The Use of STAMP in Aircraft Evaluation, Test and Research

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Briefing Focus

- **Very high level discussion of STPA / STAMP within Boeing Test and Research**

Boeing Test and Evaluation

- **Boeing Test and Evaluation**
  - 6500 employees
  - 23 States and 60 Sites
  - Flight Operations
  - Lab Operations

Boeing 787 over Mt Rainier. *Boeing Photo*

NELLIS AIR FORCE BASE, Nev.--F-22A Raptor and F-15C Eagle in formation over Lake Mead, Nev. *USAF Photo*
http://www.nellis.af.mil/photos/media_search.asp?q=433rd&btnG.x=0&btnG.y=0

Boeing 787 static test being moved around Everett Washington ramp. *Photo Boeing*.

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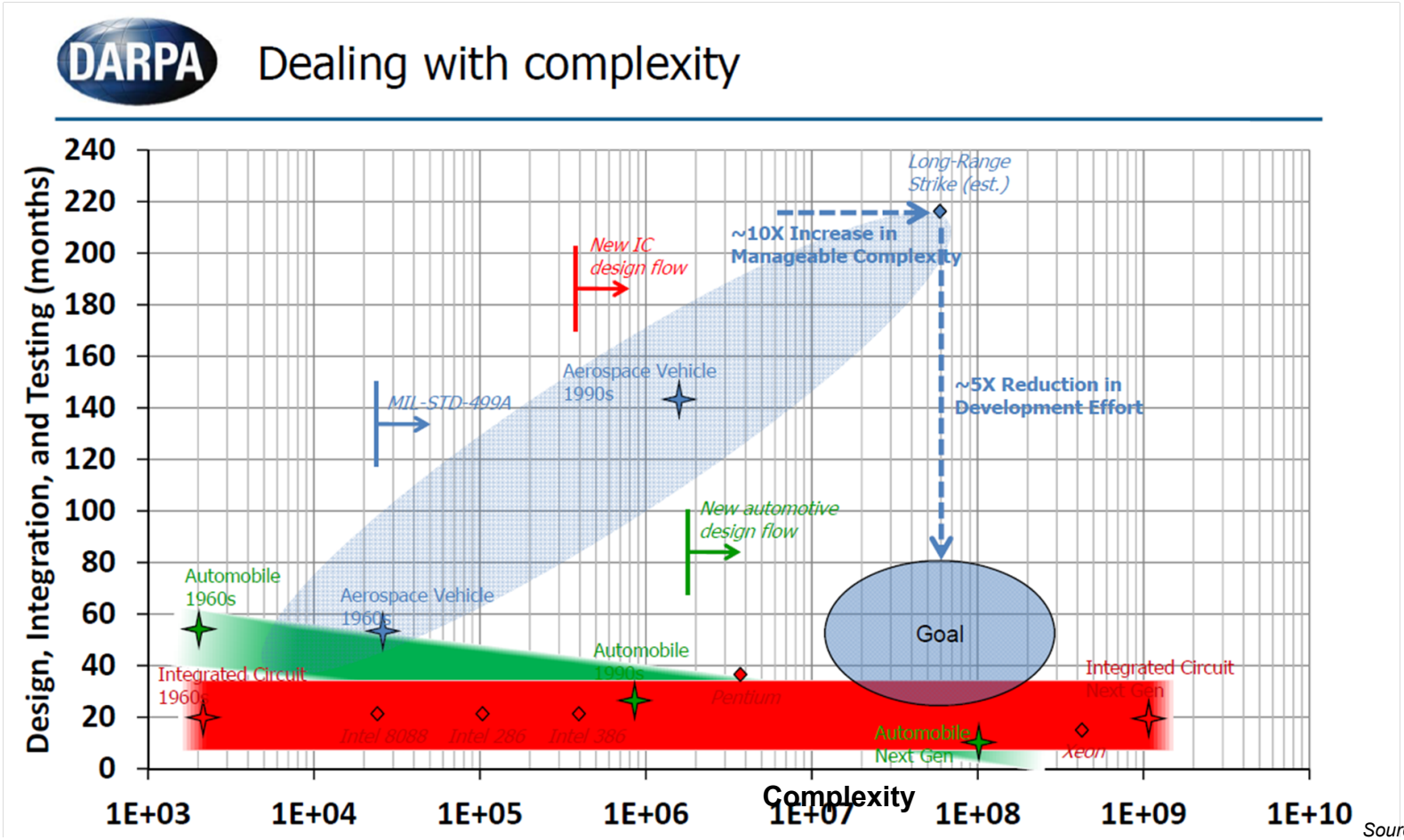
System Complexity Growth



Source - DARPA

System complexity is growing exponentially !

Existing Methodologies

- **FMEA, FMECA and HAZOP are similar**
  - A committee (workshop environment) applies past history in conjunction with mental models to identify “what if?” Scenarios
  - FMEA/FMECA
    - Most commonly used in pragmatic risk analysis
    - Can be overly focused on root cause’s
  - HAZOP
    - Existing or planned operations or processes
    - Tends to be better for well understood complex systems
- **Event and fault trees**
  - More complex and costly due to focusing on the details
  - Post mortem
    - Event and fault trees used to gain further insight into failure process

STPA / STAMP Journey for Test

- **STPA / STAMP workshop 2012**
- **MIT Intern 2013 (James Clark)**
  - Created internal education package
  - Extensive internal socialization
- **Prototyping STPA / STAMP Implementation**
  - Start small to learn and gain success

Areas of interest

- **Ramp safety**
  - Complex movement of people, equipment, vehicles and aircraft

http://asrs.arc.nasa.gov/publications/directline/dl8_ramp_title.jpg

Port-au-Prince's International Airport, crowded ramp operations in the aftermath of Haiti's earthquake in January 2010. *(Federal Aviation Administration photo courtesy of Kenneth Langert)*

Boeing 787 static test being moved around Everett Washington ramp. *Photo Boeing*.

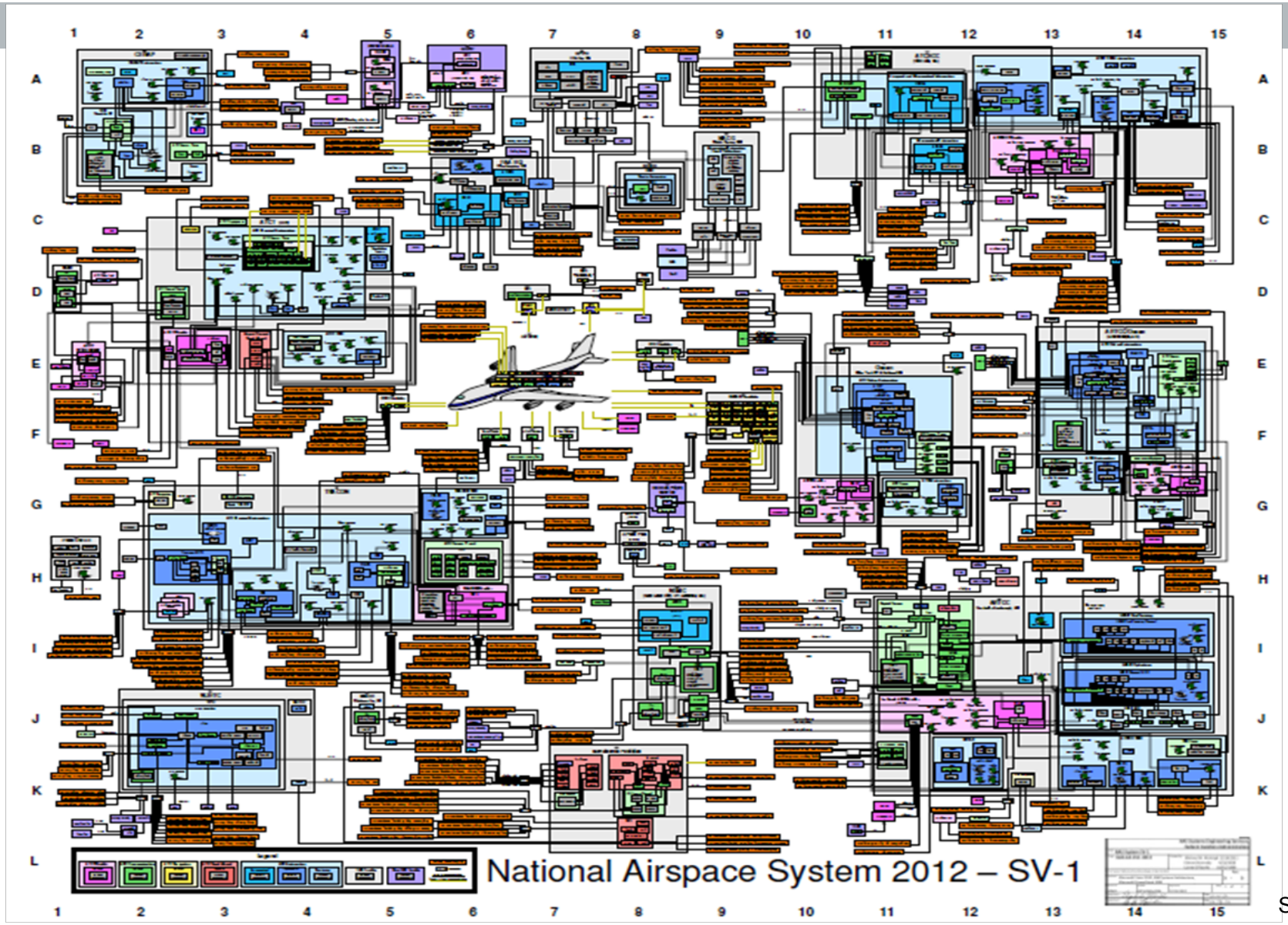
Lab Safety

- **Could STPA be applied to identify potential incidents?**
- **Full scale testing of 747 wing generates over 1 million pounds of force !**

Full scale wing testing. *Photo Boeing*

Helicopter crash testing. *Photo United States Navy*

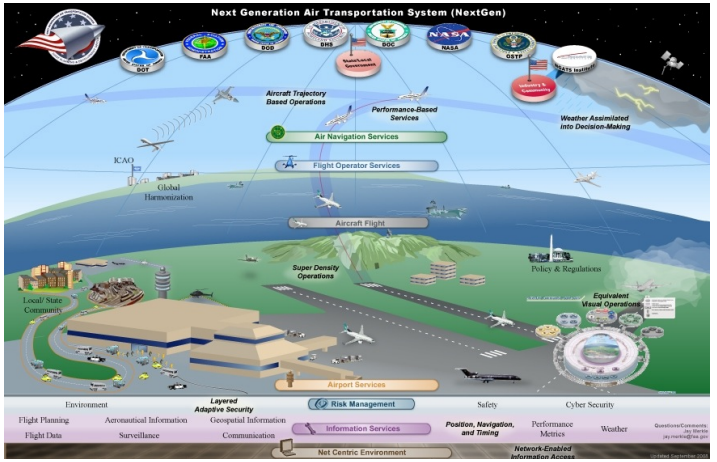
STAMP Analysis of NextGen



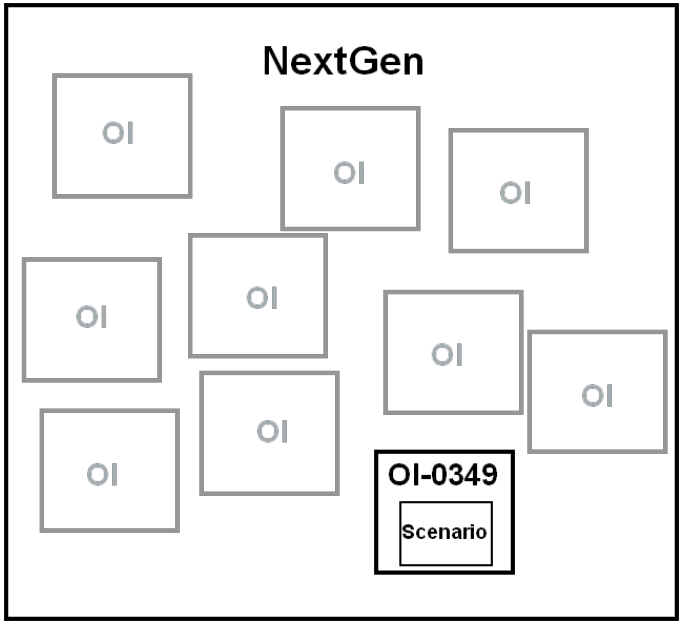
Source FAA

STAMP-Related Analysis for NextGen Safety (1/2)

- **Boeing Research & Technology (BR&T) Airspace & Operational Efficiency (AOE) group**
  - Analyzed the overall NextGen (Next Generation Air Transportation System) hazard situation
  - Performed a high-level analysis of the hazards in a selected NextGen Operational Improvement (OI) (i.e., OI-0349 Automation Support for Separation Management)
  - Performed a high-level analysis of how hazards can result from the highly dynamic complexity involved in a scenario of that OI

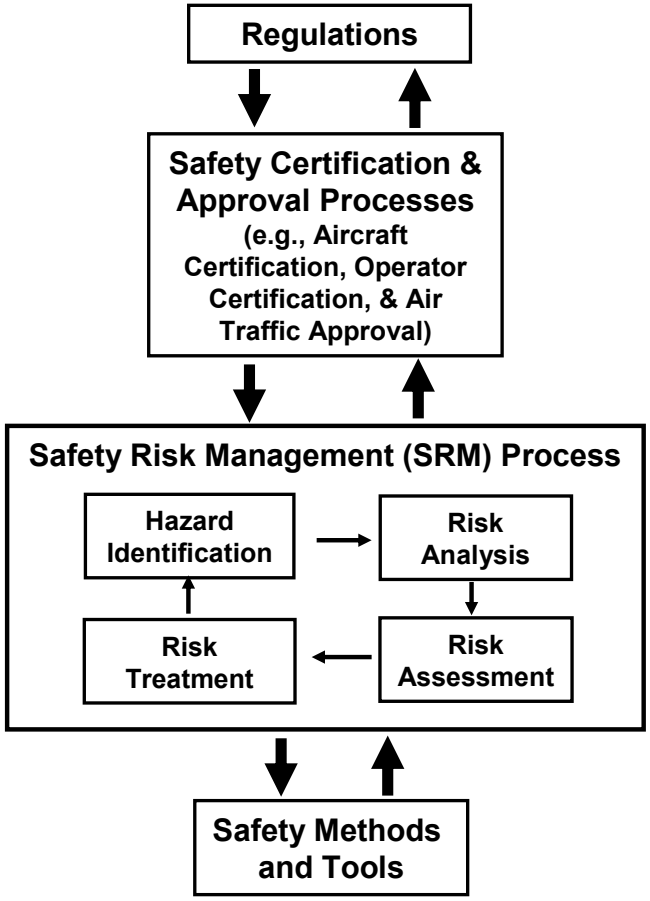


JPDO (2010, p. 5)



STAMP-Related Analysis for NextGen Safety (2/2)

- **The BR&T AOE group also analyzed whether a selected but representative set of the existing safety methods, tools, processes, and regulations are sufficient to assess safety of OI-0349 and ensure that safety will not be compromised.**
  - Adopted a control-theoretical view of the relationship among the methods, tools, processes, and regulations
  - Used STAMP control structure as the framework for the analysis



Relationship among Safety Methods, Tools, Processes, & Regulations (Xu et al., 2013, Figure 9, p. 23)

References

- Joint Planning and Development Office (JPDO). (2010). *Concept of Operations for the Next Generation Air Transportation System* (Version 3.2). Washington, DC: JPDO. http://jpe.jpdo.gov/ee/docs/conops/NextGen_ConOps_v3_2.pdf
- Leveson, N. G. (2011). *Engineering a safer world: System thinking applied to safety.* MIT Press. http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12662
- Xu, X., Ulrey, M. L., Brown, J. A., Mast, J., & Lapis, M. B. (2013). *Safety sufficiency for NextGen: Assessment of selected existing safety methods, tools, processes, and regulations.* Hampton, VA: NASA Langley Research Center. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20130010405.pdf