NASA System Engineering Design Process

Jose Roman, NASA/ Marshall Space Flight Center
What is System Engineering

♦ Systems engineering is a methodical, disciplined approach for the design, realization, technical management, operations, and retirement of a system.

♦ A “system” is a construct or collection of different elements that together produce results not obtainable by the elements alone.

♦ The elements, or parts, can include people, hardware, software, facilities, policies, and documents; that is, all things required to produce system-level results.

♦ The results include system-level qualities, properties, characteristics, functions, behavior, and performance. The value added by the system as a whole, beyond that contributed independently by the parts, is primarily created by the relationship among the parts; that is,
  - how they are interconnected.
  - It is a way of looking at the “big picture” when making technical decisions.
  - It is a way of achieving stakeholder functional, physical, and operational performance requirements in the intended use environment over the planned life of the systems.

♦ In other words, systems engineering is a logical way of thinking
One of the fundamental concepts used within NASA for the management of major systems is the program/project life cycle.

- Decomposing the project life cycle into phases organizes the entire process into more manageable pieces.
- Each phase terminate with a Key decision point (KDP).
- KDP are supported by major reviews, (SDR, PDR, etc)
In the effort to make our new and effective designs, initial studies should proceed rather than follow—*vortex design dynamics*. Many prototypes in this point include an actual physical design for the system and its stability and size. The other also produces various engineering and management plans to generate for managing the project’s downstream processes such as implementation and operations and for implementing engineering special modules.

### 3.5 Project Phases: Preliminary Design and Technology Completion

During Phase B, activities are performed to establish an initial project baseline which is reflected in NPR 7.721 and NRO 7.218. This includes a formal downlink of the technical requirements, in a cohesive set of system level design specifications for both flight and ground elements and corresponding preliminary design. The technical requirements should be sufficiently detailed to establish time, schedule, and cost estimates for the project. It also should contain, except for all direct projects, the Phases II to V, where the top-level requirements and the requirements breakdown to the next level of requirements.

- **Formulation**
- **Implementation**
- Each major phases are divided into project life cycle phases
  - Pre-Phase A
  - Phase A-E
- Each phase has a purpose and a goal to achieve at the end of cycle
- At the end of each phase a major review is performed to determine the completion of the phase
Major reviews

Each major review has a purpose and a goal
An entry and exit criteria are defined before the review is performed to assess the acceptance of the review
Typically this reviews are performed by the team/project presenting to a board
The Board is the entity that determine the success of the review and approving the completion of the current life cycle phase and approving to move into the next phase
The board is composed of experts, managers, etc.
Documents

- NASA Space Flight Program and Project Management Requirements, NPR 7120.5D
  - http://nodis.hq.nasa.gov/npg_img/N_PR_7120_005D_/N_PR_7120_005D_.pdf

- NASA System Engineering Process and Requirements, NPR 7123.1A

- NASA System Engineering Handbook, SP-2007-6105,