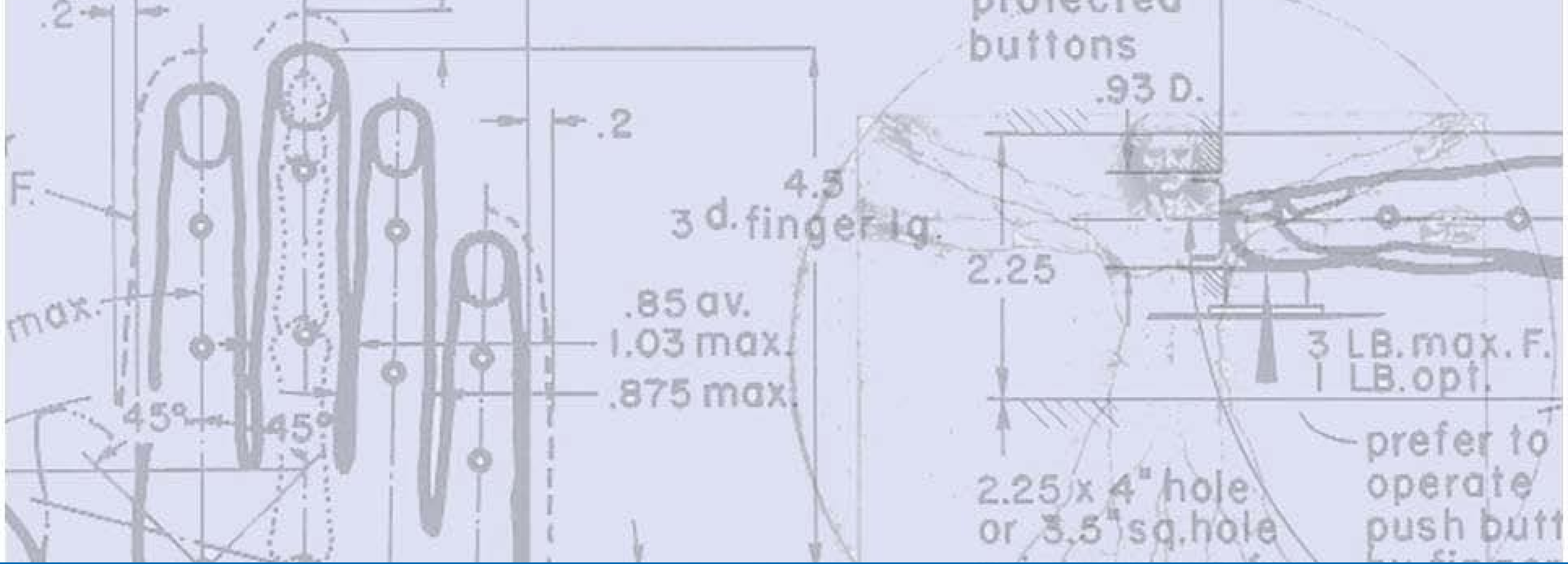

HUMAN SYSTEMS INTEGRATION:

DEFINING AND VALIDATING A FRAMEWORK FOR ENHANCED SYSTEMS DEVELOPMENT

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Human Systems Integration (5.1.4)

NDIA 12th Annual System Engineering Conference, October 26-29, 2009

Understanding the HSI Process

- What: Human Systems Integration is a management and technical process that ensures human capabilities and limitations are considered an essential part of total system performance in each phase of system development.
- Why: HSI Mandate: DoD Instruction 5000.02, Enclosure 8 (HSI)
- How: HSI practitioners employ proven scientific processes, tools, products, and standards to:
  - support concept development, user-centered design, and testing
  - work collaboratively with program managers, engineers, and end-users
- When: HSI technical work is coordinated with the overall needs of the system engineering process to support timely product development in each phase.
- Benefits: Enhances usability, reduces human error, optimizes workload, mitigates safety risks, improves decision-making, operational workflow, and ROI.

Rationale: HSI Process Challenges

- However, both internal and external challenges exist when executing HSI processes.
  - External - Challenges outside of the HSI domain involving stakeholders who directly impact our work process
  - Internal – Challenges within the HSI domain involving coordination of HSI practitioners with varied expertise
- Externally, HSI and system engineering disciplines each have their established set of processes; however, one of the challenges is the effective assimilation of the two.
- Internally, HSI guidance to-date has some limitations:
  - May be written at a level that is ambiguous and difficult to interpret
  - Activities are not always synchronized with acquisition events
  - Limited guidance on collaboration (trade-off) opportunities among HSI practitioners (e.g., Human Factors Engineering and Training)

Mitigation and Purpose

- An HSI Integrated Framework (HSIIF) was developed to provide specific guidance on how to integrate HSI processes, products, and tools into the Defense Acquisition Lifecycle.
  - Referenced DoD policy, guidance, and standards - defined and mapped activities for all HSI domains to each acquisition phase.
  - Scoped activities in the middle at an "action" level vice a higher “policy”, or lower "how-to" level
  - Sequenced activities with system engineering and acquisition events
- The intent of the Framework is to provide a coordinating mechanism, aligned with the Defense Acquisition Lifecycle, to support:
  - Program Managers
  - Technical Authority/Warrant Holders and Program Reviews
  - System Engineering
  - HSI Domain Practitioners

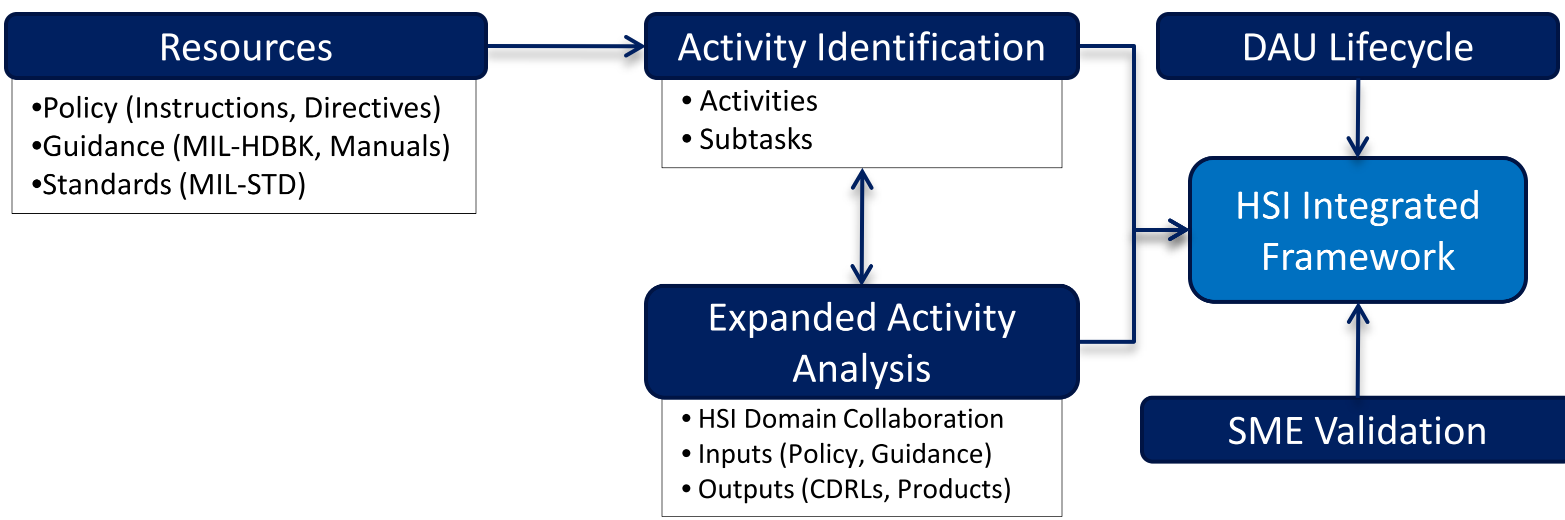
Framework Development Methods

Five primary methods were used to develop the HSI Integrated Framework:

1. *Documentation Review* – DoD policy, guidance, and standards were reviewed for HSI domain relevance
2. *Activity Identification* – Multiple resources (e.g. guidance documents, HSI architecture, manuals, etc) were combined to define HSI activities
3. *Sequence and Timing Analysis* - Key HSI activities were aligned with acquisition events and information from the Defense Acquisition University (DAU) Life Cycle Management System.
4. *SME Validation* – MPT activities were independently reviewed, edited, and validated by a Government MPT SME
5. *Expanded Activity Analysis* – identified and traced inputs (policy documents) and outputs (products) through each activity

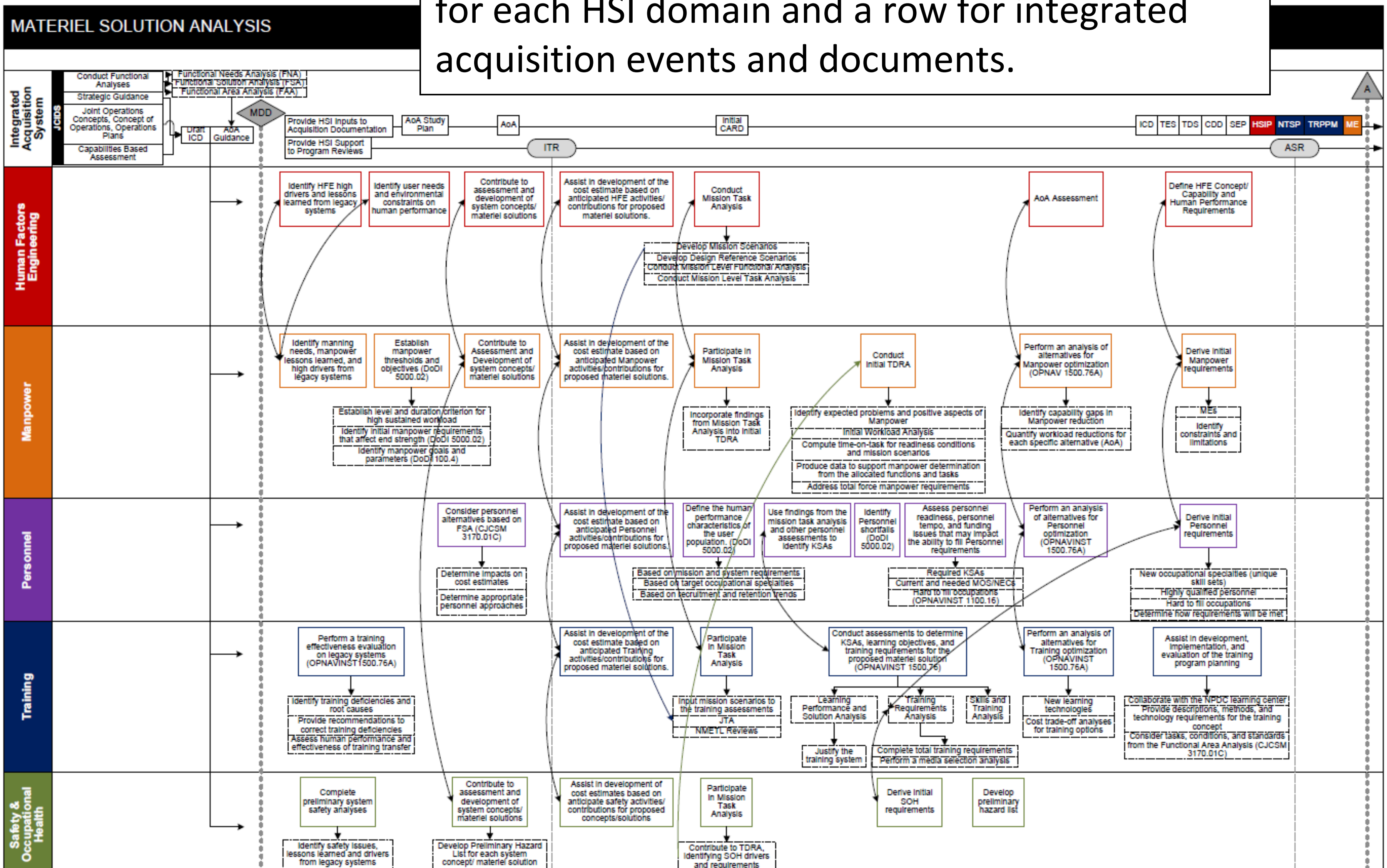
Framework Development Process

- Complete sets of HSI activities across the Defense Acquisition Lifecycle were derived from the analysis of source documentation.
- Timing of HSI activities were analyzed and aligned:
  - With the DAU Lifecycle diagram and relevant acquisition events
  - Between and within the various HSI domains
- An expanded activity analysis derived the inputs and outputs for each of the activities.



Example: HSI Integrated Framework Diagram

Materiel Solution Analysis phase includes rows for each HSI domain and a row for integrated acquisition events and documents.



Example: HSI Integrated Framework Documentation

Policy, Standards, and Guidance for each HSI domain.

DOCUMENTATION

	POLICY	STANDARDS	GUIDANCE
Human Systems Integration	DoDD 5000.01 DoDI 5000.02 SECNAVINST 5000.2D OPNAVINST 5310.23 (draft)		SECNAV M-5000.2 JCIDS Manual [G-A-7] SPAWARINST 5400.3 (Policy within SPAWAR Enterprise) NAVSEAINST 3900.8A (Policy within NAVSEA Enterprise) DAU Guidebook [Ch 6]
Human Factors Engineering	DoDI 5000.02 [Pg. 29 Section 8.c.(1)(c)2.a. & Pg.60 Section 2.a.] SECNAVINST 5000.2D [Encl 7 Pg. 12-13 Section 7.2.3; Pg. 26; Pg. 9] OPNAVINST 5310.23 (draft) [Pg. 2-7 Section 4.f.(5)(a); Pg. 2-9 Section 4.g.(3); Pg. 2-3: Section 2.c.(2)(a); Pg. 3; Pg. 5 (HFE risk)]	MIL-STD-1472F	MIL-HDBK-46855A MIL-HDBK-759C SECNAV M-5000.2 [Encl 7 Pg. 25 Section 7.2.3]
Manpower	DoDI 5000.02 [Pg. 60] DoDD 1100.4 SECNAVINST 5000.2D [Encl 7 Pg. 12-13 Section 7.2.2] OPNAVINST 1000.16K OPNAVINST 1500.76A OPNAVINST 5310.23 (draft) CJCSI 3500.1D CJCSM 3170.1C DoDD 1104.4 DoDD 4630.5 DoDD 5000.1 DoDI 1100.22 DoDI 4630.8 DoDI 8510.1 DoDM 5000.4M	Interim Policy and Procedures for Strategic Manpower Planning and Development of Manpower Estimates OPNAV P-751-1-9-97 OPNAV P-751-2-9-97 OPNAV P-751-3-9-97	NAVPERS 18068F Vol II
Personnel	DoDI 5000.02 [Pg. 60] DoDD 1100.4 SECNAVINST 5000.2D [Encl 7 Pg. 12-13 Section 7.2.2] OPNAVINST 1000.16K OPNAVINST 1500.76A OPNAVINST 5310.23 (draft) CJCSI 3500.1D CJCSM 3170.1C DoDD 4630.5 DoDD 5000.1 DoDI 1100.22 DoDI 4630.8 DoDI 8510.1 DoDM 5000.4M	OPNAV P-751-1-9-97 OPNAV P-751-2-9-97 OPNAV P-751-3-9-97	
Training	DoDI 5000.02 [pg. 61] CJCSI 3500.01E DoDD 1322.18 DoDI 1322.20 DoDI 1322.26 SECNAVINST 5000.2D [Encl 7 Pg. 12-13 Section 7.2.2] OPNAVINST 11102.2 OPNAVINST 1500.76A OPNAVINST 5310.23 (draft) CJCSI 3500.1D CJCSM 3170.1C DoDD 4151.18 DoDD 4630.5 DoDD 5000.1 DoDI 4151.22 DoDI 4630.8 DoDI 8510.1 DoDM 5000.4M NAVSO P-1000 OPNAVINST 3500.34F NNWCINST 12271.1 SPAWARINST 4160.3B	OPNAV P-751-1-9-97 OPNAV P-751-2-9-97 OPNAV P-751-3-9-97 DI-MGMT-81650 DI-SESS-81519B DI-SESS-81520B DI-SESS-81523B DI-SESS-81524B DI-SESS-81526B MPT&ECIOSWIT-ILE-GUID-1B MPT&ECIOSWIT-ILE-GUID-2B MPT&ECIOSWIT-ILE-GUID-3B MPT&ECIOSWIT-ILE-GUID-4A MPT&ECIOSWIT-ILE-GUID-5A MPT&ECIOSWIT-ILE-HDBK-1B MPT&ECIOSWIT-ILE-INTR-1B MPT&ECIOSWIT-ILE-SPEC-1B MPT&ECIOSWIT-ILE-SPEC-2B MPT&ECIOSWIT-ILE-SPEC-3B MPT&ECIOSWIT-ILE-SPEC-4D MPT&ECIOSWIT-ILE-STD-1B	DI-ILSS-81070 DI-SESS-81517B DI-SESS-81518B DI-SESS-81521B DI-SESS-81522B DI-SESS-81525B DI-SESS-81527B MIL-HDBK-29612-1A MIL-HDBK-29612-2A MIL-HDBK-29612-3A MIL-HDBK-29612-4A MIL-HDBK-29612-5 MIL-PRF-29612
ESOH	DoDD 4715.1E DoDD 4151.18 [Pg. 3 Section 3.1.9] DoDI 5000.02 Pg. 61 DoDI 4715.15 OPNAVINST 5310.23 (draft)	MIL-STD-882D MIL-STD-1474D	SECNAV M-5000.2 [Encl 7 Pg. 27 Section 7.3] JCIDS Manual [G-A-7]
Survivability	DoDI 5000.02 Pg.61		JCIDS Manual
Habitability	DoDI 5000.02 Pg.60		

HSI Integrated Framework Version 1.3 DRAFT (9/30/09) - Contact: Pacific Science and Engineering Group/SPAWAR 5.1.4

Summary

The HSI Integrated Framework augments previous HSI guidance efforts by introducing additional capabilities and specificity with respect to:

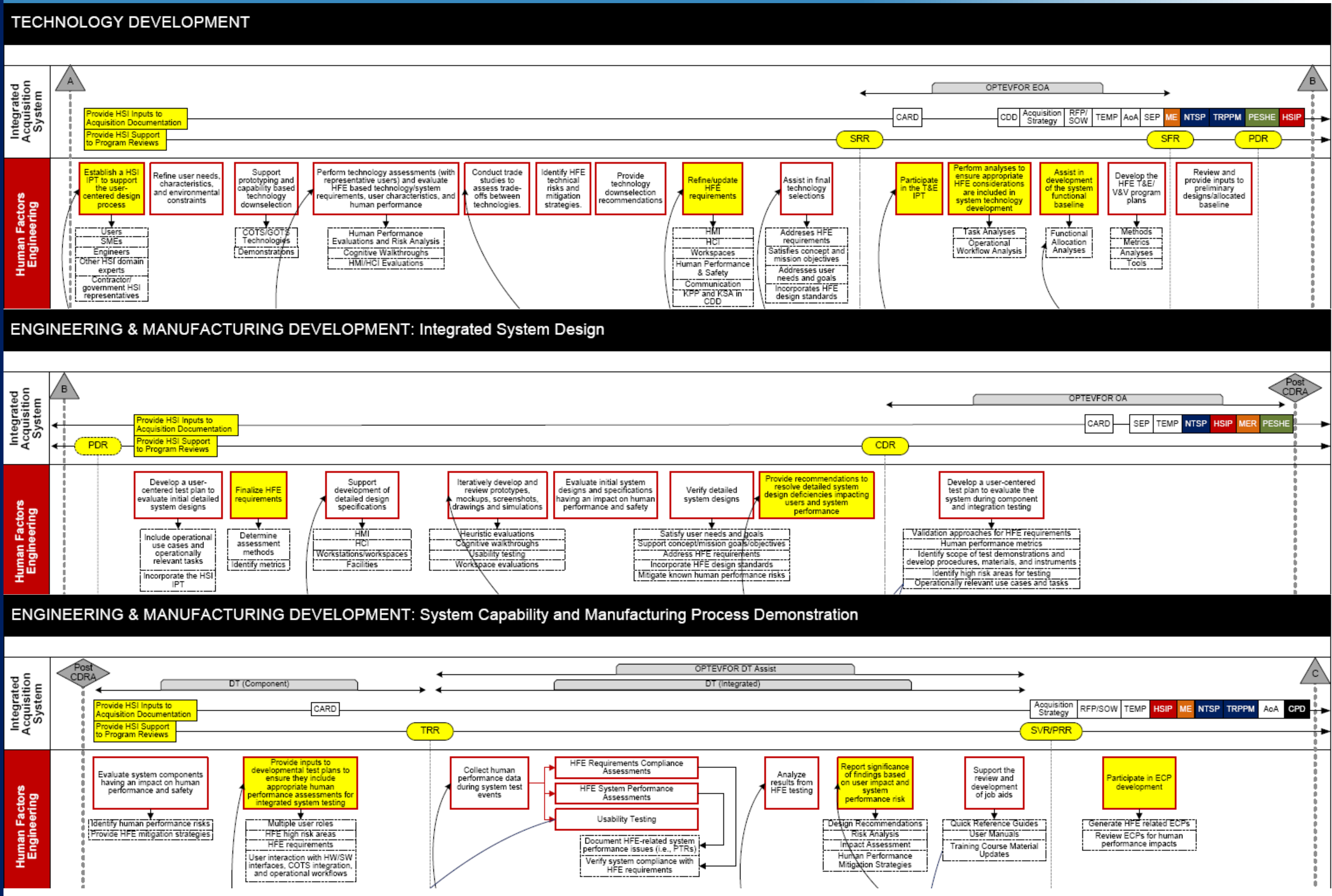
- Individual HSI domains (horizontal)
- Interactions among HSI domains (vertical)
- Sequence and timing of activities with acquisition milestones, documentation, technical reviews, and testing events
- Support for multiple users - Program managers, System Engineering, Technical Authority/Warrant Holder, and HSI practitioners
- Identification of inputs and outputs for each activity
- Tasks and products from HSI best practices and past acquisition program support experience (lessons learned)

A FRAMEWORK VALIDATION: METMF(R) NEXGEN

METMF(R) NEXGEN

- The Mobile Meteorological Facility (Replacement) Next Generation (METMF(R) NEXGEN) is a USMC mobile tactical meteorological system designed in a sheltered HMMWV in support of the Marine Air Ground Task Force (MAGTF).
  - Up-armored sheltered HMMWV with tactical trailer
  - 4 modes of operation (Full, Limited, Remote, Stand-alone)
  - 3 racks of equipment, 3 displays, and 2 operator workstations
  - 5 major sensor systems with 25 cases
  - Multiple communication pathways
- HSI-related Key Performance Parameter (KPP): Full setup in 3-hours with 8 Marines and Limited setup in 1-hour with 2 Marines.
- Sub-systems must be stored within a limited space and used safely and efficiently by operators and technicians within tight time constraints under various environmental conditions.

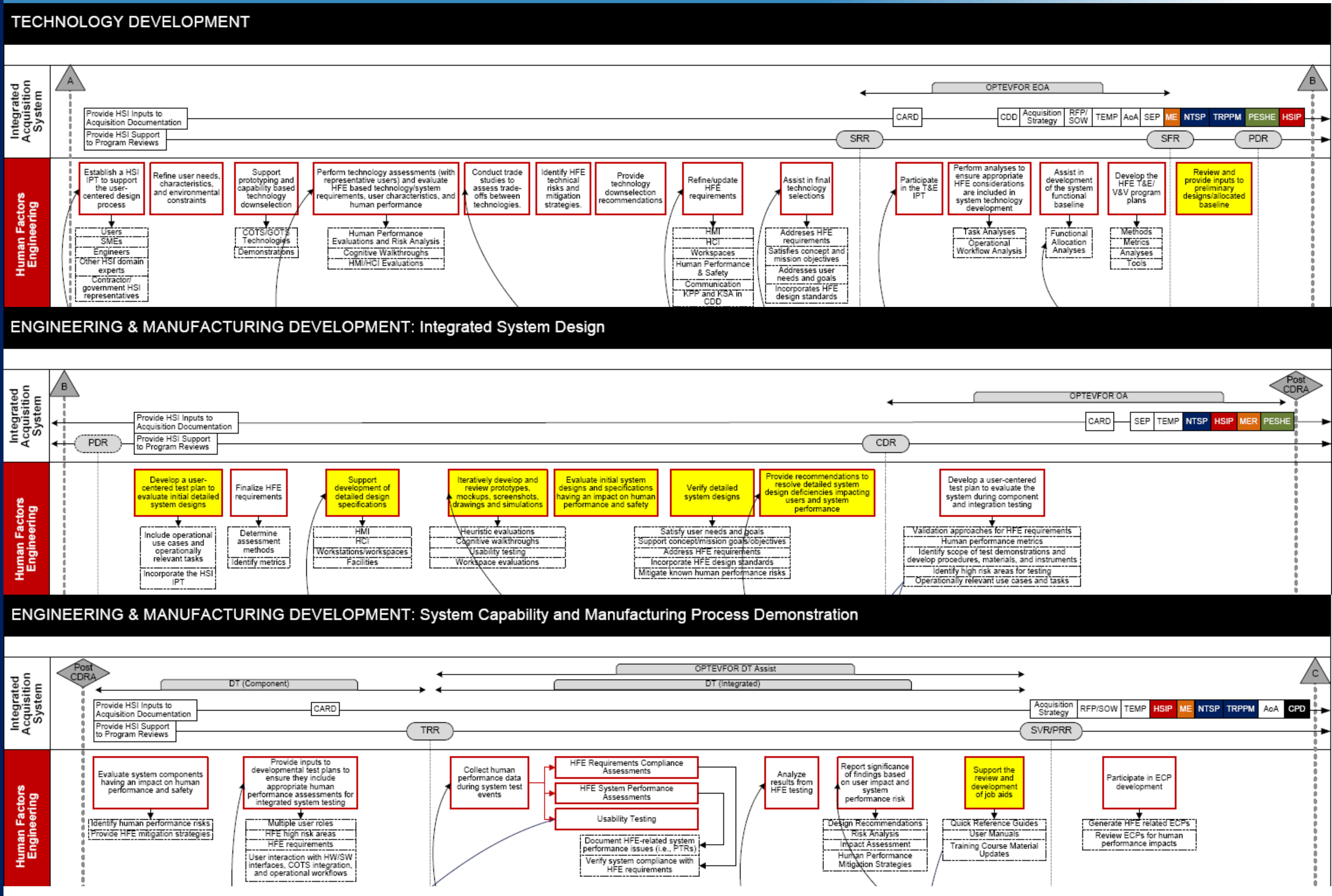
HSIIF in METMF(R) NEXGEN HSI Program Office Support



METMF(R) NEXGEN: HSI Program Office Support

- Provided continuous HSI analyses and products to support requirements definition, through design and integration, and into test and evaluation
- Performed user advocacy role with engineering team
- Participated in System Engineering Technical Reviews as HSI representative
    - SRR, SFR, PDR, CDR, IPRs, TRR, SVR
- Participated in Government design and testing meetings
- Reviewed and provided inputs to HSI-related CDRLs
    - e.g., user manuals, training materials
- Provided inputs to Government acquisition documents
    - e.g., CDD, TEMP, CPD

HSIIF in METMF(R) NEXGEN Design Support

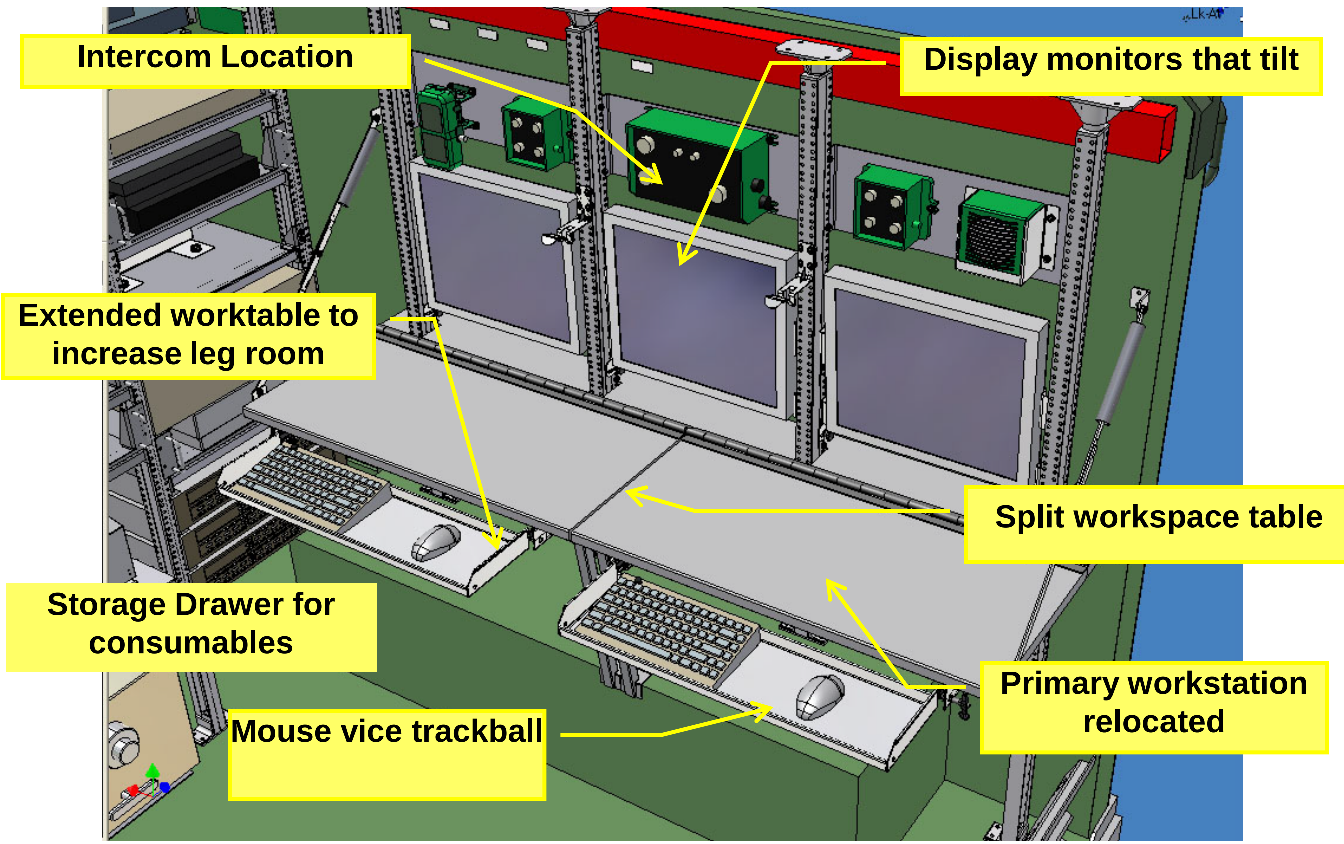


METMF(R) NEXGEN: Design Support

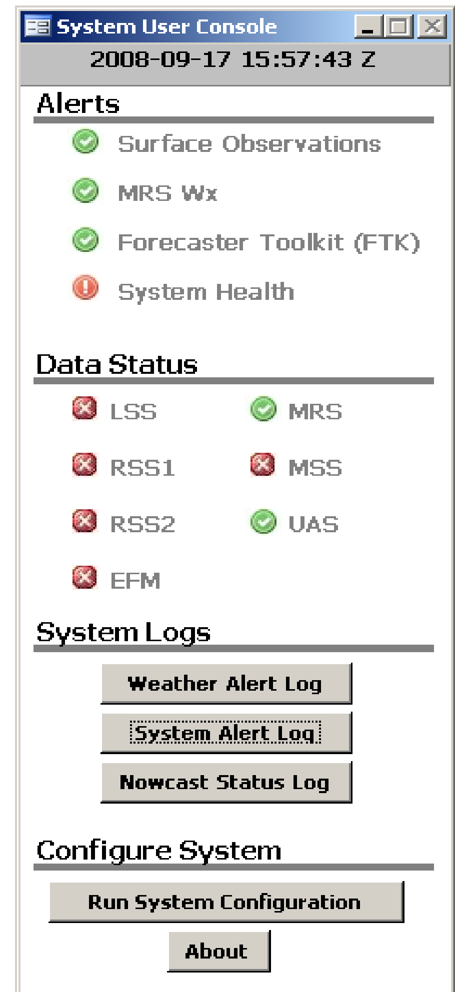
- Leveraged capabilities and requirements documents, user workflows, and user needs assessment to scope design efforts
- Facilitated multiple HSI Working Groups with users and engineers to work through operational task flows.
  - Derived 82 detailed system design requirements and generated 7 new design concepts across 10 sub-systems to optimize system performance and safety during meteorological operations
- Provided human factors design inputs and recommendations to:
  1. Organization and placement of controls and displays in the shelter
  2. Ergonomic design of physical workstations
  3. Design and usability of software user interfaces
  4. Alerting and system status displays
  5. Mitigation of safety risks
  6. Coding and labeling of 25 sub-system cases, cables, and controls
  7. Shelter and trailer pack-out configurations
  8. Inclusion of human engineering standards

METMF(R) NEXGEN: Example Design Concepts

- Provided workspace design inputs
- Designed system user console (GUI)



View of Passenger Side Wall

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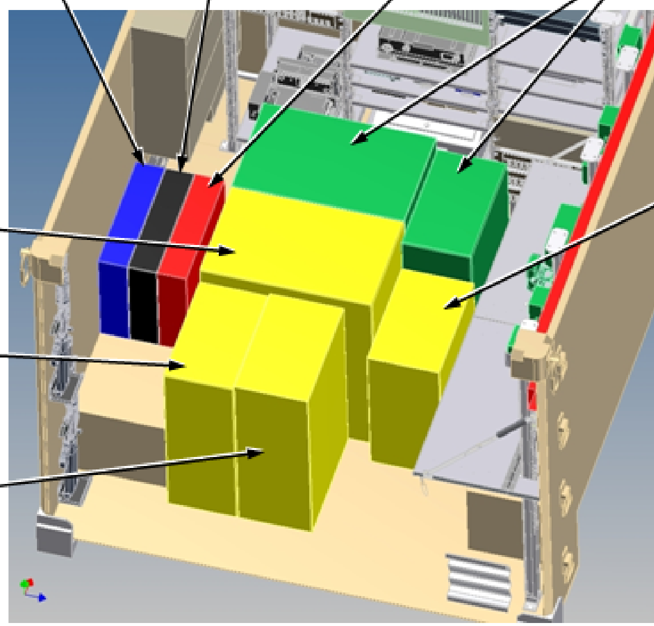
METMF(R) NEXGEN: Shelter Storage

Smart storage of local sensor suite and satellite receiver facilitates rapid deployment requirement to reach initial capability with 2 Marines in 1 hour.

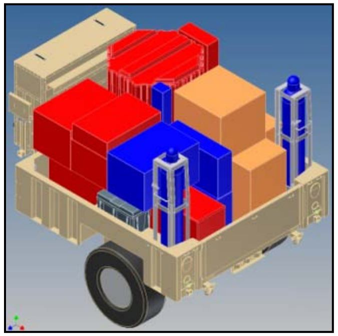


Legend

Red:	RADAR
Blue:	Upper Air System (UAS)
Yellow:	Local Surface Sensor (LSS)
Green:	Satellite
Black:	Broadband Global Area Network (BGAN)

METMF(R) NEXGEN: Trailer Storage

- Flexible configuration for additional hatches, side or roof mounted equipment, and cable pass-thru openings.
- Trailer can be packed differently to accommodate various operational scenarios.
- Equipment is grouped by sub-system.
- Modifications: tie-down configurations, cable reel storage, helium transport, & radar mast mount.



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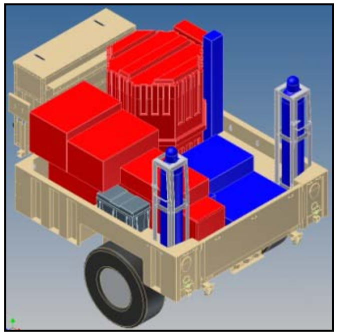

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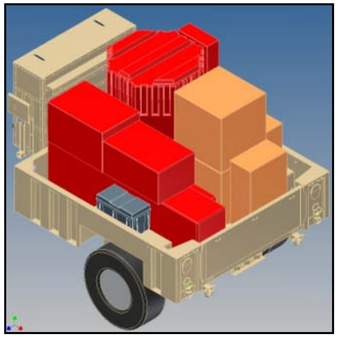

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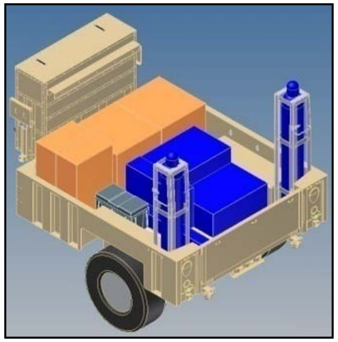
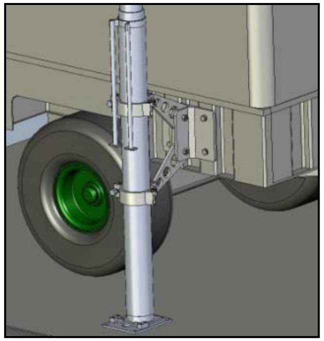
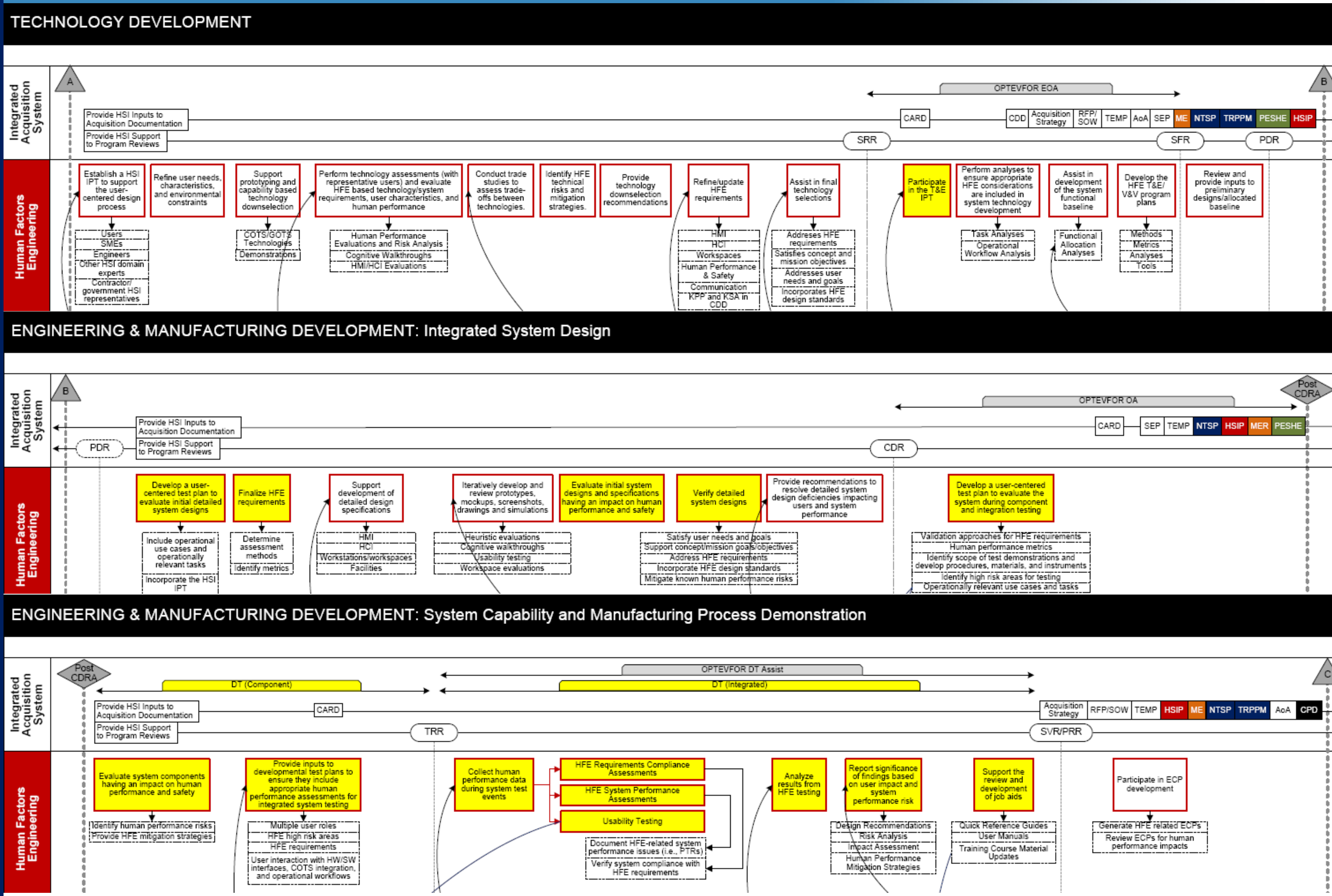


No RADAR



RADAR Mast Mount

HSIIF in METMF(R) Testing Support

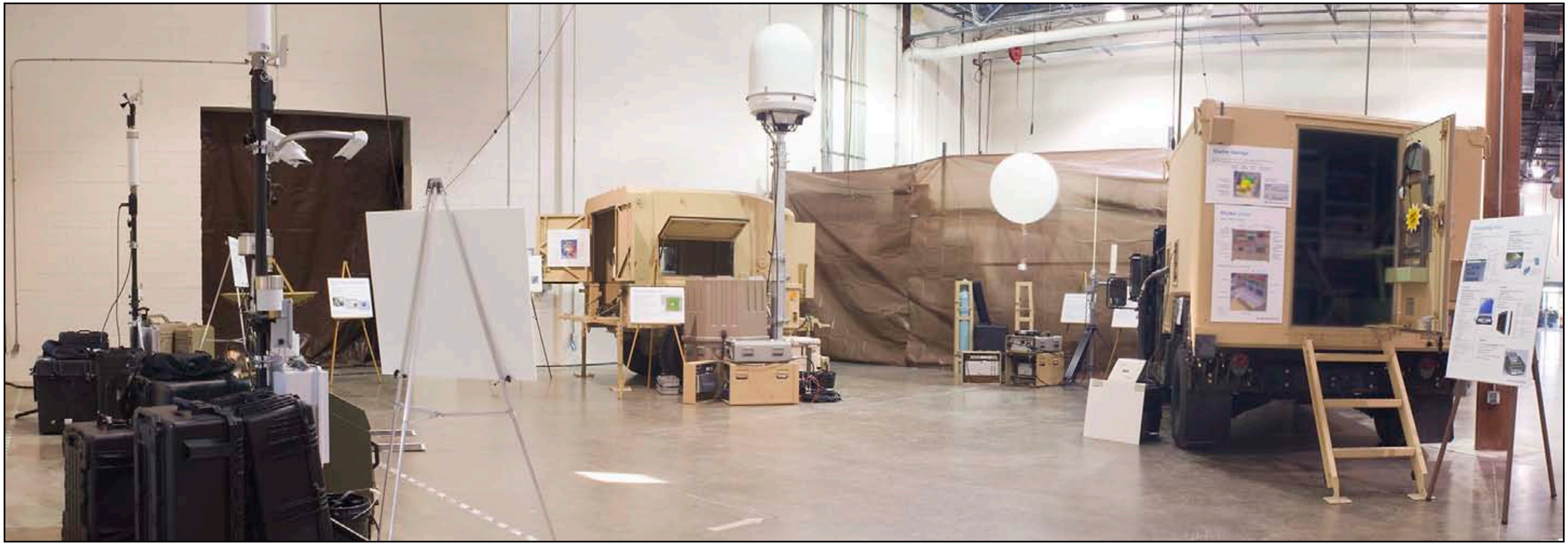


METMF(R): HSI Testing Support

- Ensured DT/OT test plans included procedures consistent with operational task flows to support human performance assessments.
- Supported data collection and performed direct observations and assessments with users during contractor and government test events.
- HSI DT/OT evaluations included:
  - Verification and validation of HSI *system* and HFE *design* requirements
  - Ergonomic and usability assessments
  - Occupational safety hazard assessments
  - Assessments of human performance risk (workload, safety, error)
- HSI findings and recommendations from DT/OT evaluations:
  - Solutions/mitigation strategies for high-risk human performance areas
  - Shelter and trailer hardware pack-out guidance
  - Various user Quick Reference Guides (QRGs)
  - Inputs to user manuals and training material
  - Task-based analysis and redesign of the system configuration user interface
  - Feedback on system usability, user impact, and any existing or future operational HSI issues

METMF(R) NEXGEN:
Work Environment Assessment

- Optimized Embark/Debark procedures
- Identified safety hazards and mitigation strategies (e.g., power-on, cable trip hazards, lift and carry, visible labeling)
- Determined sensor placement for different operational configurations
- Optimized spatial workflow during sensor setup and initialization to meet 1-hour (with 2 Marines) and 3-hour (with 8 Marines) observation and dissemination requirements



METMF(R) NEXGEN: Summary

HSI Successes

- HSI improved the usability and design of the METMF(R) NEXGEN by reducing operator workload, human error, and safety hazards. This helped maximize the throughput of the system, its capabilities, and operational utility.
- HSI enabled the program office to make key decisions as a result of the HSI analyses that identified system- and operational-level human performance risks
- Integrated HSI processes, analyses, and products with:
  - System engineering and program management – addressed external challenge
  - Other HSI domains (i.e., HFE, Training, and Safety) – addressed internal challenge

Conclusions

The HSI Integrated Framework:

- makes HSI activities explicit and facilitates the alignment of tasks and products among all stakeholders.
- can help identify HSI activity gaps relative to other acquisition activities which can be used to support future HSI policy and requirements.
- supports the consistent application of HSI processes, tools, and products within the acquisition community to mitigate human performance shortfalls and maximize system effectiveness.

Contact

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