NAVAL POSTGRADUATE SCHOOL

Transitioning to Autonomy: A Human Systems Integration Perspective

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Greetings from NPS and Monterey, CA

My Plan

A Few Definitions

The Big Picture

A Tale of What Not to Do in System Acquisition

System Design and Acquisition in the DoD

The Role of Human Systems Integration (HSI) in the Acquisition Process

The Role of HSI in the Design and Development of an Autonomous Civil Aviation System

Definitions

Futurist: One who engages in interdisciplinary and systems thinking to advise private and public organizations on such matters as diverse global trends, possible scenarios, emerging market opportunities and risk management.

Soothsayer: One who predicts the future, using magic, intuition or intelligence; a diviner.

Fortuneteller: An individual who predicts information about a person's life.

Psychic: A person who claims to use extrasensory perception (ESP) to identify information hidden from the normal senses.

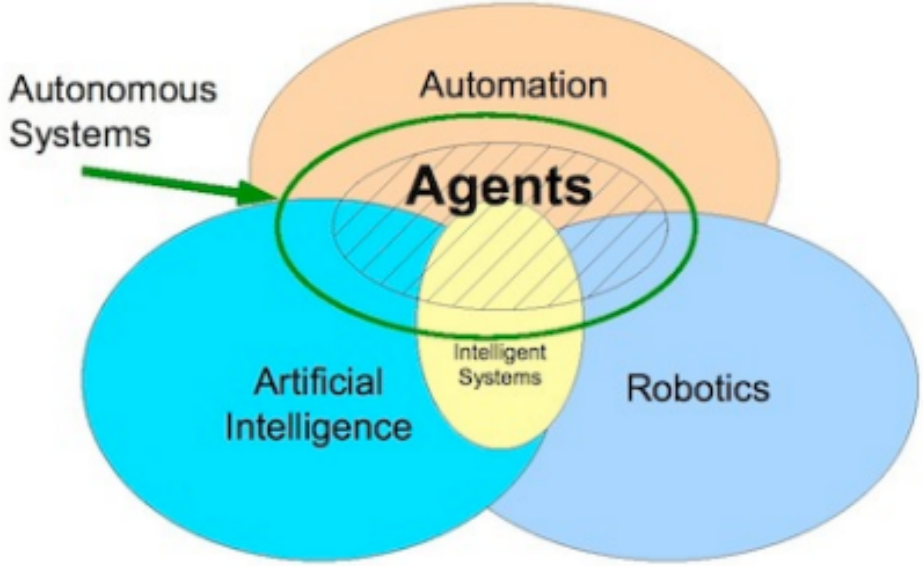
Prophet: An individual who is claimed to have been contacted by the supernatural or the divine, and to speak for them, delivering this newfound knowledge to other people.

IHMC Definitions

ihmc
FLORIDA INSTITUTE FOR HUMAN & MACHINE COGNITION

Definitions: intelligent system, autonomy, automation, robots, and agents

<- BACK



IHMC Definitions

Artificial Intelligence (AI): is the ability of a system to act appropriately in an uncertain environment, where an appropriate action is that which increases the probability of success, and success is the achievement of behavioral sub- goals that support the system's ultimate goal.

Intelligent System - An application of AI to a particular problem domain. Usually very specialized -- not "general intelligence". **State of the Art**: *Not as broadly competent as people and lack common sense.*

- In some domains machine intelligence equals all but the most skilled humans; in a few areas they excel above all.
- Taking on tasks once thought only do-able by humans.
- Accomplishing tasks no human can perform without their help.
- Their complexity makes it nearly impossible for anyone but an expert to understand them, and that is becoming increasingly difficult as intelligent systems gain the ability to learn.

Autonomy: The ability of an intelligent system to independently compose and select among different courses of action to accomplish goals based on its knowledge and understanding of the world, itself, and the situation.

IHMC Definitions

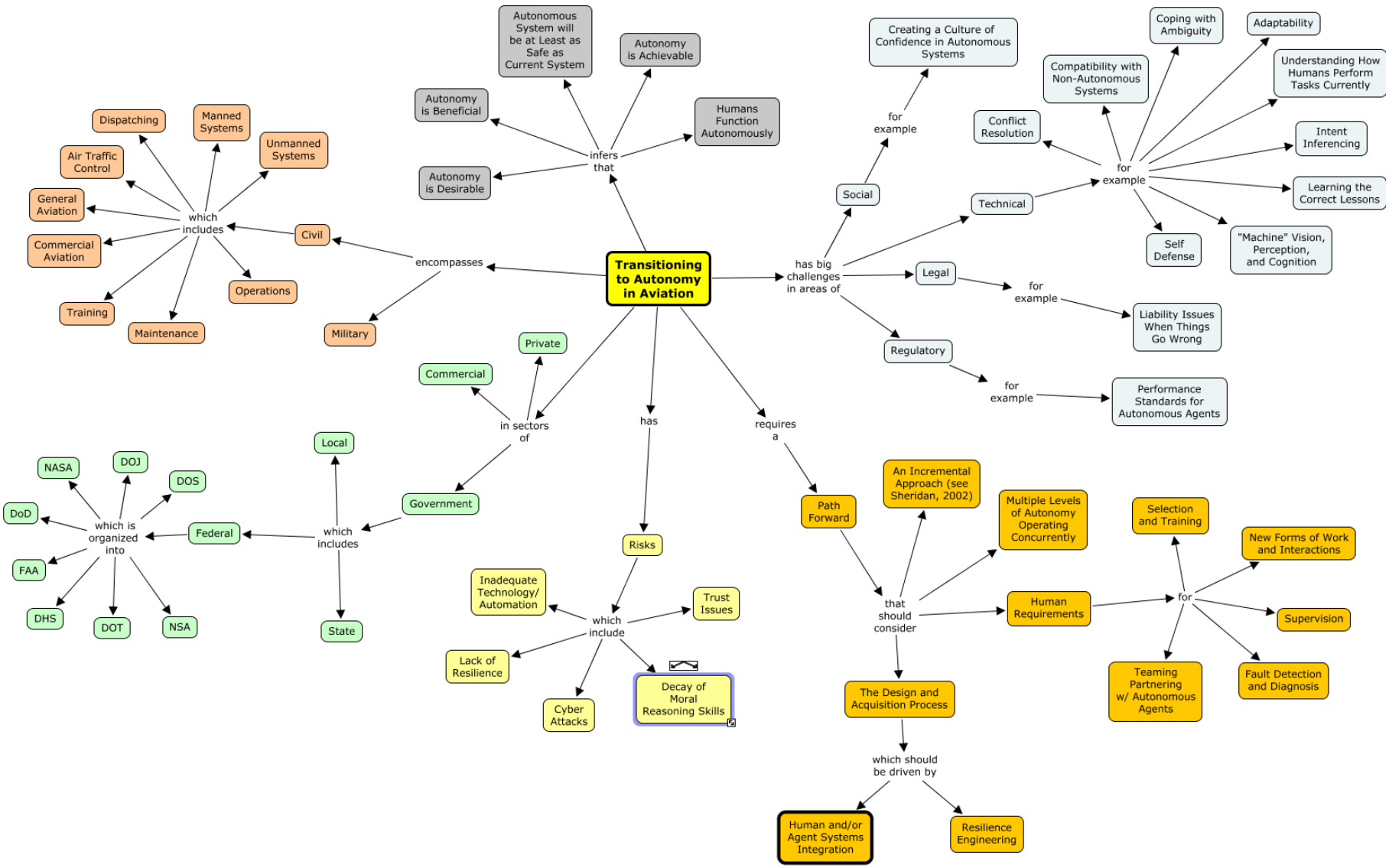
Robotics focuses on systems incorporating sensors and actuators that operate autonomously or semi-autonomously in cooperation with humans. Robotics research emphasizes *intelligence* and *adaptability* to cope with **unstructured** environments.

Automation emphasizes efficiency, productivity, quality, and reliability, focusing on systems that operate without direct control, often in **structured** environments over extended periods, and on the explicit structuring of such environments.

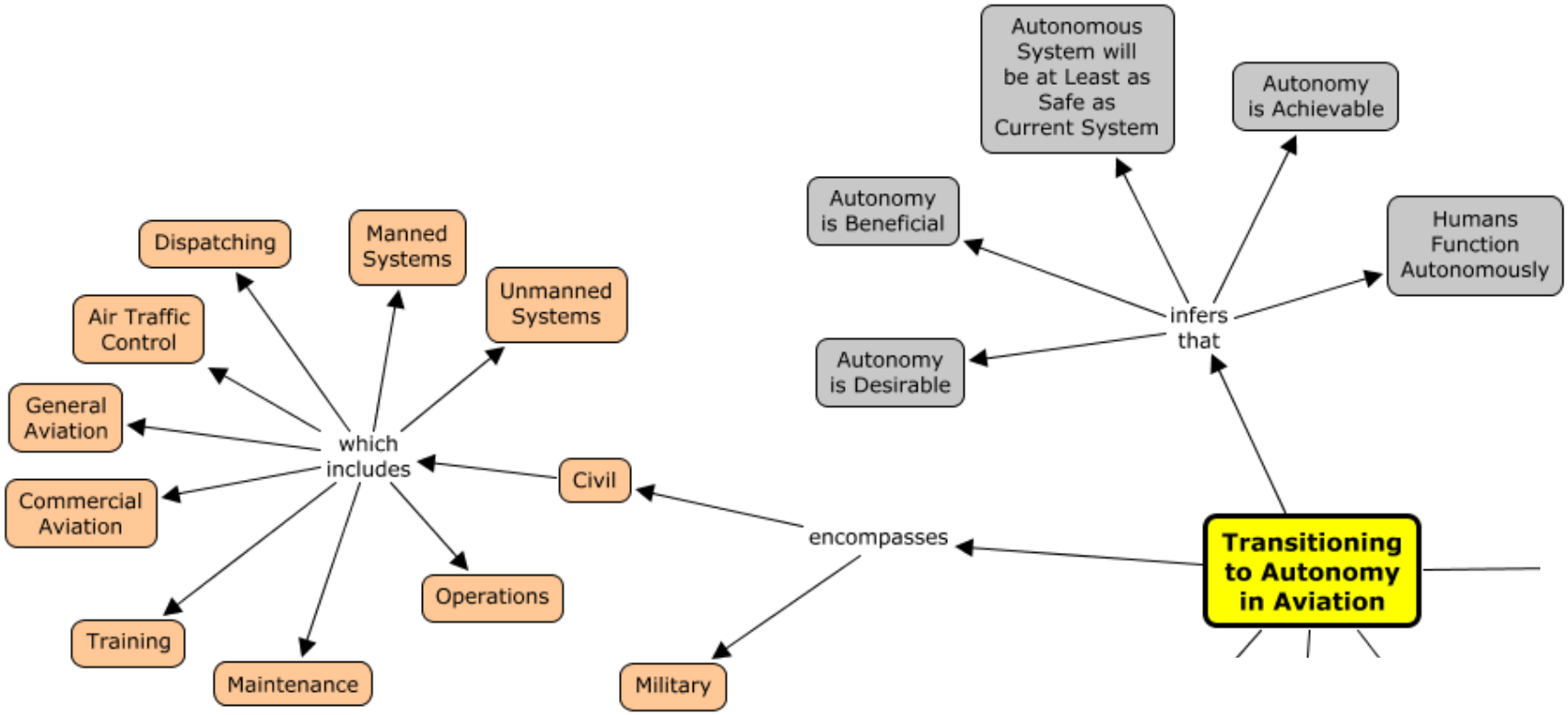
Agent: A self-activating, self-sufficient and persistent computation:

- May be an intelligent system.
- May include significant automation.
- Is capable of modifying the manner in which it achieves objectives (fulfills purpose).
- May reside and act entirely in the cyber world, or be embodied in a device such as a robot.

The Big Picture



The Big Picture



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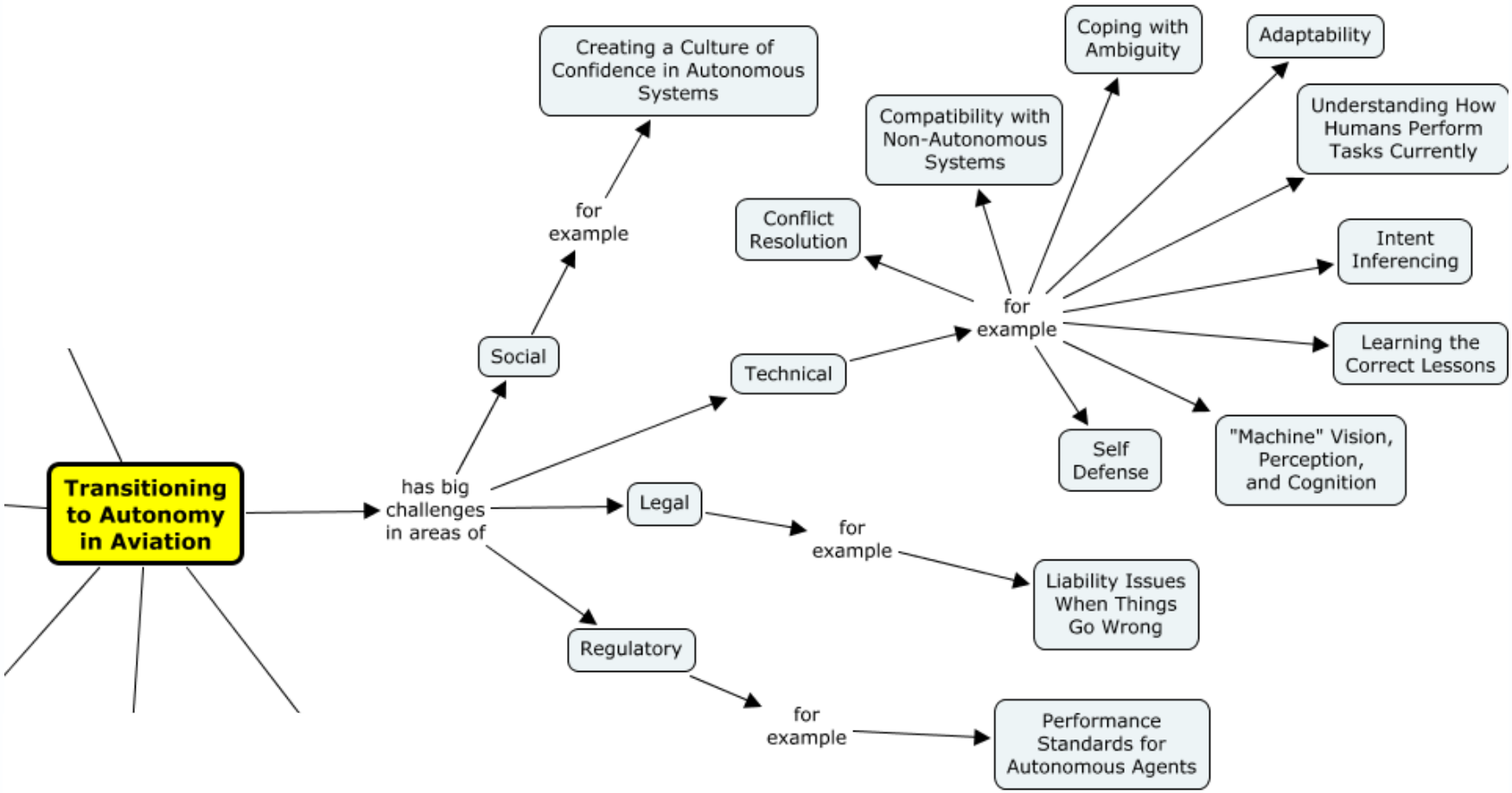

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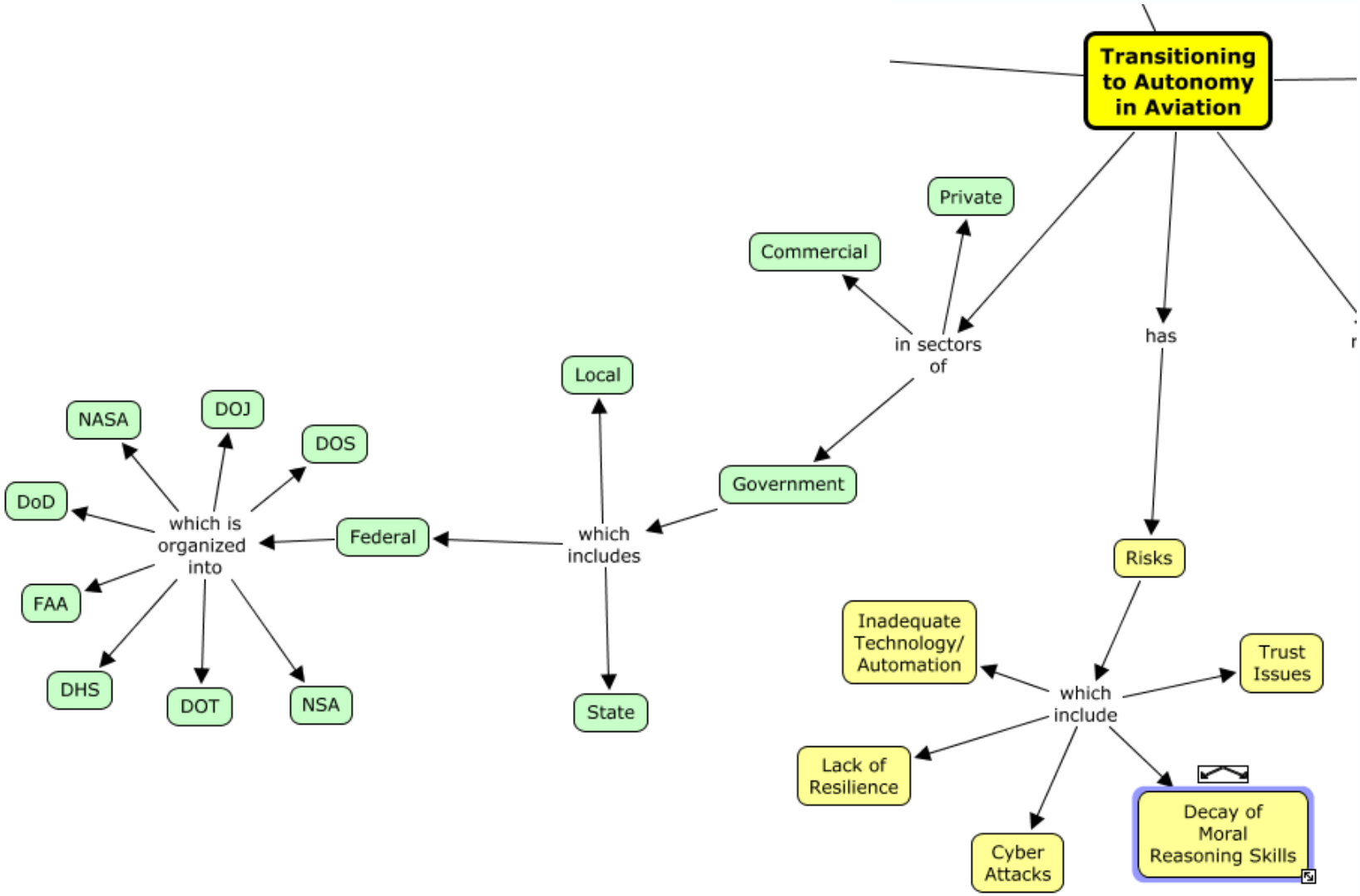
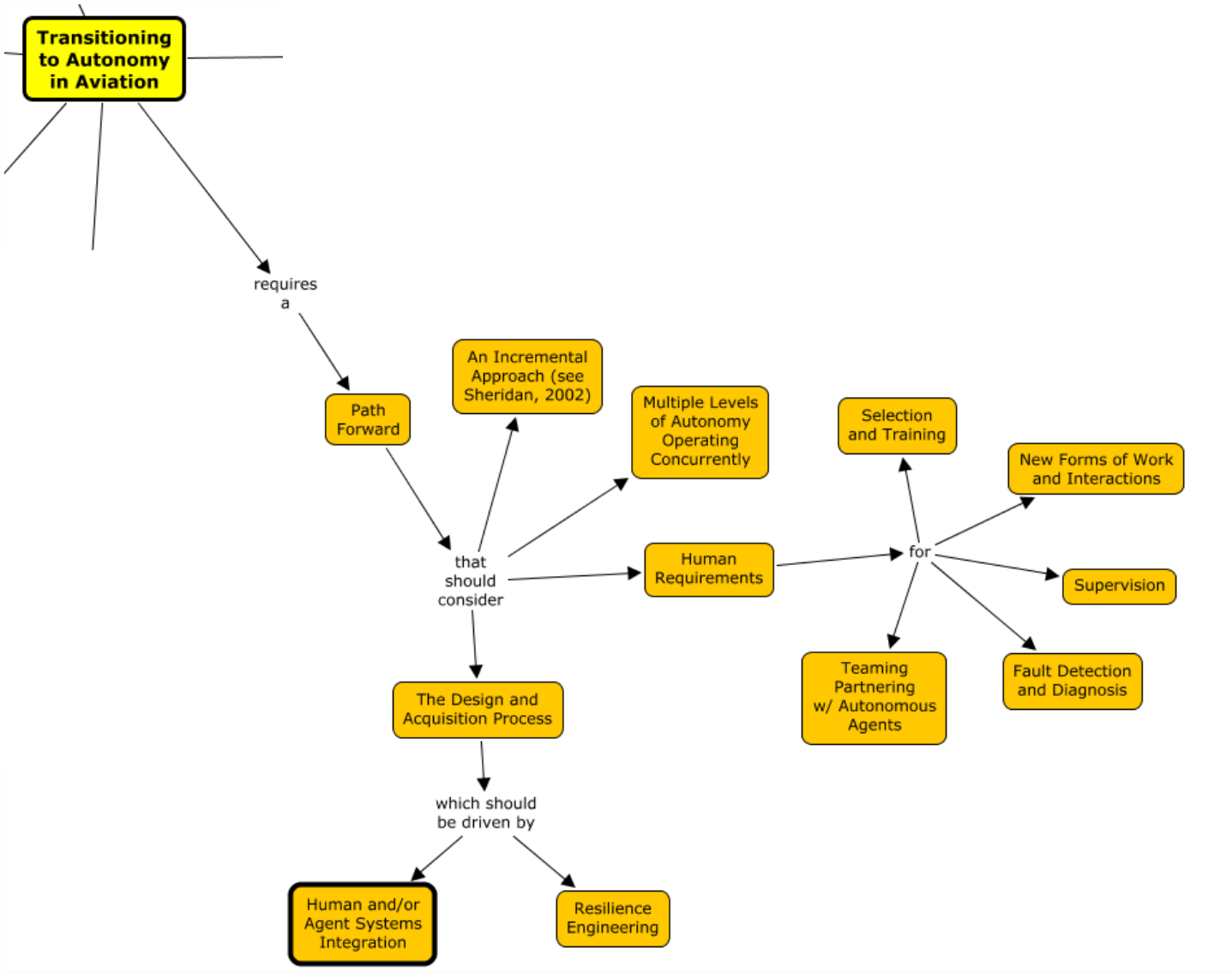


The Big Picture



A Tale of What Not to Do in System Acquisition

A military service determines it needs an additional capability to counter an asymmetric threat.

A conscious decision is made to reduce manpower to the greatest extent possible.

Sophisticated automation will compensate for the reduced manpower.

Two defense companies are given contracts to develop prototypes.

At MS B, a decision was made not to down-select to one system.

Both companies were contracted to develop the operational systems.

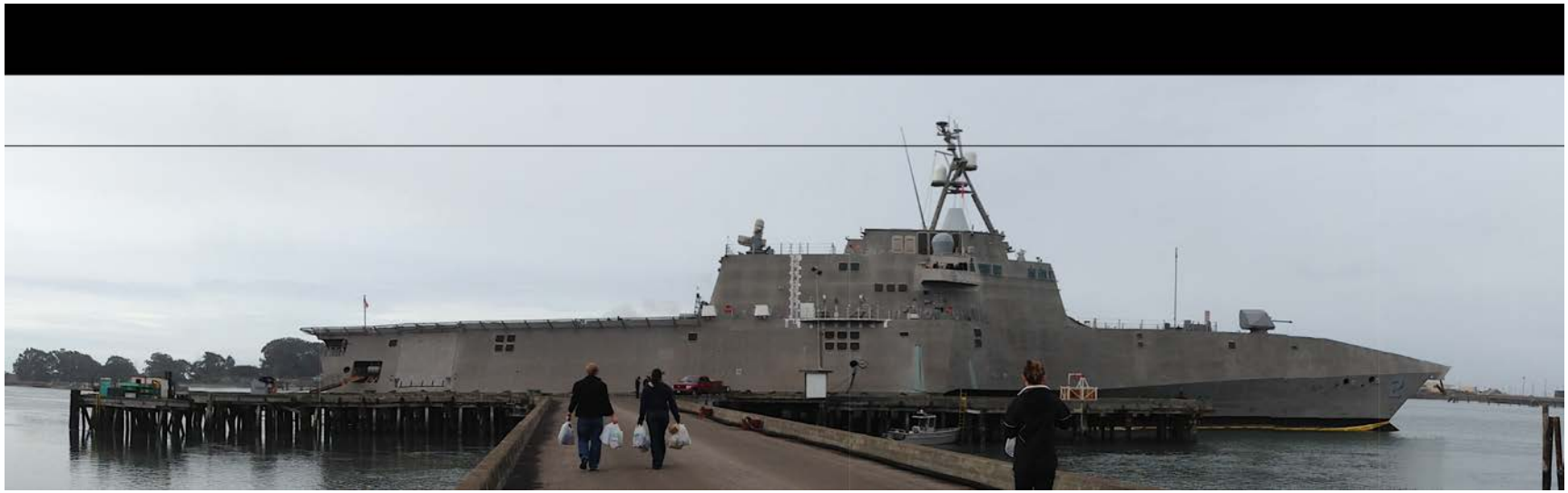
Huge cost overruns for both productions costs and annual operating costs.

A Tale of What Not to Do in System Acquisition

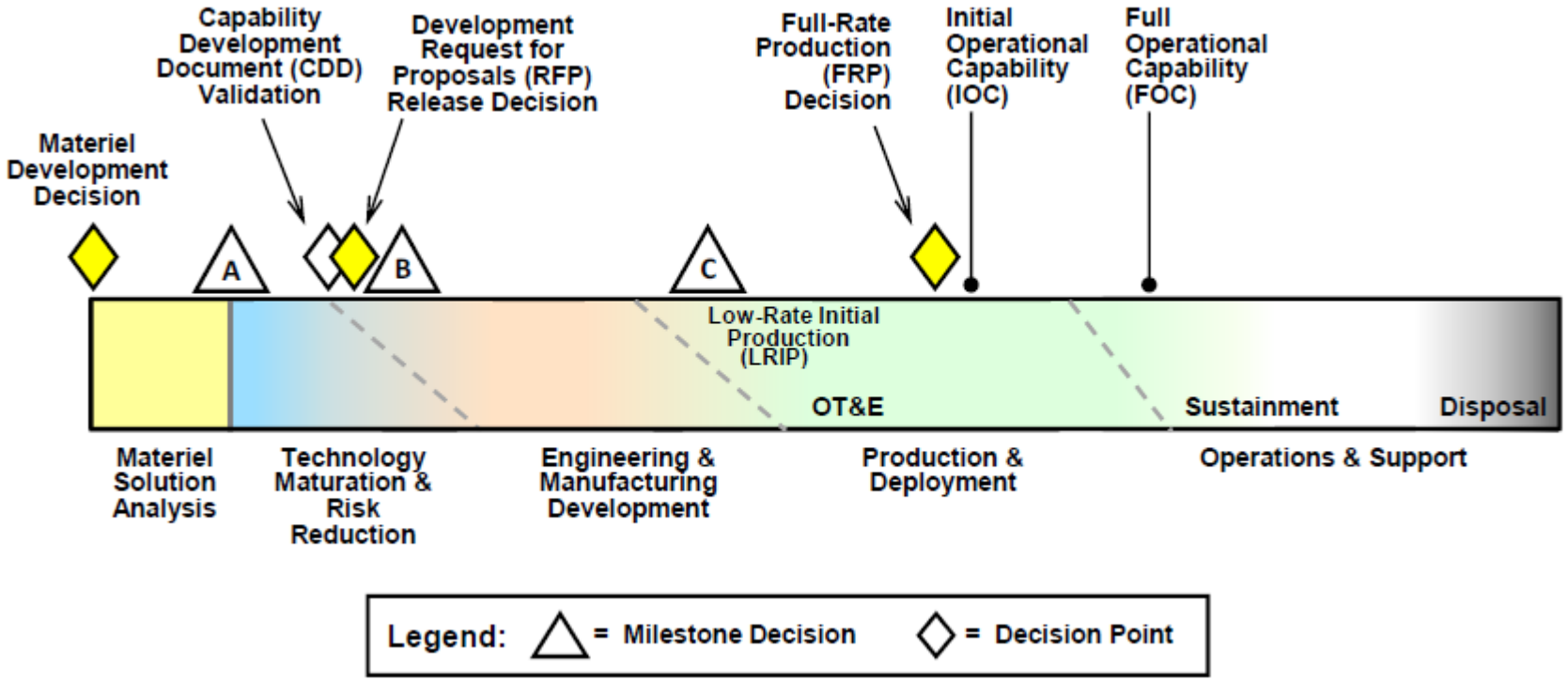
The result:

- The service gambled on technology (automation) and lost. **(Poor tradeoff)**
- System was undermanned by 50%. **(Manpower)**
- Workload and fatigue levels for personnel much higher than anticipated. **(HFE and Safety)**
- System will require an expensive retrofit to accommodate additional personnel. **(Habitability)**
- Systems require different training pipelines. **(Training)**
- Negative transfer of training from one system to the other. **(Training)**
- Service members must be at least an E-5 to be assigned to the system. **(Personnel)**

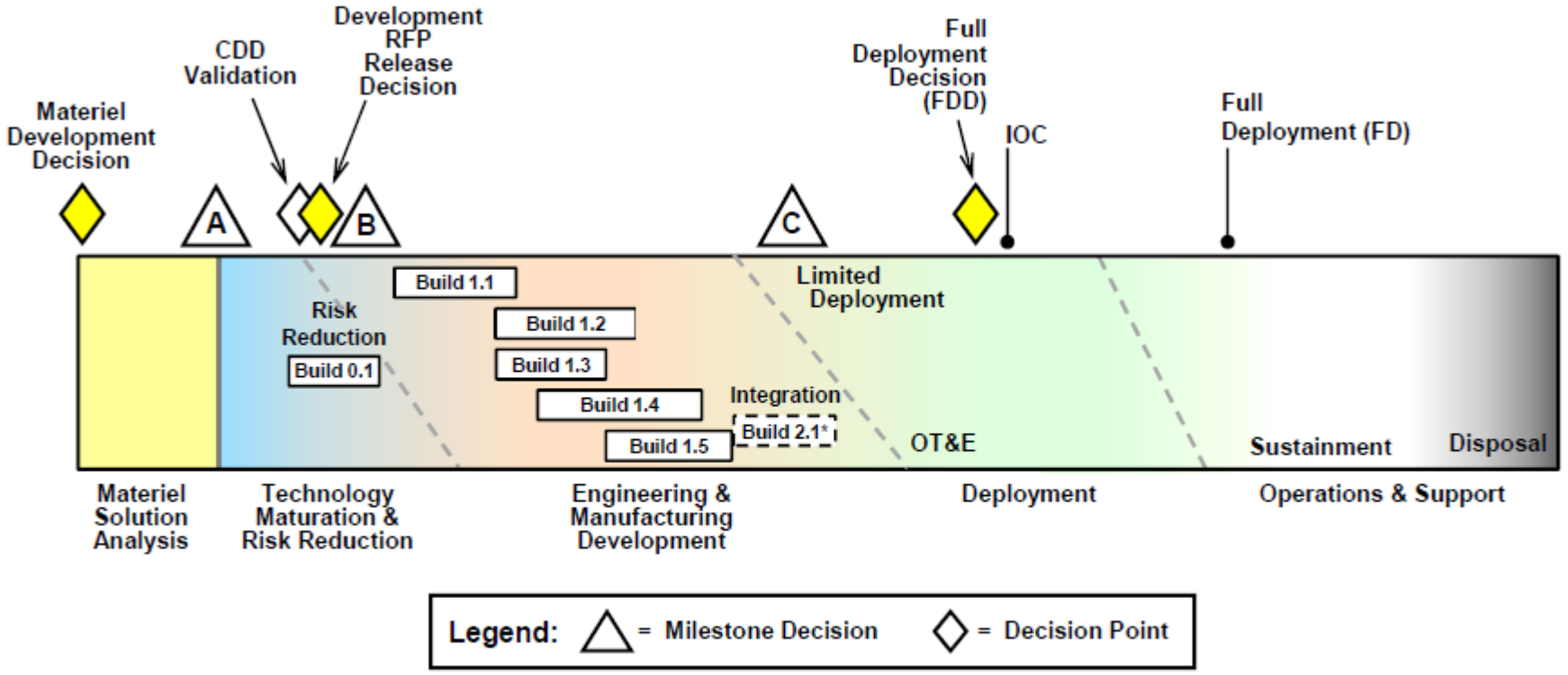
A Tale of What Not to Do in System Acquisition
(Littoral Combat Ship)



System Design and Acquisition in the DoD (Hardware)



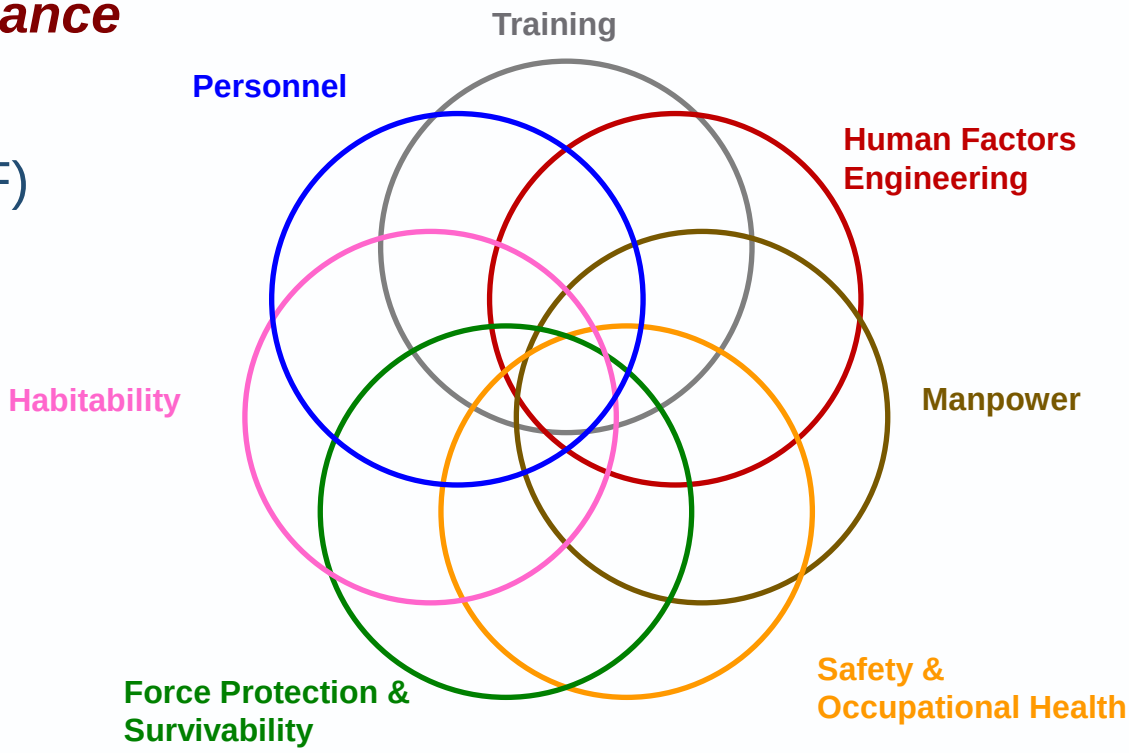
System Design and Acquisition in the DoD (Software)



* The actual number and type of builds during the program will depend on system type.

The Role of HSI in the Acquisition Process HSI Definition)

Human Systems Integration (HSI) acknowledges that the human is a critical component in any complex system. It is an ***interdisciplinary*** approach that makes explicit the ***underlying tradeoffs*** across the HSI domains, facilitating optimization of ***total system performance*** in both materiel and non-materiel (DOTLPF) solutions to address the capability needs of organizations.



The Role of HSI in the Acquisition Process

Program Manager will plan for and implement HSI:

- Beginning early in the acquisition process
- Throughout the product life cycle.

The goal is to:

- Optimize total system performance and total ownership costs
- Ensure the system is designed, operated, and maintained:
- Effectively provide users with the ability to complete their mission.

Program Manager will ensure HSI is considered at each milestone during program life cycle.

The Role of HSI in the Acquisition Process

1 – Legacy System

2 – Capability Based Assessment

3 – Analysis of Alternatives

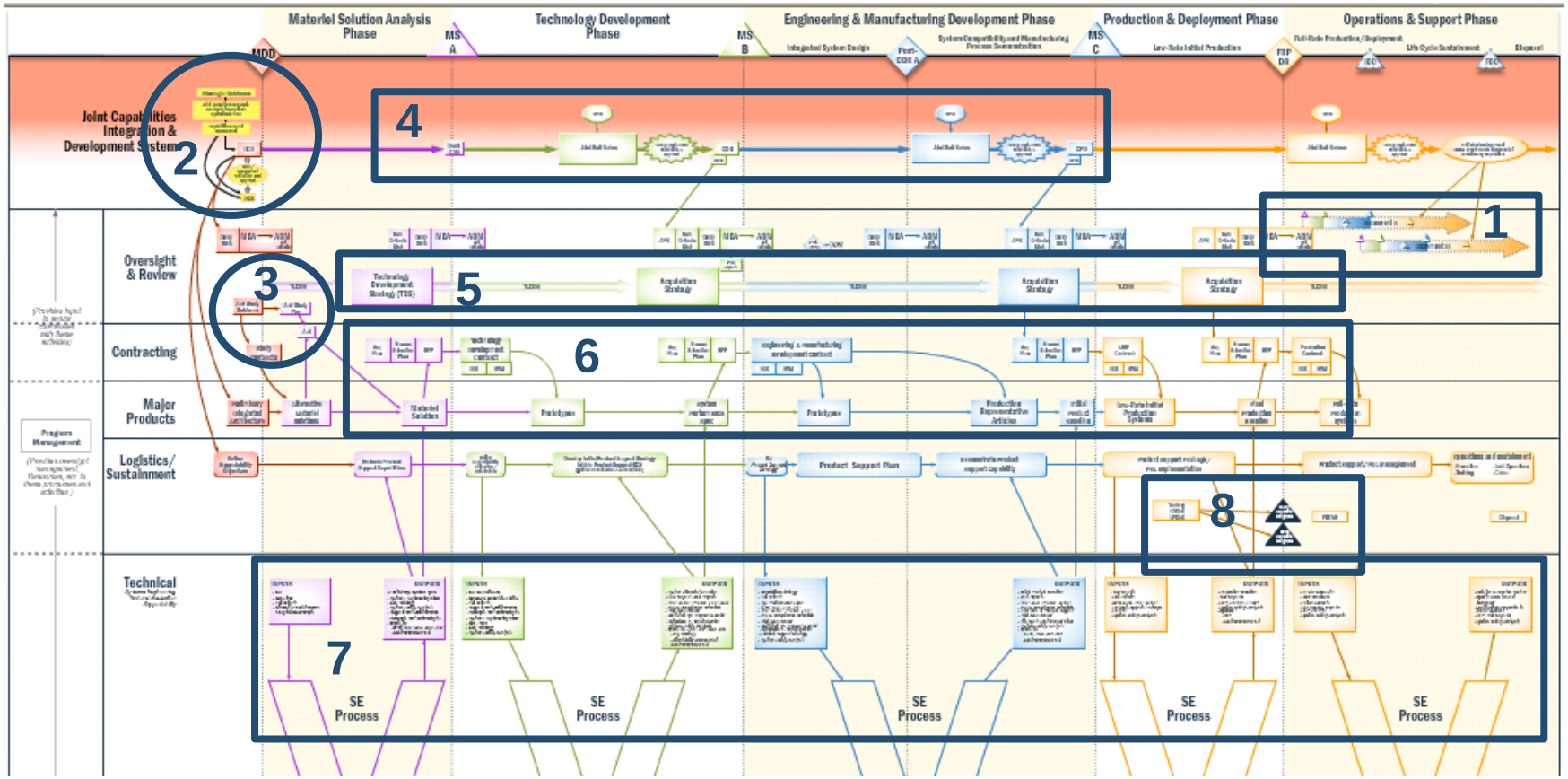
4 – CDD and KPPs

5 – Acquisition Strategy

6 – Source Selection and RFP

7 – Systems Engineering Process

8 – Test & Evaluation



The Role of HSI in the Design and Development of an Autonomous Civil Aviation System (Six Premises)

1. Humans have capabilities and limitations (C&L); technology offers affordances and constraints (A&C).
   - C&L and A&C are two sides of the same coin.
   - C&L bound what the human can do.
   - A&C bound what can be done with the technological system.
   - Human C&L encompass (at a minimum) the domains of M, P, T, and HFE.

2. Total system performance is enhanced when the *technology A&C* map well to *human C&L*. This mapping happens within the acquisition process.

3. *Human C&L* are variable within a specific range and measureable for a given subset of the population. *Technology A&C* have more degrees of freedom, especially early in the acquisition process.

The Role of HSI in the Design and Development of an Autonomous Civil Aviation System (Six Premises)

4. The mapping of *technology A&C* to *human C&L* will ebb and flow throughout the acquisition process. The mapping can be close at one point but a bad decision could result in a gap later in the process.

5. Those who design and build the technological systems must ensure that the *technology A&C* map well to *human C&L*.

6. The assessment of HSI in an acquisition process should be based on empirical data that evaluate the extent to which *human C&L* are mapped appropriately to *technology A&C* to enhance total system performance.

Human Systems Integration (HSI)

Agent Systems Integration (ASI)

Human Agent Systems Integration (HASI)

HSI

Manpower

Personnel

Training

HFE

Safety &
Occ Health

Force Protection
& Survivability

Habitability

The Role of HSI in the Design and Development of an Autonomous Civil Aviation System

1. Humans and agents have capabilities and limitations (C&L); technology offers affordances and constraints (A&C).
   - C&L and A&C are two sides of the same coin.
   - C&L bound what the human and agent can do.
   - A&C bound what can be done with the technological system.
   - Human and agent C&L encompass (at a minimum) the domains of Manpower/# of Agents; Personnel/Agent Attributes; Training/Programming and Learning; and, HFE/Agent-Centered Design.

2. Total system performance is enhanced when the *technology A&C* map well to *human and agent C&L*. This mapping happens within the acquisition process.

3. *Human C&L* are variable within a specific range and measureable for a given subset of the population. *Agent C&L* will be less variable than human C&L. *Technology A&C* and *agent C & L* have more degrees of freedom, especially early in the acquisition process.

4. The mapping of *technology A&C* to *human and agent C&L* will ebb and flow throughout the acquisition process. The mapping can be close at one point but a bad decision could result in a gap later in the process.

5. Those who design and build the technological systems must ensure that the *technology A&C* map well to *human and agent C&L*.

6. The assessment of HSI, ASI, or HASI in an acquisition process should be based on empirical data that evaluate the extent to which *human and agent C&L* are mapped appropriately to *technology A&C* to enhance total system performance.

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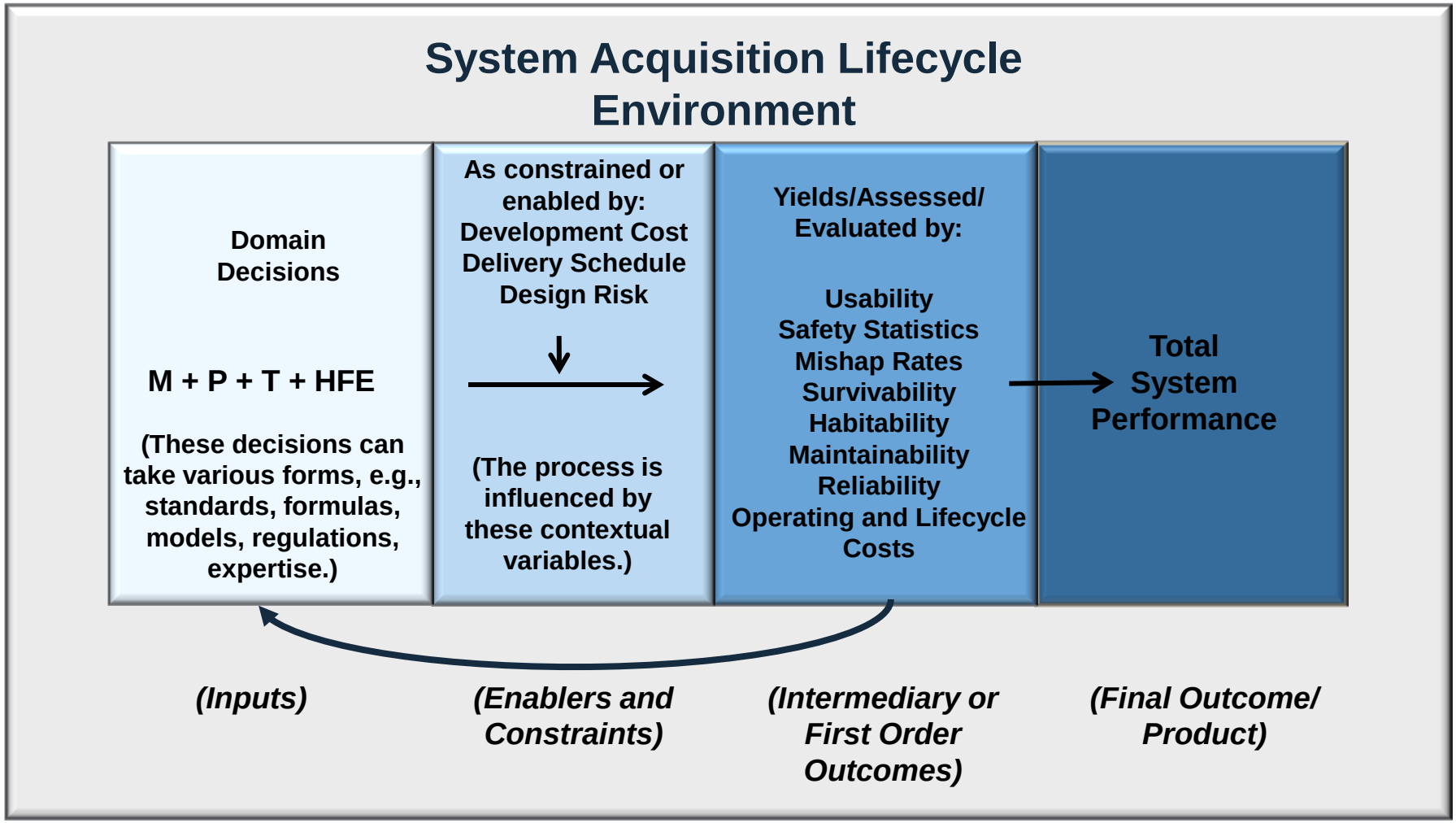
The Role of HSI in the Acquisition Process (HSI Model)



Miller & Shattuck, 2008