Human Systems Integration (HSI)

Engineering the Complete System: Hardware, Software, AND People

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Agenda

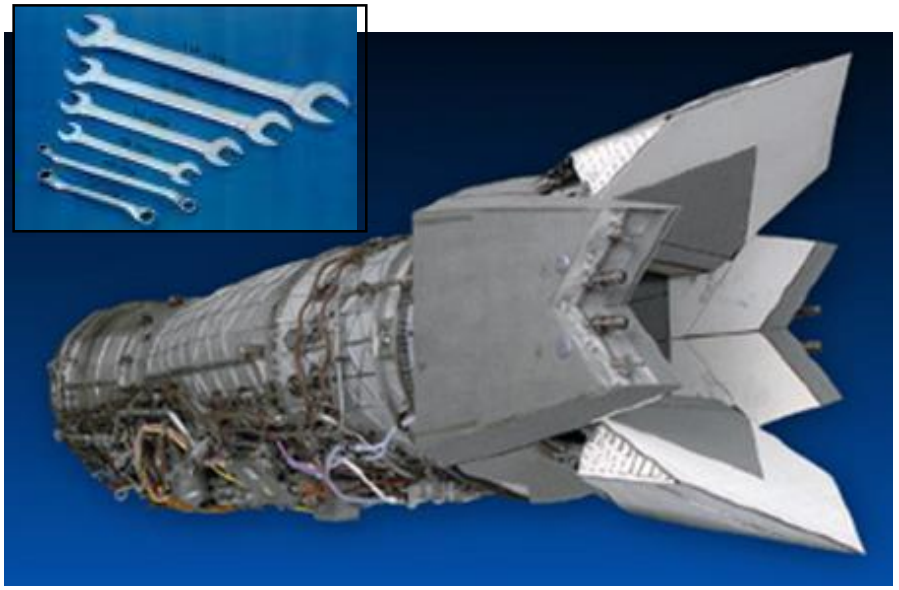
- What is HSI?
- Why HSI?
- Who does HSI?
- How to do HSI

What is HSI

Example: Flightline maintenance

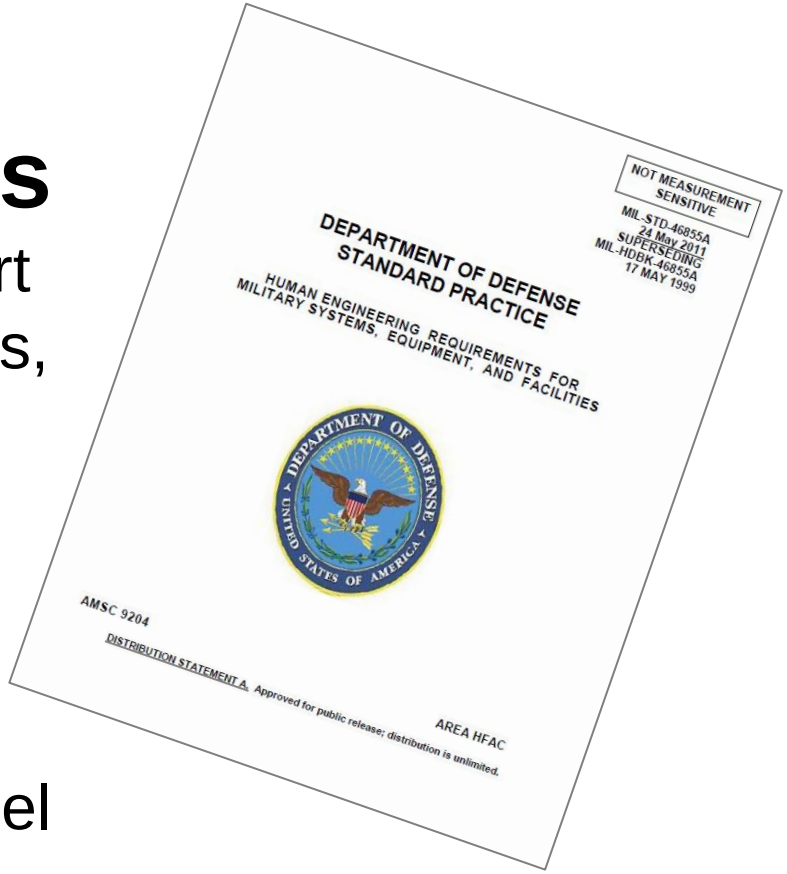
- **F-15 F100-PW-220 engine**
  - **About 150 tools**
  - **Access issues**
  - **Stands required**

- **F-22 F-119-PW-100 engine**
  - **Six tools**
  - **All rapid access**
  - **No stands**



DoD Definition of HSI

HSI is "the **systems engineering process** and program management effort that provides integrated analysis, design, and assessment of requirements, concepts and resources for human engineering, manpower, personnel, training, system safety, health hazards, personnel survivability, and habitability."


NOT MEASUREMENT SENSITIVE

MIL-STD-46855A
24 May 2011
SUPERSEDING
MIL-HDBK-46855A
17 MAY 1999

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

HUMAN ENGINEERING REQUIREMENTS FOR MILITARY SYSTEMS, EQUIPMENT, AND FACILITIES

AMSC 9204

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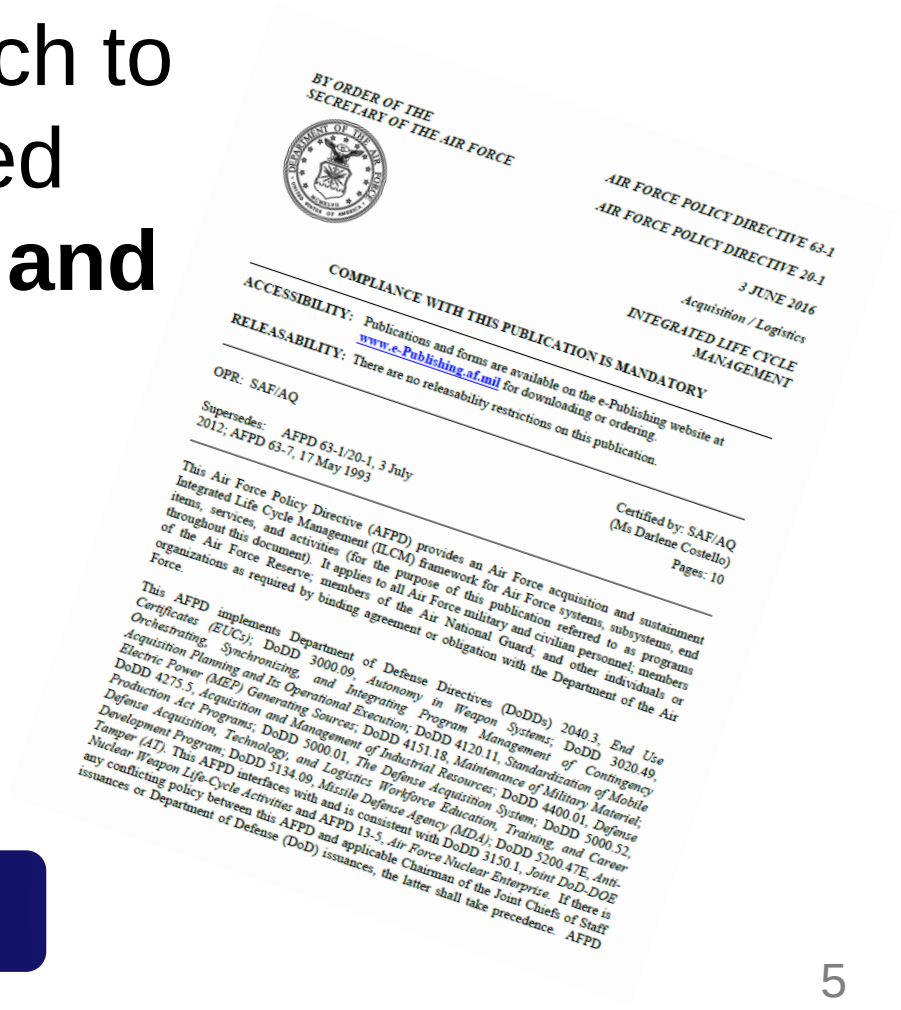
AREA HFAC

Definition of SE

Systems Engineering—an interdisciplinary approach to a total life cycle balanced set of **system, people, and process** solutions that satisfy customer needs.



BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE POLICY DIRECTIVE 63-1
AIR FORCE POLICY DIRECTIVE 20-1
3 JUNE 2016
Acquisition / Logistics
INTEGRATED LIFE CYCLE MANAGEMENT

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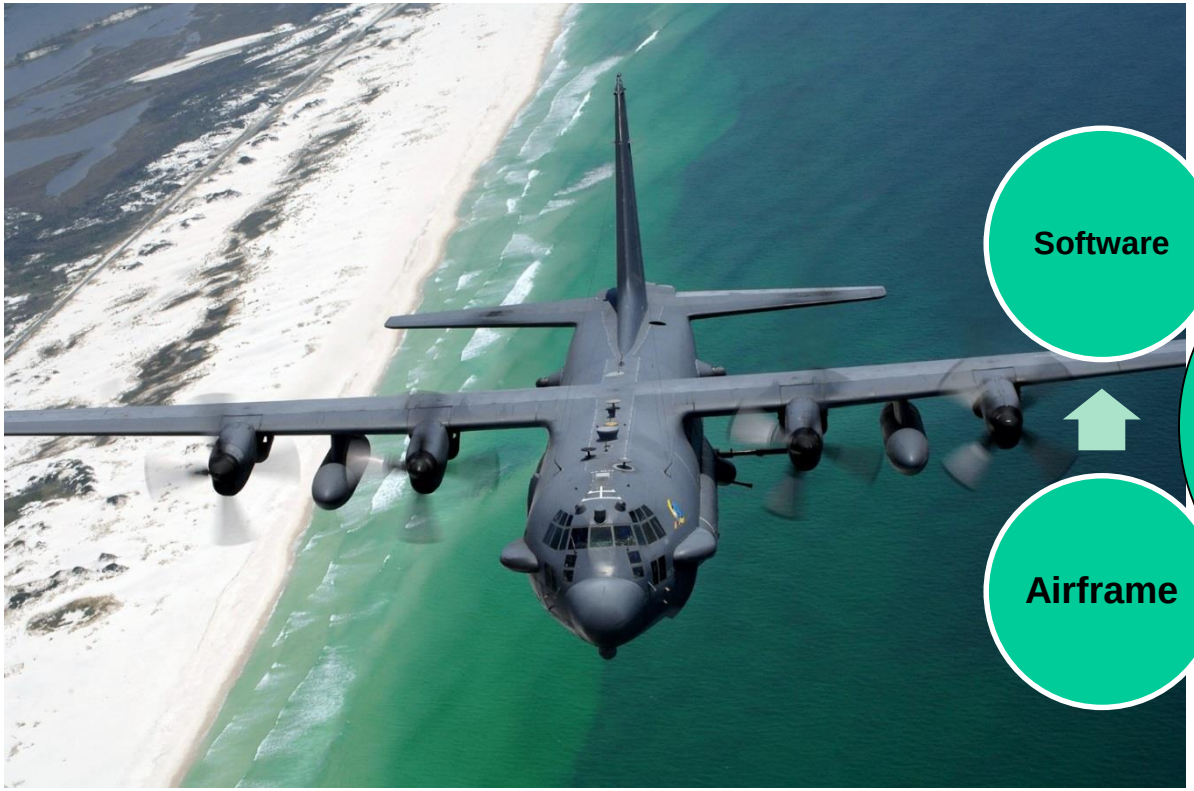
Pages: 10

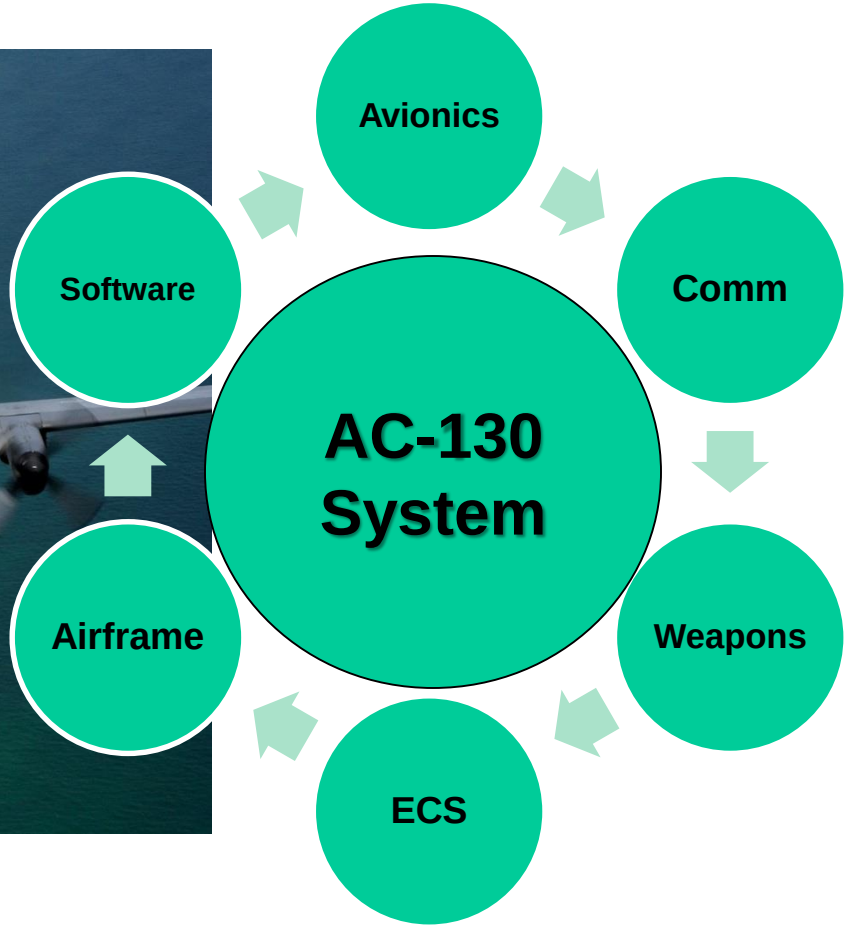
This Air Force Policy Directive (AFPD) provides an Air Force acquisition and sustainment Integrated Life Cycle Management (ILCM) framework for Air Force systems, subsystems, end items, services, and activities (for the purpose of this publication referred to as programs throughout this document). It applies to all Air Force military and civilian personnel; members of the Air Force Reserve; members of the Air National Guard; and other individuals or organizations as required by binding agreement or obligation with the Department of the Air Force.

This AFPD implements Department of Defense Directives (DoDDs) 2040.3, *End Use Certificates (EUCs)*; DoDD 3000.09, *Autonomy in Weapon Systems*; DoDD 3020.49, *Orchestrating, Synchronizing, and Integrating Program Management of Contingency Acquisition Planning and Its Operational Execution*; DoDD 4120.11, *Standardization of Military Materiel*; *Electric Power (MEP) Generating Sources*; DoDD 4151.18, *Maintenance of Military Materiel*; *Production Act Programs*; DoDD 4400.01, *Defense Production Act Purchases*; DoDD 5000.52, *Defense Acquisition, Technology, and Logistics Workforce Education, Training, and Career Development Program*; DoDD 5000.01, *The Defense Acquisition System*; DoDD 5134.09, *Missile Defense Agency (MDA)*; DoDD 5200.47E, *Anti-Tamper (AT)*. This AFPD interfaces with and is consistent with DoDD 3150.1, *Joint DoD-DOE Nuclear Weapon Life-Cycle Activities* and AFPD 13-5, *Air Force Nuclear Enterprise*. If there is any conflicting policy between this AFPD and applicable Chairman of the Joint Chiefs of Staff issuances or Department of Defense (DoD) issuances, the latter shall take precedence. AFPD

Think "Whole System"

“Whole System” Example





AC-130 “System” Components

But the “system” is 100% NMC without…

People! Integral to any system

The Human-Centered Domains of HSI

- ***Manpower*** **= number of spaces needed**

- ***Personnel*** **= skills, experience, aptitude**

- ***Training*** **= developing Airmen today for tomorrow**

- ***Force Protection & Survivability*** **= protecting our Airmen**

- ***Habitability*** **= living and working conditions**

- ***Human Factors Engineering*** **= fitting the system to the human, not vice versa**

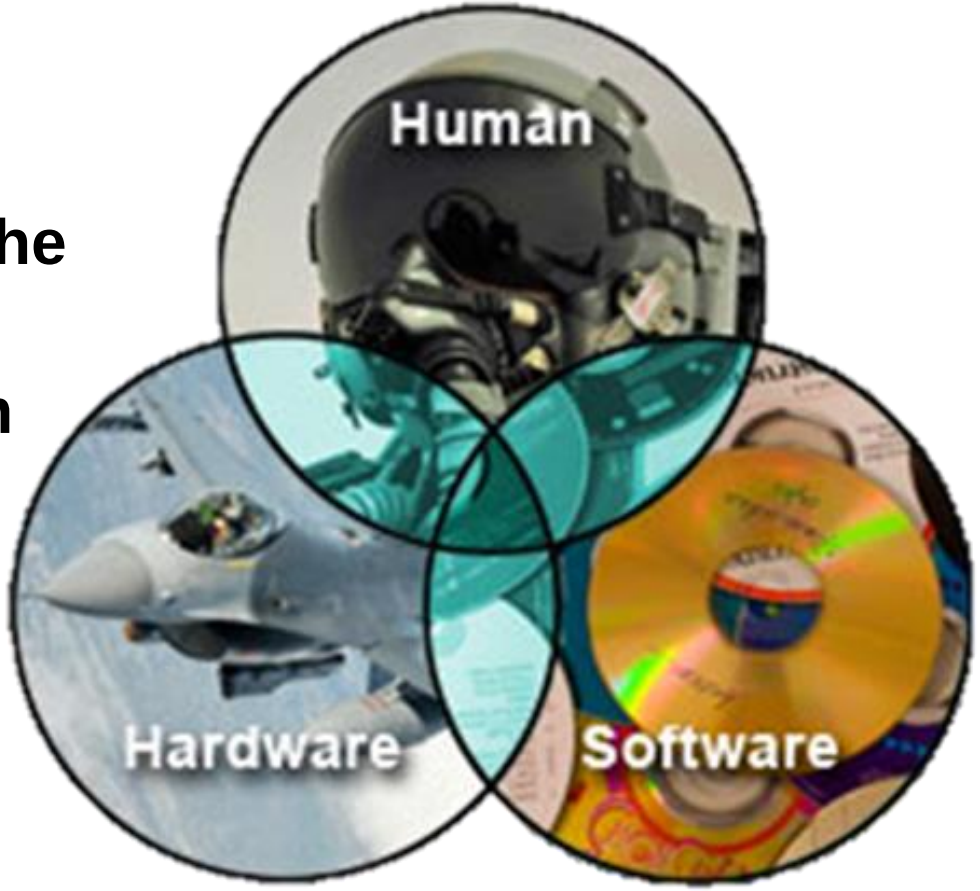
- ***Safety & Occupational Health*** **= minimize risks of acute or chronic illness, disability, death, or injury**

Domain are simply a way to organize thinking.
They also point you to domain SMEs who can help

So… a concise definition

HSI

- Is Systems Engineering
- Includes integration of the human component to:
  - optimize total system performance
  - reduce LCC
- Informs the decision making process with a human-centered focus



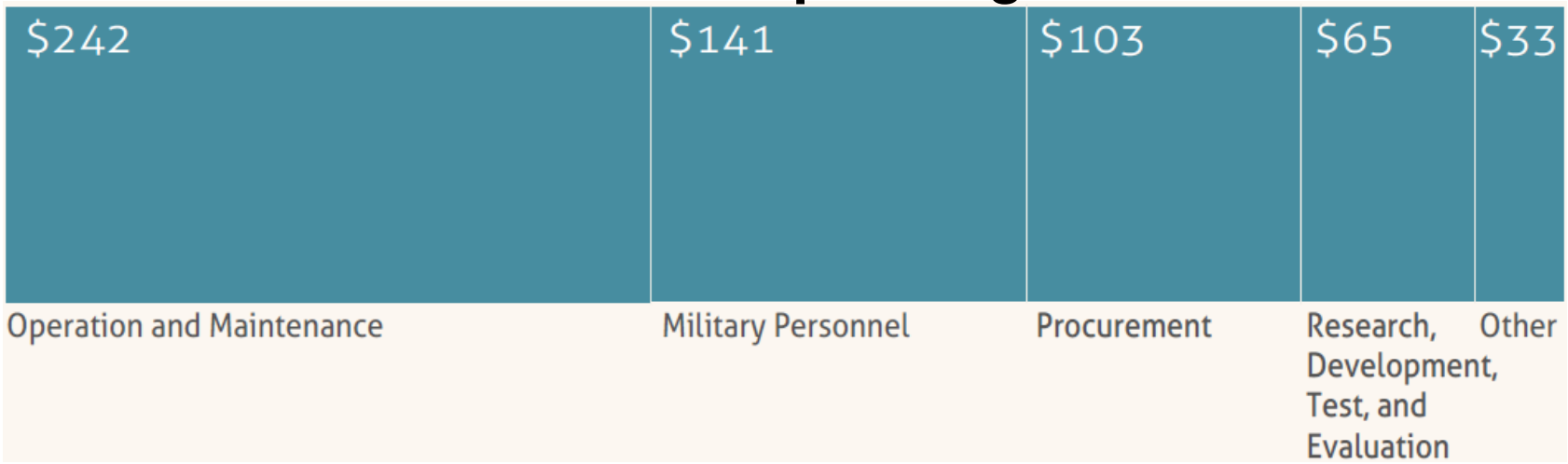
- **Management & technical strategy for the human component of a system**

Agenda

- What is HSI?
- **Why HSI?**
- Who does HSI?
- How to do HSI

Huge Impact of getting it wrong

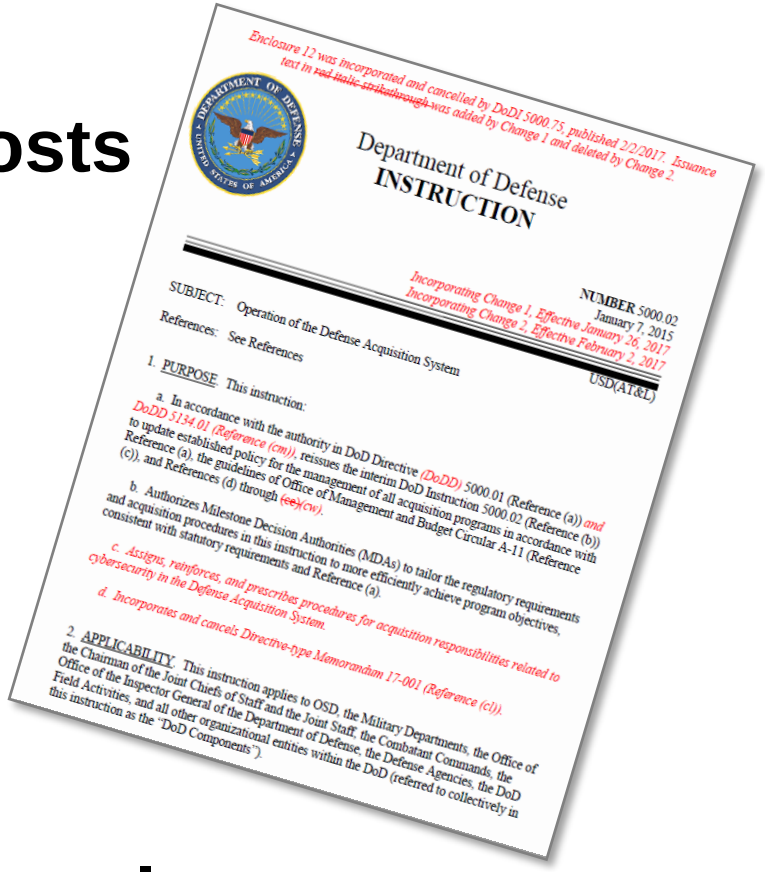
FY16 Defense Spending $584B



Human-related costs = 2/3rds of all DoD spending

And because DoDI 5000.02 says HSI …

- **Optimizes total system performance**
- **Reduces total ownership costs**
- **Helps ensure system is designed so users can effectively complete their mission**
- **… and that the PM will implement HSI <u>early</u> in the acquisition process and <u>throughout</u> the product life cycle**



Enclosure 12 was incorporated and cancelled by DoDI 5000.75, published 2/2/2017. Issuance text in ~~red italic strikethrough~~ was added by Change 1 and deleted by Change 2.

Department of Defense
INSTRUCTION

NUMBER 5000.02
January 7, 2015
Incorporating Change 1, Effective January 26, 2017
Incorporating Change 2, Effective February 2, 2017

USD(AT&L)

SUBJECT: Operation of the Defense Acquisition System

References: See References

1. PURPOSE. This instruction:

a. In accordance with the authority in DoD Directive (DoDD) 5000.01 (Reference (a)) and DoDD 5134.01 (Reference (cm)), reissues the interim DoD Instruction 5000.02 (Reference (b)) to update established policy for the management of all acquisition programs in accordance with Reference (a), the guidelines of Office of Management and Budget Circular A-11 (Reference (c)), and References (d) through ~~(ee)~~(cw).

b. Authorizes Milestone Decision Authorities (MDAs) to tailor the regulatory requirements and acquisition procedures in this instruction to more efficiently achieve program objectives, consistent with statutory requirements and Reference (a).

c. Assigns, reinforces, and prescribes procedures for acquisition responsibilities related to cybersecurity in the Defense Acquisition System.

d. Incorporates and cancels Directive-type Memorandum 17-001 (Reference (cl)).

2. APPLICABILITY. This instruction applies to OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the DoD (referred to collectively in this instruction as the "DoD Components").

Example of Early HSI

- C-17 Globemaster
- Fueling station redesign reduced manpower from three to one
- What is the ripple effect of needing only one airman to refuel rather than three?

Domains effected: manpower, human factors, safety

Agenda

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Program Manager & Chief Engineer

- **The PM ensures the HSI domains are addressed throughout the life cycle**
- **The CE, in support of the PM, is responsible for assuring proper application of SE principles**
- **The CE uses SE processes across the life cycle to accomplish trade-offs to affordably satisfy needs**

They sure do have a lot on their plates!

But they have help!

- **Functional community expertise in**
  - **Human Systems Integration**
  - **Environmental Engineering**
  - **Human Factors Engineering**
  - **Manpower & Personnel**
  - **Occupational Health**
  - **Training**
  - **Systems Safety, etc.**

- **These communities have technical and management processes, specialty expertise, standards, and guidance that address human considerations throughout the system life cycle**

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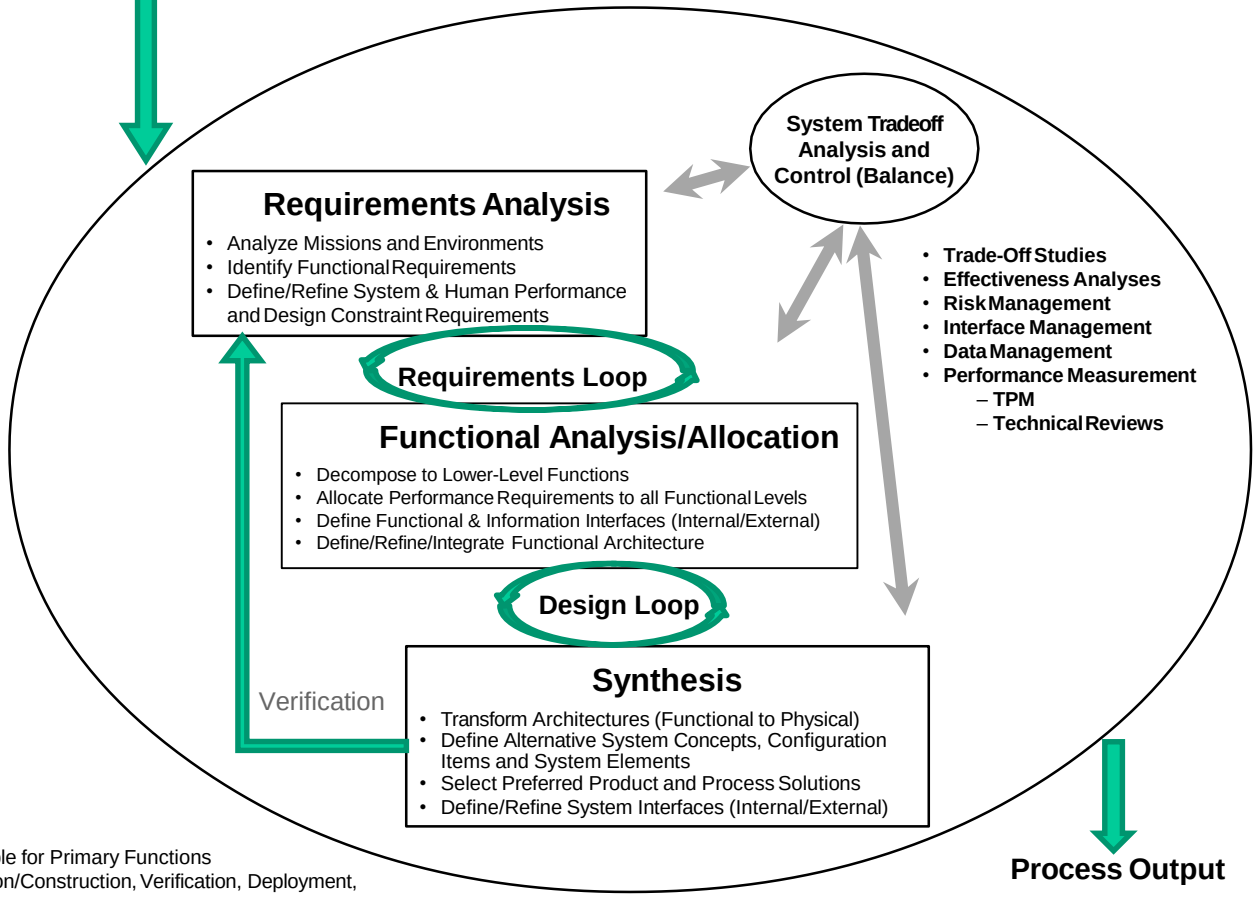
The Human Systems Engineering Process

Process Input

- Customer Needs/Objectives/ Requirements
  - Missions
  - Measures of Effectiveness
  - Environments
  - Constraints
- Technology Base
- Output Requirements from Prior Development Effort
- Program Decision Requirements
- Requirements applied through Specs and Standards



Related Terms:

Customer = Organizations responsible for Primary Functions
Primary Functions = Development, Production/Construction, Verification, Deployment, Operations, Support, Training, Disposal
Systems Elements = Hardware, Software, Personnel, Facilities, Data, Material, Services, Techniques, Processes

Process Output

- Development Level Dependent
  - Decision Database
  - System/Configuration Item Architecture
  - Specifications and Baselines

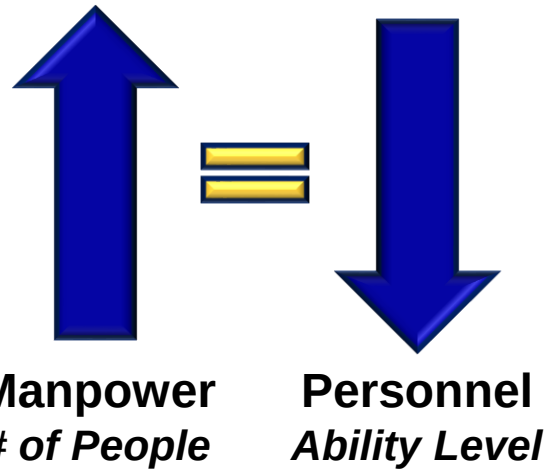
Same processes as the classic systems engineering "V"!

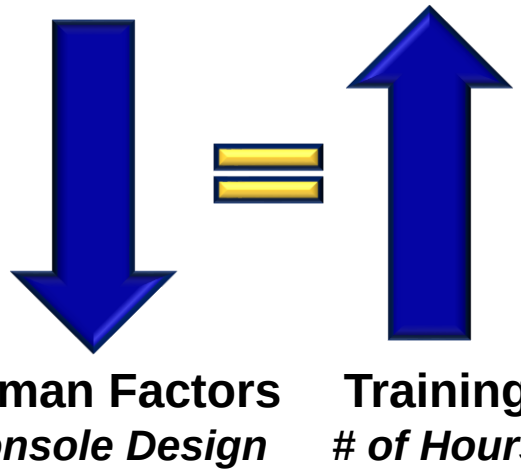
HSI Planning & Execution

- **IPT! As a minimum, PM should consider reps from: FM, PK, SE, HSI, safety, ESOH, intel, test, JA, logistics, and info protect**
- **The backbone of the HSI program is the SEP and the HSIP within it**
- **HSI should be a clearly identified section within the SEP or as a stand-alone document in an HSI Plan (HSIP)**
- **Document all decisions made to address risk or competing trade-offs that impact HSI domains in the SEP**

Trade Space Includes Explicit Considerations of

- System effectiveness
- Availability
- Manpower costs
- Opportunity cost
- Risk (safety, survivability)
- Long-term costs associated with attrition and morale
- Training hours

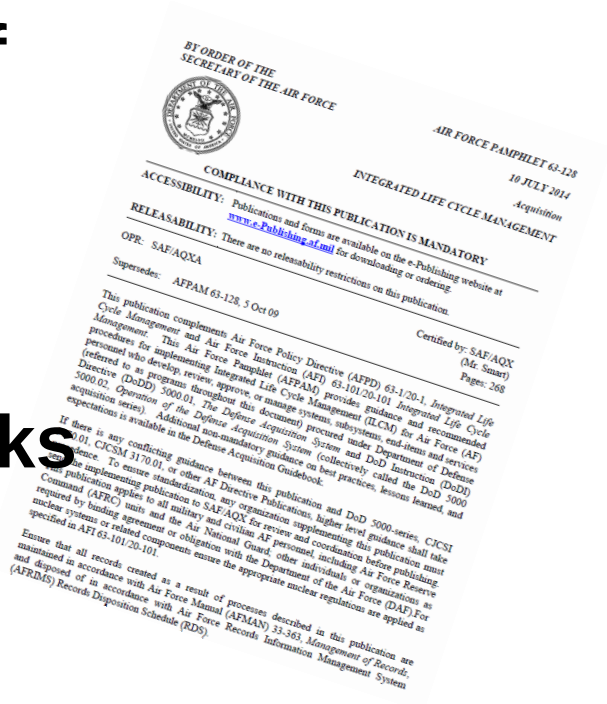




Goal is to make consequences apparent to decision maker

Recap

- **HSI is not a stand-alone program, but an integral part of the SE process**
- **Best practice: maintain cross-domain *relationships* to *continuously* work issues & risks**
- **Optimal design harmonizes hardware & software with physical and cognitive <u>abilities</u> and <u>limitations</u> of humans**


BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE PAMPHLET 63-128

10 JULY 2014

Acquisition

INTEGRATED LIFE CYCLE MANAGEMENT

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This publication complements Air Force Policy Directive (AFPD) 63-1/20-1, Integrated Life Cycle Management and Air Force Instruction (AFI) 63-101/20-101, Integrated Life Cycle Management. This Air Force Pamphlet provides guidance and recommended procedures for implementing Integrated Life Cycle Management (ILCM) for Air Force (AF) personnel who develop, review, approve, or manage systems, subsystems, end-items and services (referred to as programs throughout this document) procured under Department of Defense Directive (DoDD) 5000.01, The Defense Acquisition System and DoD Instruction (DoDI) 5000.02, Operation of the Defense Acquisition System (collectively called the DoD 5000 acquisition series). Additional non-mandatory guidance on best practices, lessons learned, and expectations is available in the Defense Acquisition Guidebook.

If there is any conflicting guidance between this publication and DoD 5000-series, CJCSI 3170.01, CJCSM 3170.01, or other AF Directive Publications, higher level guidance shall take precedence. To ensure standardization, any organization supplementing this publication must submit their implementing publication to SAF/AQX for review and coordination before publishing. This publication applies to all military and civilian AF personnel, including Air Force Reserve Command (AFRC) units and the Air National Guard. other individuals or organizations as required by binding agreement or obligation with the Department of the Air Force (DAF).For nuclear systems or related components ensure the appropriate nuclear regulations are applied as specified in AFI 63-101/20-101.

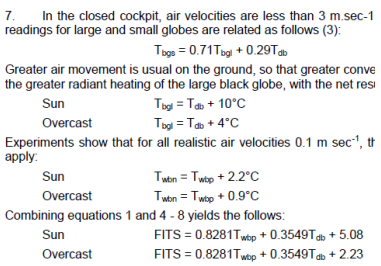
Ensure that all records created as a result of processes described in this publication are maintained in accordance with Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of in accordance with Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS).

Engineering approach applied to the Human "Configuration Item"

- **Humans are a key weapon subsystem**
- **Many processes used for hardware & software can be applied to humans**

- **Failure modes**
  - **Workload exceedance**
  - **Exceeded physiological limits**
  - **Not enough oxygen**
  - **Fatigue**
  - **Loss of Situation Awareness**
  - **Other sources of human error**

- **Performance attributes**
  - **Reliability**
  - **Processing speed**
  - **Physical parameters**
  - **Thermal operating parameters**
  - **Vibe and acoustic**



7. In the closed cockpit, air velocities are less than 3 m.sec-1 readings for large and small globes are related as follows (3):

$$T_{bgs} = 0.71T_{bgl} + 0.29T_{db}$$

Greater air movement is usual on the ground, so that greater conve the greater radiant heating of the large black globe, with the net resi

Sun $T_{bgl} = T_{db} + 10°C$

Overcast $T_{bgl} = T_{db} + 4°C$

Experiments show that for all realistic air velocities 0.1 m sec^{-1}, th apply:

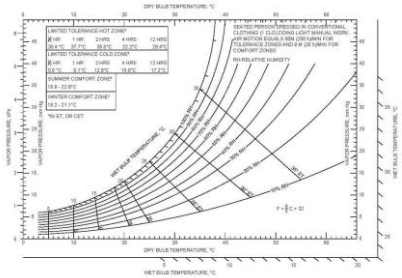
Sun $T_{wbn} = T_{wbp} + 2.2°C$

Overcast $T_{wbn} = T_{wbp} + 0.9°C$

Combining equations 1 and 4 - 8 yields the follows:

Sun $FITS = 0.8281T_{wbp} + 0.3549T_{db} + 5.08$

Overcast $FITS = 0.8281T_{wbp} + 0.3549T_{db} + 2.23$



(Just a suggestion on how to incorporate HSI into the engineering thought process)

DoDAF Viewpoints and Models

- SV-4 Systems Functionality Description addresses human and system functionality. It provides details for the allocation of functions
  - Description of task workflow
  - Identification of functional system requirements
  - Functional decomposition of systems
  - Relate human and system functions
- OV-5b Activity Model describes the activities (or tasks) that are conducted in the course of achieving a mission
  - Description of activities and workflows
  - Definition of roles and responsibilities
  - Support task analysis to determine training needs
  - Information flow analysis

Programmatic HSI Touch Points

• **Perform HSI Assessments**	Identify gaps, concerns, risks
• **Integrate HSI across SPO**	PM, IPT & WG activities: SE, Test, Safety, Logistics
• **Develop HSI Plan**	HSI strategy tailored specifically for program
• **Develop Requirements**	JCIDS level (ICD, CDD, CPD) & SRD
• **Develop Contract Language**	RFP, SOW, SOO, CDRLs, …
• **Review Program Documents**	SEP, IMP/IMS, TEMP, Test plans, LCMP/LCSP, MER, …
• **Participate in Technical and Design Reviews**	HSI risk input for design decisions and reviews
• **Review/ Assess Deliverables**	Review of contractor deliverables and test reports
• **Participate in Logistics planning**	Maintainability, affordability
• **Analyze Trade Space**	Assess complex HSI domain interrelationships

Information for PMs, chief engineers, and functional owners to complement decision making

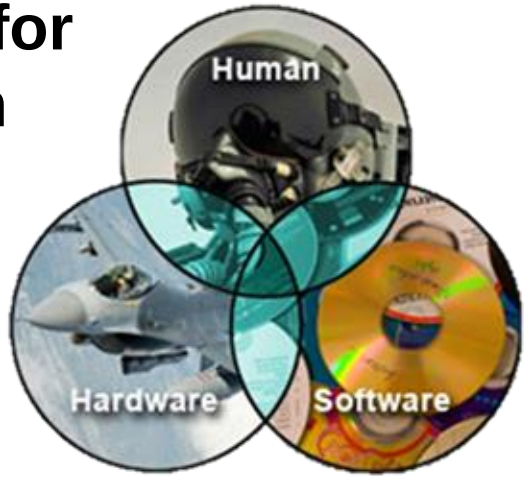
Sample of HSI-Related DIDs

HSI in Systems Engineering	
Systems Engineering Management Plan (SEMP)	DI-SESS-81785
Human Systems Integration	
Human Systems Integration Program Plan (HSIPP)	DI-HFAC-81743
Human Systems Integration Report (HSIR)	DI-HFAC-81883
Manpower and Personnel	
Logistics Product Data Summaries	DI-SESS-81759
Technical Report – Study Services	DI-MISC-80508
Training	
Training Situation Document	DI-SESS-81517
Training Evaluation Document	DI-SESS-81524
Training System Support Document	DI-SESS-81527
Human Factors Engineering	
Human Engineering Test Plan (HETP)	DI-HFAC-80743
HE Design Approach Document – Operator (HEDAD-O)	DI-HFAC-80746
Human Engineering Program Plan (HEPP)	DI-HFAC-81742
Safety and Occupational Health	
System Safety Hazard Analysis Report	DI-SAFT-80101
Threat Hazard Assessment	DI-SAFT-81124
System Safety Program Plan (SSPP)	DI-SAFT-81626

But they all cost money!

Summary

- What is HSI?
  - Systems Engineering!
  - Management & technical strategy for the human component of a system
- Why HSI?
  - Improve system performance
  - Reduce life cycle costs
- Who does HSI?
  - PM is responsible, but we all know the Systems Engineer does the work!
- How to do HSI
  - Apply sound SE processes to <u>all</u> system components: Hardware, Software, & *People*



Questions

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