Measurement and Modeling of Seated Soldier Posture and Body Shape

ARC Conference

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Background

- Current and future vehicle programs face major challenges in provide adequate accommodation for soldiers while ensuring performance and safety
- Current MIL-STD 1472g lacks detailed information on soldier posture and body shape, including the effects of personal protective equipment (PPE) for seat and vehicle interior layout

- Current design guidance is based on outdated anthropometry
- Previous studies of seated anthropometry have not included the effects of PPE on posture and body shape
- Warrior Injury Assessment Manikin (WIAMan) blast dummy program needs detailed seated anthropometry data

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Objectives

1. Gather detailed data on the **postures of soldiers with a wide range of body sizes sitting in military vehicle seats** as drivers and passengers with and without protective equipment and with and without protective footrests.
2. Gather detailed data on the **position and space requirements for body armor and other gear** in both standing and seated postures.
3. Gather quantitative data on the **locations of protective equipment relative to the soldier and vehicle seat** for use in human modeling and blast event simulation.
4. Develop data-based **tools to represent the postures, positions, and body size** (space claim) for soldiers as drivers and passengers in tactical vehicles as a function of occupant and vehicle characteristics.

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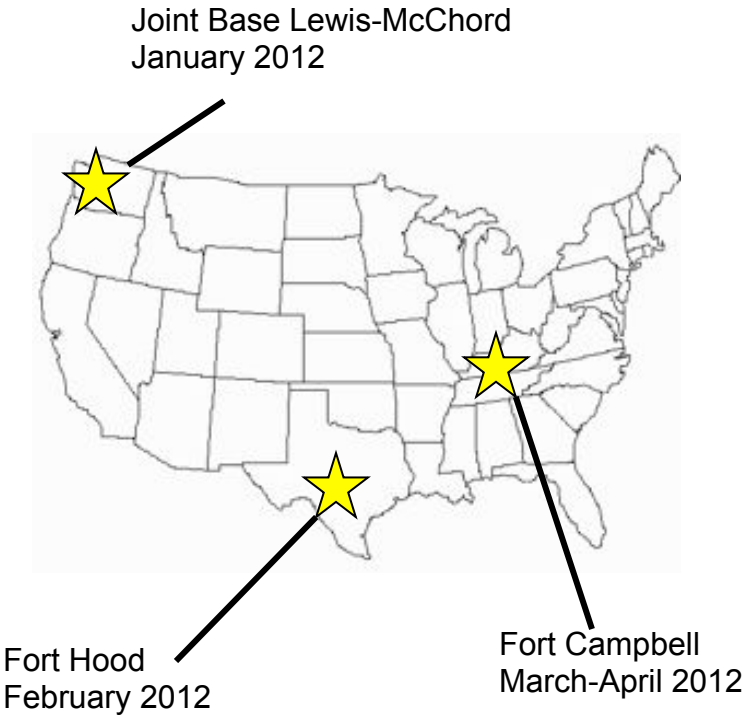
Test Plan

- Data collection January – April 2012 at three Army posts: Joint Base Lewis-McChord, Ft Hood, Ft Campbell
- Goal was to measure 300 soldiers with a wide range of body size, including as many women as possible
- Data collection conducted by subcontractor Anthrotech, Inc., which is providing six trained staff
- Substantial additional coordination by TARDEC and the data collection sites



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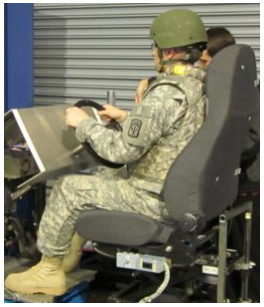
Methods - Overview

Standard Anthropometry

Hardseat Body Landmarks

Whole-Body Scanning

Driving Postures



Crew Postures

Four Garb Levels: minimal, ACU, armor, encumbered

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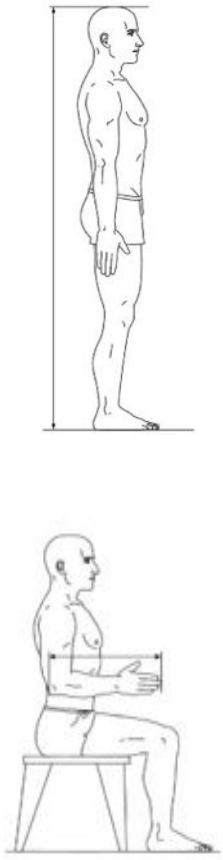
Standard Anthropometry

- Using ANSUR II methods*
- 36 dimensions
- Focus on characterizing subjects relative to ANSUR II
- Minimal garb only



*ANSUR II is a large-scale Army anthropometry study currently underway.

Standard Anthropometric Dimensions

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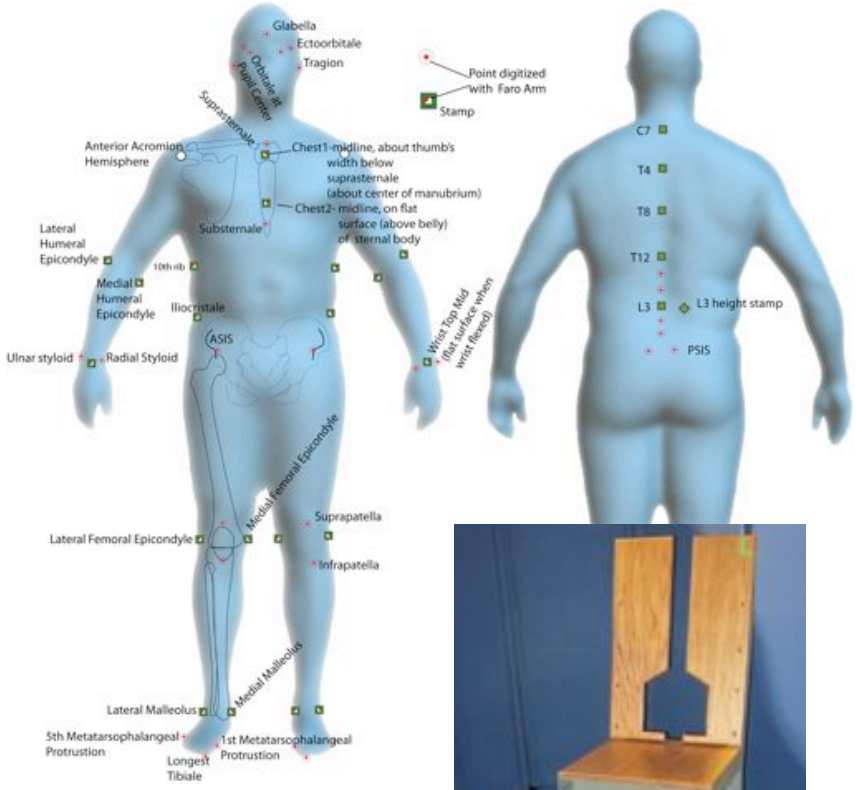
Hardseat Body Landmarks

- Laboratory seat that allows access to posterior torso landmarks
- Body landmark locations measured using FARO Arm coordinate digitizer
- Data are used to accurately quantify torso skeleton geometry (pelvis, spine, ribcage)
- Minimal garb only



Driver Mockup

- Steering wheel, pedals, adjustable seat(fore-aft, up-down, back angle)
- Range of vehicle packages (steering wheel-to-pedal relationships) representing different vehicle types
- Driver adjusts seat to obtain comfortable posture
- Body landmarks defining posture measured using FARO Arm coordinate digitizer
- Garb: ACU, armor, encumbered (not all configurations at all garb conditions)

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Crew Mockup

- Fixed seat (no sitter adjustments)
- Range of seat height, seat cushion angle, seat back angle, and foot position (including representation of protective footrest)
- Body landmarks defining posture measured using FARO Arm coordinate digitizer
- Garb: ACU, armor, encumbered (not all configurations at all garb conditions)

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Laser Scanning

- Standing and erect sitting postures for reference to other datasets
- Supported sitting postures spanning the range of driver and crew postures
- Garb: minimal, BDU, armor, encumbered (not all postures in all garb conditions)

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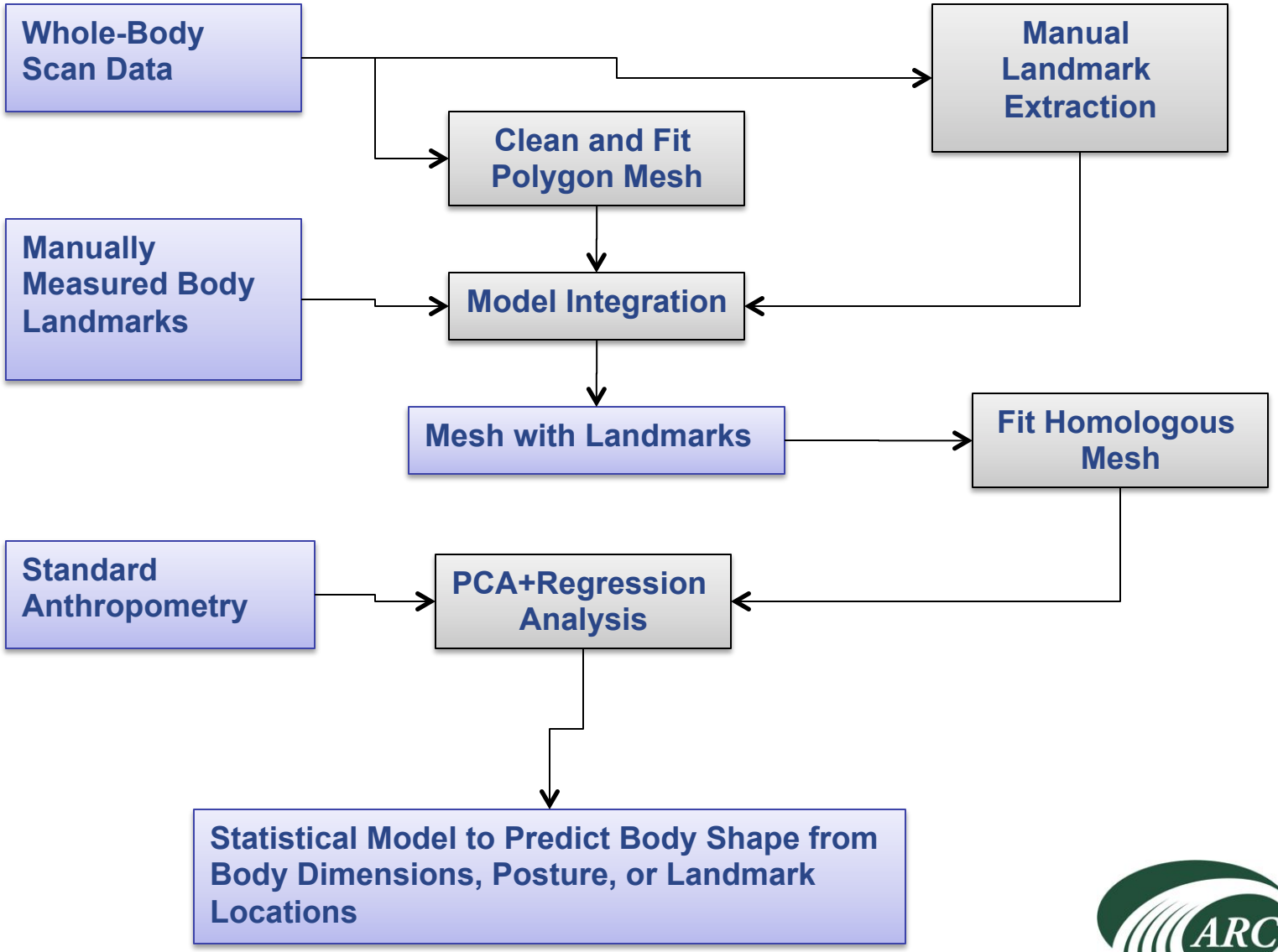
Body Shape Modeling



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Current Status

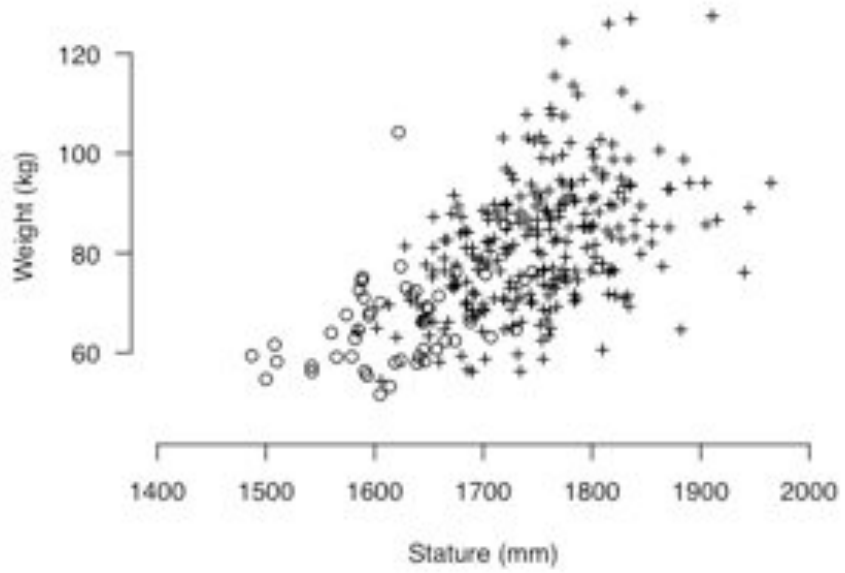
Data collection completed:

309 soldiers measured

257 men (83%)

52 women (17%)

Data processing underway



Male Summary (preliminary)

		5th%ile	50th%ile	95th%ile
Seated Soldier				
	Stature (mm)	1654	1755	1866
	Weight (kg)	63.6	82.4	104.3
	BMI (kg/m^2)	21.0	26.7	33.8
A2P				
	Stature (mm)	1643	1755	1872
	Weight (kg)	63.9	84.2	110.7

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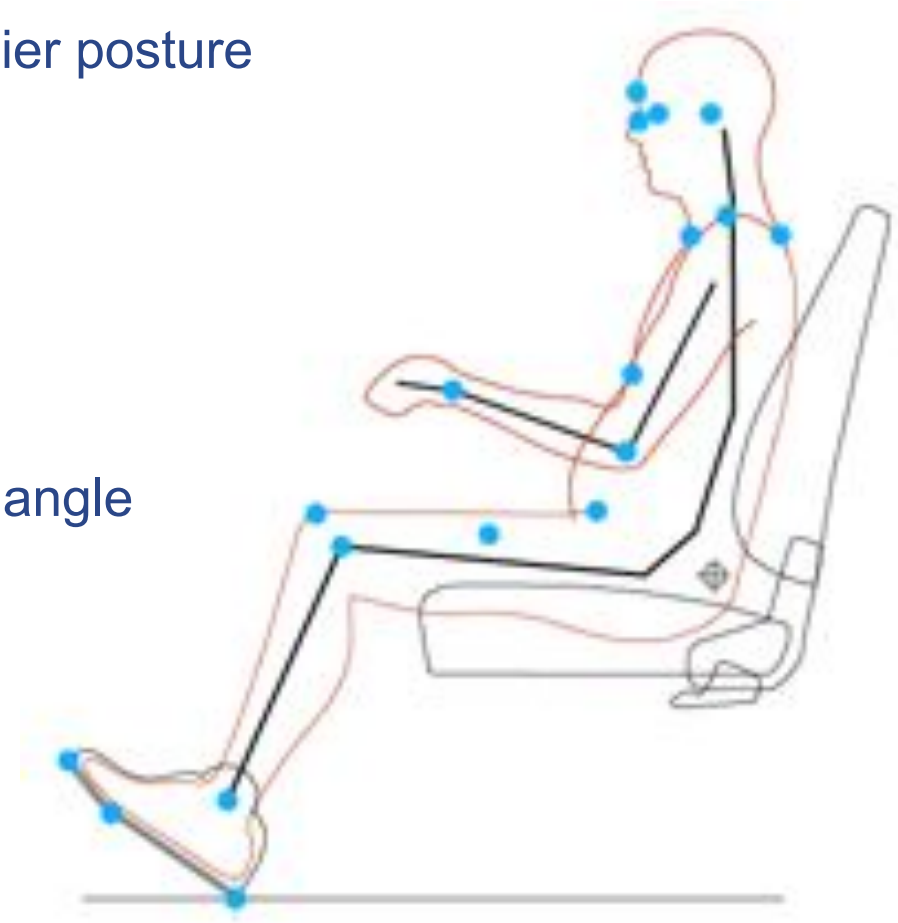
Outcomes

1. Statistical models of seated soldier posture as driver and crew
   - ~40 surface landmarks
   - major body joints
   - eye location, hip location
   - seat H-point location and back angle
   - including effects of PPE



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Outcomes

2. Statistical models of soldier body shape in seated postures

Statistical body shape models from a previous studies
(new model will include whole body in seated postures)

Overlaid scans from current study

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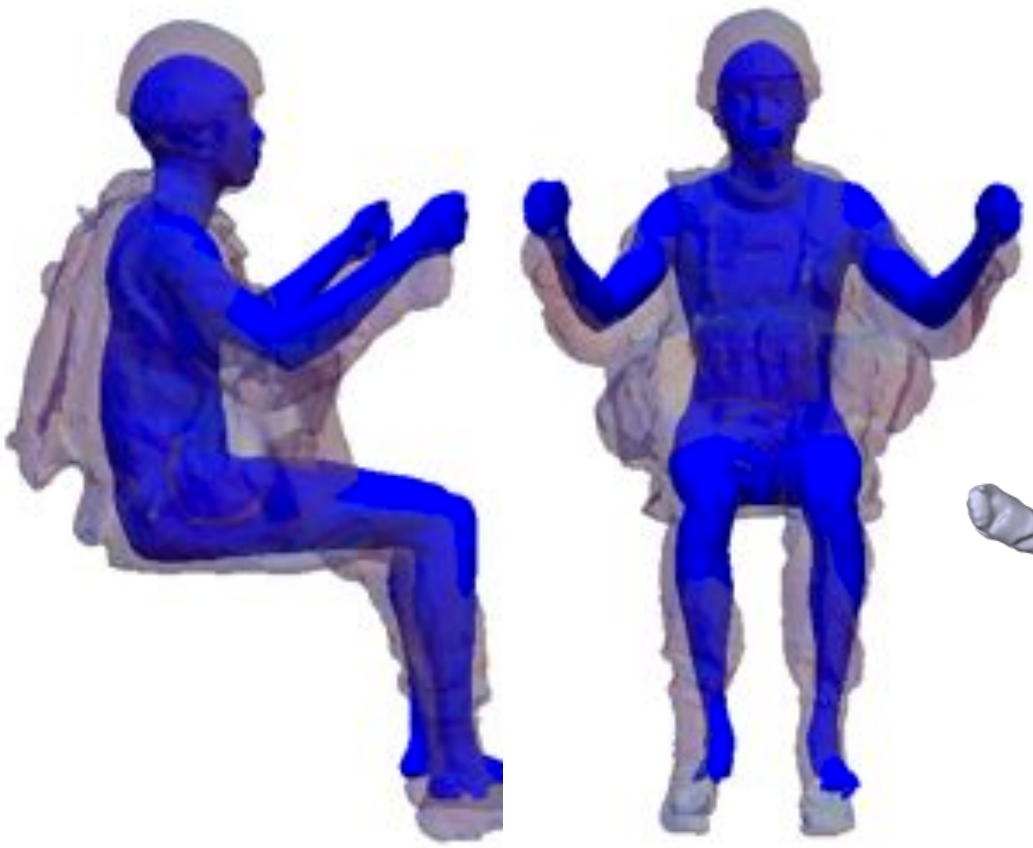
Outcomes

3. 3D space claim for encumbered soldiers

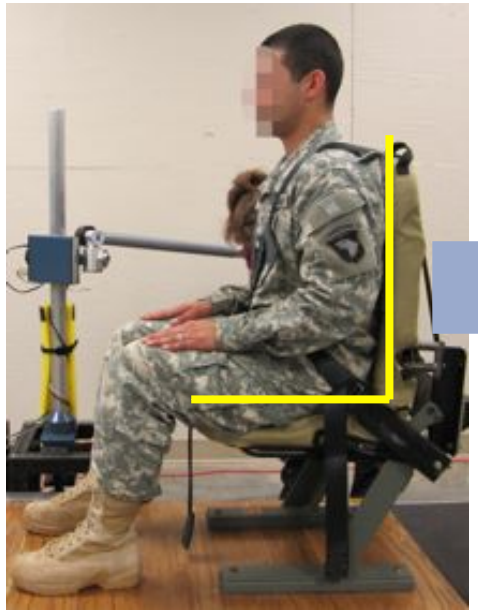


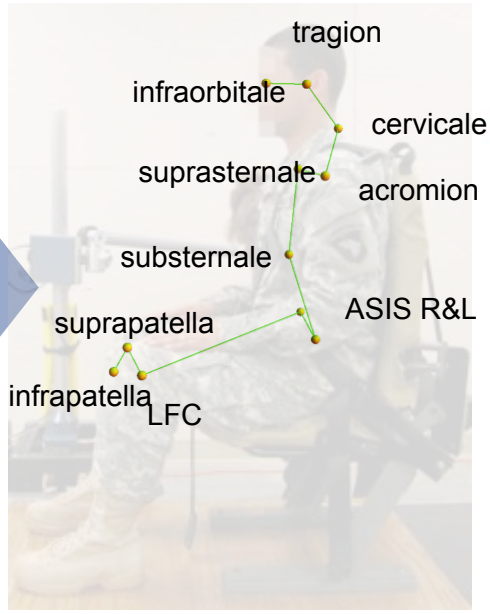
Overlaid scans without posture adjustment

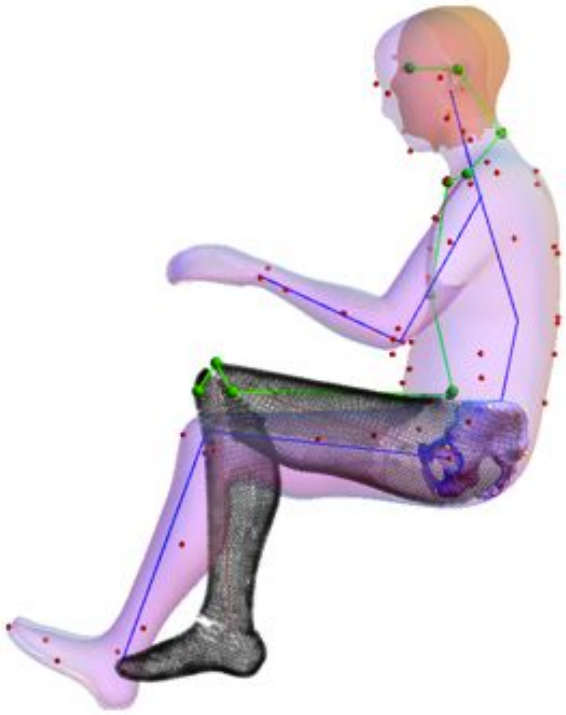
Outcomes

4. Anthropometric specifications for WIAMan (new Army blast dummy):

- external body contours
- external body landmarks
- internal joint estimates, include hips and spine







Preliminary Anthropometric Specifications for WIAMan

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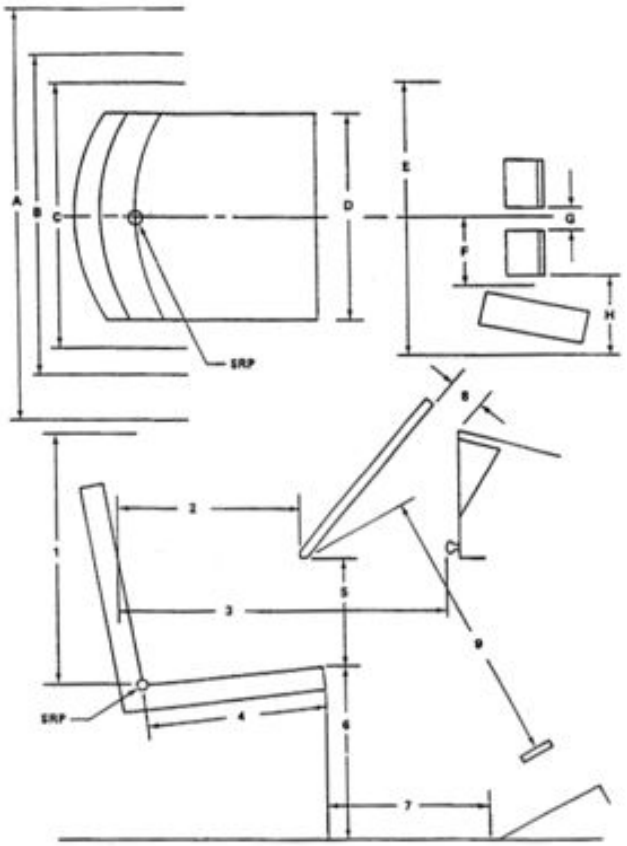
Outcomes

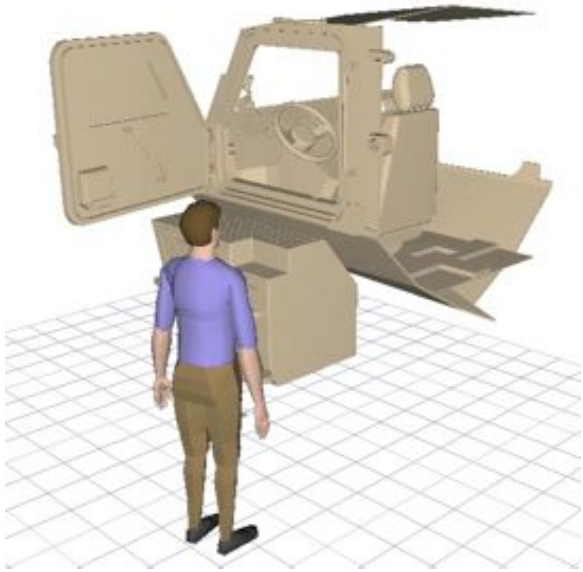
5. Guidance for vehicle and seat design based on current soldier anthropometry including effects of encumbrance, providing input for a revision of the sections of MIL-STD 1472 dealing with seat and vehicle design



TARDEC Applications

Blast Dummy Development

Human Body Models for Blast Simulation



Ergonomics (Erika Baker, TARDEC)

Vehicle Interior Layout (Packaging)

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