

# Systems Engineering

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JANUARY, 2021



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# Daniel Patrick Pereira, D.Sc.

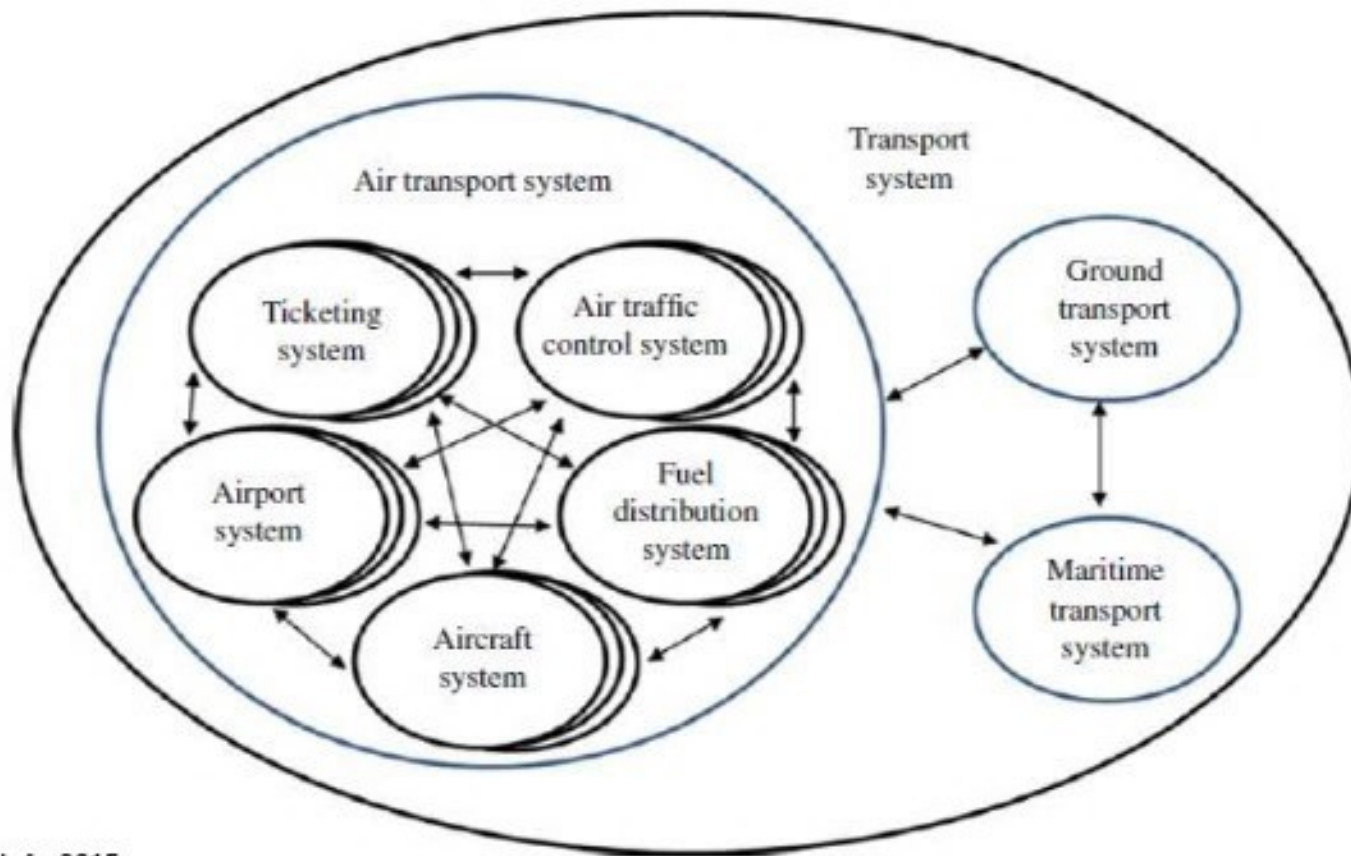
- Doctor of Science in Electronic Engineering and Computing by the Aeronautics Institute of Technology (Abril/2020) – research area in Systems Security Engineering (integrating safety and security);
- Master of Science in compute engineering by Federal University of Amazonas (April 2008) – research area in wireless sensor networks;
- Member of INCOSE Brazil – used to work as a regional director promoting and disseminating 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.



# What is a system?



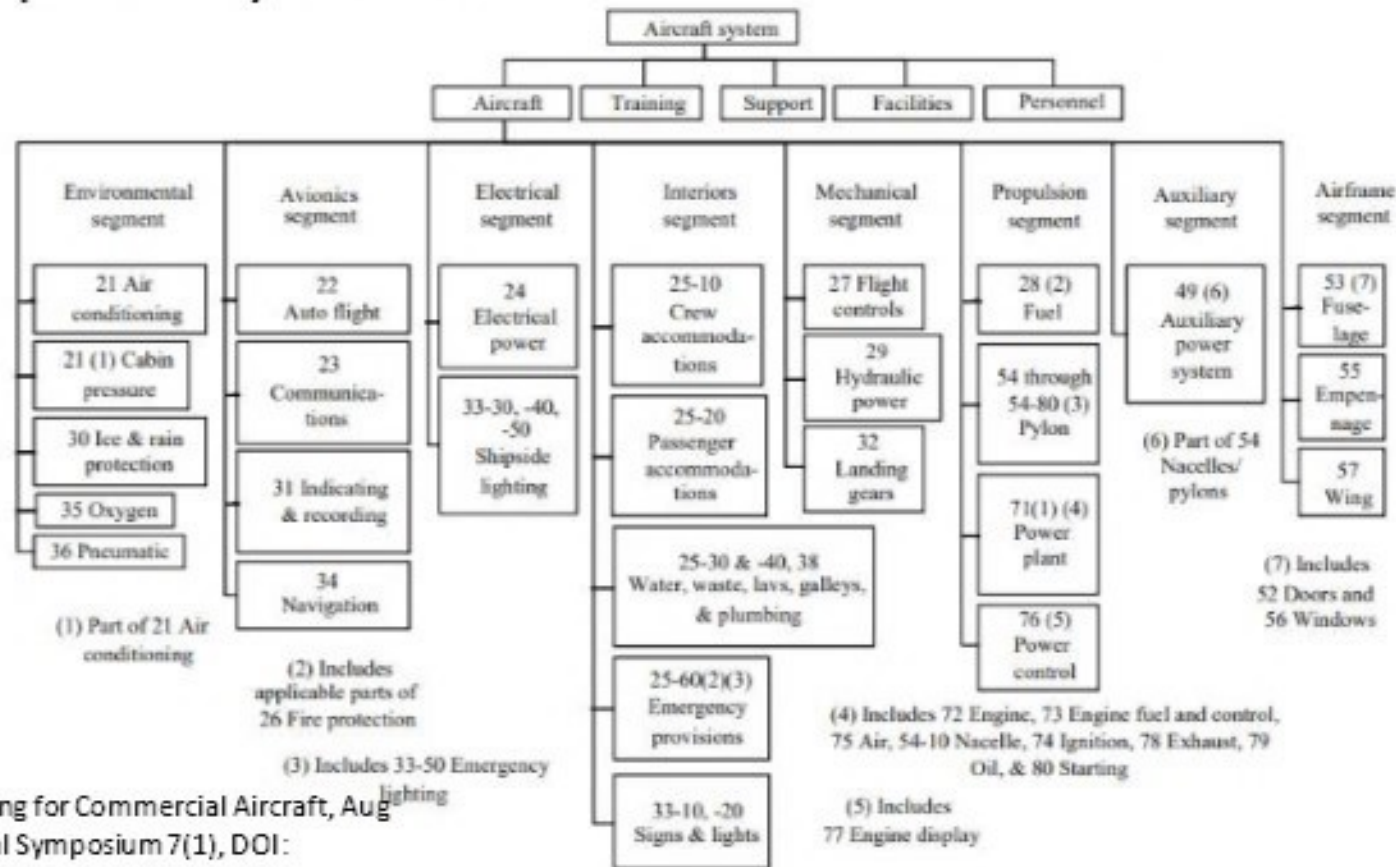
# Transport system



Source : INCOSE Handbook 4e 2015



# Transport system



Source: Systems Engineering for Commercial Aircraft, Aug 1997, INCOSE International Symposium 7(1), DOI: 10.1002/j.2334-5837.1997.tb02151.x Scott Jackson.

# 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);

# Understanding System complexity

- **Source of complexity:**

- System;
- Environment;
- Design/ management.

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

- **For some classes of systems, a strategic design the proper system:**

- System decomposition;
- Abstraction;
- Formal analysis.

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

design

- **Common questions:**

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

- Large number of people and organizations involved

The diagram illustrates the integration of NextGen and legacy technologies within the National Airspace System (NAS). A central airplane is shown flying over a globe. A box above the airplane states: "Internet Protocol (IP)-based communications provide systemwide interconnectivity". The diagram shows various components connected to the airplane and each other:

- Terminal radar**: Connected to the airplane via a dashed line.
- Control tower**: Two towers are shown, one on the left and one on the right, connected to the airplane via dashed lines.
- Airline operations and dispatch voice and data**: A building icon connected to the left control tower.
- Flight services station**: A building icon connected to the left control tower.
- Voice communications**: A tower icon connected to the airplane via a dashed line.
- Enroute radar**: A dish icon connected to the airplane via a dashed line.
- Satellite surveillance**: A tower icon connected to the airplane via a dashed line.
- Enroute control**: A building icon connected to the right control tower.
- Landing systems**: A building icon connected to the right control tower.
- GPS Satellite**: A satellite in space connected to the airplane via a dashed line.
- Weather data**: A tower icon connected to the right control tower.

Key communication features are highlighted:

- Improved routing**: Indicated by a green dashed line connecting the left control tower to the airplane.
- Digital communication including text messages**: Indicated by a yellow dashed line connecting the left control tower to the airplane.
- Interconnectivity via IP**: Indicated by a yellow dashed line connecting the airplane to the right control tower.



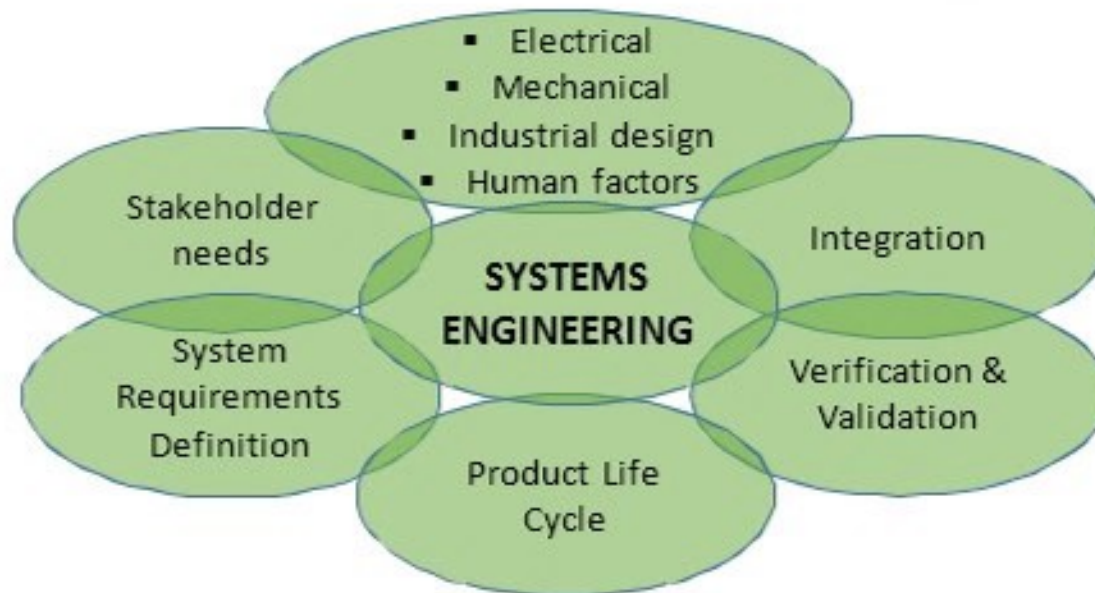
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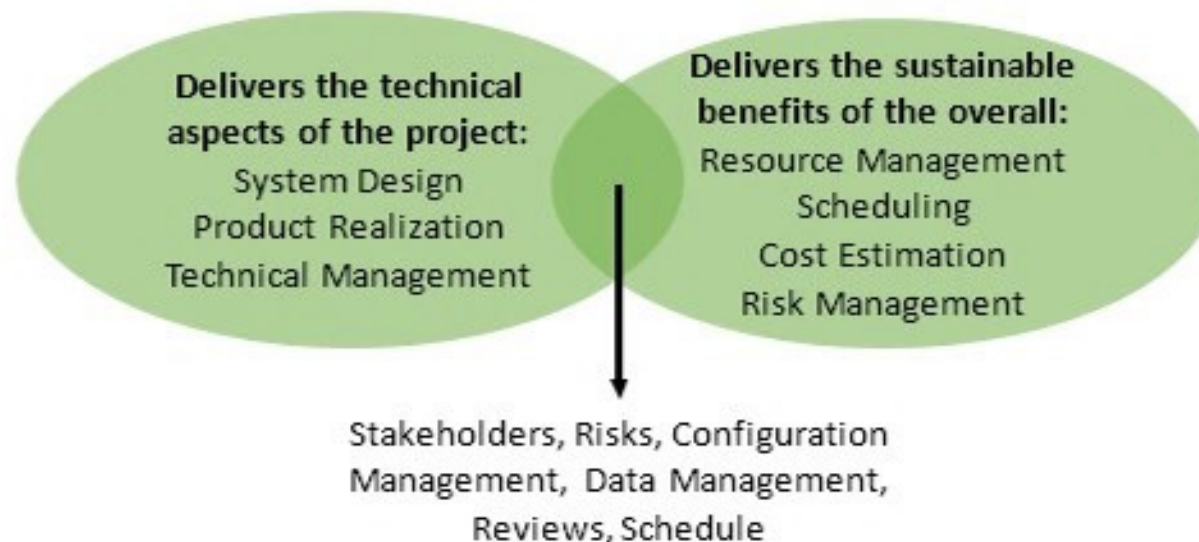
# What is systems engineering?

- Systems engineering is responsible for the big picture.



# 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.

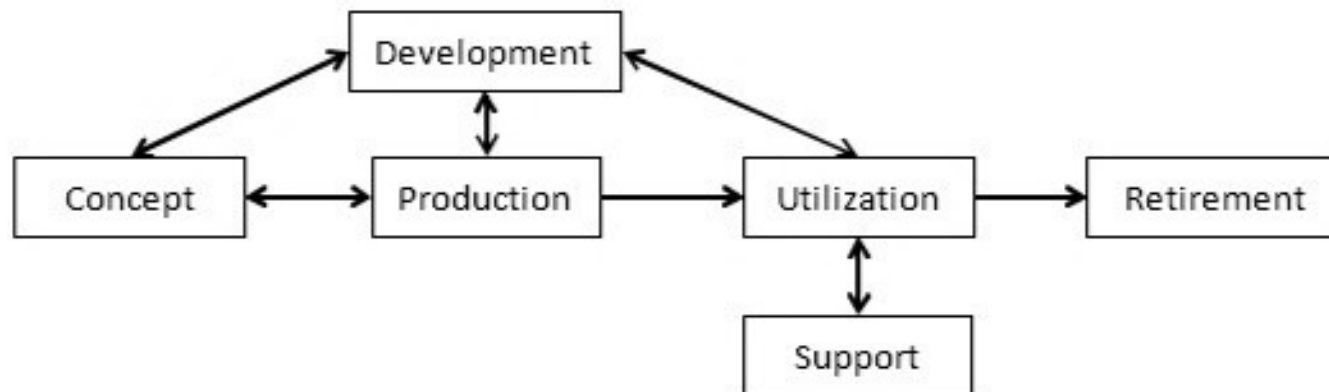


# The role of the systems engineering

- 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.

# Life cycle stages

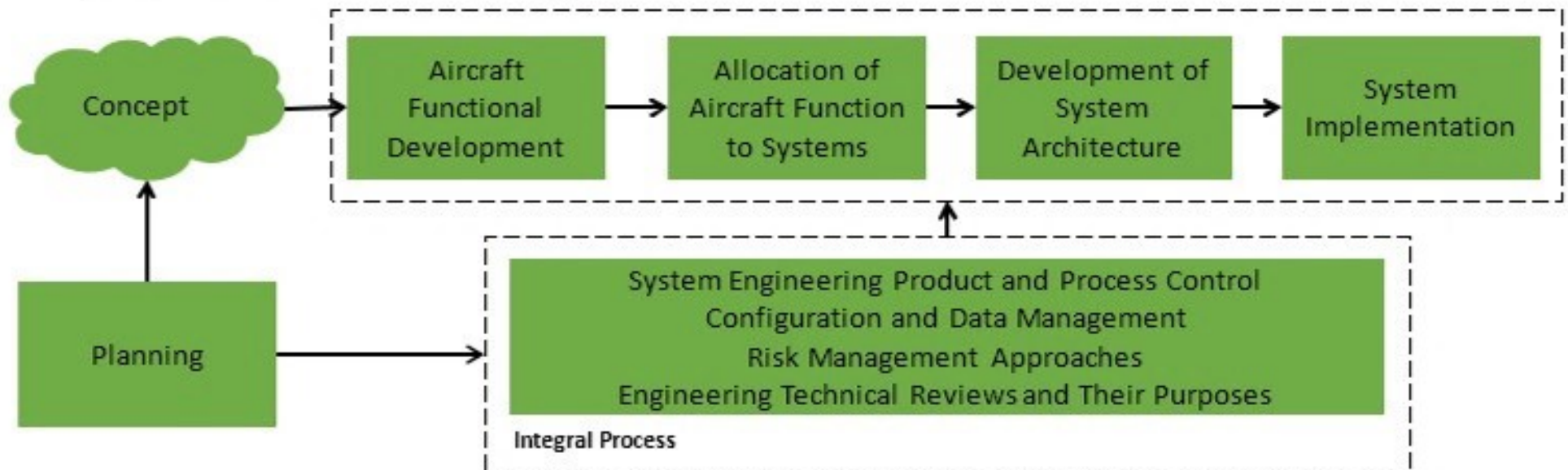
- A system “progresses” through a common set of life cycle stages where it is conceived, developed, produced, utilized, supported and retired.



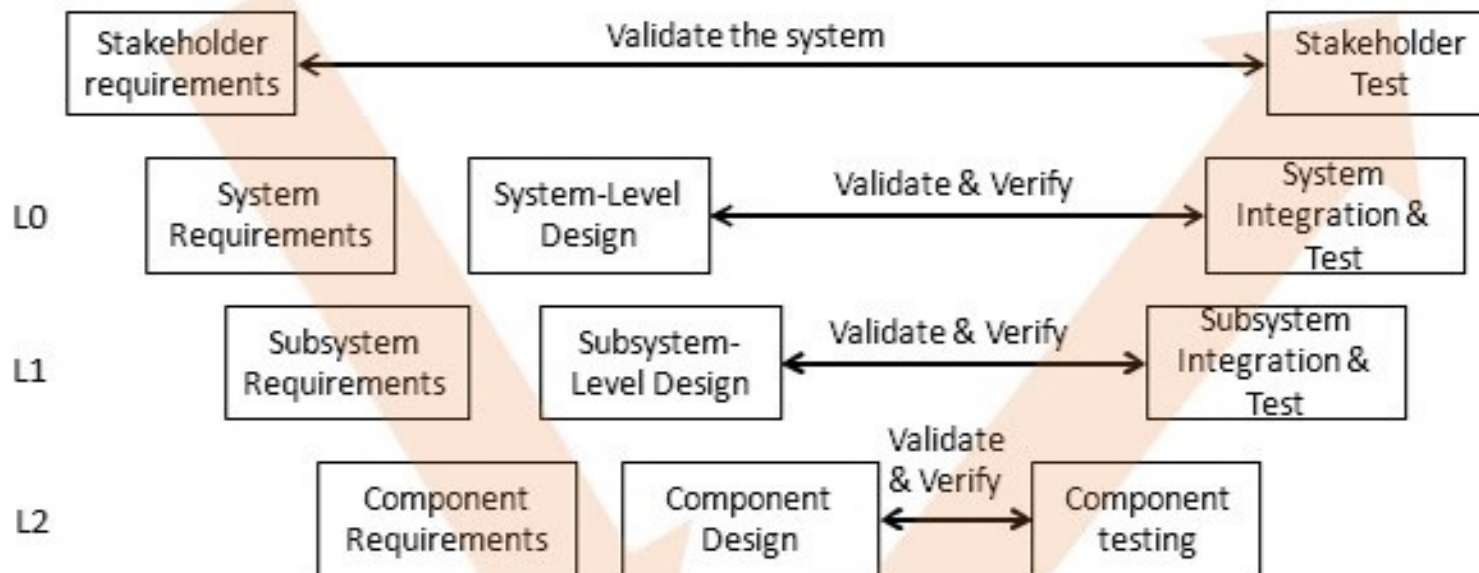


# The systems engineering process

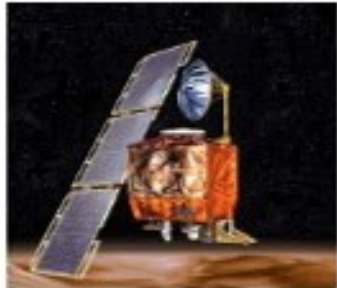
- The major steps in the completion of a typical systems engineering project are the following:



# V-Model of Systems Development



# Impact of not [properly] SE in the projects



## Mars Climate Orbiter

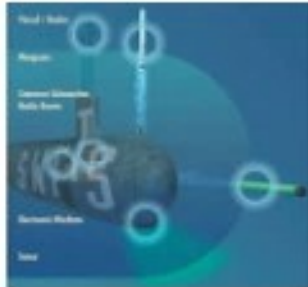
- Loss of mission (cost of \$327.6M);
- Inadequate consideration of the entire operation;
- Inconsistent communications;
- Lack of complete end-to-end verification of navigation software.



## Therac-25

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

# 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.

# About INCOSE



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# INCOSE Workgroups

<p>Affordability</p> <p>✉ Jay Haimowitz</p> <p>🔧 Analytic Enablers</p>	<p>Agile Systems and Systems Engineering</p> <p>✉ Rick Dove / ✉ Ren Lyells, Lam Rossler, Kevin Gunn</p> <p>🔧 Transformational</p>	<p>Anti-Terrorism International</p> <p>✉ Bill Mackey</p> <p>🔧 Application Domains</p>	<p>Architecture</p> <p>✉ M. Wilkinson / ✉ R. Martin / ✉ A. Kumar / ✉ J.L. Garnier</p> <p>🔧 Process Enablers</p>	<p>Automotive</p> <p>✉ Alain Dauron / ✉ Gary Rushton</p> <p>🔧 Application Domains</p>
<p>Challenge Team</p> <p></p> <p></p>	<p>Competency</p> <p>✉ Cliff Whitcomb</p> <p>🔧 Analytic Enablers</p>	<p>Complex Systems</p> <p>✉ Jimmie McEver</p> <p>🔧 Analytic Enablers</p>	<p>Configuration Management</p> <p>✉ Paul Nelson / ✉ Dale Brown / ✉ Adriana DSouza</p> <p>🔧 Process Enablers</p>	<p>Critical Infrastructure</p> <p>✉ Mitchell Kerman</p> <p>🔧 Application Domains</p>
<p>Decision Analysis</p> <p>✉ Frank Salvatore</p> <p>🔧 Analytic Enablers</p>	<p>Defense Systems</p> <p>✉ Karl Gebt</p> <p>🔧 Application Domains</p>	<p>Digital Engineering Information Exchange</p> <p>✉ John Coleman / ✉ Frank Salvatore / ✉ Chris Schreiber</p> <p>🔧 Transformational</p>	<p>Enterprise Systems</p> <p>✉ Willy Donaldson</p> <p>🔧 Process Enablers</p>	<p>Global Earth Observation System of Systems (GEOSS)</p> <p>✉ Ken Crowder</p> <p>🔧 Application Domains</p>

# 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



872



2002



308





# Join INCOSE



## Join INCOSE

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Join Now

## Renew your Membership in Profile Home \*

If you are or have been an INCOSE member and wish to renew, submit an ASEP, CSEP or ESEP application or renewal, LOGIN and select **Profile Home** by clicking on your name. Select "Join/Renew" in the **My Membership** section. To submit an application for certification, click on the application links in the **My Certification** area of the Profile Home page. Membership must be current to submit a new application.



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<https://www.jcose.org/>

# Join INCOSE - Japan



[home](#) > JCoseについて

## JCoseについて

JCoseとは、INCOSEの日本支部であり、2007年3月23日にINCOSE日本支部（Japan Chapter）が認められ、日本支部の前組織であるINCOSE日本支部準備会のメンバーを中心に定期的な会議、勉強会を行ってまいりました。

JCoseの使命、目的についてはこちらをごらん下さい。

→ [JCoseの使命](#)

## JCoseの構成

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# 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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