Updates on Human Systems Integration Governance and Responsibilities for Department of Defense

National Defense Industrial Association - Human Systems Division Conference

R. Christopher DeLuca
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Office of the Under Secretary of Defense
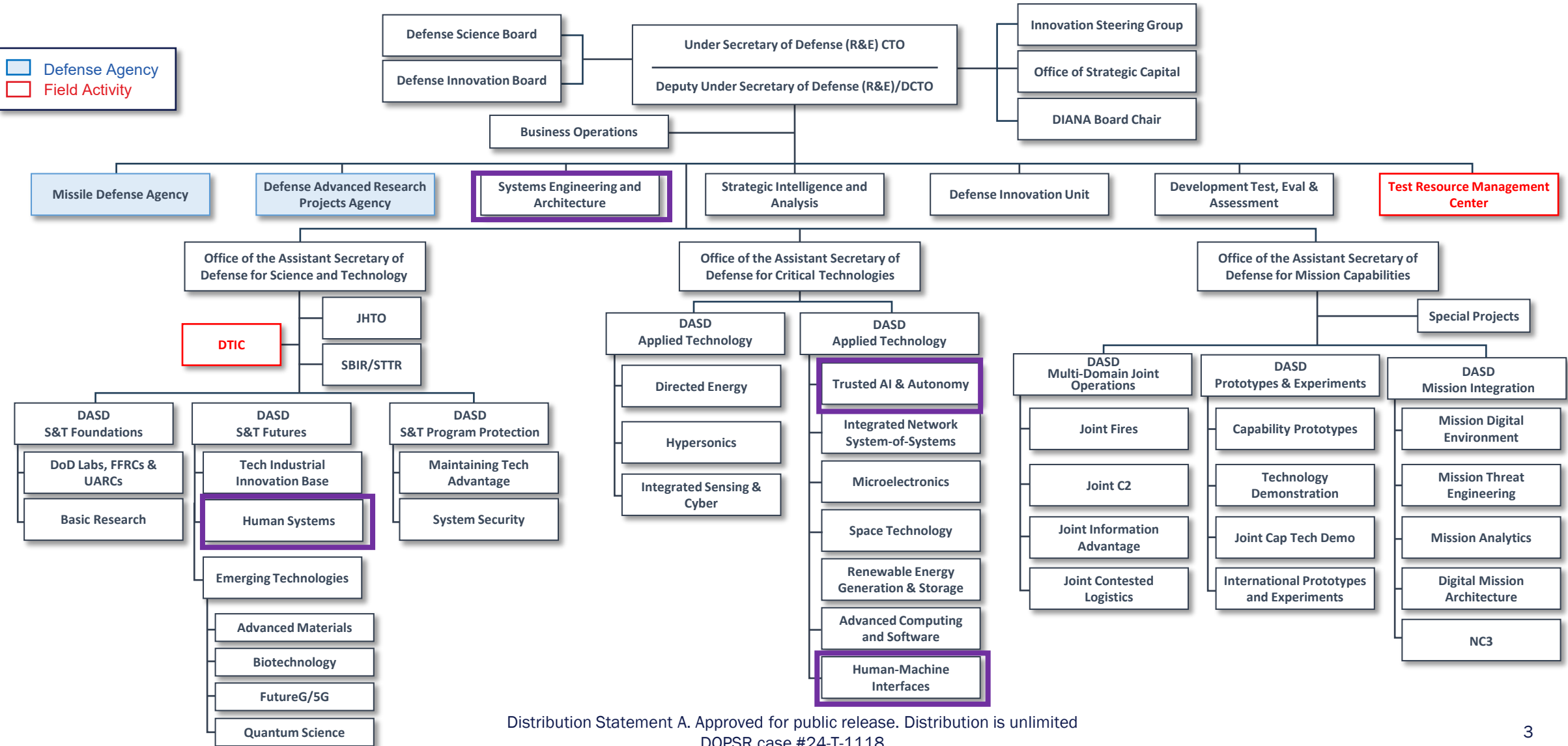for Research and Engineering

Arlington, Virginia
March 2024

Agenda

- Research and Engineering (R&E) and Systems Engineering and Architecture (SE&A) Overview

- HSI Policy Requirements and Guidance

- HSI Governance and Capabilities-Based Assessment (CBA) Overview

- Upcoming HSI Challenges

- Path Ahead

OUSD(R&E) ORGANIZATIONAL STRUCTURE

Legend:
- Defense Agency (blue box)
- Field Activity (red box)

Defense Science Board

Defense Innovation Board

Under Secretary of Defense (R&E) CTO

Deputy Under Secretary of Defense (R&E)/DCTO

Innovation Steering Group

Office of Strategic Capital

DIANA Board Chair

Business Operations

Top-level offices:
- **Missile Defense Agency**
- **Defense Advanced Research Projects Agency**
- **Systems Engineering and Architecture**
- **Strategic Intelligence and Analysis**
- **Defense Innovation Unit**
- **Development Test, Eval & Assessment**
- **Test Resource Management Center**

Office of the Assistant Secretary of Defense for Science and Technology

- **JHTO**
- **DTIC**
- **SBIR/STTR**

DASD S&T Foundations
- DoD Labs, FFRCs & UARCs
- Basic Research

DASD S&T Futures
- Tech Industrial Innovation Base
- Human Systems
- Emerging Technologies
  - Advanced Materials
  - Biotechnology
  - FutureG/5G
  - Quantum Science

DASD S&T Program Protection
- Maintaining Tech Advantage
- System Security

Office of the Assistant Secretary of Defense for Critical Technologies

DASD Applied Technology
- Directed Energy
- Hypersonics
- Integrated Sensing & Cyber

DASD Applied Technology
- Trusted AI & Autonomy
- Integrated Network System-of-Systems
- Microelectronics
- Space Technology
- Renewable Energy Generation & Storage
- Advanced Computing and Software
- Human-Machine Interfaces

Office of the Assistant Secretary of Defense for Mission Capabilities

- **Special Projects**

DASD Multi-Domain Joint Operations
- Joint Fires
- Joint C2
- Joint Information Advantage
- Joint Contested Logistics

DASD Prototypes & Experiments
- Capability Prototypes
- Technology Demonstration
- Joint Cap Tech Demo
- International Prototypes and Experiments

DASD Mission Integration
- Mission Digital Environment
- Mission Threat Engineering
- Mission Analytics
- Digital Mission Architecture
- NC3

National Security Authorities: Research and Engineering (R&E)

Leaders

Heidi Shyu
Under Secretary of Defense for Research and Engineering

Dr. David A. Honey
Deputy Under Secretary of Defense for Research and Engineering

Authority From

DoDD 5137.02

https://www.esd.whs.mil/DD/

Purpose: Under the authority vested in the Secretary of Defense by Sections 113 and of Title 10, United States Code (U.S.C.), this issuance:
• Establishes the position….of the USD(R&E).
• **Develops** "governing policy and **advances practices** and **workforce competency** for… **human systems integration…**"

Priorities

National Defense Science and Technology Strategy 2023, Section I Focus on the Joint Mission, pg 3

"In 2022 the Department designated these Critical Technology Areas to address the key national security challenges the nation faces, including… **human-machine interfaces**…"

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SE&A Roles and Responsibilities

SE&A: Develops and promotes innovative engineering principles and techniques to advance DoD engineering practice. SE&A develops policy, guidance, standards, and best practice resources; manages DoD Standards; facilitates engineering-related communities of practice; and develops the defense engineering workforce by refining competency models and curricula. SE&A applies engineering and risk management expertise to inform decisions and improve system-of-systems architectures to reduce integration risk in mission-enabling systems.

Policy and Workforce: Leads policy, guidance, and workforce development initiatives for the DoD engineering and technical workforce.

Systems Engineering (SE): Focuses on modernizing SE practice, including using modular open systems approaches to build systems that can be upgraded to incorporate new technology and respond to emerging threats.

Digital Engineering Modeling & Simulation (DEM&S): Focuses on digital engineering transformation and implementation, promoting the use of models and simulations across the DoD life cycle.

Software Engineering (SWE): Promotes Agile/DevSecOps software practices and cross-organizational collaboration to modernize DoD software capability and expertise.

Specialty Engineering (SpE): Focuses on improving delivery of advanced capability to warfighters by modernizing reliability and maintainability, manufacturing and quality, system safety, human systems integration, and value engineering practices.

Defense Standardization Program Office (DSPO): Identifies, develops, and provides access to standardization processes and products for the defense community to promote interoperability, reduce cost, and sustain readiness.

Joint Architecture for Capabilities and Systems (JACS): Promotes system of systems fielded with speed, fidelity, and adaptability to enable continual evolution of U.S. warfighting dominance.

Collaborators: OUSD(R&E) offices, the Services, DOT&E, CIO, CDAO, and OUSD(A&S)

SE&A develops and promotes advanced engineering principles, techniques, and practices to improve Joint Warfighting Capabilities
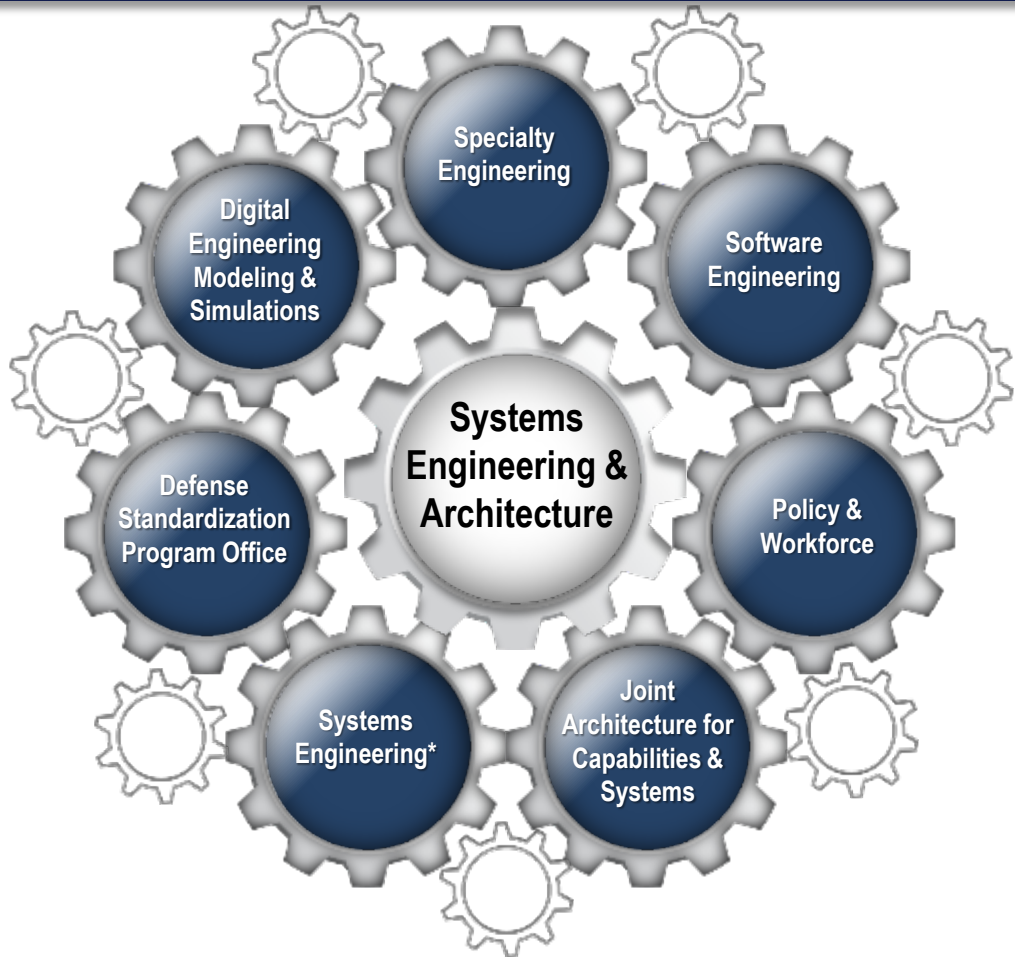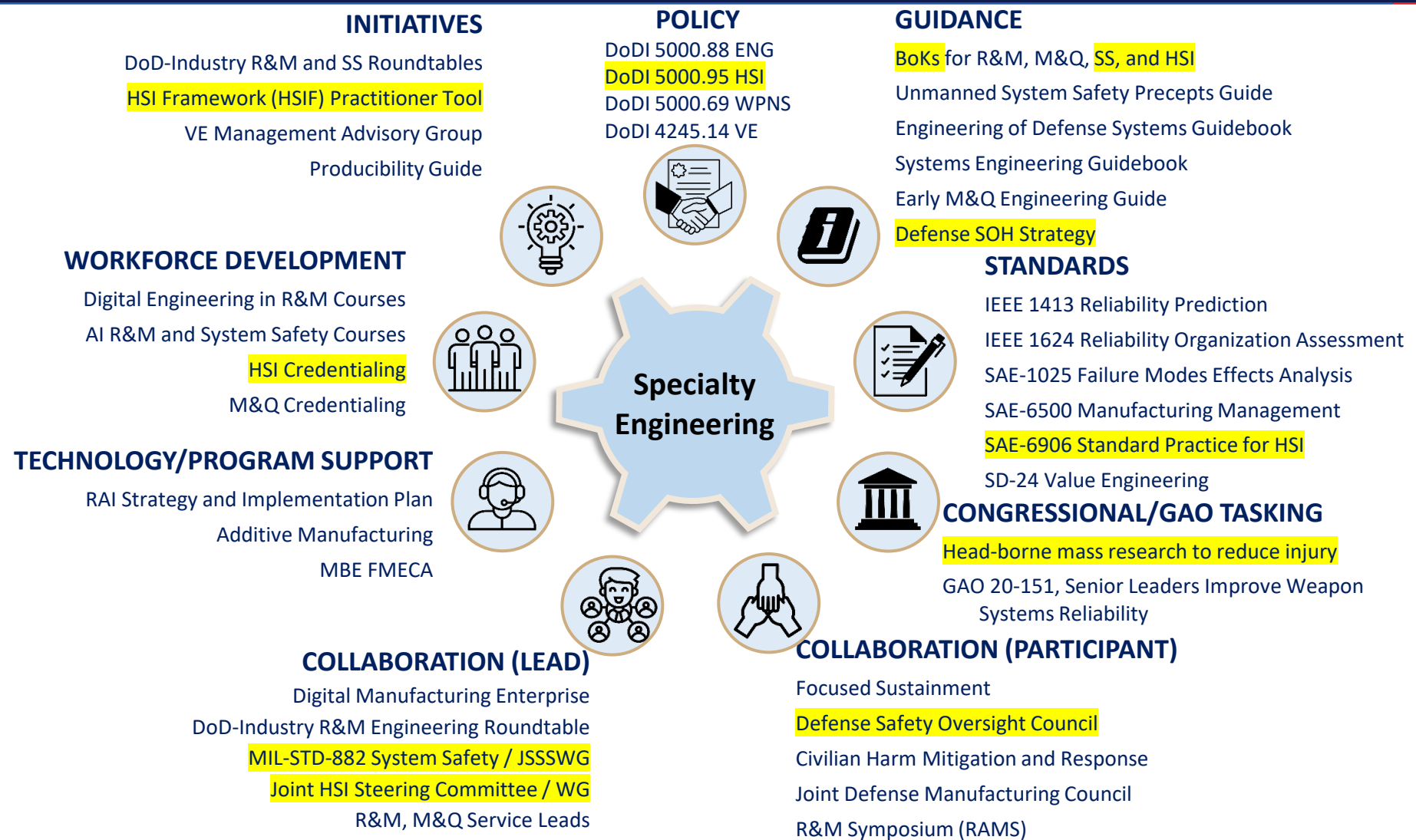

Lines of Effort

1. Advance the Engineering Practice
2. Connect and Strengthen the Technical Community
3. Develop the Workforce
4. Advance and Manage Standards
5. Provide Technical Expertise for Independent Engineering Assessments
6. Provide System of Systems (SoS) Architectures Guidance

*Includes Modular Open Systems Approach (MOSA)

Specialty Engineering at a Glance

INITIATIVES

DoD-Industry R&M and SS Roundtables
HSI Framework (HSIF) Practitioner Tool
VE Management Advisory Group
Producibility Guide

POLICY

DoDI 5000.88 ENG
DoDI 5000.95 HSI
DoDI 5000.69 WPNS
DoDI 4245.14 VE

GUIDANCE

BoKs for R&M, M&Q, SS, and HSI
Unmanned System Safety Precepts Guide
Engineering of Defense Systems Guidebook
Systems Engineering Guidebook
Early M&Q Engineering Guide
Defense SOH Strategy

STANDARDS

IEEE 1413 Reliability Prediction
IEEE 1624 Reliability Organization Assessment
SAE-1025 Failure Modes Effects Analysis
SAE-6500 Manufacturing Management
SAE-6906 Standard Practice for HSI
SD-24 Value Engineering

WORKFORCE DEVELOPMENT

Digital Engineering in R&M Courses
AI R&M and System Safety Courses
HSI Credentialing
M&Q Credentialing

TECHNOLOGY/PROGRAM SUPPORT

RAI Strategy and Implementation Plan
Additive Manufacturing
MBE FMECA

CONGRESSIONAL/GAO TASKING

Head-borne mass research to reduce injury
GAO 20-151, Senior Leaders Improve Weapon Systems Reliability

COLLABORATION (LEAD)

Digital Manufacturing Enterprise
DoD-Industry R&M Engineering Roundtable
MIL-STD-882 System Safety / JSSSWG
Joint HSI Steering Committee / WG
R&M, M&Q Service Leads

COLLABORATION (PARTICIPANT)

Focused Sustainment
Defense Safety Oversight Council
Civilian Harm Mitigation and Response
Joint Defense Manufacturing Council
R&M Symposium (RAMS)

Specialty Engineering

Specialty Engineering
System Safety Activity Focus Areas

Policy, Standards & Guidance

- DoD Manual 5000.69 and Safety Data Package- Joint Weapon SS Review Process
- Unmanned Systems Safety Engineering Precepts for Acquisition Manual
- MIL-STD-882E Update:
  - w/ CHANGE-1 - Civilian Harm Mitigation and Response
  - Gaps and Priority Assessment
  - Use of Non Government Standards (NGSs) with technical merit
- Machine Learning System Safety Engineering Handbook (FY24 -25)

Workforce Development

- Defense Acquisition University System Safety Courses:
  - AI System Safety Engineering I
  - AI System Safety Engineering II
  - Software System Safety Engineering (Funded)
  - System Safety Engineering Basics (FY25)

Collaboration

- Civilian Harm Mitigation and Response
- Joint Weapon Safety WG Annual Meeting, Policy and Weapon SS Topics
- Joint System Safety Standards WG co-Chair
- DoD Acquisition ESOH IPT WG
- Defense Safety Oversight Council
- International System Safety Society -DoD Industry SS Roundtable - Pain Points

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HSI Statute and Policy

- **HASC recommendations FY2017 HASC Report (HR) 4909**:
  - *Continuing top-level HSI leadership* through existing committees, such as the Joint HSI Steering Committee (JHSISC) and Working Groups
  - *Provide a DoD HSI Standard practice* and update existing HSI-related MIL Standards
  - Incorporate additional *HSI learning content into DAU's systems engineering courseware*
  - Provide support to USD(A&S) to *strengthen HSI language in the revamped DoDI 5000.02 (as a result of the Adaptive Acquisition Framework transformation of DoD policy)*

- **Public Law No: 116-92, SEC. 902, January 3, 2019**:

  "The Secretary of Defense, acting through the Under Secretary of Defense for Acquisition and Sustainment, shall coordinate and **manage human systems integration activities throughout the acquisition programs** of the Department of Defense."

- **DoDD 5000.01, Defense Acquisition System (DAS)**:

  "1.2.p. Human systems integration planning will begin in the early stages of the program life cycle. The goal will be to **optimize total system performance and total ownership costs**, while **ensuring that the system is designed**, operated, and maintained **consistent with mission requirements**."

Create an HSI culture in DoD

Marines prepare to take off in a MV-22B Osprey at Norwegian Air Force Base Bodø during Exercise Cold Response 22, Norway, March 16, 2022. (Lance Cpl. Elias E. Pimentel III/Marine Corps)

Pilot error the cause of Norway Osprey crash that killed 4 Marines (Aug 2022)

KC-46A's long-troubled vision system cannot reliably show the end of the refueling boom (May 2021)
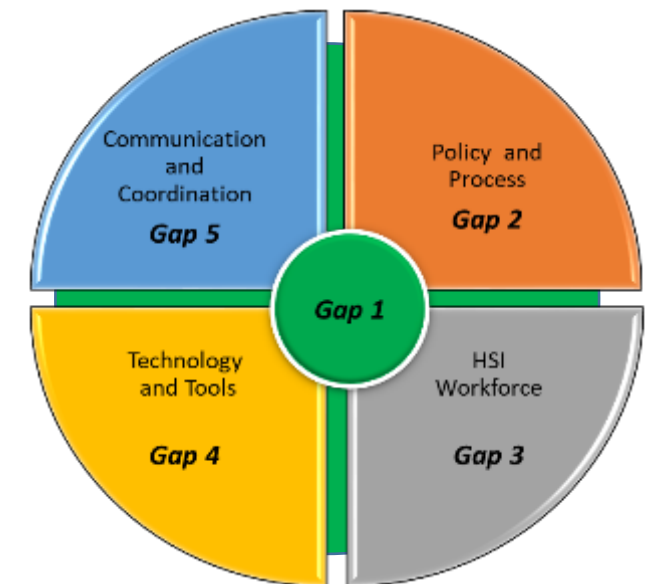
The Army's futuristic new goggles are a literal pain in the neck (Oct 2022)

***USS Fitzgerald* and container ship *MV ACX Crystal*; *USS John S. McCain* and *Alnic MC* collisions (2017-2018)** "The ship's user interface was found to have contributed to the sailors' confusion."

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Joint HSI Steering Committee

- OSD has **tri-chair** responsibilities in the JHSISC for providing leadership direction for the HSI enterprise across DOD
  - OUSD(R&E) Principal Deputy Executive Director, Systems Engineering and Architecture
  - OUSD(R&E)/DCTO(ST&T), Director, Human Systems Directorate
  - OUSD(P&R)/DASD(SOH) Director, Force Safety and Occupational Health

- The JHSISC guides accelerating the delivery of human systems capabilities, scaling the Department-wide impact of HSI, and synchronizing DoD HSI activities

- The Joint HSI Steering Committee commissioned an HSI Gap Capabilities-Based Assessment (CBA) Report in 2018, which identified five lines of effort to enhance HSI maturity and effectiveness

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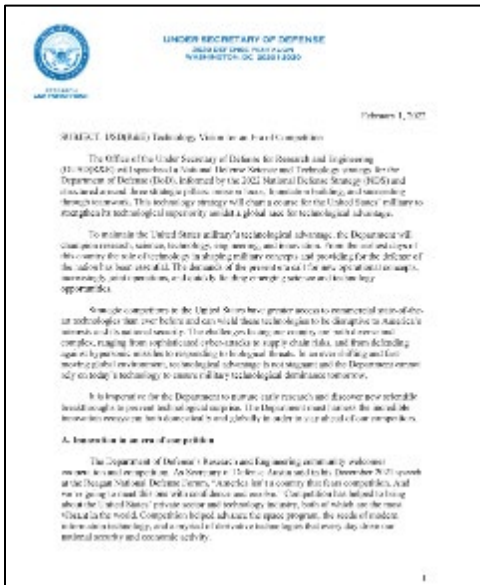
Published 1 Feb 2022

Trusted AI and Autonomy: Autonomy is the engineering discipline that expands robots' **abilities to perform tasks while limiting the need for human interaction**. AI holds tremendous promise to improve the ability and function of nearly all systems and operations. Trusted AI with trusted autonomous systems are imperative to dominate future conflicts. As AI, machine learning, and autonomous operations continue to mature, the DoD will focus on evidence-based AI-assurance and enabling operational effectiveness.

Human-Machine Interfaces: Human-Machine Interface refers to technologies related to human-machine teaming and augmented and virtual reality. Rapid advancements in this technology will have a multitude of benefits for our service members. **Highly immersive realistic training environments** provide **real-time feedback** to **enhance warfighter performance**. **Intuitive interactive** human-machine interfaces **enable rapid mission planning and mission command** by providing a common operational picture to geographically distributed operations.

The Problem → HSI is the DoD Solution

Human

Human-Machine Interface

People, Users

Technology, Capability, Engineering

HSI and HMI Trade Space

Hardware

Software

Training

Processes, Procedures

Task Design
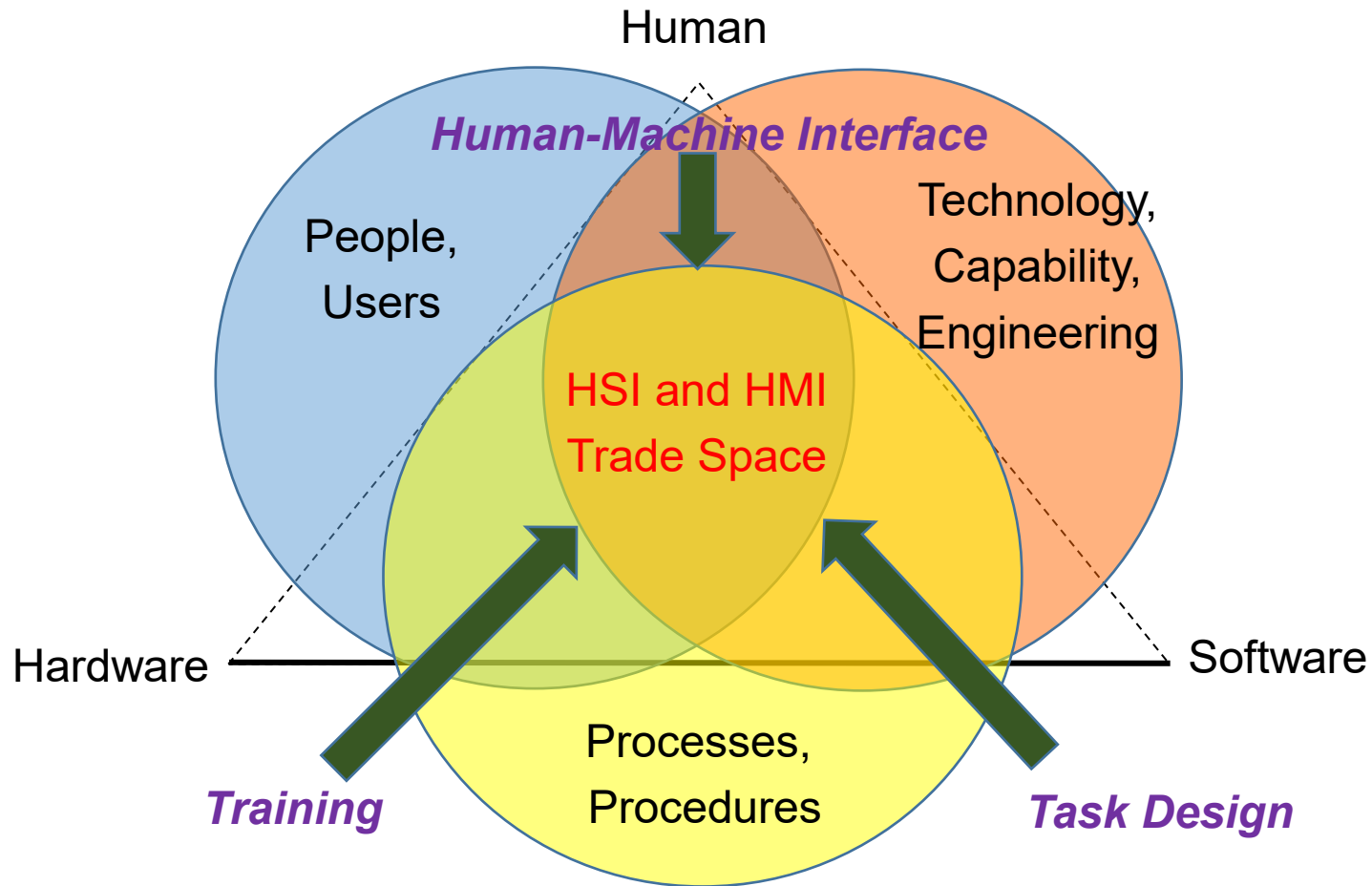
- When Human requirements are not adequately considered → reduced system effectiveness and higher risk for failures.
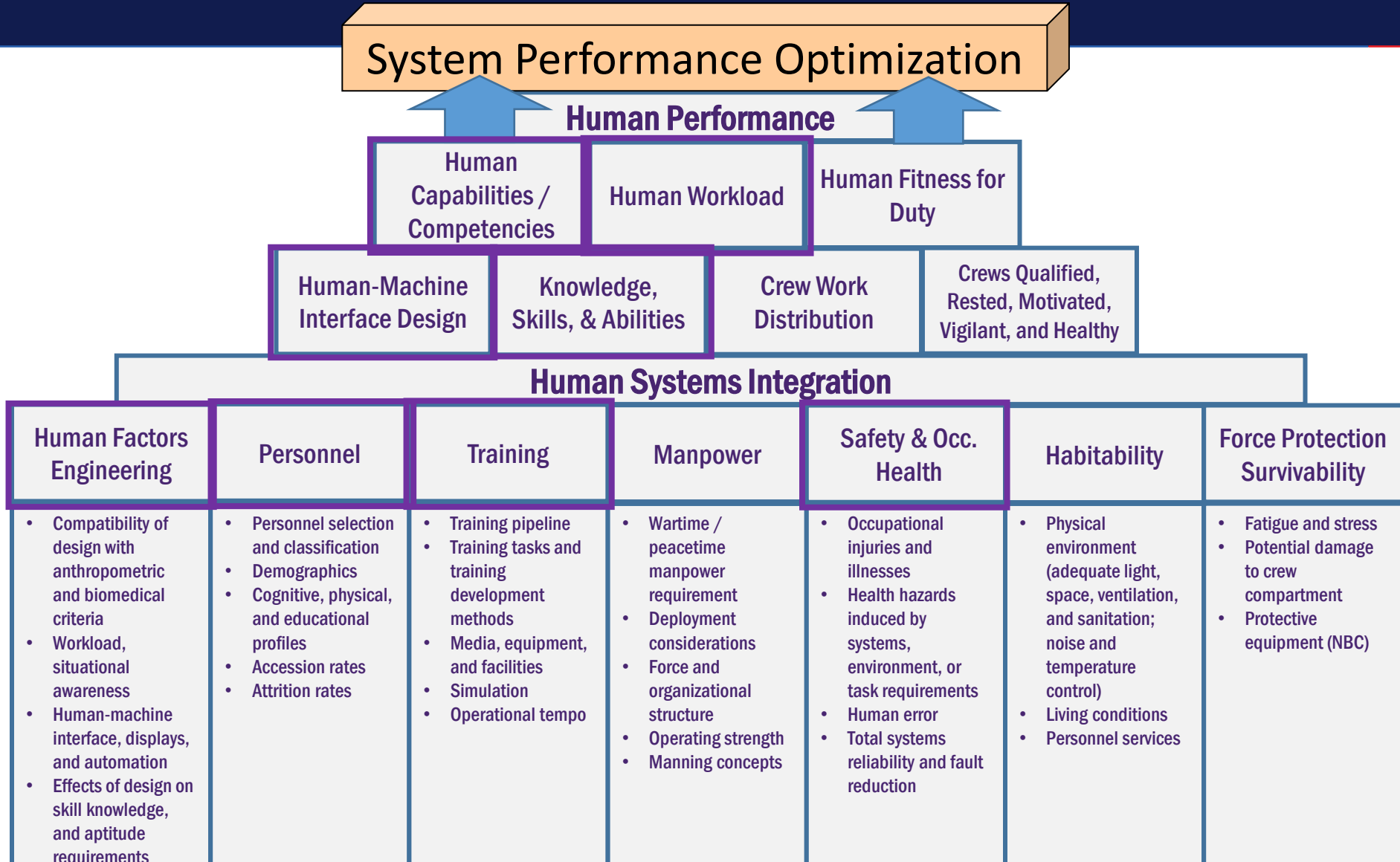- Late human requirements integration → Increased Cost

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- Evolving HSI challenge areas
  - Lack of Decision-maker <u>awareness and appreciation</u> of HSI contributions
  - Lack of <u>metrics</u> for return of investment (ROI) (Program and Enterprise-wide)
  - Lack of properly <u>trained personnel</u> who claim to be HSI SMEs
  - Lack of <u>Digital</u> Data to build human-model behavior into Model-based Systems Engineering
  - Lack of HSI <u>maturity metrics</u>
  - Continue to support HSI <u>Workforce development</u> and understand role in the Engineering Technical and Management competency
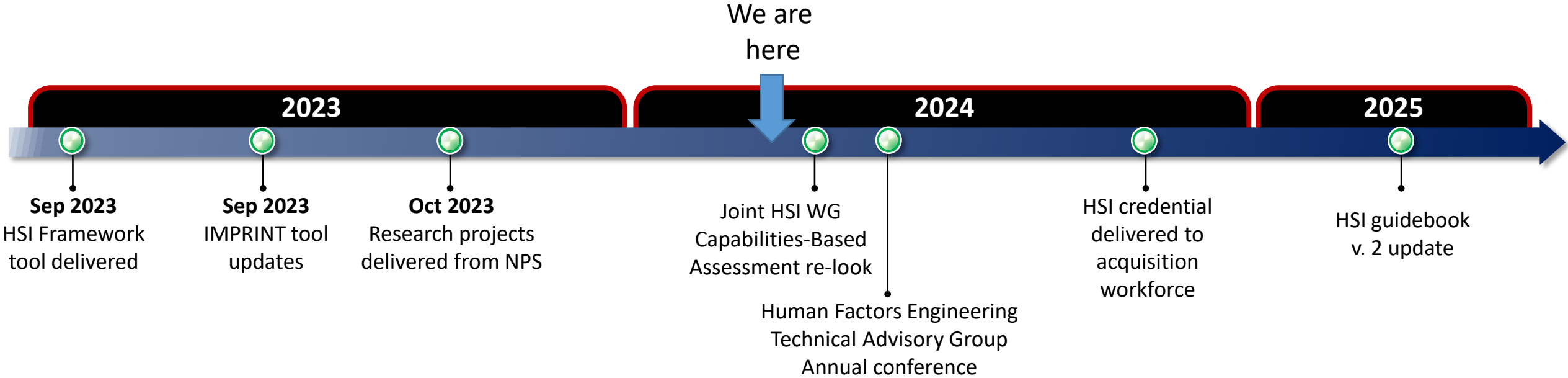
Human Performance → HSI Acquisition Translation Model

System Performance Optimization

Human Performance

Human Capabilities / Competencies	Human Workload	Human Fitness for Duty

Human-Machine Interface Design	Knowledge, Skills, & Abilities	Crew Work Distribution	Crews Qualified, Rested, Motivated, Vigilant, and Healthy

Human Systems Integration

Human Factors Engineering	Personnel	Training	Manpower	Safety & Occ. Health	Habitability	Force Protection Survivability
• Compatibility of design with anthropometric and biomedical criteria • Workload, situational awareness • Human-machine interface, displays, and automation • Effects of design on skill knowledge, and aptitude requirements	• Personnel selection and classification • Demographics • Cognitive, physical, and educational profiles • Accession rates • Attrition rates	• Training pipeline • Training tasks and training development methods • Media, equipment, and facilities • Simulation • Operational tempo	• Wartime / peacetime manpower requirement • Deployment considerations • Force and organizational structure • Operating strength • Manning concepts	• Occupational injuries and illnesses • Health hazards induced by systems, environment, or task requirements • Human error • Total systems reliability and fault reduction	• Physical environment (adequate light, space, ventilation, and sanitation; noise and temperature control) • Living conditions • Personnel services	• Fatigue and stress • Potential damage to crew compartment • Protective equipment (NBC)

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Future Roadmap for Human Systems Integration

We are here

2023

2024

2025

Sep 2023
HSI Framework tool delivered

Sep 2023
IMPRINT tool updates

Oct 2023
Research projects delivered from NPS

Joint HSI WG Capabilities-Based Assessment re-look

Human Factors Engineering Technical Advisory Group Annual conference

HSI credential delivered to acquisition workforce

HSI guidebook v. 2 update

Office of Systems Engineering and Architecture

osd-sea@mail.mil | Attn: Specialty Engineering - HSI

https://www.cto.mil/sea/

Questions?

POCs

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Mitchell Woods – OUSD(R&E) ED SE&A (CTR HII-TSD)
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BACK-UP

Leaders

Lloyd J. Austin III
Secretary of Defense

Dr. Kathleen H. Hicks
Deputy Secretary of Defense

Authority From

Title 10: U.S. Code

https://uscode.house.gov/browse /prelim@title10&edition=prelim

"(a)(1) There is a Secretary of Defense, who is the **head of the Department of Defense**, appointed from civilian life by the President, by and with the advice and consent of the Senate."

Priorities

2022 National Defense Strategy
Section VIII. Building Enduring Advantages, pg 19

"We will be a fast-follower where market forces are driving commercialization of militarily-relevant capabilities in trusted artificial intelligence and autonomy, integrated network system-systems, … and storage, and **human-machine interfaces**."

HSI Domain Primer Sheet

Human Factors Engineering domain

The application of knowledge about human capabilities and limitations to system or equipment design and development to achieve efficient, effective, and safe system performance at minimum cost and manpower, skill, and training demands.

Personnel domain

The human aptitudes (i.e., cognitive, physical, and sensory capabilities); knowledge, skills, abilities; and experience levels needed to properly perform job tasks and required to train, operate, maintain, and sustain materiel and information systems.

Manpower domain

Total number of personnel or positions required to perform specific tasks. Indexed by requirements including jobs lists, slots, or billets characterized by descriptions of the people required to fill them and the number of people required to operate, maintain, train, and support a system.

Habitability domain

The consideration of the characteristics of systems focused on satisfying personnel needs that are dependent upon physical environment, such as berthing and hygiene.

Training domain

The policy, processes and techniques, training aids, devices, simulators and simulations, planning, and provisioning for the training, to include equipment used to train personnel to operate, maintain, and support a system.

Safety & Occupational Health domain

The characteristics of system design that can:
- Minimize the risk of acute or chronic illness, disability, injury or death to the operator or maintainers
- Enhance the human performance and productivity of personnel who operate, maintain, or support the system in the intended operational environment

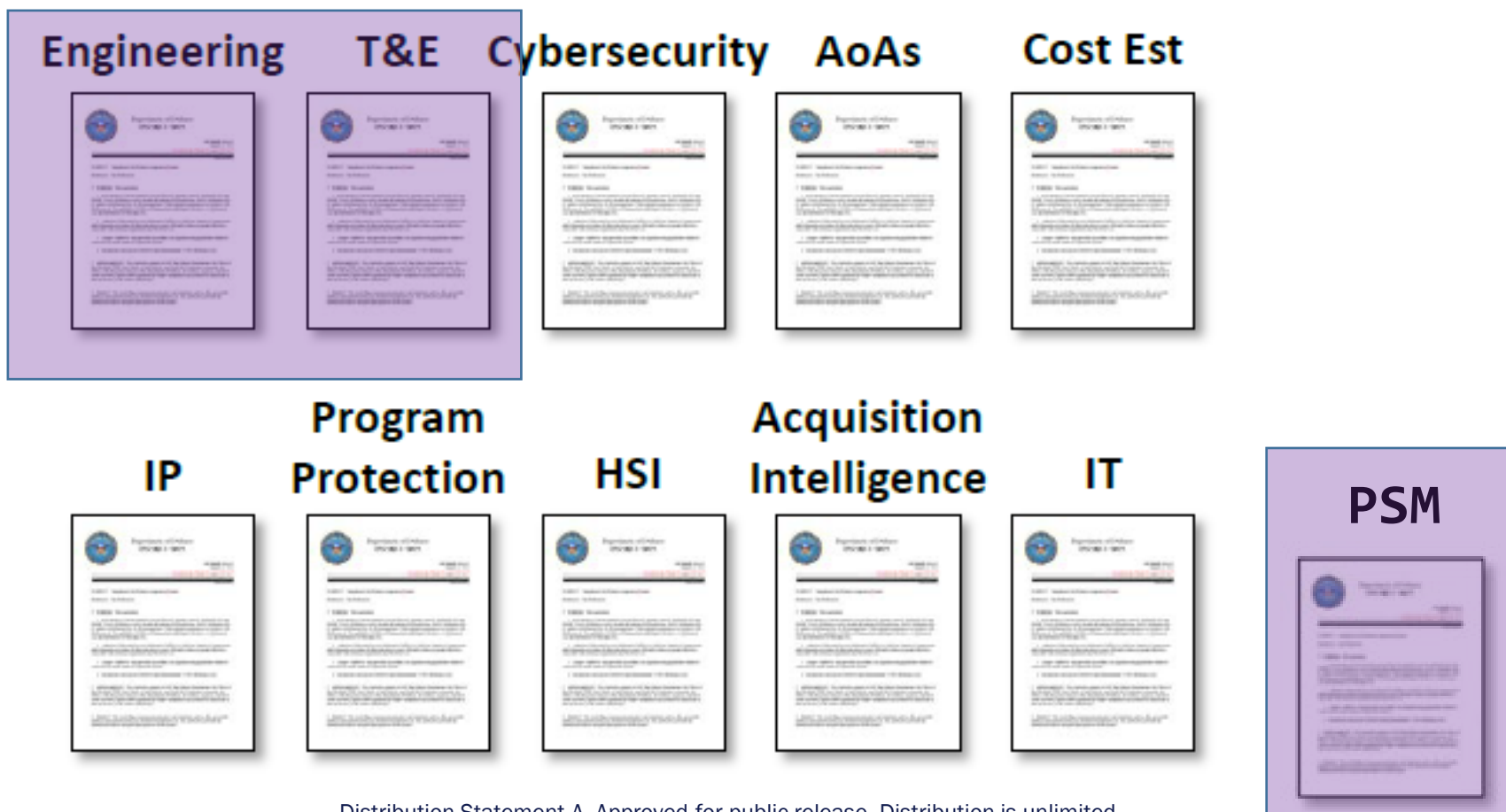## Force Protection & Survivability domain

The characteristics of a system that can:
- Reduce fratricide, detectability, and probability of being attacked.
- Minimize system damage and soldier injury.

DODIs for Each Functional Area

Engineering · T&E · Cybersecurity · AoAs · Cost Est

IP · Program Protection · HSI · Acquisition Intelligence · IT

PSM

- "3.6. SPECIALTY ENGINEERING, d. Human Systems Integration. The **LSE will**:

    (1) Working for the PM, use **a human-centered design approach** for system definition, design, development, test, and evaluation to optimize human-system performance.

    (2) **Conduct frequent and iterative end user validation of features and usability** for identifying, communicating, and visualizing user needs under defined operational conditions and expected mission threads.

    (3) Working for the PM, **ensure human systems integration risks are identified and managed throughout the program's life-cycle**."

- "3.4.a.(3) For MDAPs, ACAT II, and ACAT III programs, the **[Systems Engineering Plan] SEP will contain these elements**, unless waived by the SEP approval authority:...(t) **Specialty engineering** and architectural factors..."

DoDI 5000.88, November 18, 2020

- "3.5.d. The DOT&E requires testing of cybersecurity during OT&E to include the representative users and an operationally representative environment. This may include hardware; software (including embedded software and firmware); operators; maintainers; operational cyber and network defense; end users; network and system administrators; help desk; training; support documentation; tactics, techniques, and procedures; cyber threats; and other systems that input or exchange information with the system under test, as applicable."

- "4.6.b. DBS PMs will develop a TEMP or other test strategy documentation. The PM will describe the test strategy and essential elements of the TEMP in the DBS implementation plan. Specific T&E management content requirements in the implementation plan include:...

  (3) T&E planning will include mission-oriented developmental T&E with actual operators performing end-to-end scenarios in a controlled environment to collect human-system interface data and reduce risk during operational testing."

- "4.5.d. To maximize the benefit of early and automated data collection opportunities, the PM must collaborate with the T&E interfaces and work through the T&E processes defined for DT&E (see Section 5) and OT&E (see Section 6) to tailor a plan that will enable the effective and efficient execution of analysis and evaluation, as well as the determination of test adequacy.

  (1) Automated testing should be used at the unit level, for application programming interface and integration tests, and to the maximum extent possible for user acceptance and to evaluate mission effectiveness."

DoDI 5000.89, November 18, 2020

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- 4.3. The Program Support Strategy (PSS) and the Lifecycle Support Plan (LCSP).
  - "An LCSP is required for all covered systems and is the principal document establishing the system's product support planning and sustainment, pursuant to Section 2337 of Title 10, U.S.C. For covered systems, a detailed LCSP will include:
    - (2) Performance goals, including:
      - (a) Sustainment key performance parameters (KPPs).
      - (b) Key system attributes.
      - (c) Other appropriate metrics.

      HSI is an Other System Attribute and is embedded within Sustainment KPPs (via Training domain, Reliability and Maintainability)
    - (7) Engineering and design considerations, including DMSMS resilience, that support cost-effective sustainment for the system.

- "The PSM will collaborate with users, systems engineers, cost analysts, and other stakeholders to develop risks and assumptions unique to the systems."

- "(1) The PSM will work with systems engineers and users to develop the RAM-C rationale report to ensure supportability, maintenance, and training are incorporated into the design through early user assessments; and to incorporate user feedback into supportability planning.

- "i. Demonstrating and Evaluating Performance.
  - In support of the PM, the PSM will work with systems engineers and the testing and user communities to incorporate costs and manpower planning necessary to conduct user supportability related demonstration and evaluation events into the program test strategy."

DoDI 5000.91, November 4, 2021

DODI 5000.95 impacts to DODI 5000.91, "PRODUCT SUPPORT MANAGEMENT"

- a. Disposition Analysis.
  - "The PM and the PSM (or LCL) will use operational data, including an assessment of the fielded urgent need capability's operational utility, as well as user feedback concerning its performance, to help inform the disposition official's recommendation and highlight key risk areas. The PSM or LCL will identify risks to inform any follow-on procurement and product support performance metrics to incentivize future improvements in the capability's design to achieve A_0 and control costs should it transition to a PoR."

- "(3) The PSM will further influence design through coordination with users to assess models or physical prototypes, to ensure maintainability and usability within an operational environment. The PSM will provide user feedback, along with system and operational data, to systems engineers to support the development of modeling tools to improve the prototype's design."

- "(4) User Assessment Planning. In support of the PM, the PSM will coordinate with the lead software developer to identify and pre-plan for user participation in product support-related user assessments of the software technical manual, source codes, training materials, and supportability."
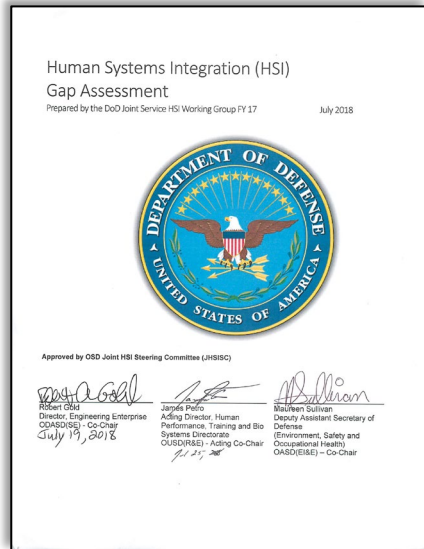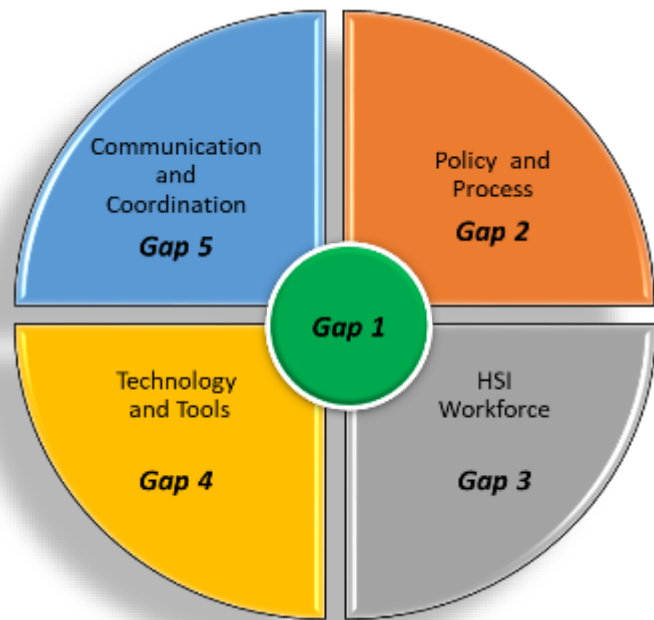
HSI is involved in all sustainment activities involving the end user!

DoDI 5000.91, November 4, 2021

Capabilities Based Assessment Overview

The Joint HSI Steering Committee commissioned in 2018 an HSI Gap Capabilities Based Assessment (CBA) Report and identified five (5) lines of efforts to enhance HSI maturity and effectiveness:
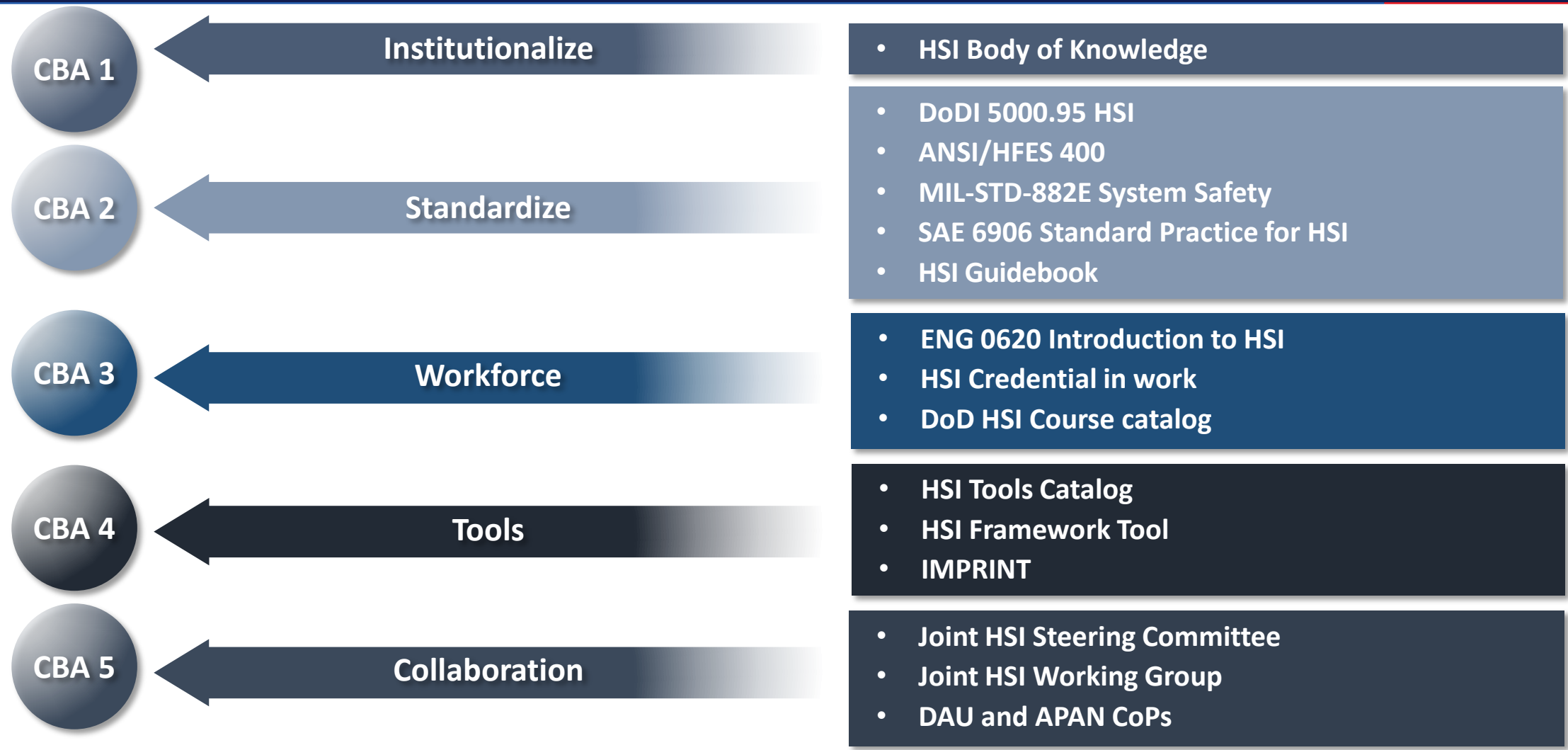
- CBA 1: Institutionalize an HSI Body of Knowledge
- CBA 2: Standardize HSI Best Practices across the Services
- CBA 3: Develop Career Certification and Career Paths/Billets for HSI Workforce Supported by a Persistent Training Function
- CBA 4: Provide and Maintain Tools, Databases, and Processes to Support HSI Analyses Early in Acquisition
- CBA 5: Implement a Professional, Coordinated HSI Outreach and Marketing Function

Capabilities-Based Assessment (CBA) report - Apr 4, 2018

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Capabilities-Based Assessments from 2018

CBA 1 — Institutionalize

- **HSI Body of Knowledge**

CBA 2 — Standardize

- **DoDI 5000.95 HSI**
- **ANSI/HFES 400**
- **MIL-STD-882E System Safety**
- **SAE 6906 Standard Practice for HSI**
- **HSI Guidebook**

CBA 3 — Workforce

- **ENG 0620 Introduction to HSI**
- **HSI Credential in work**
- **DoD HSI Course catalog**

CBA 4 — Tools

- **HSI Tools Catalog**
- **HSI Framework Tool**
- **IMPRINT**

CBA 5 — Collaboration

- **Joint HSI Steering Committee**
- **Joint HSI Working Group**
- **DAU and APAN CoPs**

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Take Aways

- HSI optimizes human performance outcomes and improves total system performance

- HSI practices have a foundation in statute and current policy

- Capability Developers and Program Managers have responsibilities to resource HSI requirements

- Joint HSI Steering Committee oversight of the CBA efforts is improving HSI

- User engagement during requirements generation can ensure system and capability is designed, operated, and maintained consistent with mission requirements

- Acquisition Workforce education resources are available for S&T stakeholders, functional area leads and the HSI practitioner

- Joint HSI WG CBA activities instill HSI in SE, T&E, Product Support activities for appropriate HSI considerations in all defense acquisition system phases