Systems Engineering

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**MITAC ACADEMY
IN NAGOYA UNIVERSITY**

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# Daniel Patrick Pereira, D.Sc.

- Doctor of Science in Electronic Engineering and Computing by the Aeronautics Institute of Technology (Abril/2020) – research area in Systems Security Engineering (integrating safety and security);

- Master of Science in compute engineering by Federal University of Amazonas (April 2008) – research area in wireless sensor networks;

- Member of INCOSE Brazil – used to work as a regional director promoting and dissiminating systems engineering practices in companies and universities;

- More than 19 years of experience covering the full stack of systems engineering processes, working in several projects (12 years dedicated to safety-critical systems);

- Member of Eurocae WG-72/RTCA SC-216 workgroup to revise the new security aeronautic regulations (i.e. ED-202A / DO-326A and ED-203A / DO-356A);

- Currently, I am working at Mitsubishi Aircraft Company (MITAC) as an Engineering Manager in Cybersecurity in charge of creating the product cybersecurity process and modifying the existing processes to address cybersecurity concerns.
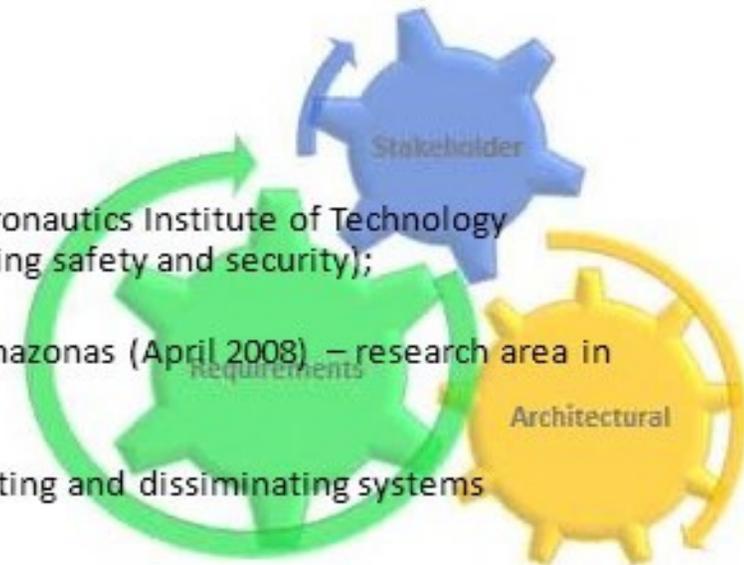
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What is a system?

Transport system
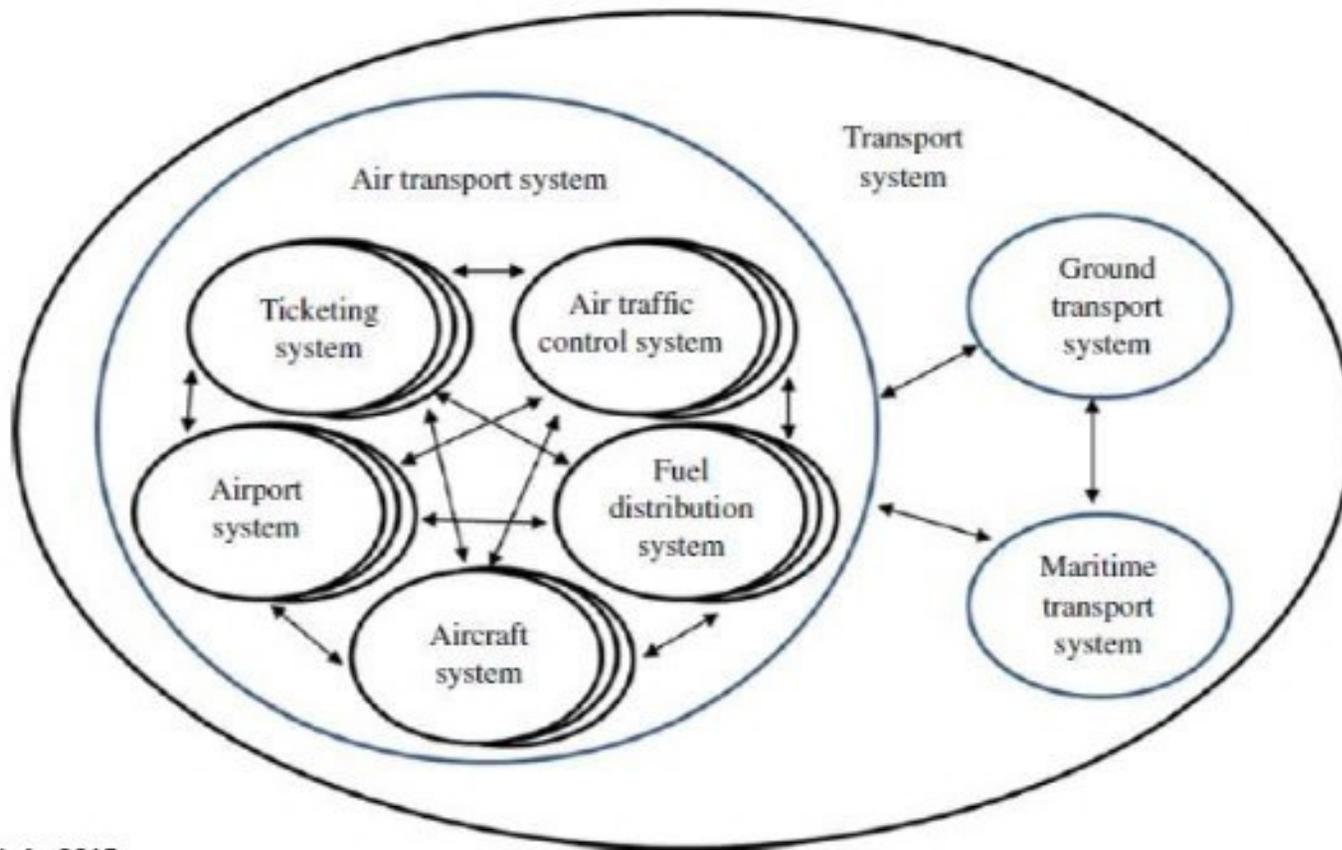
Transport system
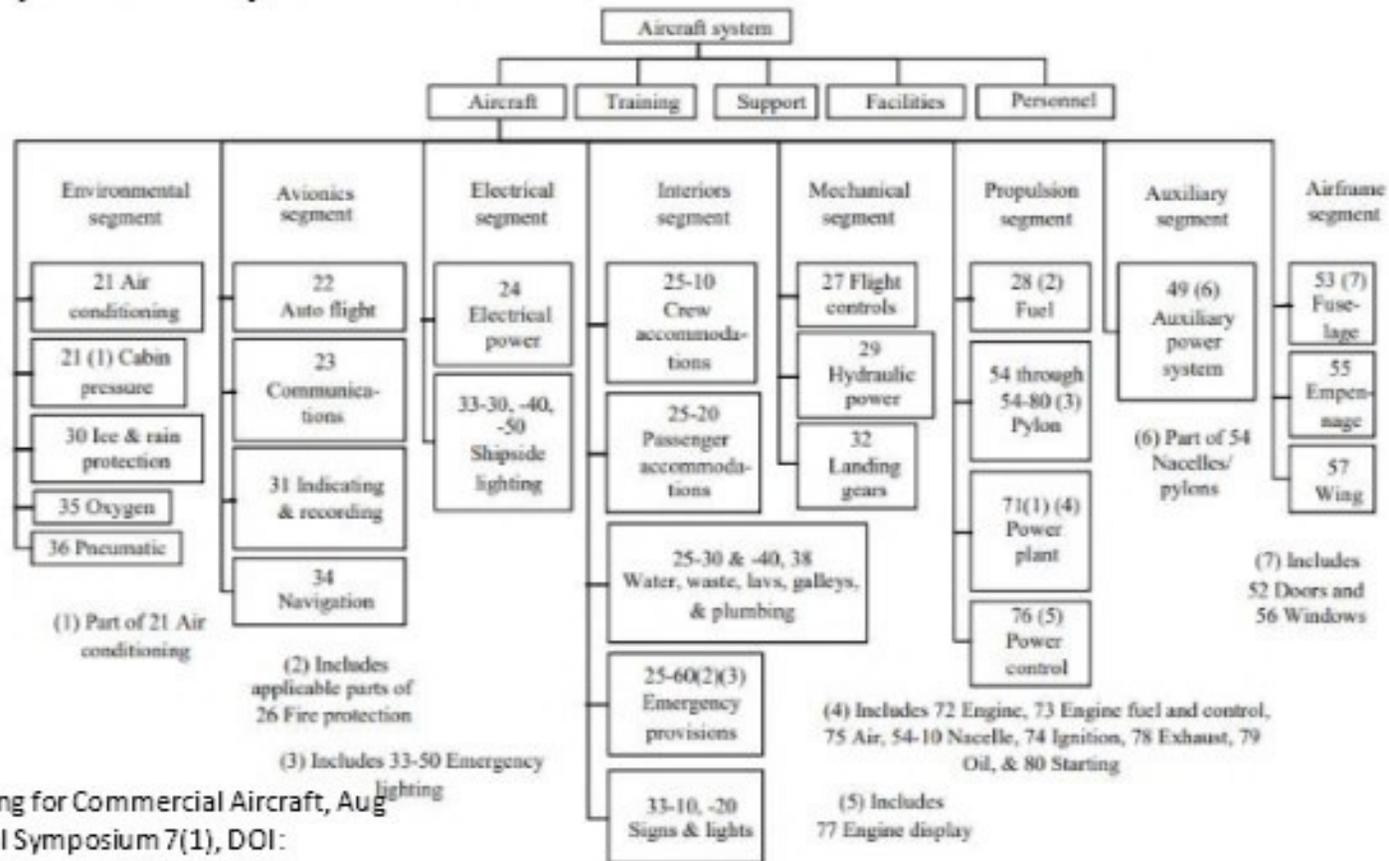
A system is ...

- **Formal definition:**

  - A man-made, created and utilized to provide products or services in defined environments for the benefit of users and other stakeholders (ISO/IEC/IEEE 15288);

  - An integrated set of elements, subsystems, or assemblies that accomplish a defined objective (INCOSE);

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Understanding System complexity

- Source of complexity:
  - System;
  - Environment;
  - Design/ management.

- For some classes of systems, a strategic [...] esign the proper system:
  - System decomposition;
  - Abstraction;
  - Formal analysis.

- Common questions:
  - What are the subsystems and how are they connected internally?
  - How does the system interact with the environment?

- Large number of components, many intricate interdependencies
- Adaptive components, interactions;
- Interfaces with human users or other complex entities ;
- Evolving technology.

- Operational environment (conditions);
- System environment (changes to elements of the larger system)

- Large number of people and organizations involved

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Example of a Complex System
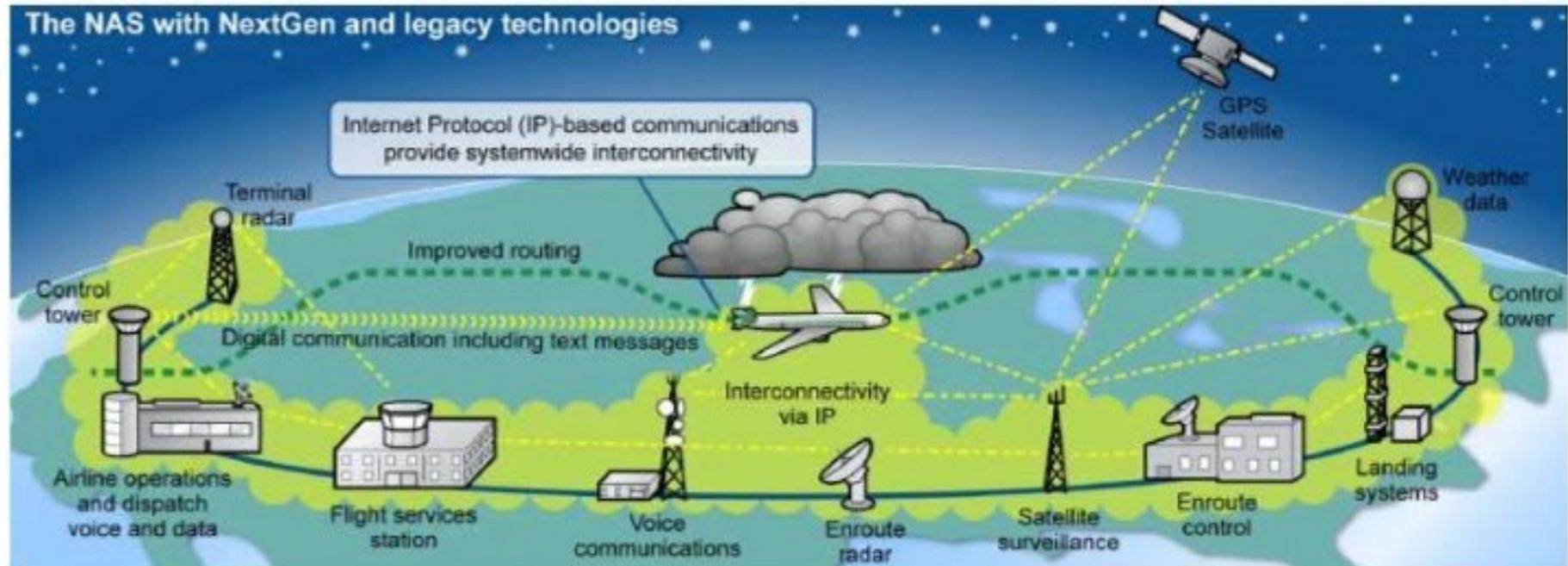
Source: NASA/CR–2015 - Operadic Analysis of Distributed Systems.

What is systems engineering?

- Systems engineering is responsible for the big picture.

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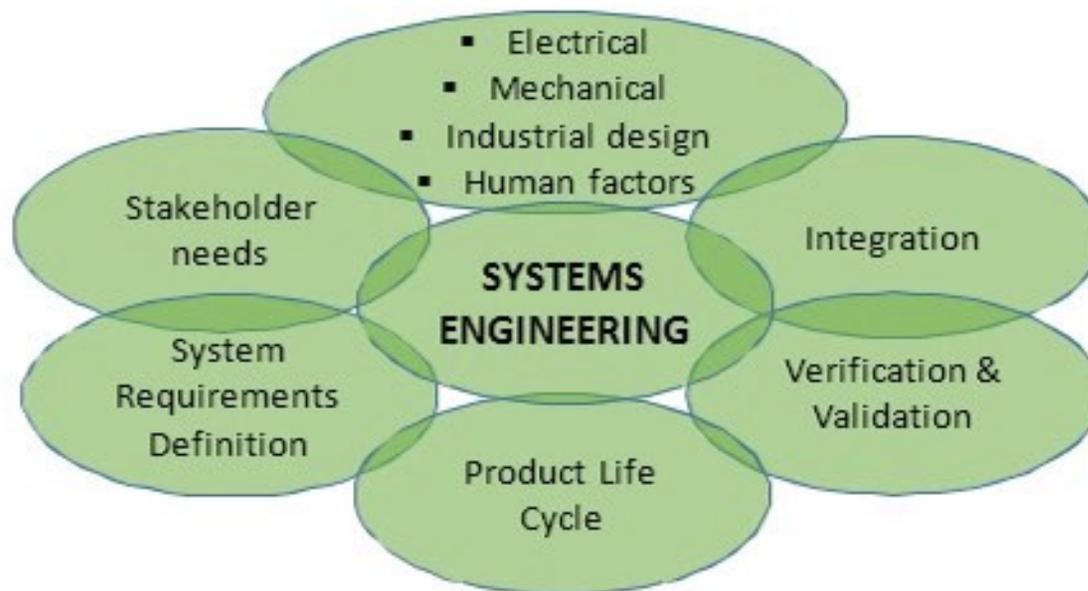
Systems engineering covering

- Systems Engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs.

Delivers the technical aspects of the project:
System Design
Product Realization
Technical Management

Delivers the sustainable benefits of the overall:
Resource Management
Scheduling
Cost Estimation
Risk Management

Stakeholders, Risks, Configuration Management, Data Management, Reviews, Schedule

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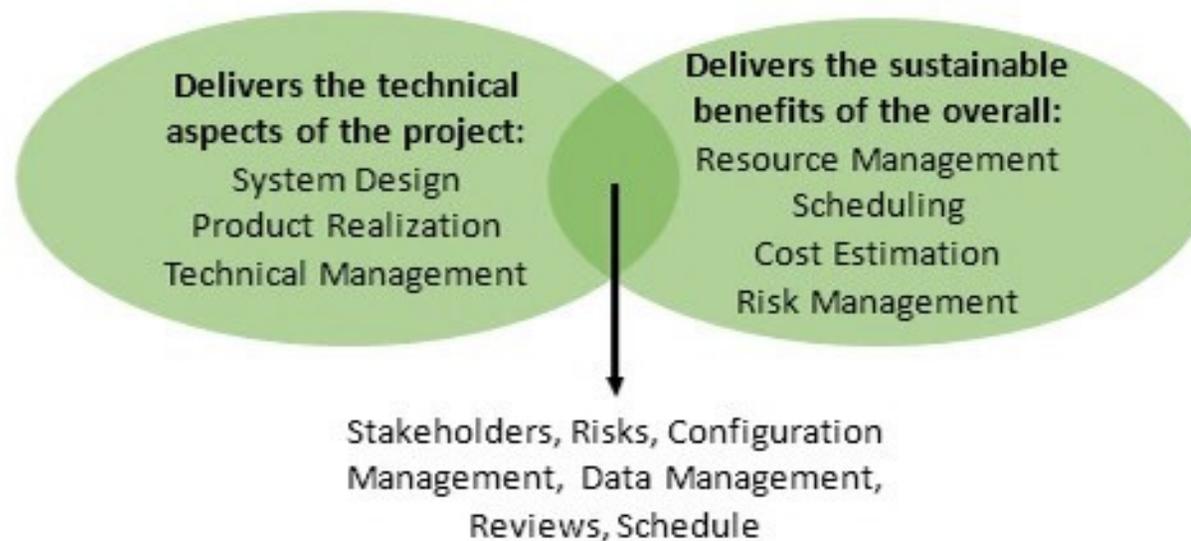
The role of the systems engineering

- Any engineer acts as a systems engineer when responsible for the **design and implementation** of a total system;

- The difference with "traditional engineering" lies primarily in the greater emphasis on **defining goals**, the **creative generation** of alternative designs, the **evaluation of alternative designs**, and the **coordination and control** of the diverse tasks that are necessary to create a complex system focusing on stakeholder needs;

- The role of systems engineering is one of manager that utilizes a structured value delivery process.

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Life cycle stages

- A system "progresses" through a common set of life cycle stages where it is conceived, developed, produced, utilized, supported and retired.

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                    ┌──────────────┐
           ┌────────│ Development  │────────┐
           │        └──────┬───────┘        │
           ▼               ▼                ▼
      ┌─────────┐    ┌────────────┐   ┌─────────────┐    ┌─────────────┐
      │ Concept │◄──►│ Production │──►│ Utilization │───►│ Retirement  │
      └─────────┘    └────────────┘   └──────┬──────┘    └─────────────┘
                                             ▼
                                       ┌──────────┐
                                       │ Support  │
                                       └──────────┘
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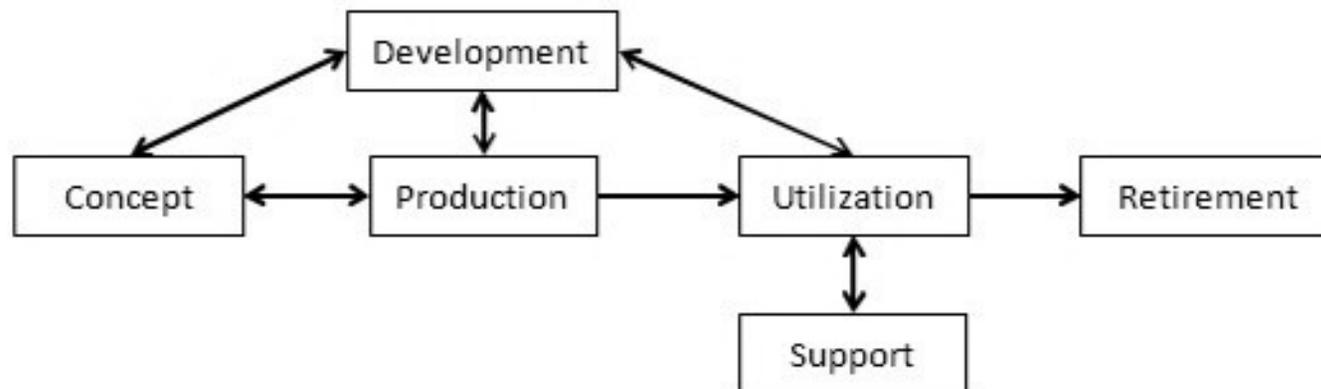
The systems engineering process

- The major steps in the completion of a typical systems engineering project are the following:
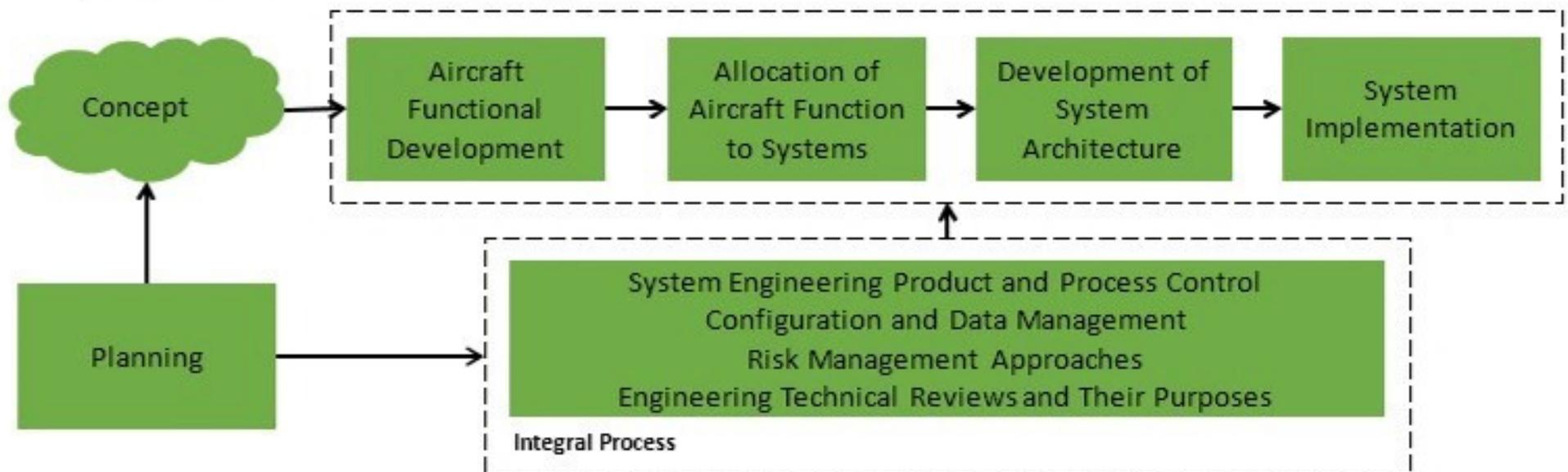
V-Model of Systems Development
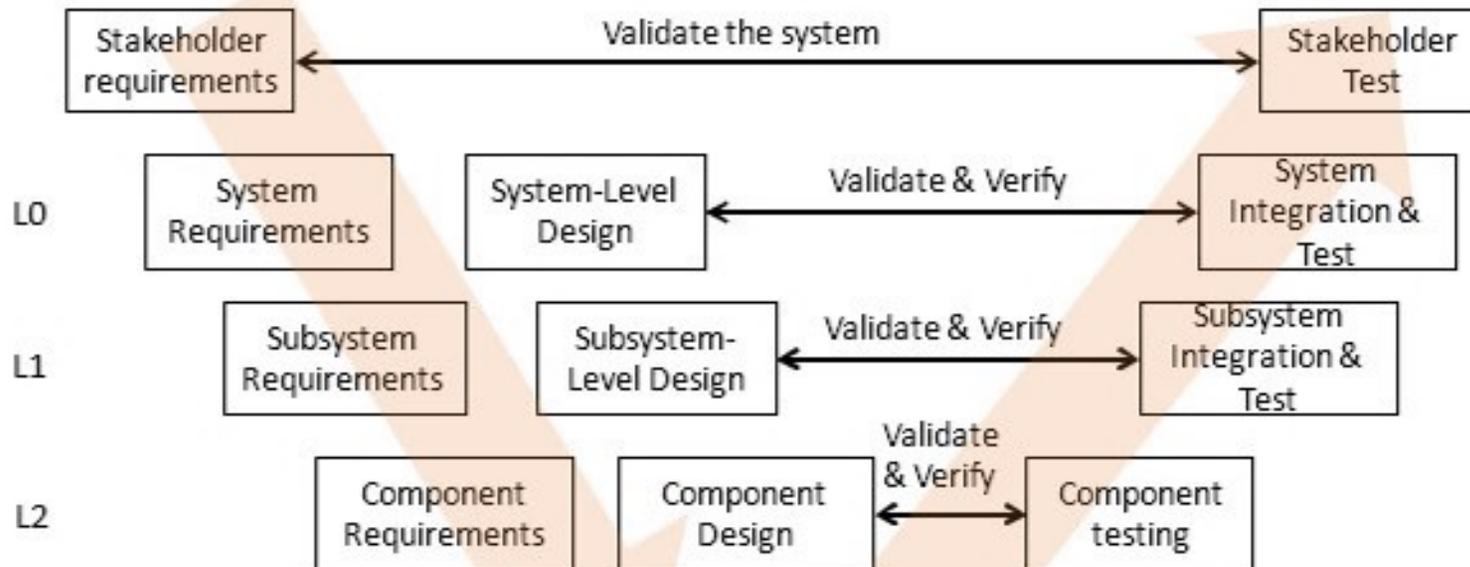
Impact of not [properly] SE in the projects
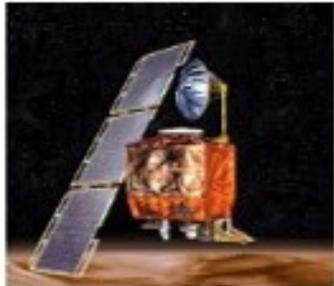
Mars Climate Orbiter
- Loss of mission (cost of $327.6M);
- Inadequate consideration of the entire operation;
- Inconsistent communications;
- Lack of complete end-to-end verification of navigation software.

Therac-25
- Six accidents (03 fatalities) due to massive overdoses of radiation;
- Overconfidence in software;
- Inadequate SE process practices;
- Software reuse.

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Impact of SE in the projects

Submarine Warfare Federated tactical Systems
- Subset of 40 systems produced by 20 different program offices;
- Model Based Systems Engineering.

Hubble Space Telescope
- Broadly explore technical concepts;
- High degree of system integration;
- Consider all life cycle;
- Risk Management.

International Council on Systems Engineering

- INCOSE is a not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems;

- **Mission**:
  - To address complex societal and technical challenges by enabling, promoting, and advancing systems engineering and systems approaches;

- **Goals**:
  - To provide a **focal point for dissemination** of systems engineering knowledge.
  - To promote **international collaboration** in systems engineering practice, education, and research.
  - To assure the **establishment of competitive, scale-able professional standards** in the practice of systems engineering.
  - To improve the **professional status** of all persons engaged in the practice of systems engineering.
  - To encourage **governmental** and **industrial support** for **research** and educational programs that will improve the systems engineering process and its practice.

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INCOSE Workgroups

Affordability	Agile Systems and Systems Engineering	Anti-Terrorism International	Architecture	Automotive
✉ Jay Haimowitz	✉ Rick Dove / Ron Lyells, Larri Rosser, Kevin Gunn	✉ Bill Mackey	✉ M. Wilkinson / ✉ R. Martin / ✉ A. Kumar / ✉ JL. Garnier	✉ Alain Dauron / ✉ Gary Rushton
⚲ Analytic Enablers	⚲ Transformational	⚲ Application Domains	⚲ Process Enablers	⚲ Application Domains

Challenge Team	Competency	Complex Systems	Configuration Management	Critical Infrastructure
	✉ Cliff Whitcomb	✉ Jimmie McEver	✉ Paul Nelson / ✉ Dale Brown / ✉ Adriana DSouza	✉ Mitchell Kerman
	⚲ Analytic Enablers	⚲ Analytic Enablers	⚲ Process Enablers	⚲ Application Domains

Decision Analysis	Defense Systems	Digital Engineering Information Exchange	Enterprise Systems	Global Earth Observation System of Systems (GEOSS)
✉ Frank Salvatore	✉ Karl Geist	✉ John Coleman / ✉ Frank Salvatore / ✉ Chris Schreiber	✉ Willy Donaldson	✉ Ken Crowder
⚲ Analytic Enablers	⚲ Application Domains	⚲ Transformational	⚲ Process Enablers	⚲ Application Domains

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INCOSE - Certification

- Certification is a formal process whereby a community of knowledgeable, experienced, and skilled representatives of an organization, such as INCOSE, provides confirmation of an individual's competency (demonstrated knowledge, education, and experience) in a specified profession;

If you have just started practicing – or want to start practicing – systems engineering, then ASEP is for you. This certification is for people at the beginning of their career as a systems engineer. The ASEP has "book knowledge" but not yet significant experience as a systems engineer.

If you are a practicing Systems Engineer with more than five years of systems engineering professional work experience, then CSEP is for you.

If you are a systems engineering leader with recognized systems accomplishments and have many years of systems engineering professional work experience, then ESEP is for you

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Join INCOSE

Join INCOSE - Japan

https://www.jcose.org/

Reference

- Systems Engineering standards:
    - INCOSE Systems Engineering Handbook, A Guide for System Lifecycle Processes and Activities, INCOSE-TP-2003-002-03, version 3, International Council on Systems Engineering (INCOSE), June 2006 – version 4 was just issued in July 2015;
    - ISO/IEC 15288:2008(E), IEEE Std 15288-2008, Second edition, 2008-02-01 Systems and software engineering — System life cycle processes – May 2015 edition ;
    - NASA Systems Engineering Handbook, NASA/SP-2007-6105, Rev 1, Dec 2007.
    - Functional Analysis Module, Space Systems Engineering, version 1.0, NASA.

Questions

Thank you for boarding

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