

This Directed Acyclic Graph and write-up is an excerpt from a larger NASA document.

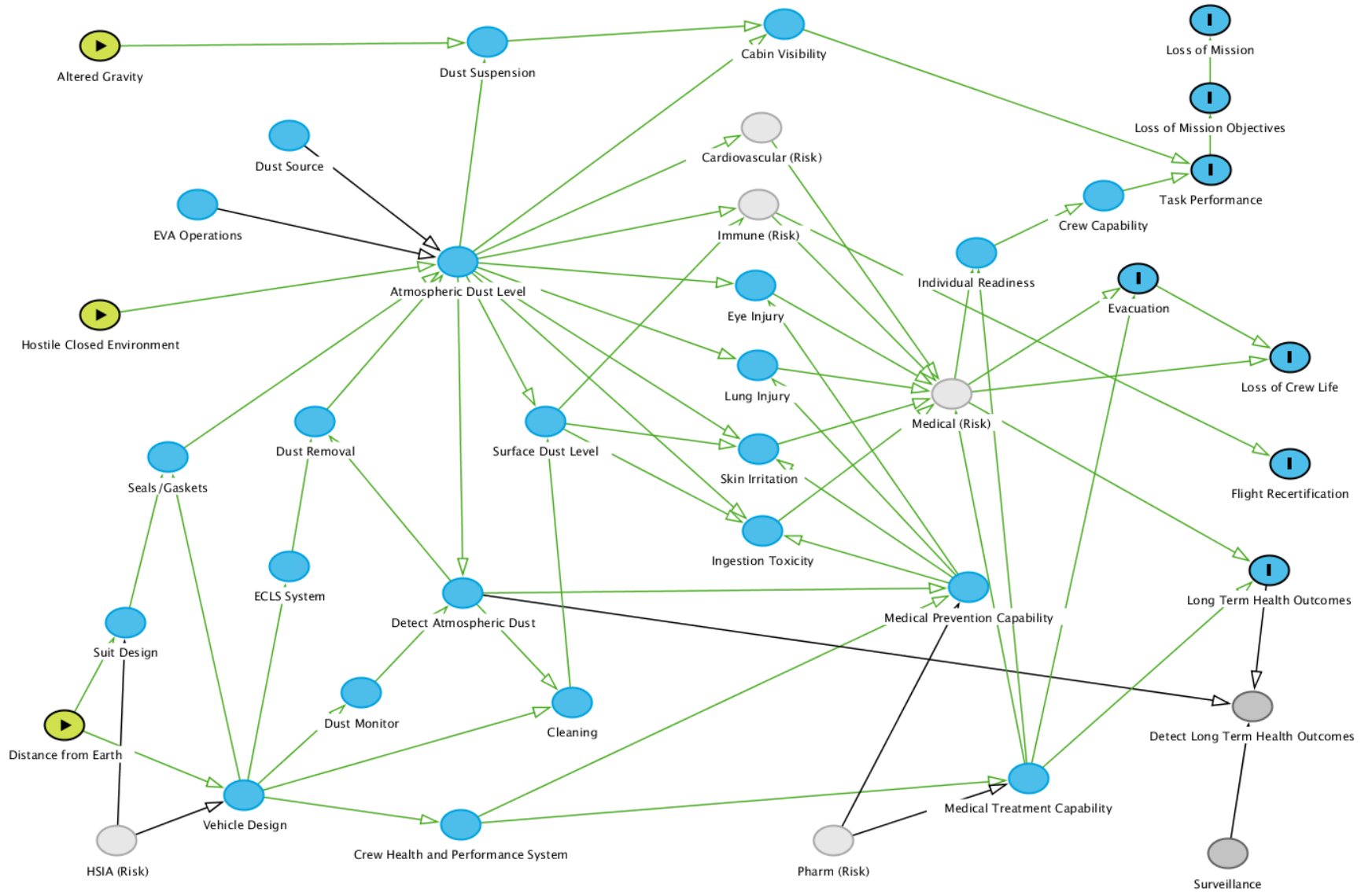
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**Directed Acyclic Graphs: A Tool for Understanding the NASA
Spaceflight Human System Risks**

Human System Risk Board

October 2022

Risk of Adverse Health & Performance Effects of Celestial Dust Exposure (Dust Risk)



Dust Risk DAG Narrative

- This DAG centers around **Atmospheric Dust Levels** that can occur within vehicles after Extravehicular Activity (**EVA Operations**) on celestial bodies. During **EVA Operations, Dust Sources** from the lunar or Martian surface can result in dust being carried back into a vehicle or habitat, potentially on space suits. The extent to which this will occur depends on **Vehicle Design, Suit Design,** and the **Seals/Gasket** designs that are included to prevent dust entry into a vehicle.
- If dust gets into a vehicle or habitat, then the extent of exposure that crews face depends on several factors:
 - The level of **Dust Suspension** that occurs in the vehicle atmosphere.
 - The **Surface Dust Level** that builds up when dust settles from the atmosphere onto vehicle surfaces.
- The capability for **Dust Monitoring** that enables crews to **Detect Atmospheric Dust** levels must be included in the Environmental Control and Life Support (**ECLS**) **System** in order to determine the appropriate contamination levels that should prompt **Dust Removal** (filtration) and **Cleaning** of surfaces.
- Inappropriate levels of **Dust Suspension** in the atmosphere can lead to issues with **Cabin Visibility** affecting performance when piloting vehicles, especially on return to microgravity. This can also lead to several health challenges that affect **Crew Capability**.
- Dust exposure can lead to **Eye Injury, Lung Injury** and **Skin Irritation** which can all progress to affect the **Medical (Risk)**. Most evidence suggests that the medical issues are likely to be minor in mission.
- Dust that gets into food or pharmaceuticals may lead to **Ingestion Toxicity**, especially in the case of Martian dust with perchlorates.
- There is some evidence that the **Cardiovascular (Risk)** and **Immune (Risk)** may be affected by celestial dust exposures, but this remains at the speculative level currently.
- Countermeasures can include:
 - **Medical Prevention Capabilities** such as artificial tears, skin coverings, etc.
 - **Medical Treatment Capabilities** including creams and ointments to treat skin irritation as well as medical eye drops to address eye irritation or injury. Antibiotics may be required if secondary infection develops.
- **Long Term health Outcome** may include pneumoconiosis, hypersensitivity conditions, autoimmune disorders, and cancers, but the level of evidence is currently low that these will occur. Surveillance post flight and post-career for these types of conditions can enable us to **Detect Long Term Health Outcomes** and better characterize the magnitude of risk in the Long-Term Health domain.