# Written in Blood

## Case Studies on Systems Engineering Failure
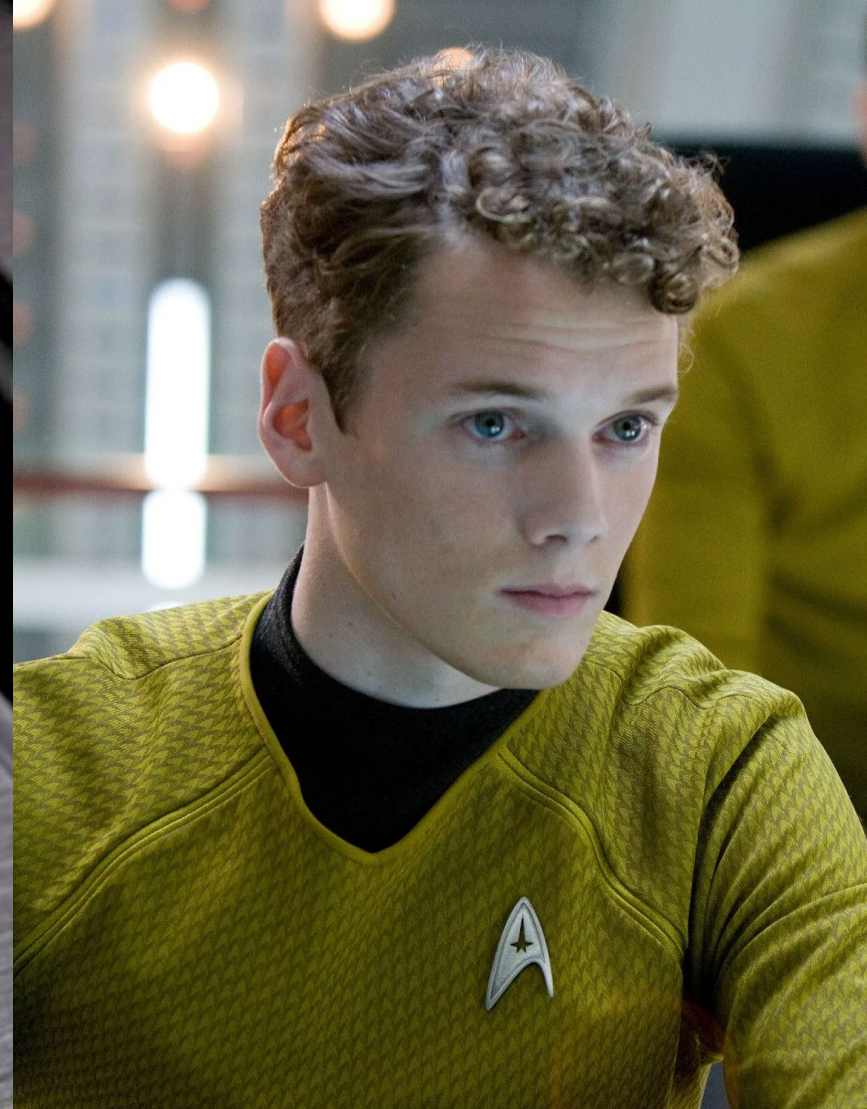
Benjamin Schwartz
Monterey Technologies, Inc.

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TECHNOLOGIES, INC.

# USS *McCain* Collision

- Confluence of design, training, and operational deficiencies

- Lack of trust in automation

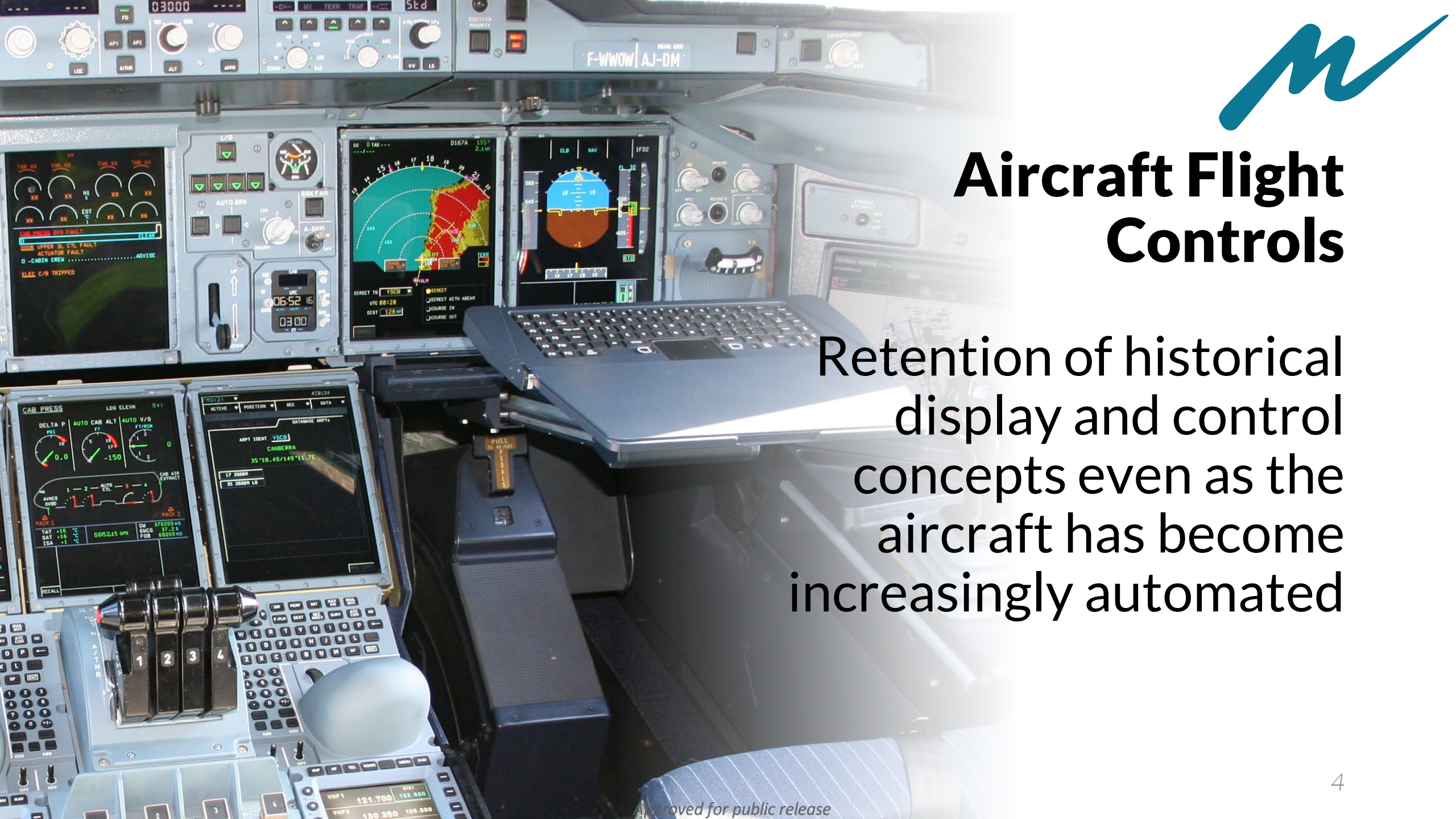- Confusing controls that didn't retain functionality of traditional physical controls

# Chekov's Gear Shifter

# Aircraft Flight Controls

Retention of historical display and control concepts even as the aircraft has become increasingly automated

**But also, Air France Flight 447**

Paradox of automation

*"We're going to crash! This can't be true. But what's happening?"*

# Lessons for Systems Engineering

$$\text{System Performance} = \text{Human Performance} \times \text{Technology Performance}$$
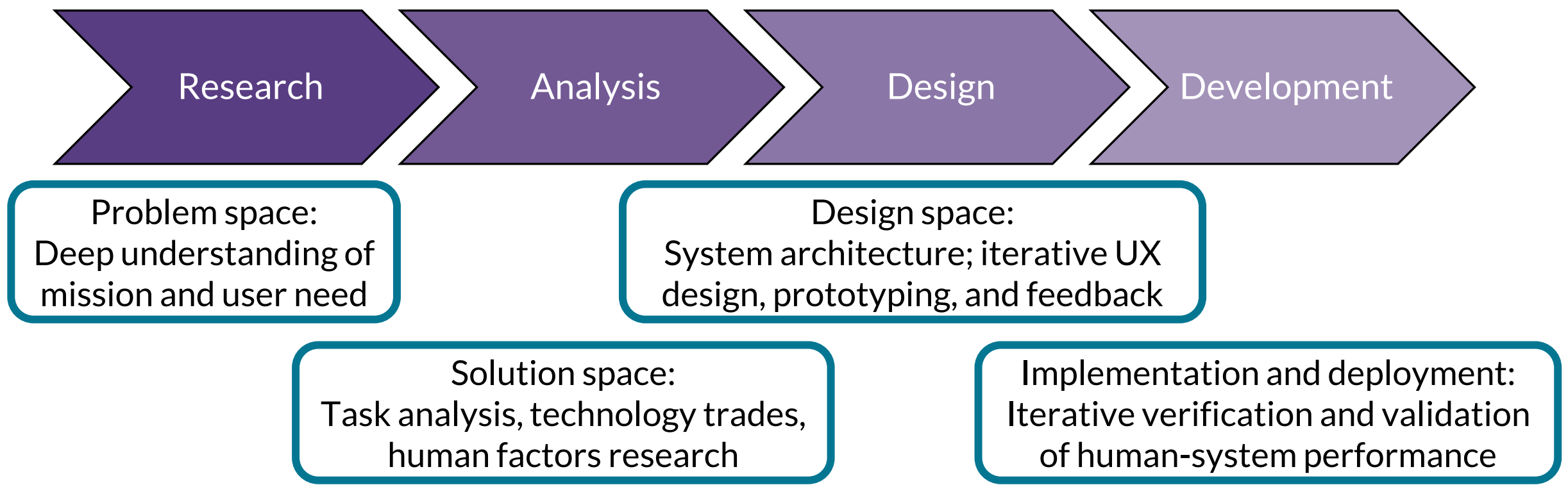
# Challenges from Complexity

- Increasing system complexity is outpacing our ability to characterize complexity and emergent behavior

- Human-system interfaces are a leading contributor to development risk and operational failures

- Increasing pace of decision-making and operations compounds interface deficiencies

# Human-Centered Approaches

Drive Agile SE processes to meet stakeholder and mission needs

Research → Analysis → Design → Development

**Problem space:**
Deep understanding of mission and user need

**Solution space:**
Task analysis, technology trades, human factors research

**Design space:**
System architecture; iterative UX design, prototyping, and feedback

**Implementation and deployment:**
Iterative verification and validation of human-system performance

# Opportunities with AI

| FULLY HUMAN | HUMANS WITH AI/ML TOOLS | COLLABORATIVE AUTONOMY | AUTONOMOUS TEAMMATE | "FULLY AUTONOMOUS" |
|---|---|---|---|---|

HUMAN IN THE LOOP          HUMAN ON THE LOOP

## Critical elements of AI/ML success

- CONOPS and Workflow Analysis
- Calibrated Trust
- Explainable AI
- Sensemaking and Reasoning
- Mission Command

## HUMAN-CENTERED ENGINEERING DRIVES AI/ML PERFORMANCE

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# Recommendations

**Adding human-centered design in SE is easy:**

- Work from first principles, always

- Model user workflows, then ask "*how might we…?*"

- Evolutionary *vs.* revolutionary technology

- Thoughtfulness is next to godliness

> CREATE FOR THE USER AND THE SYSTEM WILL BE SUCCESSFUL

"There is a tendency of designers to add automation **based on economic benefits** (e.g., reducing manning, consolidating discrete controls, using networked systems to manage obsolescence), **without considering the effect to operators** who are trained and proficient in operating legacy equipment."

— US Navy report on the *McCain* collision

MontereyTechnologies.com                    LinkedIn.com/in/BNSchwartz

bschwartz@mti-inc.com

*Approved for public release*

# Why User-Centered Design Fails

- Market forces can be positive or negative
- No scope or enforcement
- Lack of vision, alignment, leadership support

# Abstract

Danger and risk surrounds us, in our daily lives and in military contexts. For example, in August 2017, USS *McCain* collided with *Alnic MC* in the busy Singapore Strait. Ten Sailors died and dozens more were injured. The cause was identified, in part, as defective systems engineering in the design of the bridge system. This session explores case studies of systems design failure and success. Learn from the experiences of others to continue to mature highly-effective systems engineering practice, especially as artificial intelligence and other advanced technologies transform system design. We'll emphasize the creation of operationally-effective solutions that minimize the likelihood of serious injury and death for our Warfighters.

# Speaker Bio

Benjamin Schwartz is the Vice President of Human-Centered Systems Engineering at Monterey Technologies, Inc. (MTI), a small business focused on solutions for defense and federal government systems. In this role, Ben leads a team of subject matter experts in cognitive psychology, human factors engineering, user experience research and design, model-based systems engineering, and human-systems integration.

Ben became interested in human factors at Space Camp, where he was inspired by the challenges of living and working in space. Even daily activities like eating, sleeping, personal hygiene, and moving around must be completely re-engineered for microgravity environments. The realization that an engineer has to keep the human at the center of the design process ignited his passion for designing advanced systems to enhance human performance and mission success. He earned a bachelor's degree in human factors from Tufts University, a master's degree in human systems integration from the Naval Postgraduate School, and an International Council on Systems Engineering (INCOSE) Certified Systems Engineering Professional (CSEP) certification.

Ben has extensive experience in systems engineering for complex defense systems for the Navy, Army, and Air Force and is committed to delivering systems that effectively meet user needs for critical missions. As an advocate for user-centered systems engineering, he ensures that human and mission needs are integrated in the systems engineering process and drive successful operational outcomes. He also writes about defense engineering trends and practices at engineeringforhumans.com. Ben is based in Huntsville, AL.

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