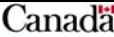


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## Presentation Overview

- Definitions
  - Human Systems Integration
  - Human Factors Engineering
- The Soldier as a System
- Key Challenges to Effective Soldier Systems Integration
- Lessons Learned, Tools & Opportunities for more effective HSI in soldier systems

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**Human Systems Integration:** the technical process of integrating the 5 HSI domains with a materiel system to ensure safe, effective operability and supportability of the system:

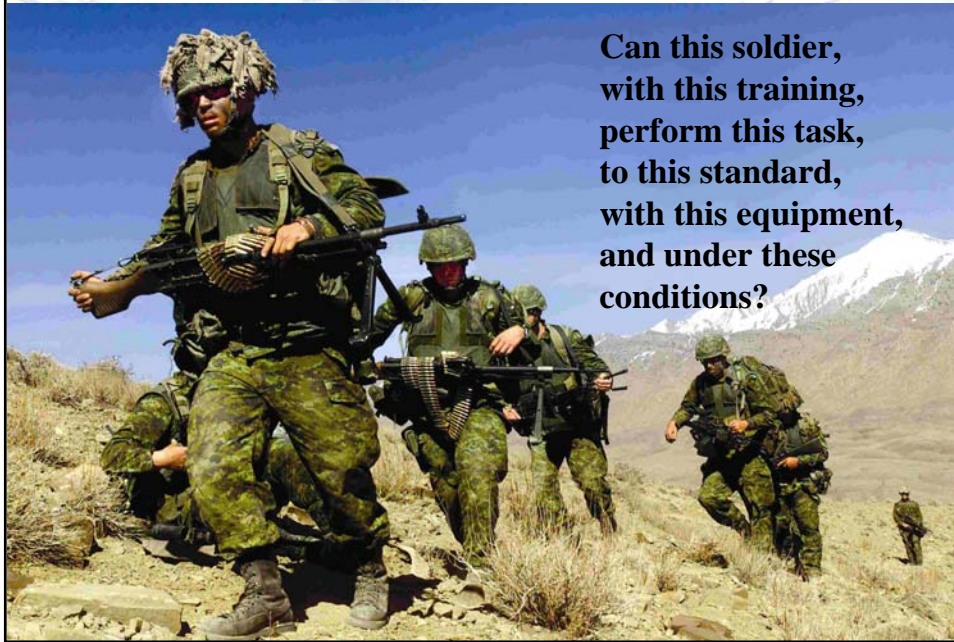
- Human Factors Engineering
- Manpower and Personnel
- Training
- System Safety
- Health Hazard Assessment



**Human Factors Engineering:**

Application of knowledge of human characteristics, capabilities, limitations and needs to the specification, design, development, testing and acquisition of equipment and systems (multi-disciplinary field combining psychology, physiology & engineering)



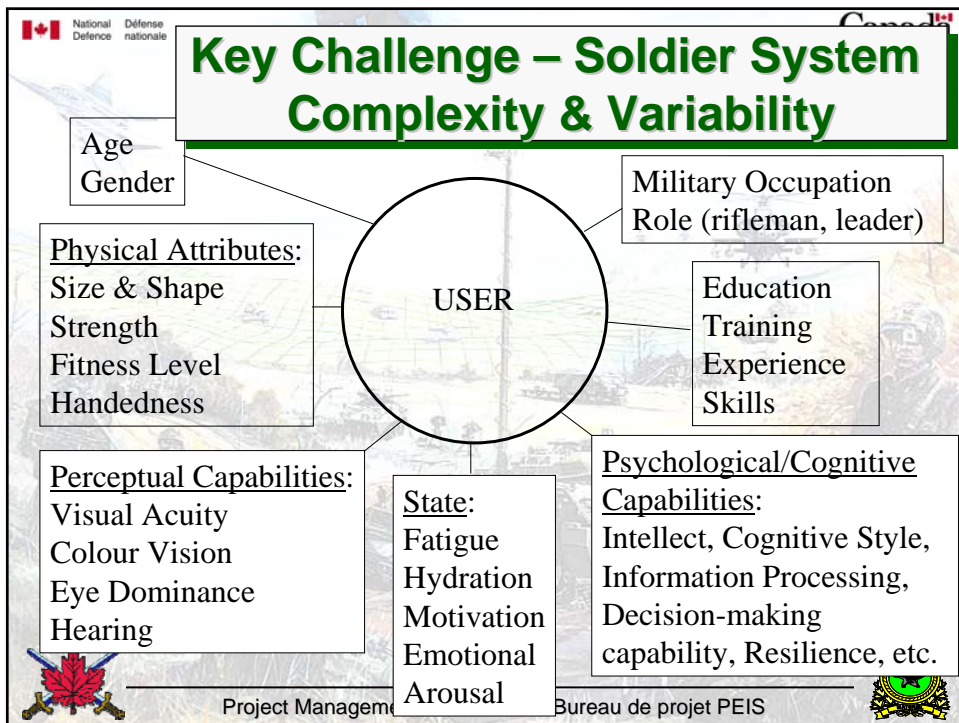
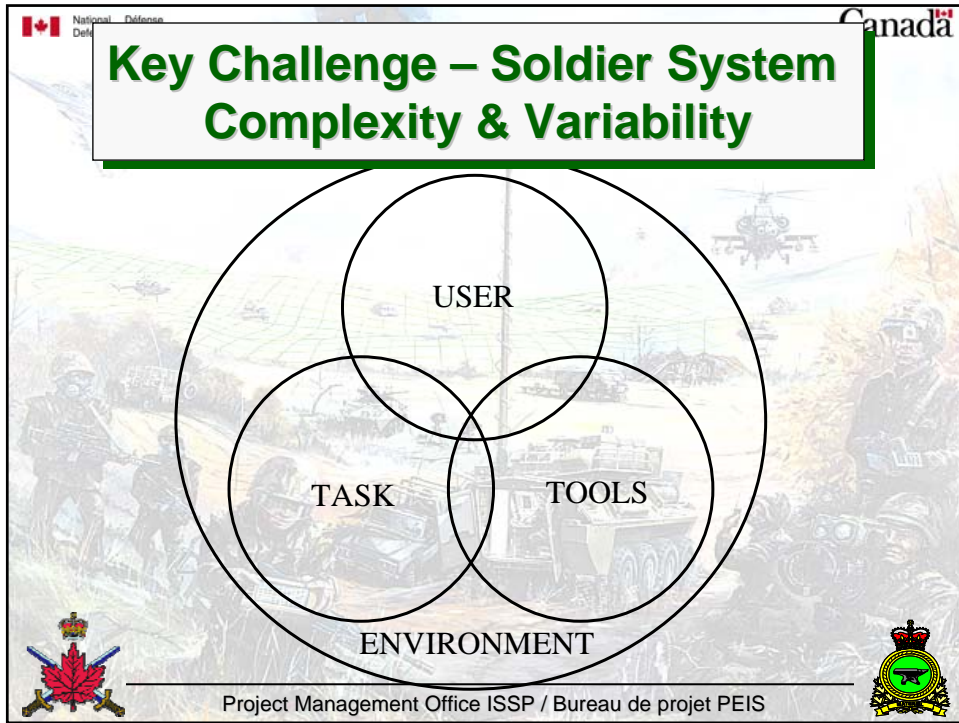


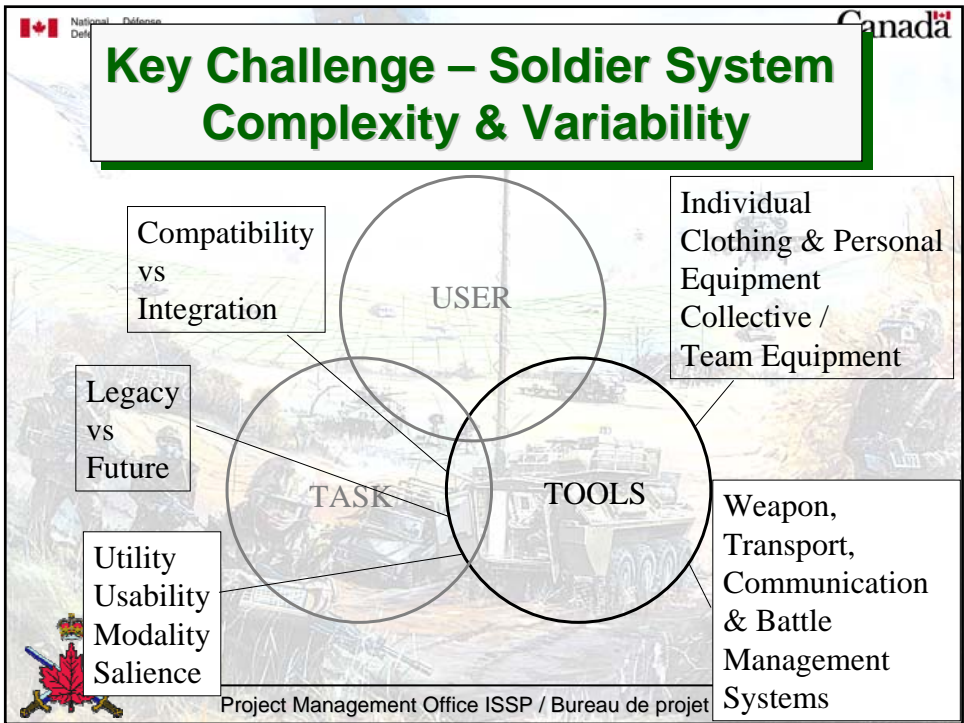
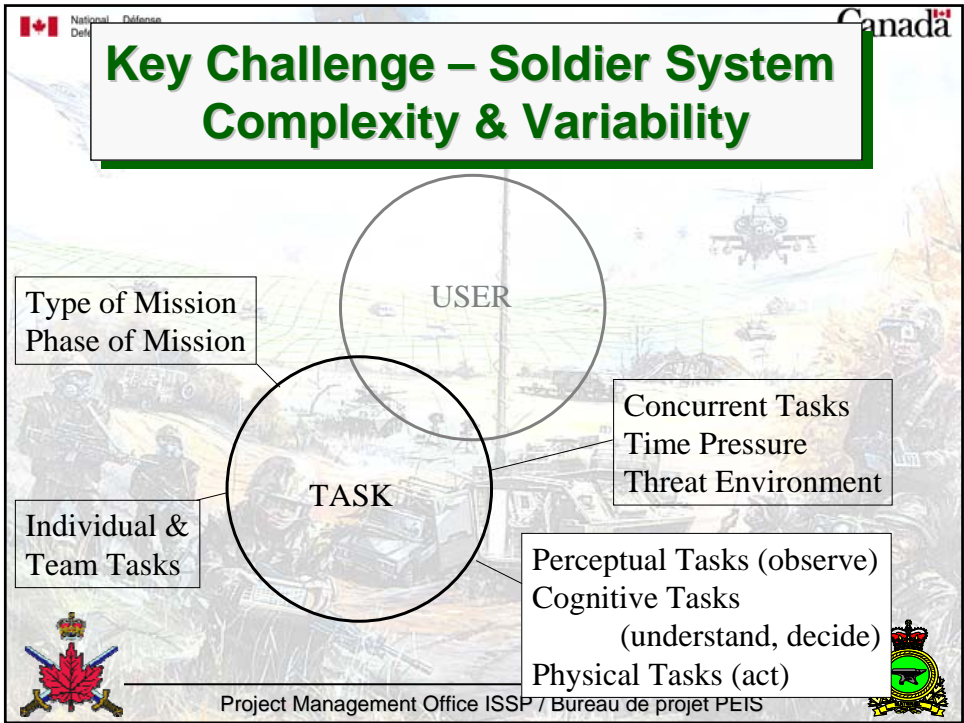
**Can this soldier,  
with this training,  
perform this task,  
to this standard,  
with this equipment,  
and under these  
conditions?**

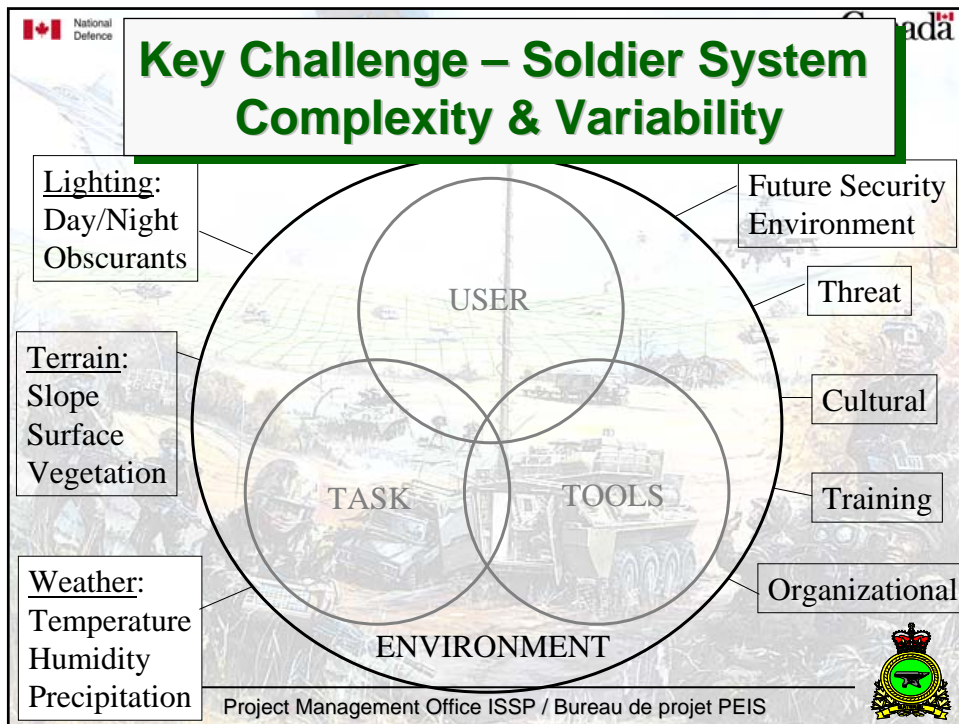
## Key Challenges for Effective Soldier System Integration

- Soldier System Complexity & Diversity
- Soldier Load
- Trade-Off between Protection & Task Performance
- Introduction of Information Technology & Potential for Information Overload
- Specification and Measurement of Effective Soldier Systems Integration







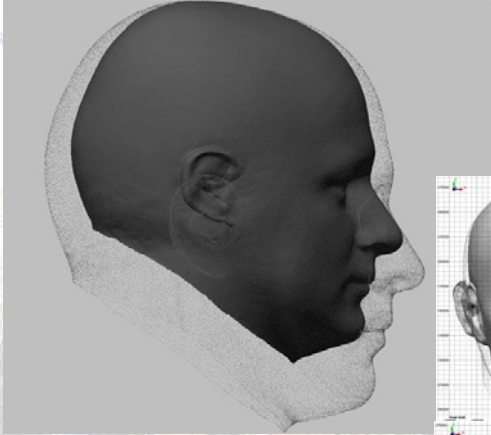
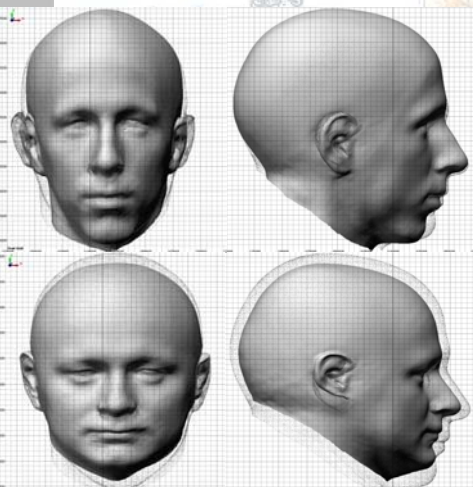


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- ## Addressing Soldier System Complexity & Variability (1)
- Characterize the soldier system to adequately represent its complexity & variability
    - Demographic information
    - Anthropometric surveys
    - Realistic scenarios to provide context
    - Detailed behavioural & cognitive task analyses
  - Make this information available to stakeholders in soldier system development
  - And provide it in a form that designers can use!
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## Anthropometric Characterization

Size and Shape Matters!

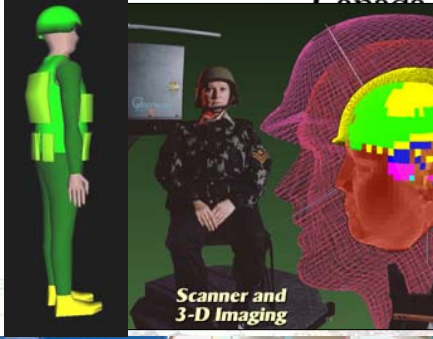
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## Anthropometric Characterization

- 1996 Clothed Anthropometry survey
- 1997 Survey of the Land Forces
- Additional surveys relevant to specific development efforts
- Development & application of 2D & 3D anthropometry to better characterize shape variability
- 3D anthro modelling tools
- Ongoing collection of data using whole body scanning system (ICISS)

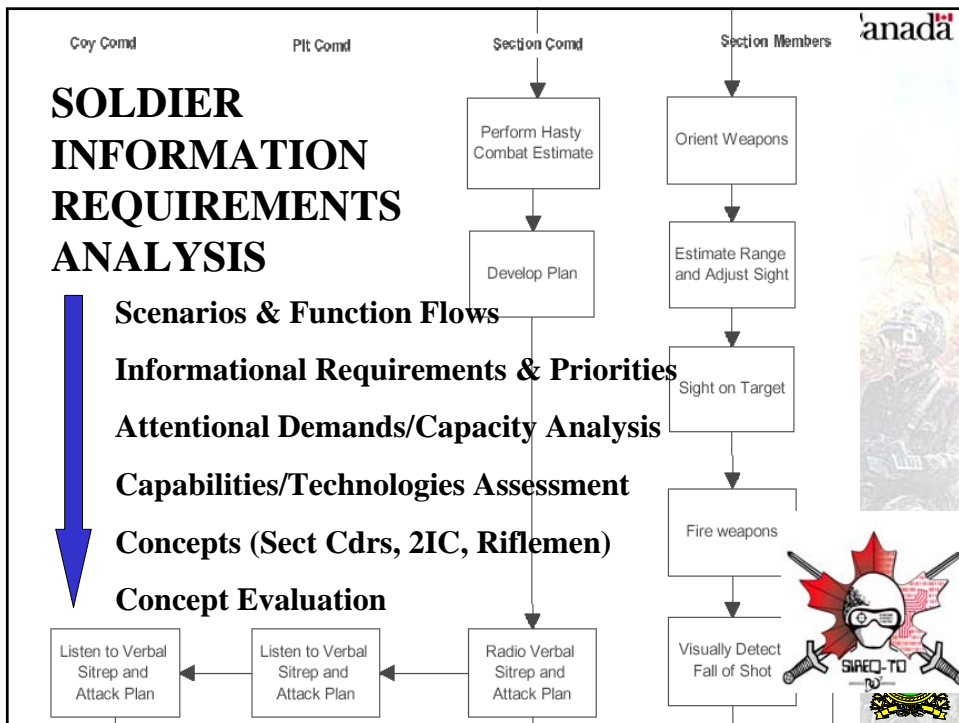
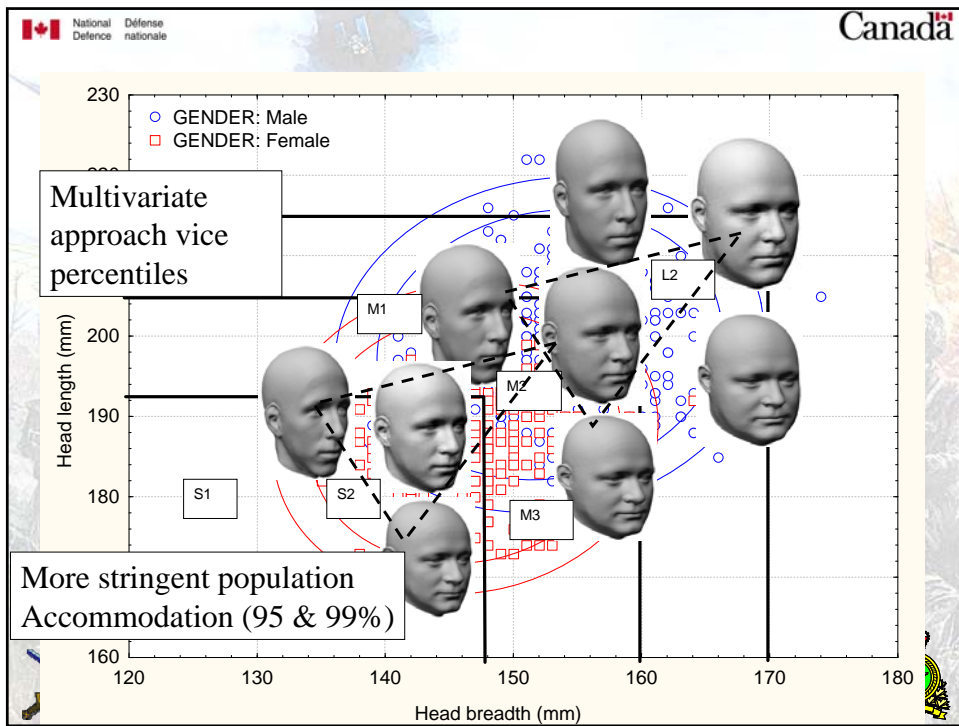


Scanner and 3-D Imaging



ICISS

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## Soldier's Day Multimedia Database



To inform all stakeholders in R&D, materiel development, acquisition & life cycle management about the Canadian soldier system.

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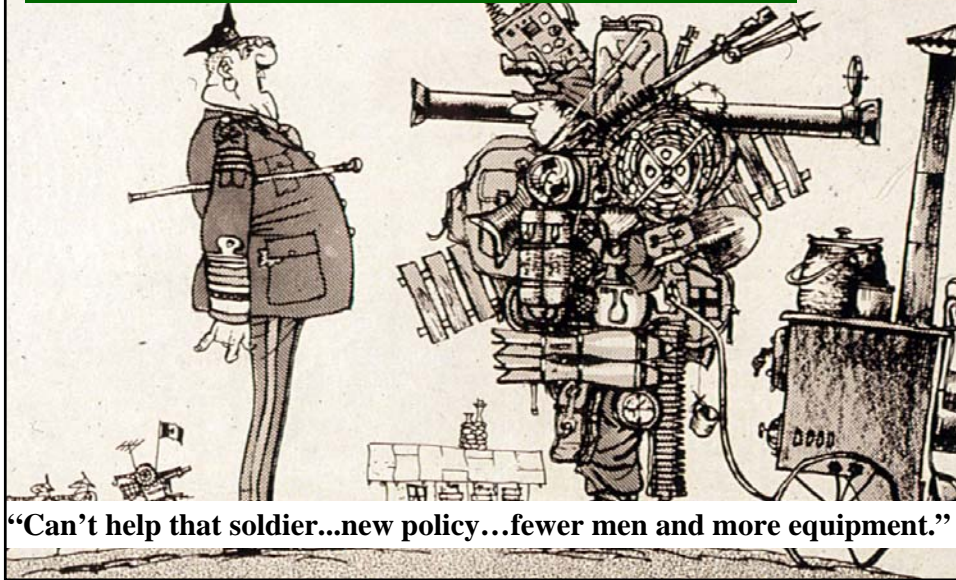
## Other Ways to Address Soldier System Complexity & Variability (2)

- **Modular Design**
  - Specify & design systems that are *modular* to accommodate the wide range of user preferences and task/environment-specific needs
- **User-Centered Design**
  - Involve *representative soldiers*, doing *realistic tasks* under *realistic conditions* throughout the design & evaluation and life-cycle management of equipment

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## Another Key Challenge – Soldier Load

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## Key Challenge – Soldier Load

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- Based on several key studies, NATO recommends that the maximum load that soldiers should carry for extended periods is 32% of body weight (26.2 kg for 82 kg soldier)
- Yet our soldiers in current operations are carrying (often by choice) significantly heavier loads
  - Extra ammunition
  - Extra water
  - Spare batteries
  - Added protection to counter new threats



## Key Challenge – Soldier Load

- Perception & acceptance of load by soldiers is complex
- Critical to acceptance of load is:
  - Absolute weight
  - Weight distribution/ balance
  - Design of interface
  - Presence of other environmental stressors
  - Value of the payload to the user
- Makes specification of soldier equipment weight problematic (very context dependent)



## Addressing Soldier Load (1)

- Develop **objective biomechanical load carriage assessment tools** to better characterize load carriage soldier tolerance/acceptance of loads (forces/moments on spine, relative motion between payload and body, skin contact pressures)
- Outcomes:
  - Validated biomechanical load limits
  - NATO Allied Test Procedure
  - Tools available to industry (on license & loan to Queens University)



## Addressing Soldier Load (2)

Determination of **biomechanical limits** relating to soldier injury/ comfort/ acceptance

Criterion	Recommended Value
Relative Motion between payload and person	<14 mm
Average Skin Contact Pressure	< 20 kPa
Maximum Continuous Skin Point Pressure	< 45 kPa
Forces borne by the shoulders	< 290 N
Lumbar shear contact force	< 135 N



## Addressing Soldier Load (3)

- **Studies** to model/determine weight limits/balance optimization for specific equipment (e.g., head-supported mass, assault rifle mass properties)



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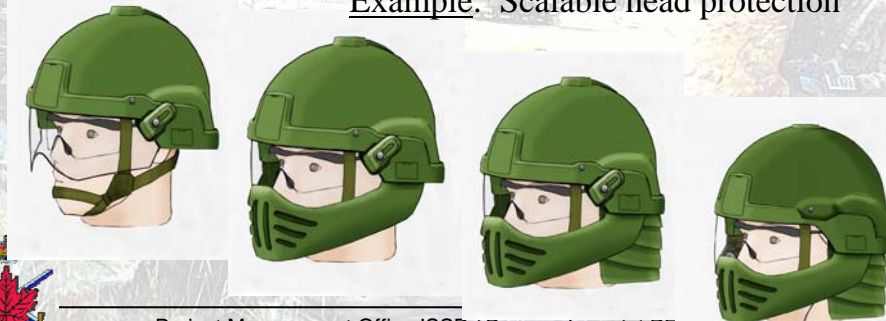


## Addressing Soldier Load (4)

(& Threat Environment Variability)

- Specify & design systems that are **modular** to accommodate the wide range of user preferences and task/environment-specific needs

Example: Scalable head protection



## Addressing Soldier Load (5)

- Require that new equipment contribute to reduced soldier load.
- Specify that any new equipment weigh less than equipment being replaced (even if capabilities are being enhanced)
- Involve representative users (doing realistic tasks under realistic conditions) in studies to determine trade-off between weight & other system attributes (e.g., protection, lethality, etc)



## Key Challenge – Trade-Off between Protection & Task Performance

- Current pressures to reduce casualties has led to lots of PPE initiatives (to increase coverage and protection levels)
- Many international programs to improve protection have failed due to lack of user acceptance of proposed solutions
- Soldiers will not accept any reduction in their ability to detect and respond to enemy action effectively



## Addressing Protection versus Task Performance Trade-Off (1)

- Injury characterization to better understand the nature of the threat
- PPE performance characterization to better understand the capabilities/limitations of our current PPE
- Study/model the impact of protective coverage, stiffness, thickness, etc (on range of motion, task performance, vulnerability, compatibility, etc)
- Involve representative users...



## Addressing Protection versus Task Performance Trade-Off (2)

- Studies of Compatibility between PPE & weapon
- Viability of alternative options for effective integration of increase face/neck/nape protection with weapon butt stocks & sights



## Key Challenge – Introduction of Information Technology

- Nature of future security environment will depend on soldiers who are situationally aware
- What information do soldier's need, under what circumstances to have this SA?
- In what form should that information be presented?
- How do we optimize the amount of information available or presented?
- How do we ensure that the soldier has access to the right information at the right time?
- How do we enhance soldier situation awareness?
- How do we avoid distracting or overloading the soldier with either inappropriate or too much information?



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## Addressing Intro of Info Technology (1) Soldier Information Requirements Technology Demonstration Project

- Aim** – To define and empirically validate the performance requirements for the future Soldier System by demonstrating capability enhancements in command execution, target acquisition and situational awareness for the individual Canadian dismounted soldier in 2010-2015.

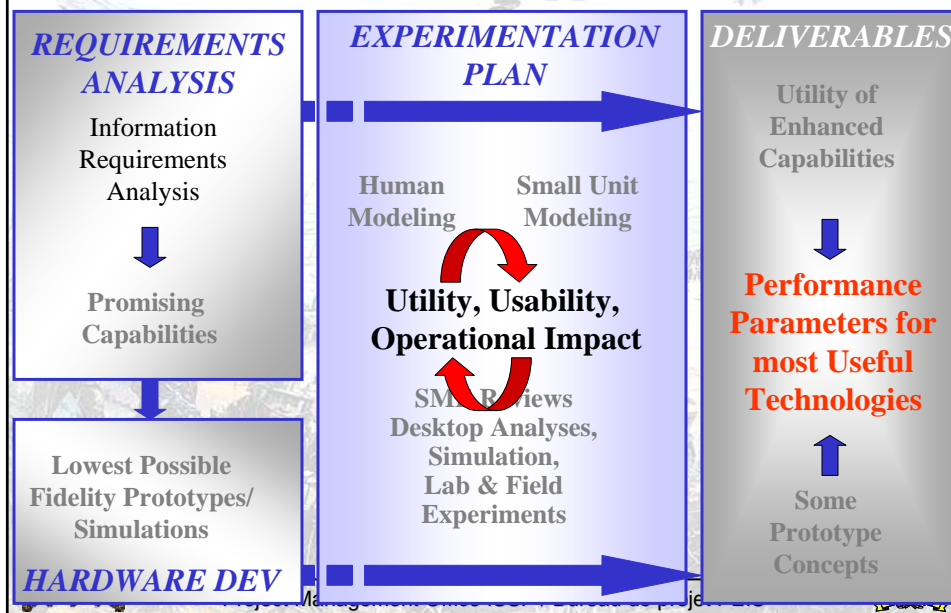
**WHAT INFORMATION DO SOLDIERS NEED?  
HOW BEST TO DISPLAY THAT INFORMATION?**

5 years (2000-2005), \$13M,  
>70 studies completed, > 80 reports published



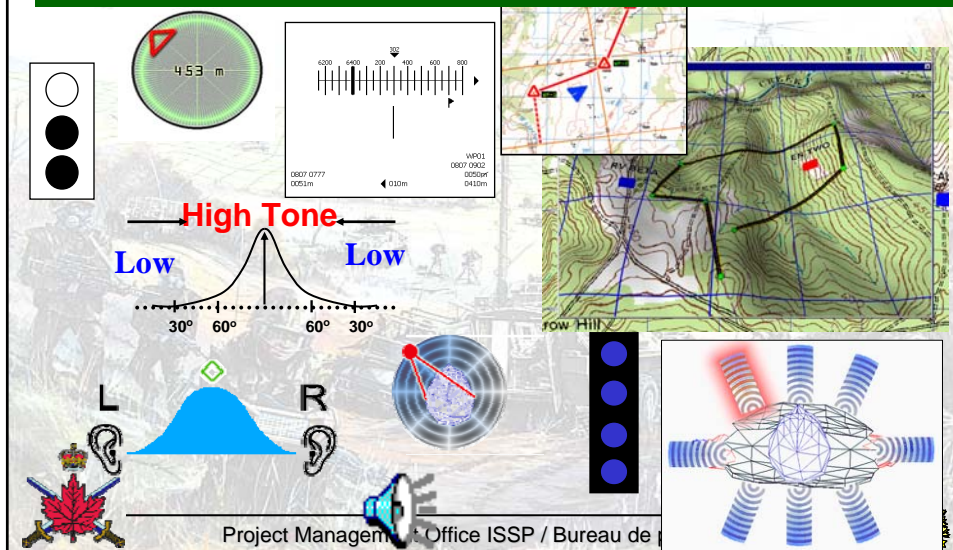
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## SIREQ TD Approach



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## Addressing Intro of Info Technology (2) Explore Alternative Display Modalities



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## Key Challenge – Specifying/Measuring Effective System Integration

- Ideally, there would be a simple and efficient bench test to determine the suitability of the soldier system and its components
- The complexity and context specific nature of soldier-system requirements makes this very difficult
- Progress is being made to develop tools and objective test methods for testing some aspects of the soldier system



## Key Challenge – Specifying/Measuring Effective System Integration

- However, the complexity of factors and trade-offs that contribute to soldier perception of comfort, judgement of system acceptability, etc make this impossible to achieve
- Demands the involvement of representative users doing representative tasks....during iterative design and evaluation
- But do so using scientific methods, with awareness of and knowledge on how to control for the error/bias potential with studies involving human subjects



## Effective Human-Systems Integration



