Systems Considerations for HWO

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First steps

- Before we “dive in” to defining GOMAP science and technologies and architectures, it’s helpful to take a step back and think about process
- Most importantly, we should try and follow good system engineering processes so we do things in the correct order
- A good starting point is to review NASA’s official documentation on how to do system engineering, the System Engineering Handbook…

NASA System Engineering Handbook Process

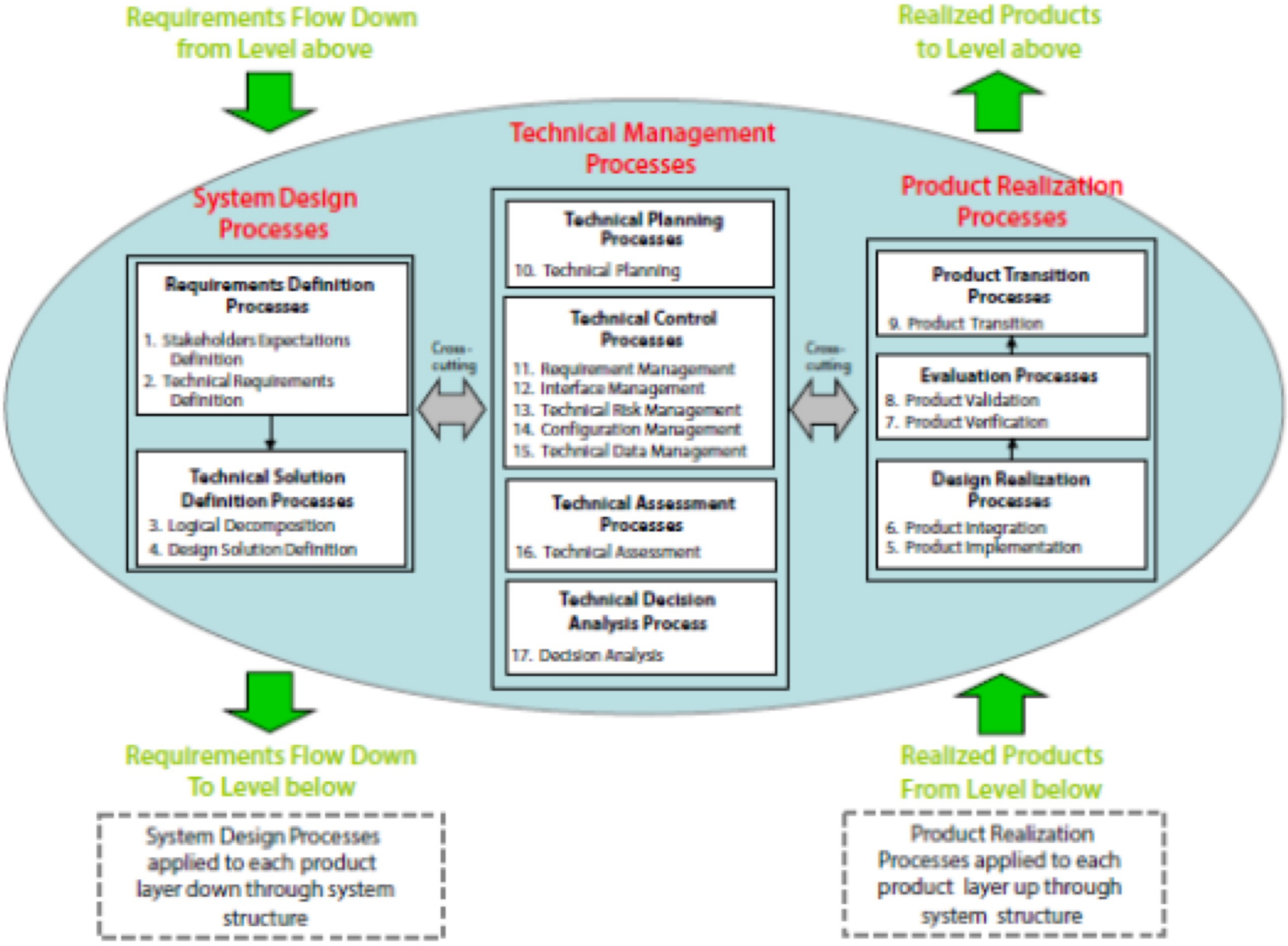


FIGURE 2.1-1 The Systems Engineering Engine (NPR 7123.1)

First steps

- **The first steps are:**
  - Stakeholder expectations
  - Technical requirements
- **Stakeholders:**
  - NASA headquarters defines key top level constraints
  - To some level, this has started with HWO Big Picture
  - Needs to include input on cost, schedule, rocket assumptions, international assumptions
- **Technical Requirements**
  - Collaboratively established between scientists and engineering teams
- **A really important aspect of this is not to consider the coronagraph separate from the telescope – need to consider the system**
  - Telescope is driven by stability, Coronagraph is driven by contrast, need a solution that optimizes the system!

The Habitable Worlds Observatory: *Big Picture Strategy*

- **Build to schedule**: Mission Level **1 Requirement - like planetary**
- **Evolve technology from what we have done before**:
  - **Build upon current NASA investments and TRL-9 technology**
  - **Segmented optical telescope system from JWST**
  - **Coronagraph from Roman‘s coronagraphic imager program**
- **Next Generation Rockets**:
  - **Larger telescope aperture sizes**
  - **Leverage opportunities for mass & volume trades**
- **Planned Servicing**: Robotic servicing at L2
- **Robust Margins**: Large scientific, technical, and programmatic margins
- **Mature technologies first**: Reduce risk by fully maturing the technologies prior to development phase.

From Mark Clampin via S. Domagal-Goldman

Example Product for Technical Requirements: JWST Science Themes Linked to L.1 Requirements

First light and reionization

The assembly of galaxies

Birth of stars and proto-planetary systems

Planetary systems and the origins of life

- First Light and Re-Ionization
- Assembly of Galaxies

L1-1: 5.1.1.1 Density of Galaxies Measure the space density of galaxies to a 2 µm flux density limit of 1.0 x 10^{-34} Wm-2Hz-1 via imagery within the 0.6 to 27 µm spectral band to enable the determination of how this density varies as a function of their age and evolutionary state.

- First Light and Re-Ionization
- Assembly of Galaxies

L1-2: 5.1.1.2 Spectra of Galaxies Measure the spectra of at least 2500 galaxies with spectral resolutions of approximately 100 (over 0.6 to 5 µm) and 1000 (over 1 to 5 µm) and to a 2 µm emission line flux limit of 5.2x10^{-22} Wm^{-2} to enable determination of their redshift, metallicity, star formation rate, and ionization state of the intergalactic medium.

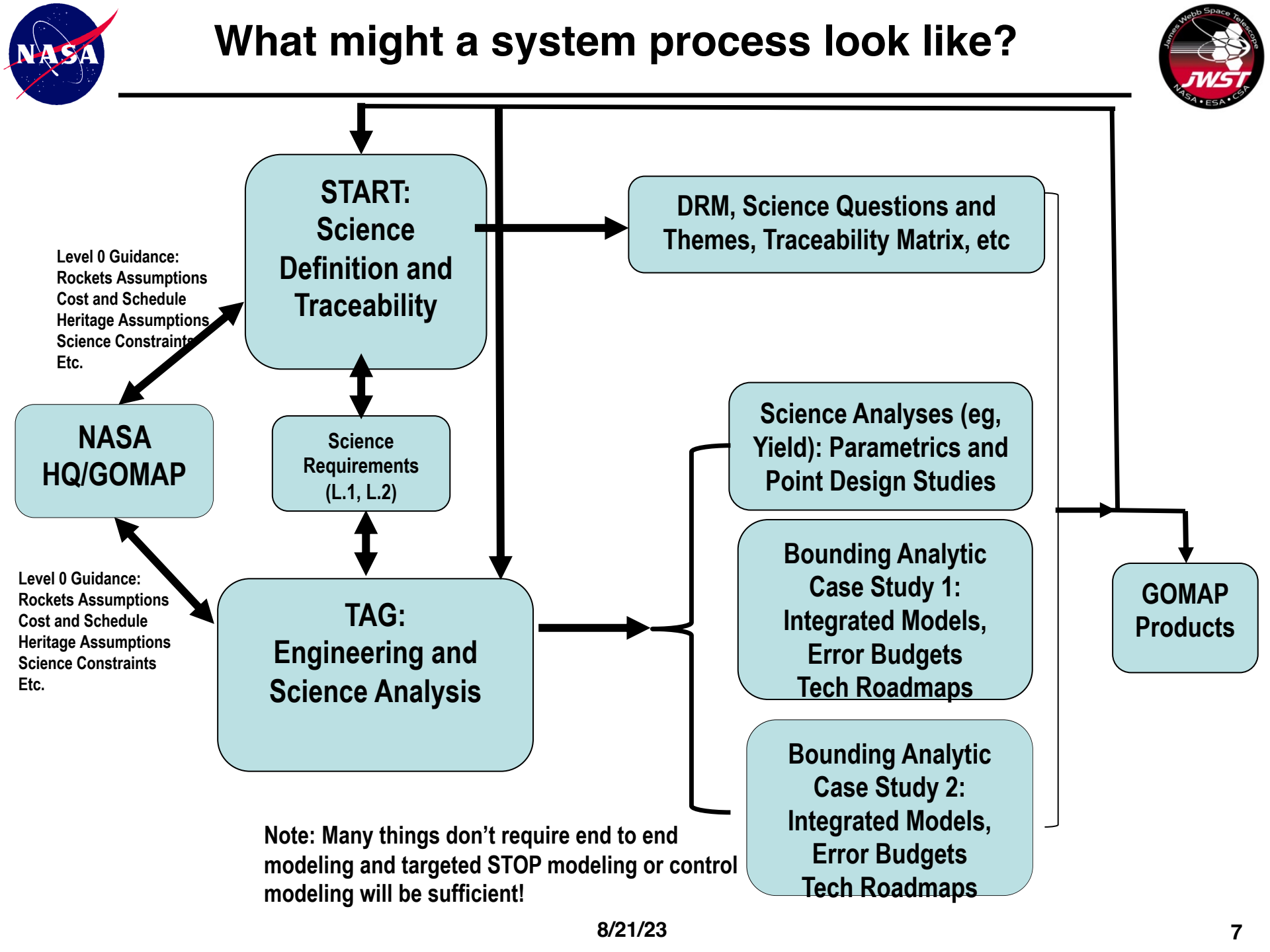
- Birth of Stars and Protoplanetary Systems
- Planetary Systems/Origins

L1-3: 5.1.1.3 Physical & Chemical Properties of Young Stellar Objects Measure the physical and chemical properties of young stellar objects, circumstellar debris disks, extra-solar giant planets, and Solar System objects via spectroscopy, and imagery within the 0.6 to 27 µm spectral band to enable determination of how planetary systems form and evolve.

- First Light and Re-Ionization
- Assembly of Galaxies
- Birth of Stars and Protoplanetary Systems
- Planetary Systems/Origins

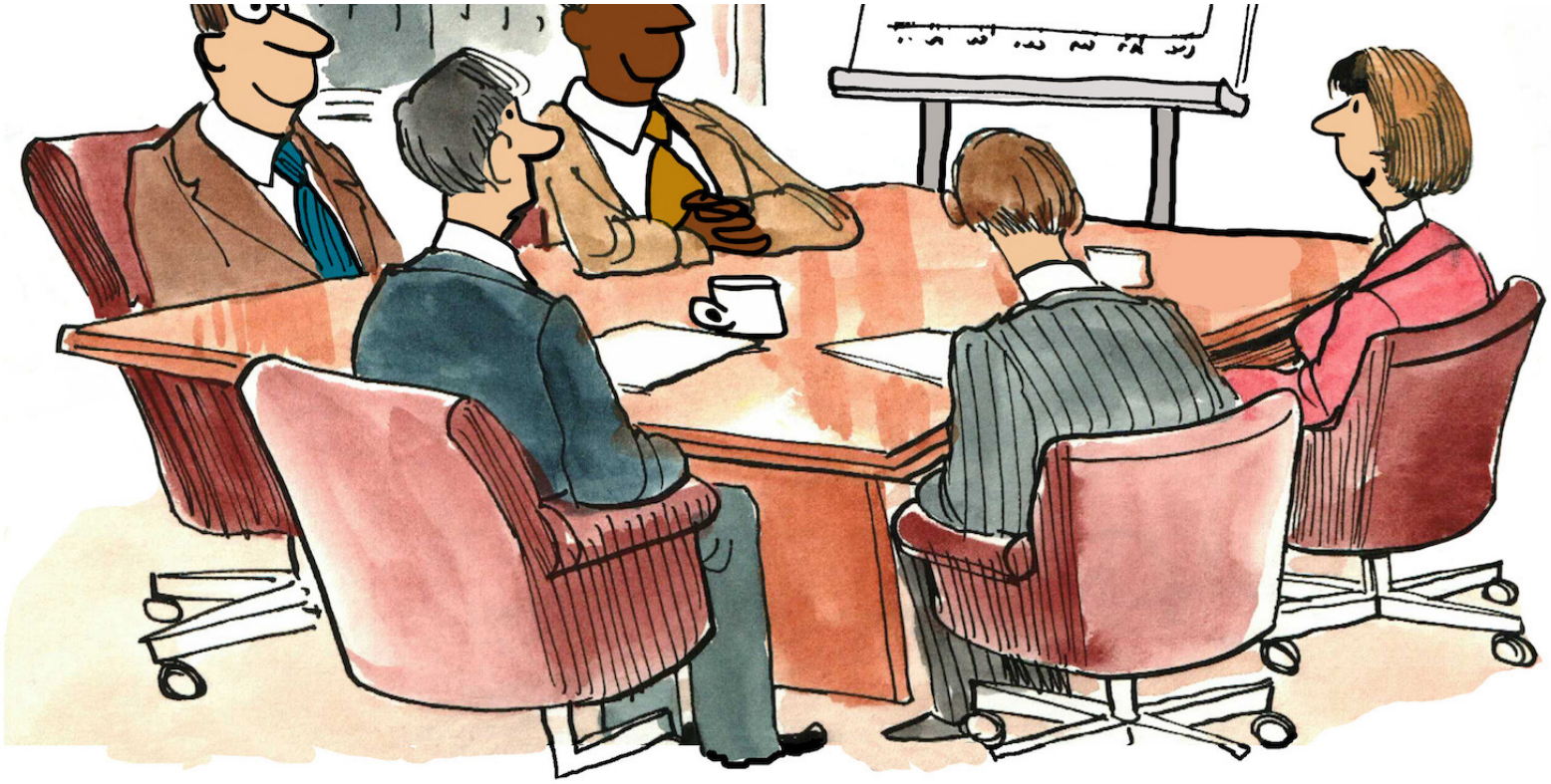
L1-4 : 5.1.1.4 Observing Time Enable, within a 5-year mission, a total observing time of at least 1.1x10^{8} seconds on targets located at any position on the celestial sphere.

What might a system process look like?



Note: Many things don't require end to end modeling and targeted STOP modeling or control modeling will be sufficient!

Closing Thought



**“Of course we’ll make a decision …
once we have considered the 5243 factors.”**