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ASPA

AD ASTRA PER ASPERA

AD ASTRA PER ASPERA (Team ASPA)

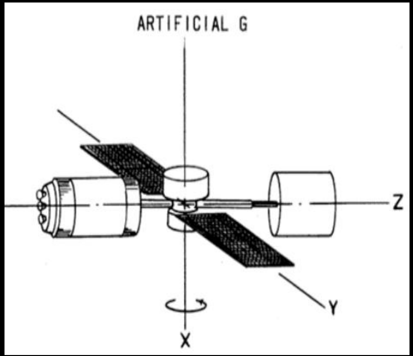
To The Stars Through Difficulties

Rotating Space Station Design

Our Project AIM

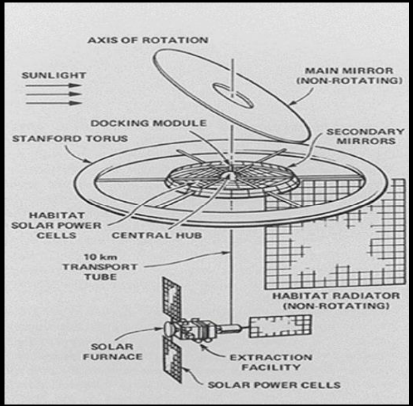
Mitigating the physiological effects of long-term space habitation through the design of a rotating space station to simulate artificial gravity.

Existing Designs for a rotating space station

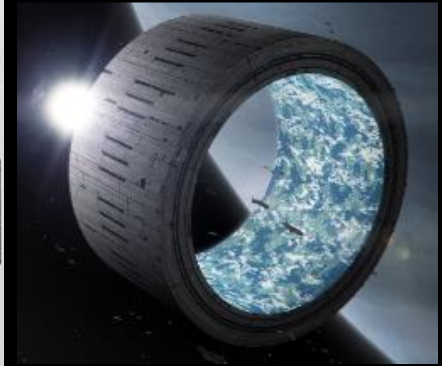


➤Sorensen (2015)

➤Van Braun Wheel



➤ Standford Torus



➤Bishop Ring

Attitude and Orbital Control System

➤ Gravity…

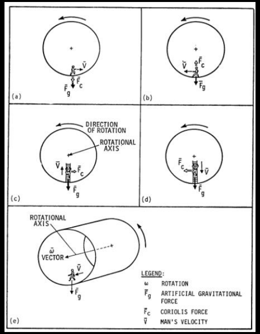


Image reference: M. Queijo, A. Butterfield, W. Cuddihy, C. King, R. Stone, and P. Garn, “Analysis of a rotating advanced-technology space station for the year 2025,” Tech. Rep., 1988.

Attitude and Orbital Control System

- Gravity…

- AOCS requires structural parameters to be defined.

- Elements of further Research:

1. What is AOCS + Coriolis force from image:
2. The best Attitude control strategies are?
3. Using the spin to our advantage.
4. Investigating existing sensors, actuators and Control systems.
5. Human factors and redundancies.

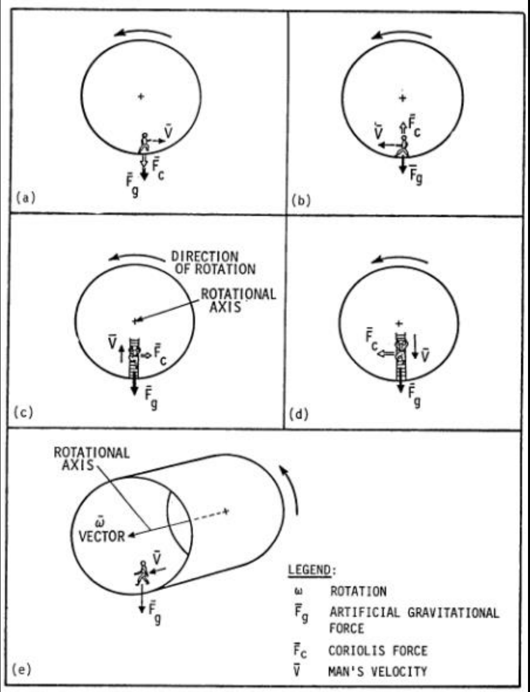


Image reference: M. Queijo, A. Butterfield, W. Cuddihy, C. King, R. Stone, and P. Garn, "Analysis of a rotating advanced-technology space station for the year 2025," Tech. Rep., 1988.

Attitude and Orbital Control System

- Preliminary design: Rotating outer wheel(s) with the station central hub remaining stationary.

- Key Challenge: Deciding between having 1 or 2 wheels. Where the 2 wheels are rotating in opposite directions.

- Further research:

1. Equations of motion.
2. Physical constraints.

Movie: The Martian

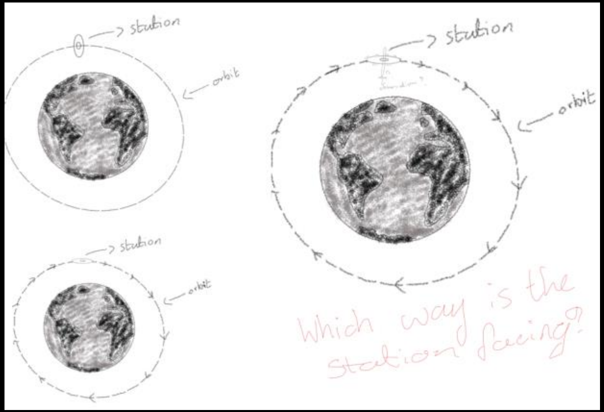
The Structural Design

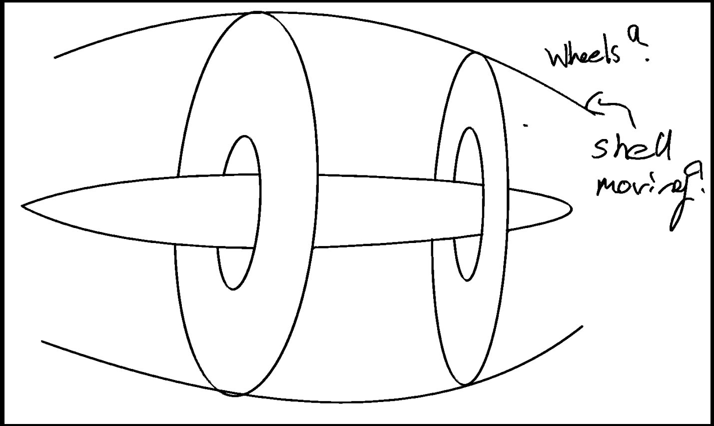
- Must Haves:

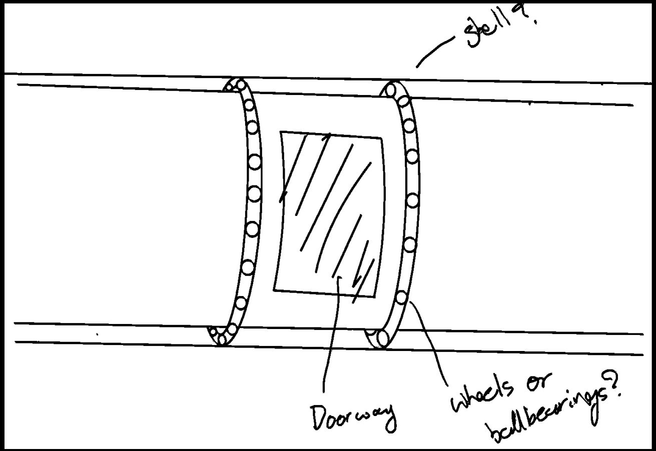
- Large enough radius to generate the desired Artificial gravity.
- Have enough structural integrity to withstand the stress that rotating In space causes.
- Light but strong Materials have to be selected.
- Reduce vibrations to a minimum for maximum comfort.

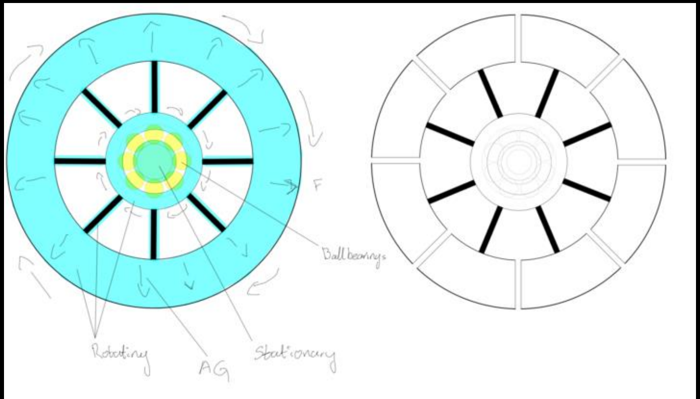
The Structural Design

Initial Design drawings:





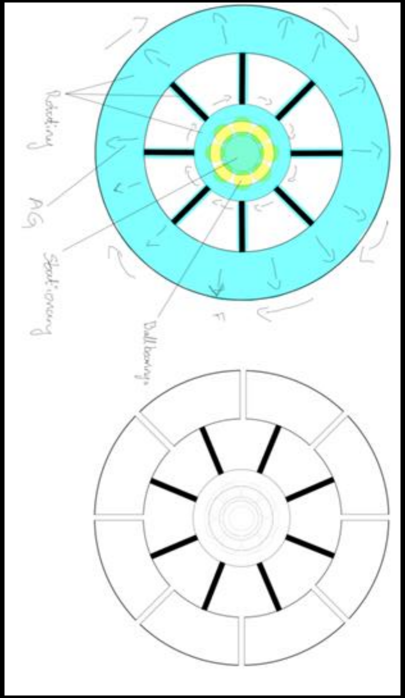




The Structural Design

- Questions and key challenges:

- What loads are usually on the station?
- What materials are currently being used?
- How large does the station have to be for it to create the desired AG?
- How can we keep the central microgravity part of the station from rotating too?



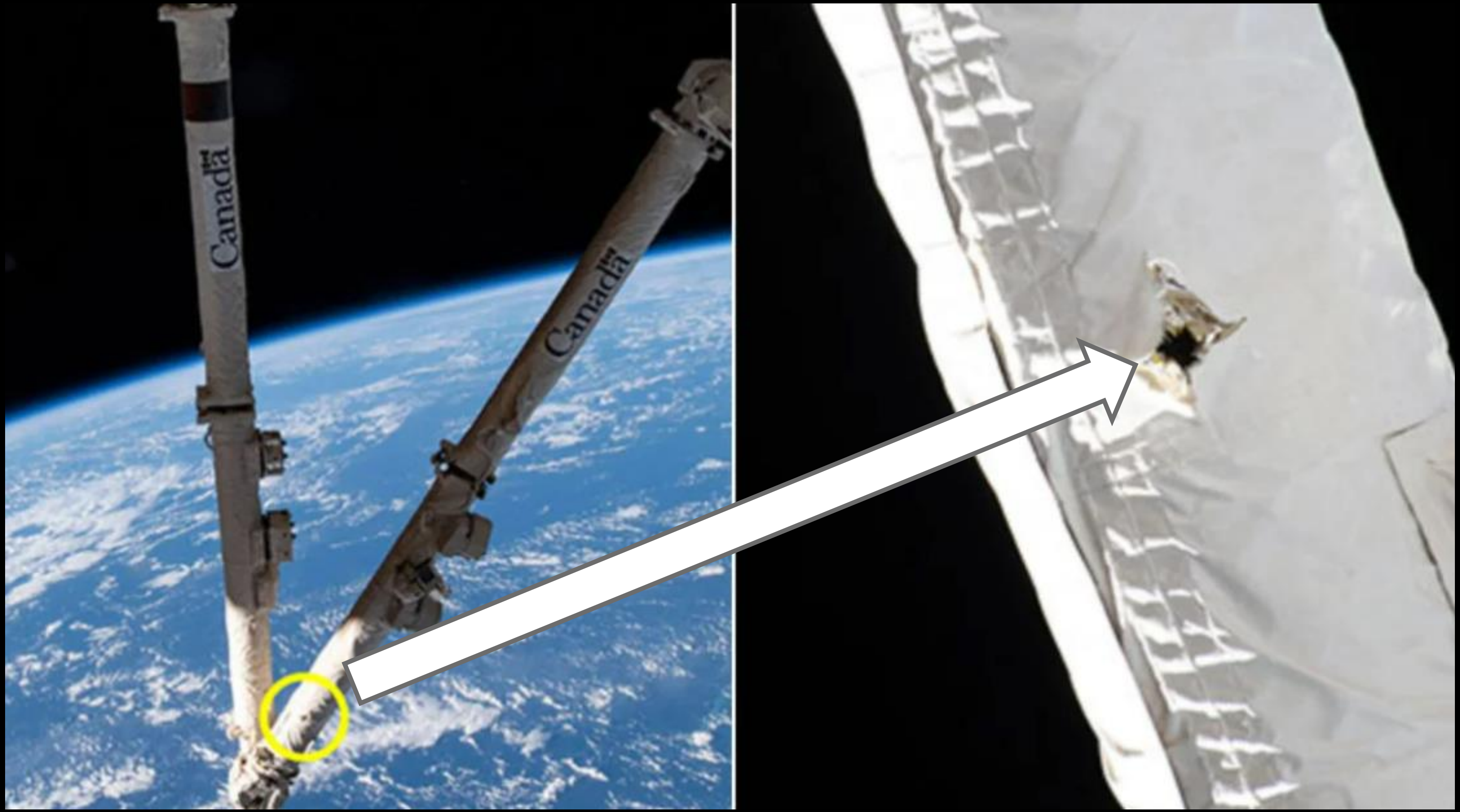
Shielding and Protection

- This subsection of the overall project is to create solutions to the following problems and to ensure that the station can provide a habitable and safe environment for the crew on board.
- **Key challenges:**
- Protection (structural shielding) from both debris and solar radiation
- Thermal regulation

IMPACT OF SPACE DEBRIS ON SOLID ALUMINIUM

- Space debris, even as small as **14 grams**, can cause severe damage to spacecraft and satellites.
- Understanding the potential impact helps us appreciate the dangers posed by debris in orbit.
- They can reach up to speeds of up to 17,500 mph (28,000 km/h) in low Earth orbit. At these speeds, a tiny piece of debris carries immense kinetic energy.

Even something as small as around 14 grams can have a devastating effect due to this energy.


Canada
Canada

Shielding and Protection: Materials

Materials Currently For Both Radiation And Impact Protection:

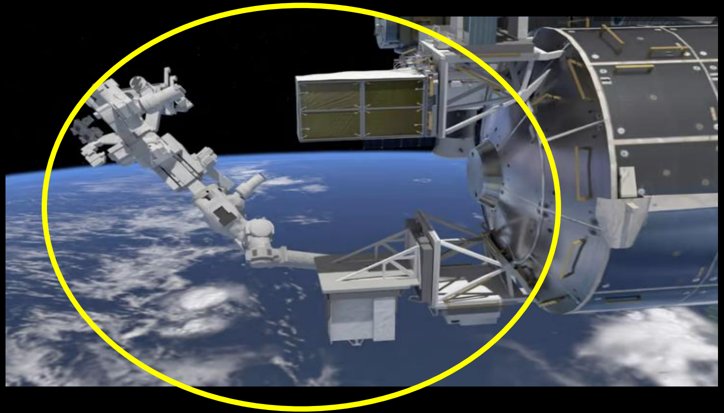
- Kevlar
- Aluminium Alloy (Ni-Ti-Al)
- Polyethylene (Plastic)
- Water

Space debri impact on a sheet of Kevlar

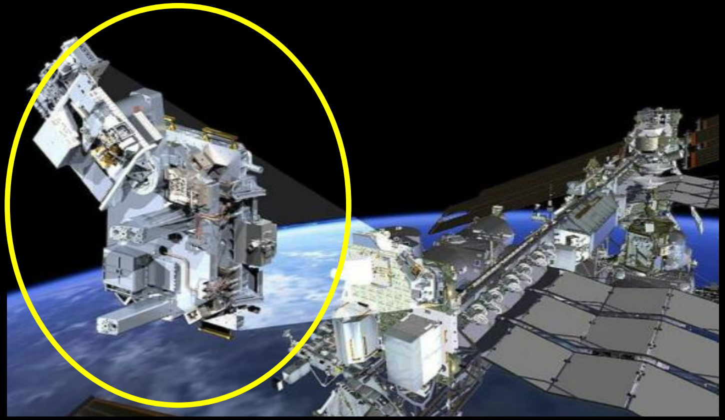
Possible Materials For Both Radiation And Impact Protection:

- Non-Newtonian Fluids
- Nextel (especially if combined with Kevlar)
- Beta Cloth (External layer for the space station)

Shielding and Protection



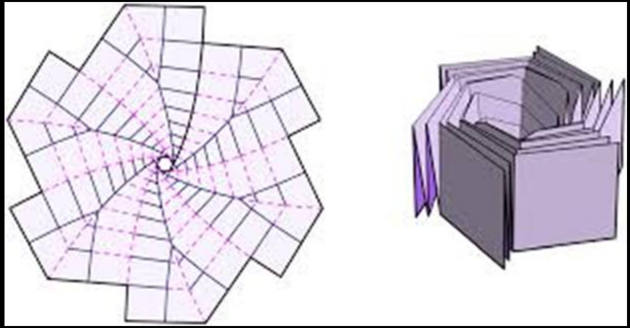
Debris Sensor on the ISS



Irradiance sensor on the ISS

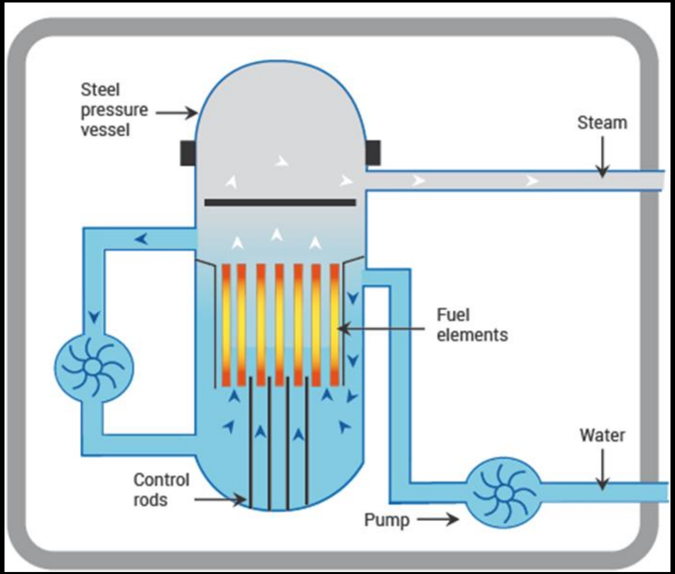
Power Systems

- Solar Panels
- Key Questions:
  - How much energy will the Space Station use in regular operation?
  - How much energy do the essential systems require?
  - How will the Space Station handle varying power usage?



Power Systems

- Things to research:
  - How efficient is energy generation projected to be at time of launch?
  - Thorium nuclear reactors – safer than uranium or plutonium?
  - Most compact design for transporting solar panels
  - Amount of waste heat generated by power sources

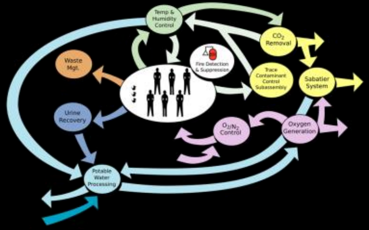


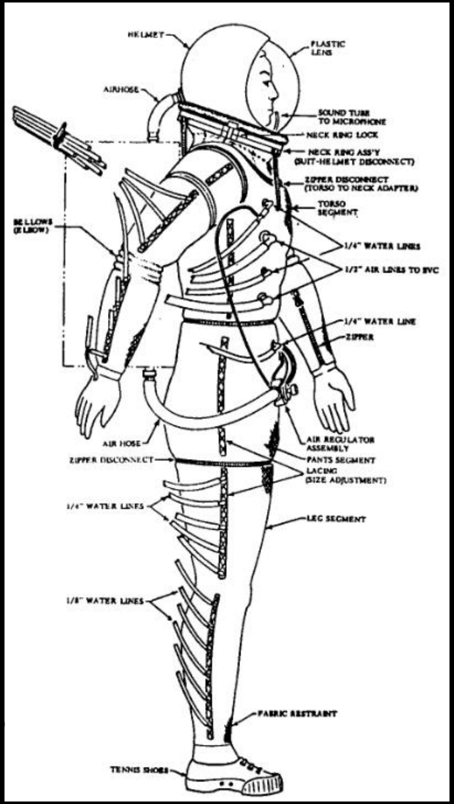
Life Support Systems

- Environmental Control And Life Support System (ECLSS):

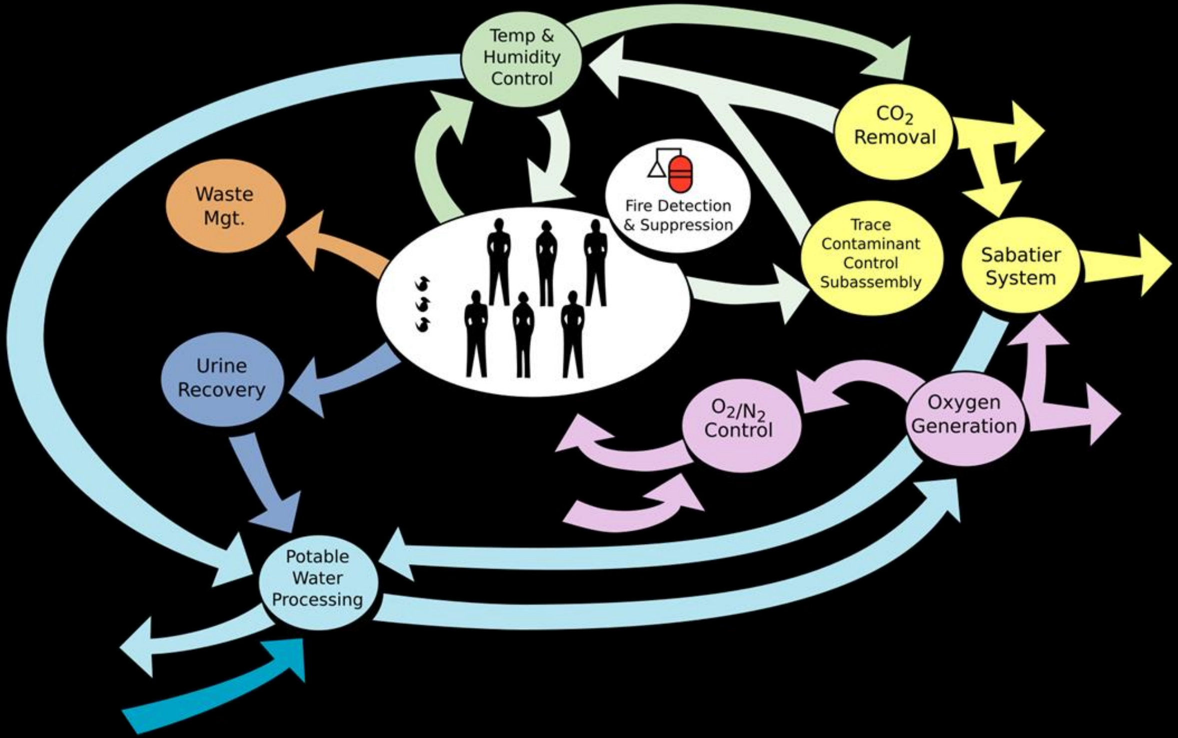
1. Atmosphere Management.
2. Water Supply and Recycling.
3. Temperature and Humidity Control.
4. Human Waste Disposal.
5. Management of non-recyclable waste.
6. Fire detection and suppression.

- Other life support systems include food production, health and medical facilities.





Life Support Systems



- Using the International Space Station’s (ISS) Environmental Control and Life Support System (ECLSS) as a proof of concept…
- **Key challenge:** The gravity gradient.

PROJECT ALLOCATION

Name:	Subsystem:
Emmanuel	Attitude and Orbital Control System, AOCS
Wania	Structural Design
Yam	Power Systems
Abaas	Thermal, Radiation and Shielding
Ilan	Health & Safety (Life systems and etc,)

THANK YOU FOR LISTENING