Human Performance

Human Performance and Effectiveness in a System-of-Systems

Highlights

Why is Human Performance important?

- Humans contribute to 20-53% of system failures (Shapiro et al. 1960)
- Human performance can degrade significantly in military situations (Lieberman et al. 2005)
- The military has identified Human Performance Modeling as a challenge and as a requirement (DoD 5000.59-P, 1995)
- SoS analysis without humans is optimistic

What are the objectives for developing this capability?

- Capture the inherent unpredictability of a large population of human participants
- Incorporate enough detail in human performance to allow a realistic view of an operating system-of-systems

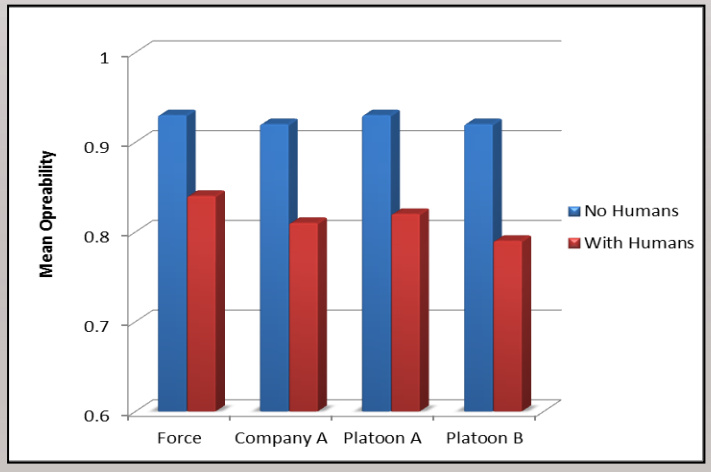
What are the research areas?

- Future research: Adaptive SoSAT—using full cognitive models of decision makers to evaluate adaptive behavior of a system-of-systems:
    - In case of combat damage
    - In severe environmental conditions

Human Performance Overview

Assessing the involvement of humans in a system-of-systems (SoS) is difficult because of the number of humans and the poorly defined nature and variety of tasks that each human must perform. Sandia has developed an approach to the problem that is analogous to hardware reliability modeling. In this approach, tasks are generalized. Human "inoperability" is a function of human error rate and human recovery time, for recoverable errors. For non-recoverable errors, human failure is a function of catastrophic failure rate with an associated replacement time. Also, as with hardware systems, the environment can affect human performance; performance-shaping factors, such as stress and fatigue, can be used to modify the human error rate. The resulting human performance model has been incorporated in the System of Systems Analysis Toolset (SoSAT). SoS assessments with the human performance model indicate that human errors contribute to approximately 30% of the unavailability of the force, a fraction that is consistent with values reported in literature.

Example results showing a marked decrease in



Human Performance

Key Features

Conceptual Understanding

- Extension of the work of Swain (1963) and Swain and Guttmann (1982)
- Generalized task concept and opportunity for failure. Basic human error rate and time-to-recover
- Catastrophic failure rate and replacement time
- Performance-shaping factors:
    - Effects of fatigue, cognitive fatigue, and stress
    - Adjustments for training, experience, and perceptual skill

Human Performance Model (HPM)

- Human Elements are included in SoSAT
- Humans have their own attributes and properties
- Humans can impact results through direct system failure, breaking a logistics chain, or causing repair delay
- Human elements can be assigned to any system:
    - Human systems, e.g., to model an officer in charge of more than one system
    - Platforms, e.g., to model soldiers assigned to a single platform
- Human elements can be part of Mechanics Collections (a pool construct added to SoSAT):
    - Mechanics can be assigned specific skill types and levels of capability
    - Specific mechanic types can be required for repairs of specific preliminary elements

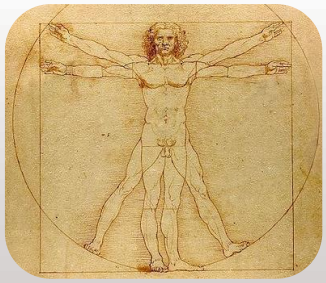
Key Benefits

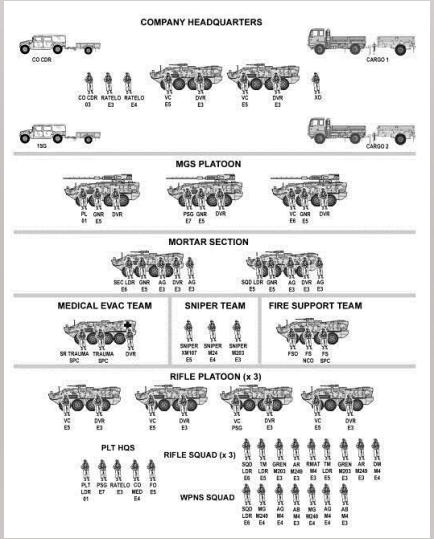
Existing Capability to Model Humans in a SoS

- Human performance is important in addressing real-world SoS issues
- Sandia has developed and implemented the capability to include 100s/1000s of humans in a SoSAT simulation

SoS Assessment

- Determine realistic sustainment availability
- Determine realistic mission vulnerabilities
- Evaluate where training (including cross training) and leader development make the most difference:
    - What General Technical (GT) test scores are needed for what positions?
- Assess formation issues:
    - #Battalions, #Companies/Battalion?
    - Reorganize the Maintenance Battalion, e.g., with Forward Logistics Companies?
- How many MPs, Battle Captains?





Contact Us

Bruce Thompson
CSR Program Lead, Manager
Tel: (505) 284-4949
bmthomp@sandia.gov

U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2011-7798 P
Sandia National Laboratories