



Soldier Performance Issues in C2 “On the Move”

Susan G. Hill
Richard A. Tauson

Human Research and Engineering Directorate
US Army Research Laboratory
Aberdeen Proving Ground, Maryland, US

June 2005



Presentation Outline



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- What is “On the Move”?
- Past On the Move studies
- Soldier Performance Issues
- Potential Areas for Mitigation
- Summary





The Issue of “On the Move” for Soldiers



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Future systems will rely on increased mobility and networking.
- Mobility – more operations on the move.
- Networking – reliance on computer-based operations.
- What are the effects of vehicle movement on Soldier performance?
 - Performance in moving vehicles, especially computer-based, visually intensive tasks.
 - Performance *during* motion and *after* motion.
- Information needed to support design of future crew stations and vehicles.
- Also referred to as “vehicle motion effects”



What We Mean by Motion Effects



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- **Motion effects:**
 - Soldier performance degradation associated with operations in moving vehicles.**
 - Includes immediate effect and persistent after effects
 - Includes sensory degradation; cognitive processes; motor control
- **Environment**
 - Vibration (vehicle weight & suspension; seat design)
 - Noise
 - Air quality (O₂, CO, temperature)
- **Task**
 - Visual demands (displays, fixation times, crew interactions)
 - Motor demands (data input; control input)
 - Cognitive demands
 - Task time & duration
- **Soldier**
 - Personal susceptibility
 - Other stressors (fitness, fatigue)
 - Training





Moving Operations Causes Soldier Degradation



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Tests in a variety of current vehicles have shown degradation in Soldier performance.

C2V



AAAV



HMMWV



MACS 113



Moving Operations Causes Soldier Degradation



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

C2V



AAAV



MACS 113

HMMWV

- Indirect Driving of a HMMWV caused 20-30% decreases in speed, 120-200% increases in driving errors, and 20% of drivers were unable to complete the task because of motion sickness. Indirect driving also increased perceived workload and stress.
- In a modified M113 cognitive task performance was less accurate (7-46%) and slower (7-40%) during moving operations.
- In a moving Amphibious Assault Vehicle 74% of the Marines tested reported moderate to severe motion sickness symptoms after working at computer workstations.

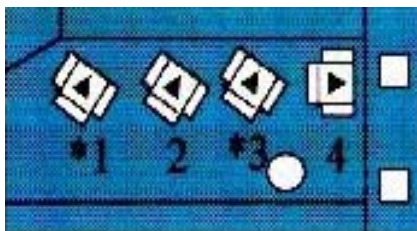


C2V 1998 Study



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- In the Command and Control Vehicle (C2V), 55% of the Soldiers tested had moderate to severe motion sickness; 37% were functionally incapacitated.



Video clip from the C2V 1998 study showed Soldier performance decrements



Soldier Performance in Moving Vehicles is an FCS Risk



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Multiple studies show Soldier performance degradation.
- Vehicular-induced motion effects are a risk to future operations.
 - Seriousness will depend on mission, vehicle and Soldier performance required.
- Recognized as FCS Program Risk C-146.



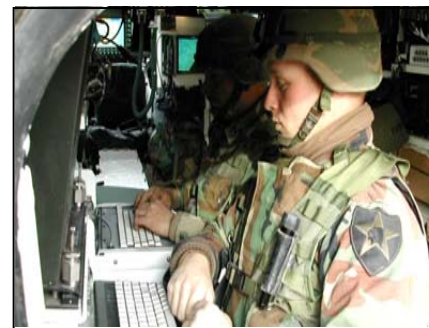
What tasks will Soldiers perform in moving operations?



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH



Training



Command and Control

Variety of tasks in moving vehicles



Mission Rehearsal



Indirect Vision Driving



Robotic Control



Soldier Performance Issues



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Vibration
- Visual Displays
- Manual Control
- Interactions among Soldiers
 - Communications
 - Collaboration
- Cognitive Functions
- Workload



Motion Effects Issues to Address



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- **Information Display**

Fonts; sizes; location on display; text reading; symbol recognition; animations; dynamic (or adaptive) displays; use of audio vs. visual, spatial vs. mono audio; display stabilization; display-motion coupling.

- **Information Input**

Input device (e.g., joystick, touch); sketching; alphanumeric input; point & click; speech recognition; wearable vs. vehicle-mounted; stabilization.

- **Cognitive Tasks**

Memory; situational awareness and understanding; communication; coordination; decision-making.

- **Workstation**

Seat; restraints; vibration profiles; location and orientation; functional reaches; airflow & quality; Environmental Control Unit requirements.



Design Guidance Available



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Vibration Standards
- Human Factors Engineering Standards
- FCS Vehicle Motion Effects Design Guidelines



Potential Areas for Mitigation of Vehicle Motion Effects



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Mitigation
 - Anything that reduces Soldier performance degradation or enhances performance during (or following) riding or operating in moving vehicles.
- Address Environment, Task and Soldier Factors
- Potential areas for mitigation
 - Design
 - Personnel selection
 - Training
 - Other interventions



Examples of Potential Mitigation Technologies



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- **Environment**

- Air circulation and cooling
- Vibration frequency control (vehicle & seat suspension)

- **Task**

- External visual references
 - Artificial horizons
 - Display – motion coupling (display stabilization)
 - Virtual window
- Display
 - Fresnel lens; font size; critical information placement
 - Replace visual with audio
- Control adaptations
 - Soft-key sizing; cursor devices; data input devices; vibration-cancellation joysticks
- Doctrinal changes (restricting tasks done during movement)



- **Soldier**

- Adaptive training (NASA's AFT; hyperstimulation)
- Medical intervention (wristband; medication)





Design



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Vehicle vibration
- Air quality
- Workstation
- Displays and controls
- Artificial horizons





Personnel Selection



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Reliable tests for performance
- Willingness to use only less susceptible Soldiers for “on the move” tasks.

- Promising approaches
 - Adaptation
 - Biofeedback
 - Knowledge of vehicle motion effects
- Training resources





Other Interventions

HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH



- Medical
 - Pharmaceuticals
 - Devices
- Diet



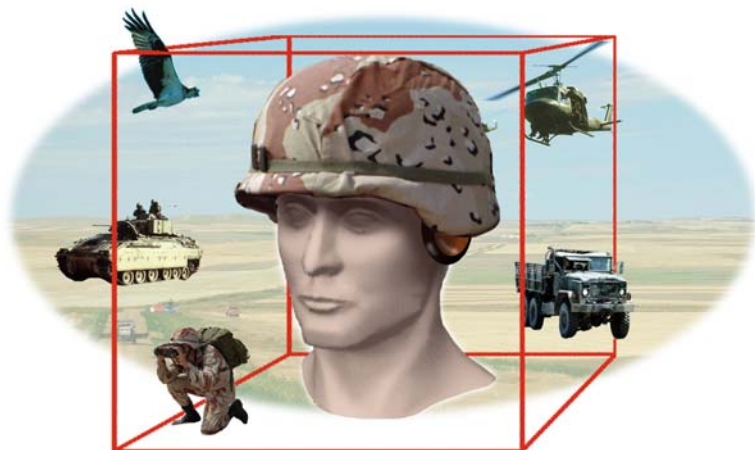


Areas for Further Research



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Collaboration and Communication During Vehicle Movement
 - Multi-person team vs. Individual performance
 - Co-located vs. Distributed teams



- Soldier-Machine Interface studies
- Multimodal interface mitigation studies



ARL-HRED Experimental Shelter Truck



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH



- Contains two workstations
- 18" touch panel displays
- Using for further research





Summary



HUMAN RESEARCH AND ENGINEERING DIRECTORATE • CREWSTATION BRANCH

- Future systems will rely on mobility and networking, i.e. increased computer operations in moving vehicles.
- Research and experience suggest that Soldier performance is affected by performing in moving vehicles.
- Various tasks may be affected differently.
- Potential mitigations exist in the areas of environment, task, and Soldier characteristics.
- Mitigations need to be assessed in the expected operational environments.
- Bottom line – Soldier Performance.