Previous Injury, and environmental factors such as Temperature, Humidity, and CO2 (Risk) that are a function of the ECLS System.

