Lesson 2: Describe the Need - System Engineering
Design Requirements and Constraints in Space Travel

On May 25, 2012, SpaceX became the first commercial spaceflight company to berth at the International Space Station (ISS), via the Dragon capsule.

Watch the video of the epic Dragon mission.
The Falcon 9 launch vehicle dictates constraints on the Dragon capsule such as:

- How large the capsule can be
- How the capsule connects to the launch vehicle
- The orbit in which the capsule will fly
- And many more...
Engineers design toward requirements.

The Dragon capsule must:

- Return to Earth and land in the Pacific Ocean (*Dragon uses parachutes*)
- Operate while in orbit independent of the ISS (*Dragon uses solar arrays*)
- Be capturable by astronauts using a robotic arm (*Dragon uses an external mechanism that fits with the robot “hand”*)
- And many more...
Your System-Level Design
Constraints and Requirements

- All systems shall
  1. Be deployed in the same way
  2. Use the same release mechanism
  3. Photograph the same target with the same equipment
  4. Be built using the metric (SI) system
  5. Sense the altitude at release
  6. Use a controlled descent, achieving a velocity $\leq 3$ m/s
  7. Operate remotely during descent
  8. Take pictures automatically using a provided digital camera
  9. Signal once the device has landed safely
  10. Be reusable
  11. Weigh no more than 300g

- Discuss these with your team. Do you have questions?
More about the constraints: All systems must...

- Be able to be deployed in the specified manner.
- Use the specified release mechanism.
- Use the provide camera, sensors, and electronics.
Requirements ➔ Functions ➔ Parts

- How do we get from system requirements...
  1. Sense the altitude at release
  2. Use a controlled descent, achieving a velocity $\leq 3\ \text{m/s}$
  3. Operate remotely during descent
  4. Take pictures automatically using a provided digital camera
  5. Signal (audibly or visually) once the device has landed safely
  6. Be reusable
  7. Mass no more than 300g

...to system functions...

...to system parts?

- Let’s decompose the system.
Create a team engineering notebook with four sections:

- Descent mechanism design
- Payload design
- Structure design
- System-level design

Purpose:

- Document design decisions at all levels
- Create a reference for other subsystem teams
- Inform final report/presentation
Some system hierarchies are very complex.
Some system hierarchies are very complex.
Where different subsystems meet and interact, you have **interfaces**. Describe the interfaces you expect between descent and structure, between structure and payload, and between payload and descent subsystems.
Place post-it notes on the appropriate pages in your notebook to denote the following items:

- Aerial imaging system hierarchy
- Reflection

Write down the name of the appropriate item on each post-it.

Place a post-it in your notebook for anything else you are particularly proud of or would like me to see.
Individual Assessment

- Assessment 2: System Decomposition