GRUNT**S**IM (load simulation)
A load bearing simulation that enables trade-off analysis. It provides a robust and validated environment for simulating tasks, loading the soldier with varying equipment, and observing whether it can be done, calculating biomechanics and physiological performance data.
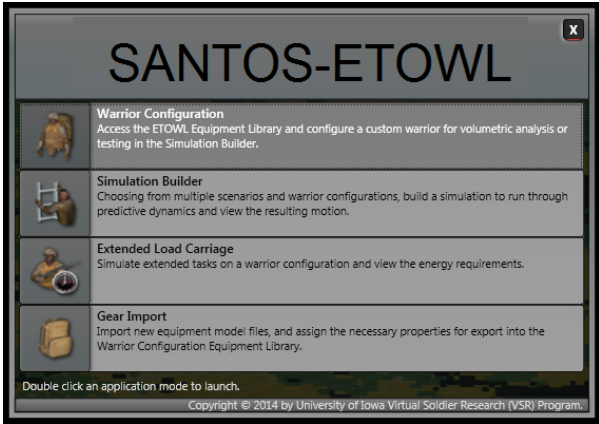
GruntSim

Warfighter load simulation

Virtual Soldier Research – University of Iowa

GruntSim Capabilities
Also called ETOWL (Enhanced Tool for the Optimization of Warfighter Load)

Attribute	Description
General Capabilities	
Ease of use	**Can be used by USMC GS personnel with 1 week of classroom training**
	Can be used by a user with 1 hour of classroom training
Software Functions	**Can perform system level analysis on a new piece of infantry equipment within 1 week by average user**
	Can perform system level analysis on a new piece of infantry equipment within 1 day by average user
Physiological Models	**Models used to predict output measures must be referenced in software user manuals**
	Open architecture with documented APIs for critical functions
	Open architecture with documented APIs for all functions
Architecture	
Dynamics Task Capabilities	
Avatars	**15 avatars are available (males and females) with varying anthropometry and strength limitations.**
Configuration	**User will be able to change equipment loading configuration**
	User can import any equipment that is not already in the ETOWL system (import/export tool)
Output Metrics	**Joint kinematics/Kinetics: angle, velocity, acceleration, torque history against time**
	Percent max. torque
	Ground reaction forces:
	Body center of mass tracking
	Static spine shear and compression

GruntSim   The University of Iowa

	Metabolic energy estimated from joint torques
	Hydration Schedule
Walking Task	**Adjust walking speed in a normal walking gait**
Agility Side to Side	**Weapon will be held at all times and the user will be able to change weapon and forestock hold**
Bounding Rushes	**"Stand to Prone"** **"Prone to Stand"**
Jumping Task	**Vertical Jump** **Platform Jump**
Stairs Task Ladder Task	**Ability to walk up and down normal & steep stairs** **Ability to walk up and down the vertical ladder.**

Posture Task Capabilities

Output Metrics	**Joint Angles** **Discomfort** **Body Center Position** **Spine Shear and Compression at L4/L5** **Joint Torques (seated & standing)** **Stability (seated & standing)** **Collision Detection** **Total Weight Carried** **Cocoon and Volume for Equipment Loading Configuration**
Weapon Postural Analysis	**Pre-defined postures for a specific avatar and weapon selection: Standing** **Crouching** **Kneeling** **Prone** **Bladed (45°)** **Extended Arm Palm Hold**
Weapon Analysis	**Visual Postural Analysis** **Aiming Envelope** **Eye Relief Analysis**

Extended Load Carriage

Inputs	**Total Load** **VO2 max** **Distance** **Time** Terrain Type Terrain Grade Work Rate
Outputs	**Heart Rate** **Energy Consumption** **Mechancial work**

	Oxygen Consumption
	Thermal
	Hydration Schedule
	Whole Body Fatigue
	Work/Rest Schedule
	Perceived Exertion
	Thermal Comfort
Tasks	**Walking**

Additional Capabilities	
Visualization	**Real-time rendering engine**
	Method and process for representing virtual avatars
	Method and process for representing clothing
	Algorithm for soft tissue deformation
	Volumetric and surface calculations and analysis
Modeling	Accurate kinematics based on the DH representation method
	Accurate biomechanics based on the DH representation method
	Skeletal system
Packaging	Installer -simplified deployment to install with all dependencies
	Licensing

GruntSim male Marines

Santos, 220 Male, 508 Male, 530 Male, 601 Male, 1719 Male, 1953 Male, 2033 Male, 2459 Male.

- Anthropometry

- Weight
- Body type
- Strength

Male Avatar Statistics			
Avatars	Height	Weight	Strength Percentile
Santos	6 ft. 1 in	173.72 lbs.	90 %
220 Male	5 ft. 7 in	160.94 lbs.	80 %
508 Male	5 ft. 7 in	143.52 lbs.	75%
530 Male	6 ft. 3 in	244.93 lbs.	90%
601 Male	6 ft. 2 in	155.43 lbs.	80%
1719 Male	5 ft. 11 in	177.91 lbs.	85%
1953 Male	5 ft. 7 in	195.11 lbs.	80%
2033 Male	6 ft. 3 in	217.82 lbs.	90%
2459 Male	5 ft. 4 in	122.14 lbs.	75%

GruntSim female Marines

Sophia, 0752 Female, 1806 Female, 2096 Female, 2316 Female, 2324 Female, 2531 Female, 2563 Female.

Female Avatar Statistics			
Avatars	Height	Weight	Strength Percentile
Sophia	5 ft. 6 in	133.00 lbs.	80%
0752 Female	5 ft. 10 in	139.33 lbs.	80%
1806 Female	5 ft. 9 in	164.91 lbs.	85%
2096 Female	5 ft. 3 in	121.92 lbs.	75%
2316 Female	5 ft. 7 in	156.75 lbs.	90%
2324 Female	5 ft. 6 in	158.29 lbs.	90%
2531 Female	5 ft. 0 in	129.19 lbs.	85%
2563 Female	5 ft. 3 in	119.93 lbs.	75%

ETOWL consists of four modules

Warrior Configuration

Simulation Builder

Gear Import

Extended Load Carriage

GruntSim – *Equipment and Models*

- Import equipment
- Large selection of gear
- Accurate models
- Attachment to body

- Configure the load
- Pick and place