Human Factors/Habitability Technology Area

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Agenda

- Operational Environment
- Lessons Learned
- Current State of the Art
- Technology Challenges

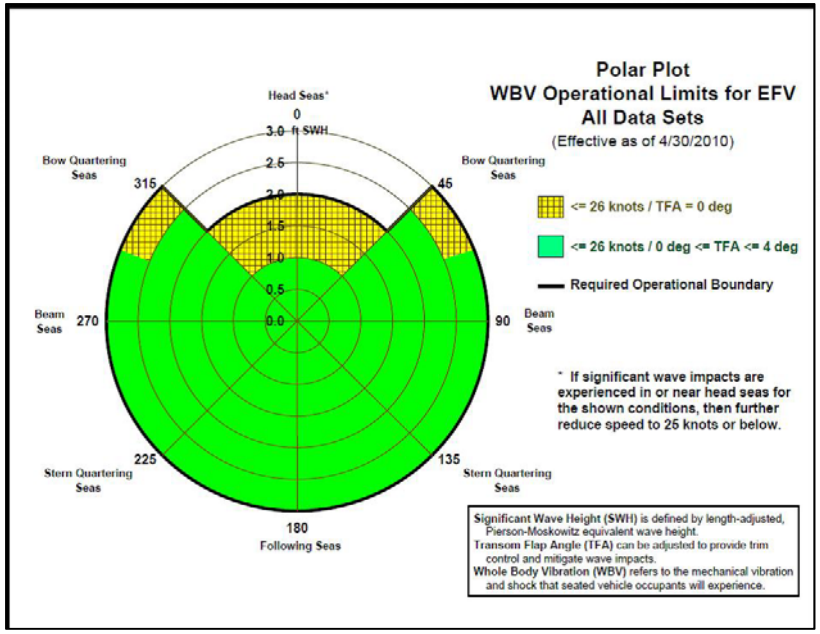
Operational Environment

- **Craft motion**
  - Repeated mechanical shock
  - Motion Induced Interruptions (MII)
  - Whole Body Vibration (WBV)
    - Impact injury risk – acute and chronic: musculoskeletal, mTBI, performance degradation
  - Motion Sickness Incidence (MSI)
  - Motion Induced Fatigue (MIF)
  - Sopite Syndrome
- **Temperature variations/Humidity**
  - Heat stress
  - Cold stress
- **Noise**
  - Hearing loss
  - Comunication issues
- **Air quality issues**
  - Hydraulic fluid, Fuel, Exhaust fumes, Emesis
    - Chronic health, vigilance issues, and quality of life issues
- **Lighting**
  - Reduced Situation Awareness (SA)
  - Degradation in communication
  - Degradation in task performance
- **Biohazards**

All may be exacerbated due to length of exposure

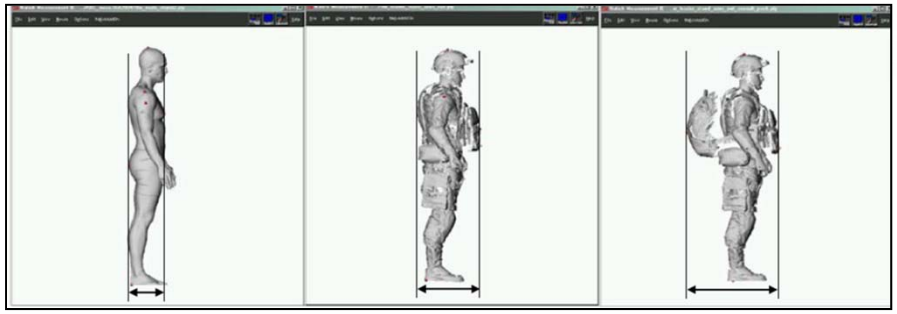
Lessons Learned

- AAV and EFV habitability assessments conducted at Camp Pendleton, CA. in FY11 and at NSWC Panama City Division, FL. in FY13 focused on the impact of duration at sea on the following mission essential tasks: perceive, communication, move, shoot
  - Results of these studies suggest a relationship between duration and performance degradation, but not so much that the missions are jeopardized, even after three hours in SS3
- Analysis of EFV acceleration data at planing speed in mid SS2 conditions (SWH 1.99’ to 3.18’ per 6.07 sec to 8.27 sec) indicates operation within safe limits for chronic injury



Lessons Learned

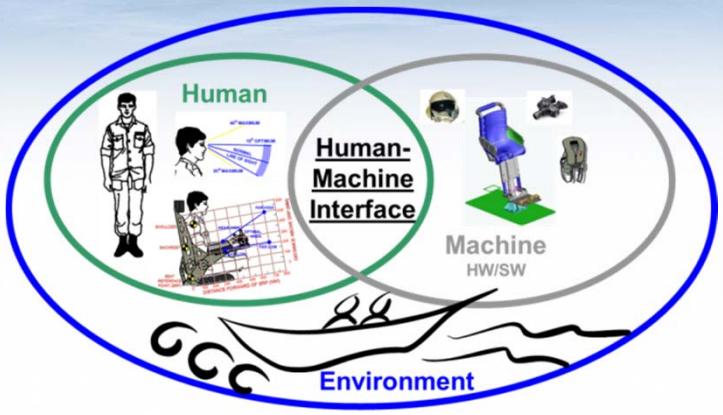
- Acute head injury in Hawaii suggests potential issue with cockpit layout, anthropometric accommodation, and/or driver tasks
  - 3-D illustration depicts (left to right) male in uniform, with body armor, and with body armor and gear bag. Operators and passengers wearing body armor require an estimated 25% more space.



- Incidents of heat exhaustion during Camp Pendleton test amplify need for reliable HVAC during all phases of mission
- Habitability tests performed at Camp Pendleton, CA and Panama City, FL provide some answers regarding Marine performance following at sea transits of varying duration and sea state

Current State of the Art

Developers follow a systems engineering approach where they recognize operators, passengers, and end users as essential components of the system being developed.



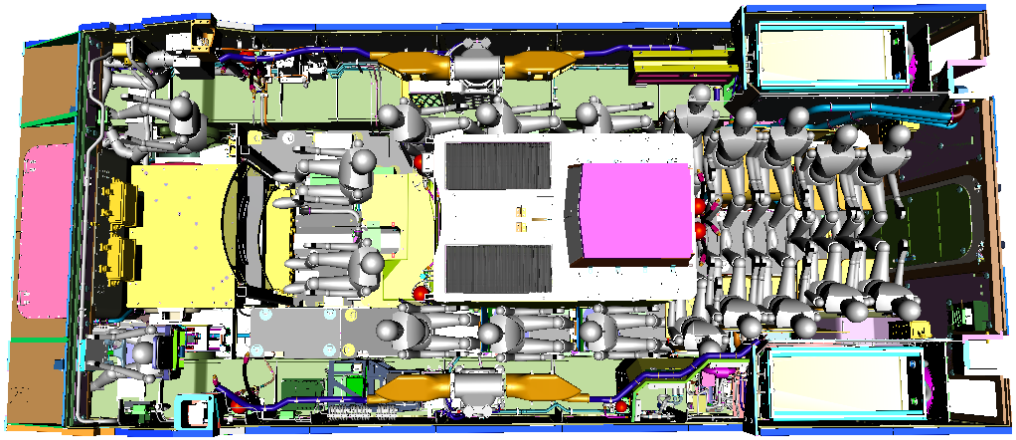
Considering the Total System

- These human 'components' have well documented capabilities, limitations, and cultural expectations which can be greatly impacted by (to the decrement of the mission) by design considerations.
- Sources for this information include:
  - MIL-STD-1472G, "DoD Design Criteria Standard - Human Engineering, 11 January 2012"
  - High Speed Craft Human Factors Engineering Design Guide ABCD-TR-08-01 V1.0
- Designs must consider what mission essential tasks must be performed, by who, with what equipment, and under what operational conditions
  - Essential analyzes include task analysis, function allocation analysis, and manning analysis

Current State of the Art

- Example 1: An ACV driver repeatedly exposed to greater than 4.7MPa spine stress dose values has a greater than 50% likelihood of a chronic lower back injury during his career (MIL-STD-1472G).
- It's well documented that acceleration values aboard watercraft tend to increase from stern to bow, particularly in incidents of slamming.
- Despite this, EFV drivers sit in the very front of the vehicle.

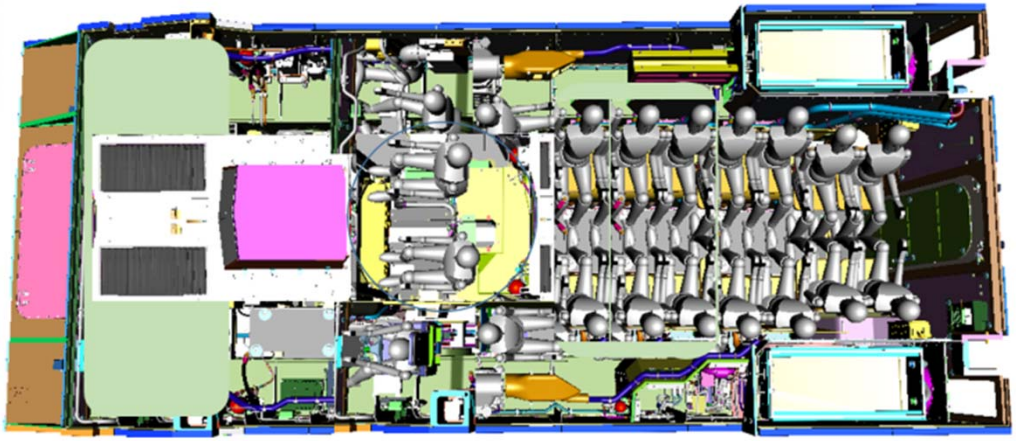
Current EFVP



Current State of the Art

- Considerations during design:
  - Keeping crew and passengers aft of the forward 1/3rd of the craft
  - Moving the engine forward

Notional Design Change

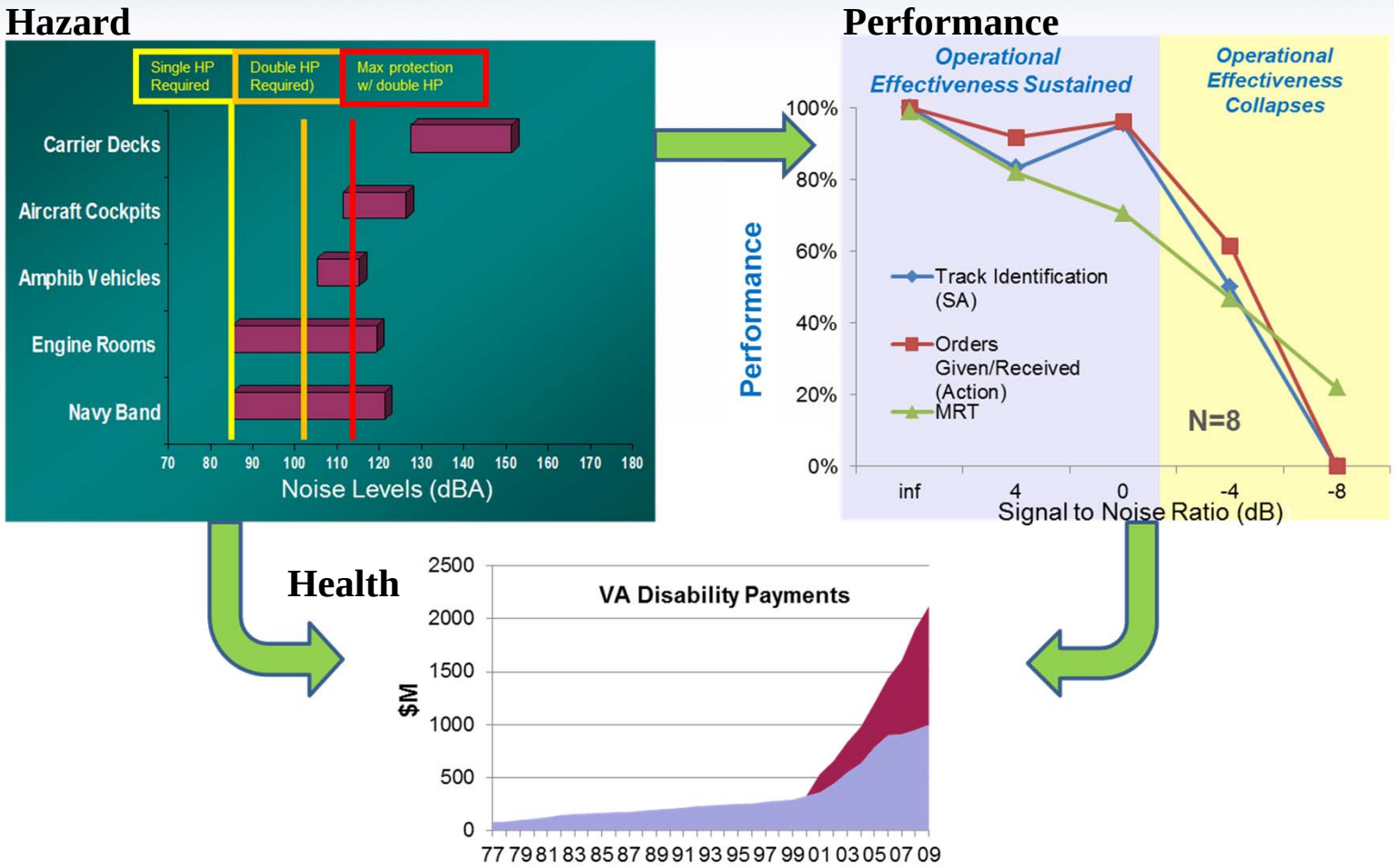


- Would likely have resulted in:
  - Less cumulative exposure to crew and passengers
  - Lower vertical accelerations at bow
  - Higher speed and greater range before encountering dangerous exposure levels
  - Also, easier/safer emergency egress and visual communication between crew and passengers

Technology Challenge: Optimal CG for sea ops may conflict with optimal land ops CG

Current State of the Art

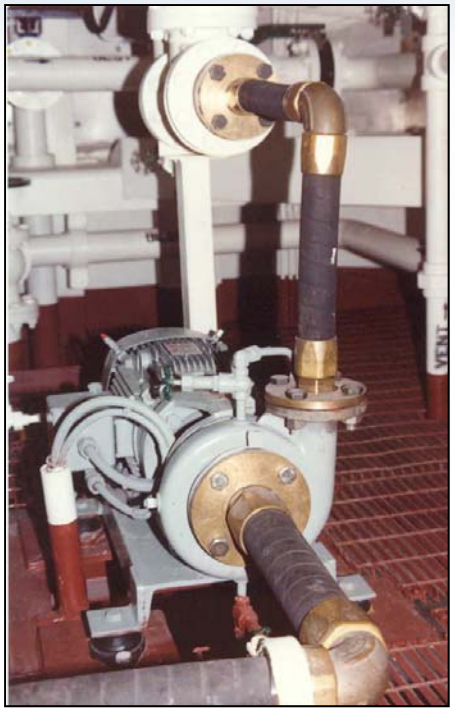
- Example 2: Hazardous noise impacts performance and health.

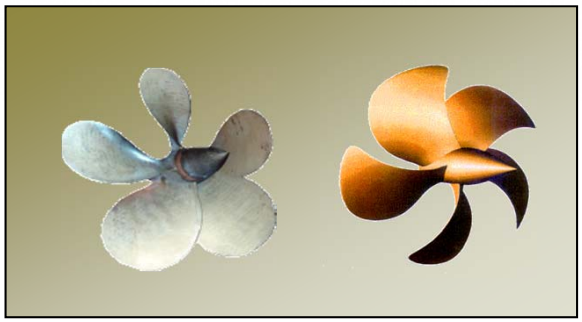


Current State of the Art

Sources of noise are well known and can be more easily and cost effectively addressed during design.

- Fans
- Ventilation
- Motors
- Pumps
- Propellers





Treating the problem after major design decisions via post design insulation, secondary hearing protection and greater reliance on intercom systems can unnecessarily add burdens for the Marines

Technology Challenges

- Design attributes and technologies that limit repeated impact exposure within safe, published limits
  - During sea transits in greater than SS3 conditions, at planing speeds
  - During ground transits on tertiary roads and off road, at speeds necessitated by CONOPS
- Technologies that reduce MSI
- Design attributes and technologies that limit WBV exposure to within safe, published limits
- Quieting technologies that are affordable and do not significantly add weight
- A variable CG solution - providing optimal weight distribution when transitioning to plane, for ride quality during water transit, and during land operations
- Optimal/safe air quality and temperature control during all phases of vehicle activity