U.S. Army Research, Development and Engineering Command

U.S. ARMY RDECOM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Blast Technologies

Mark Germundson
Ground System Survivability – Systems Integration

Report Documentation Page

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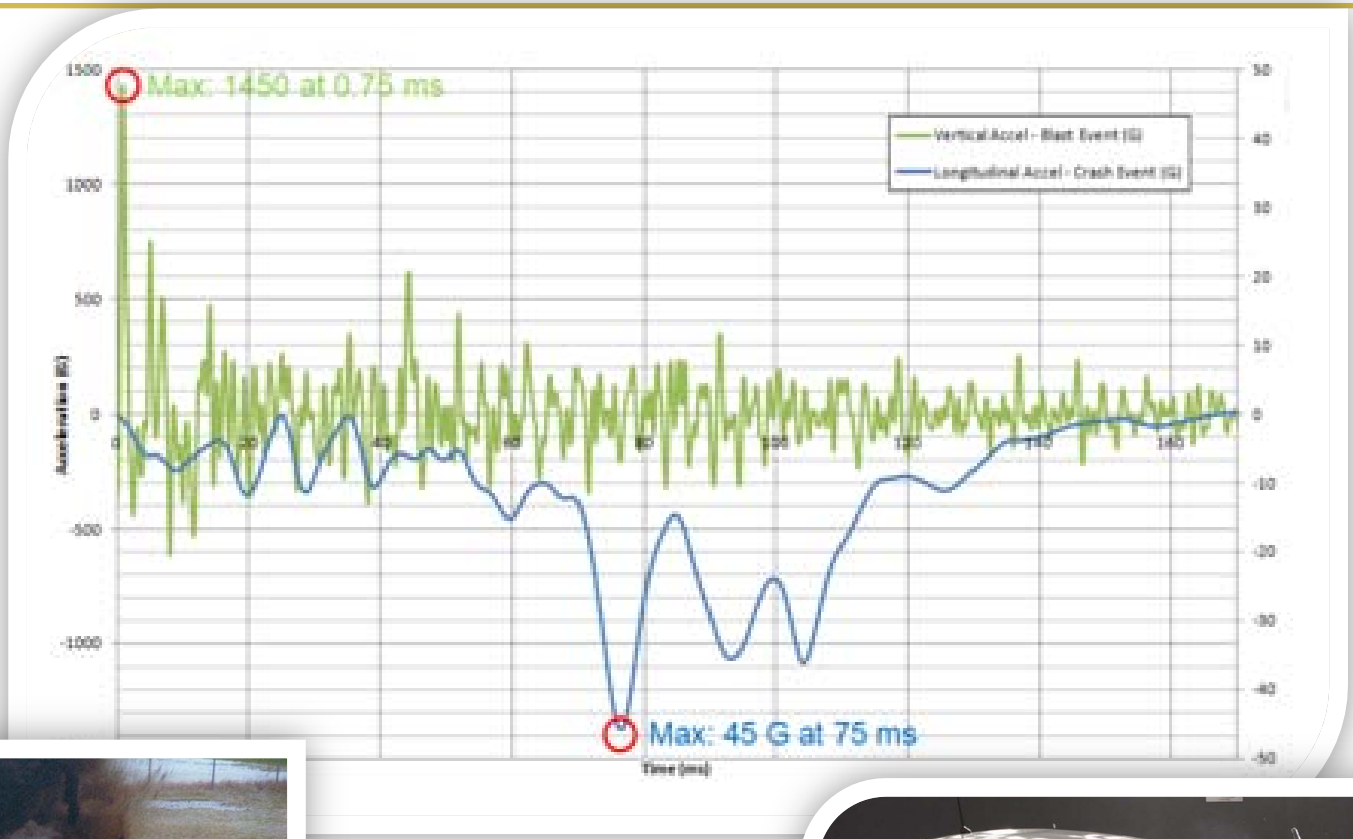
Blast Technology Development

- *Develop occupant centric vehicle design & test standards for ground vehicles*
- *Create occupant centric system-level protection against blast, crash and rollover injuries*
- *Develop tools and capabilities for quicker assessment of new technology for rapid implementation and fielding*
- *Support PM and theater requests for system level assessment of occupant and underbody protection technologies*

TARDEC's Blast Technology Resources

- Blast Technology – 20+ people dedicated
  - From component level to vehicle systems integration
- Blast M&S – 10+ people dedicated
- Partner with other government agencies, industry and academia
- Lab/ Facilities
  - Sub System Drop Tower
  - Head Impact Protection Lab within next 6 months
  - Vertical Accelerative Tower within next 18 months
  - High Performance Computer Center (M&S)
  - Other lab and test facilities within TARDEC and Government

Issues


Max: 1450 at 0.75 ms
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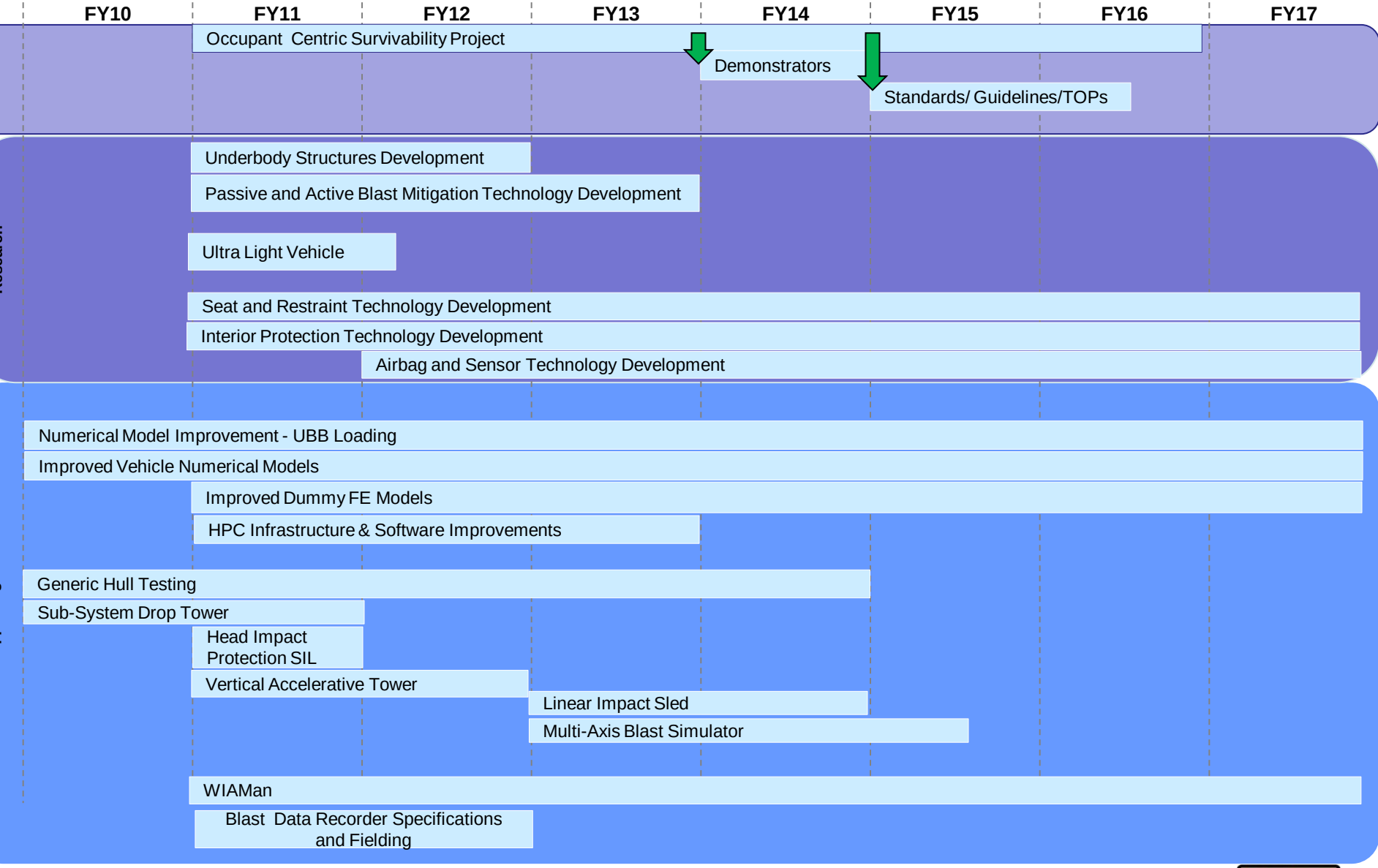
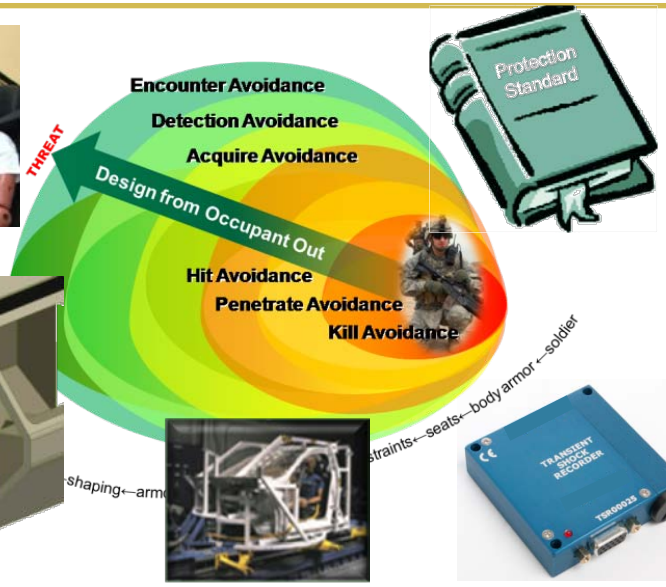
Vertical Accel - Blast Event (G)
Longitudinal Accel - Crash Event (G)
Acceleration (G)
Time (ms)

Ground Vehicle Occupant Protection Efforts



Ground Systems Survivability
Blast Technologies



	12	13	14	15	16	17
Occupant Protection Technology Development						
- Interior						
- Exterior						
- Sensor/Instrumentation						
Modeling and Simulation Tools Enhancement						
System Evaluation Lab						

Purpose:

- ❑ **Approach occupant protection from a system level; leverage defense, automotive/race industry, & medical community knowledge to integrate IED/mine, crash and rollover protection. Continue development of Modeling & Simulation (M&S) capability to predict and reconstruct mine/IED/crash events.**

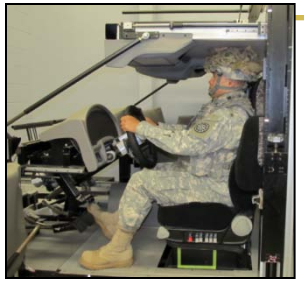
Products:

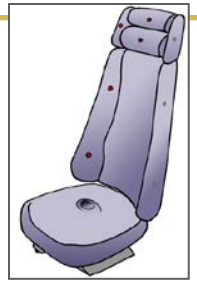
- ❑ **Advanced occupant protection technologies including, blast deflecting underbody solutions, energy absorbing seat designs, airbag and restraint systems, and energy absorbing flooring solutions**
- ❑ **Vehicle event data recorders for collecting highly accurate event data to be utilized for the development of robust test procedures to replicate in-theater events and resultant countermeasures to mitigate Warfighter injuries**
- ❑ **High fidelity system-level vehicle models which are capable of modeling crash, rollover and blast events**
- ❑ **Enhanced test and evaluation capability through the development of labs capable of repeatable representation of the inputs caused by mines/IEDs and crash/rollover events**

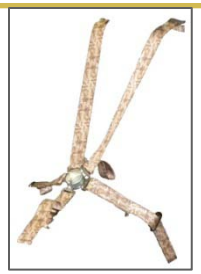
Payoffs:

- ❑ **Creates and develops infrastructure, physical and virtual tools, and technologies for enhanced occupant protection for ground vehicle systems.**

Interior and Sensor Technology Development



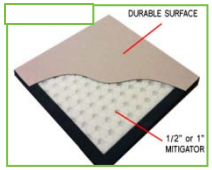




Novel Seat and Restraint Designs focused on the Warfighter's mission

Posture Studies to Support Seat and Restraint Development

Airbag and other Interior Treatments



Energy Absorbing Materials

Data Recorders and Sensors

	12	13	14	15	16	17
Energy Absorbing Seats w/ Restraints						
Blast Mats and other Interior Treatments						
Data Recorders and Sensors						
Methods and Standards Development						

Development and Implementation | Continuous Improvement

Purpose:

- **Interior Technology and Sensors provide the mechanism to evaluate, optimize, integrate, and validate occupant centric survivability and safety systems to mitigate injury due to blast, crash and rollover events.**

Requirements:

- **Upgrade the ground fleet with interior and sensors for blast mitigation for improved occupant protection. Provide accurate on-board post blast/crash data collection techniques and recording equipment.**

Products:

The test equipment simulates blast & crash events and evaluates the occupant and protection system response to these forces.

- **Blast attenuating seats that are resettable and have off-axis stroking capability.**
- **Restraints that simultaneously protect and better compliment the Warfighter's mission during multiple vehicle events.**
- **Alternative energy absorbing floor mats and interior treatments.**
- **Airbag or comparable technologies such as bolsters.**
- **Sensors that can detect and deploy/trigger interior treatments within the timeframe of a blast event and will not inadvertently activate.**
- **Vehicle data recorders for vehicle and event diagnostics and prognostics.**
- **Devices that are more receptive to usage in theater.**
- **Test methodology and standards for ground vehicle energy interior and sensor technology development and evaluation for blast, crash, rollover and side IED events.**

Exterior Technology/Underbody

Underbody Optimization and Integration

Energy Absorbing (EA) Materials and Structures

Live Fire Test and Evaluation

Full Vehicle Blast Mitigation

Reconfigurable Underbody Test Buck

	12	13	14	15	16	17
EA Materials & Structures						
Underbody Optimization & Integration						
Full Vehicle Blast Mitigation						
Live Fire Test and Evaluation						
Reconfigurable Underbody Testing						

Purpose:

- **Exterior Technology and Underbody provide the mechanism to evaluate, optimize, integrate, and validate occupant centric survivability and safety systems to mitigate injury due to blast and crash events.**

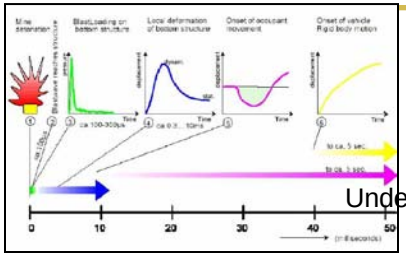
Requirements:

- **Upgrade the tactical and combat ground fleet with exterior and underbody blast mitigating technologies to include structural systems.**

Products:

- **Generic Hull Test Buck: To provide data to industry and verify various blast mitigating concepts**
- **Reconfigurable Underbody Test Buck: Quick turn-around and flexible cab/underbody testing device. Adjustable to various cab and underbody configurations. To be utilized to gather internal and external systems data.**
- **Full Vehicle Blast Mitigation: Evaluation of structures in combination with vehicle systems and other blast mitigating technologies for research and the PM.**
- **Active Blast Concepts: Evaluate blast countermeasure concepts and blast sensing.**
- **Energy Absorbing (EA) Materials: Support industry/SBIR partnerships in advancing the state-of-the art in integrated EA materials.**

Underbody Blast Modeling & Simulation



Underbody Blast Models

Occupant Finite Element Models

Full Vehicle End-to-End M&S Models

High Performance Computing Infrastructure

Purpose:

- ❑ **Enhance full system , End-to-End, M&S capability in order to reduce program risk, occupant injury and uncertainty in integration designs.**

Requirements:

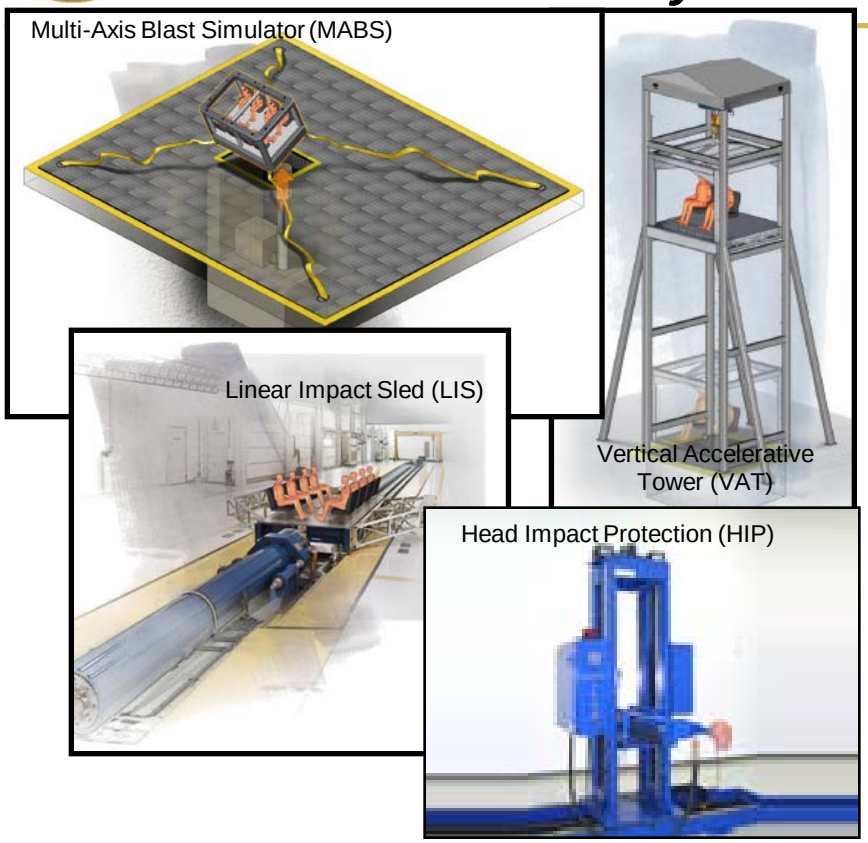
- ❑ **Upgrade the tactical and combat ground fleet with interior, exterior, and underbody blast mitigating technologies to include structural systems.**

Products:

- ❑ **Software/High Performance Computing Infrastructure: To meet significant growth in demand for computational services from PEO/PM.**
- ❑ **Occupant Finite Element Models: Improve occupant injury models (FE ATD and Human models).**
- ❑ **Full Vehicle End-to-End M&S Models: Full vehicle underbody blast M&S capability to provide program risk reduction and increased confidence during modernization development phase and Live Fire Test & Evaluation.**
- ❑ **Underbody Blast Loading: To predict transient underbody loading for mine/IED events.**

	12	13	14	15	16	17
Expanded High Performance Computing						
Full Vehicle End-to-End Models						
Occupant Finite Element Models						
Underbody Blast Loading						

Occupant Protection Systems Integration Laboratories



	12	13	14	15	16	17
Head Impact Protection						
Vertical Accelerative Tower						
Linear Impact Sled						
Multi-Axis Blast Simulator						

Purpose:

- The OP SIL provides the mechanism to evaluate, optimize, integrate, and validate occupant centric survivability and safety systems to mitigate injury due to blast and crash events.

Products:

The test equipment simulates blast & crash events and evaluates the occupant and protection system response to these forces.

- MABS: Underbelly blast events at system level
- LIS: Front & side impact, side IED, and rollover
- VAT: Vertical forces and floor deformation
- HIP: Head protection systems

Payoff:

MABS

- State-of-the-art unique piece of test equipment
- Reduced number of LFT&E (~LFT&E $75,000 - $150,000; MABS ~$15,400)

LIS

- Multiple crash events evaluated on one test device
- System design optimization for multiple impacts

VAT

- Assess multiple occupants & lower extremity injury
- Configurable platform - vehicle specific layout

HIP

- Low cost, quick assessment of a head impact protection
- Assess interior padding solutions

Blast Technologies POC's

Government Point Of Contacts (POCs):

Jim Park

Blast Mitigation

Exterior and M&S Team Leader

Risa Scherer

Blast Mitigation

Interior and Laboratory Team Leader

U.S. Army Research, Development and Engineering Command

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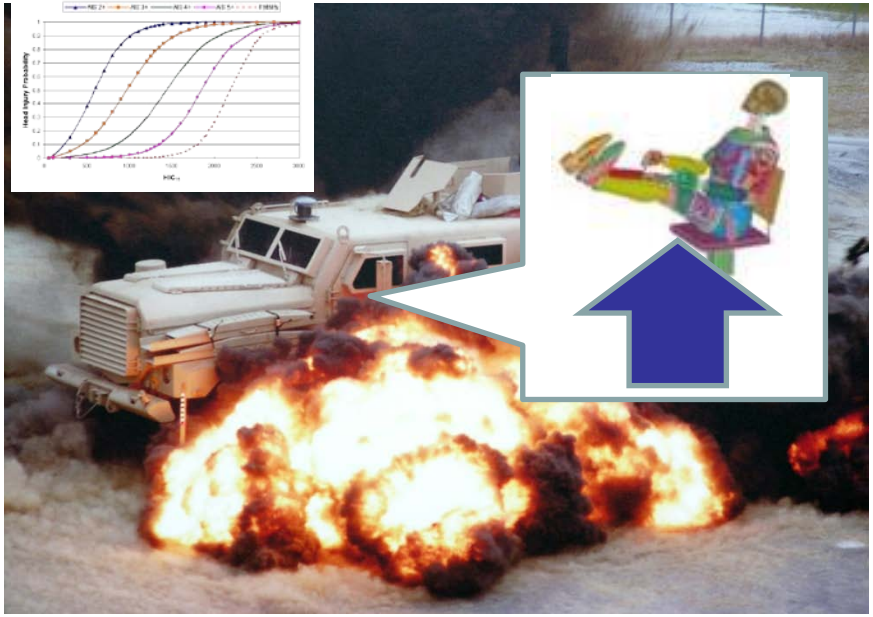
Warrior Injury Assessment Manikin (WIAMan)

Warrior Injury Assessment Manikin (WIAMan)



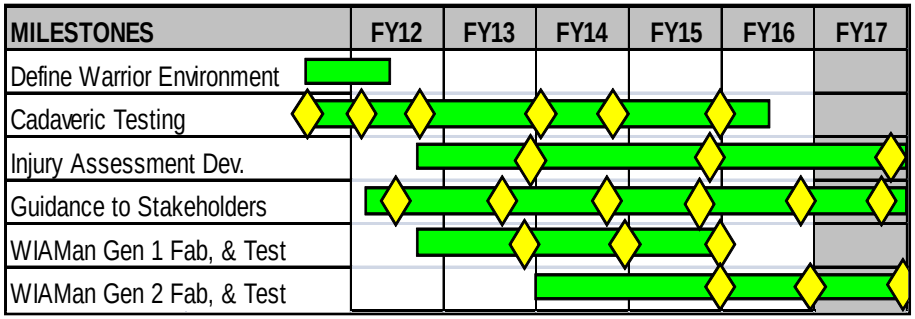
Purpose:

Create a Warrior-representative anthropomorphic test device (ATD) and associated biomedically-validated injury assessment tools and a framework for use in LFT&E and vehicle development efforts

Results:

- ***Secure a significantly robust set of baseline data on blast events and resultant injuries to establish baseline blast event assumptions***
- ***Develop realistic accelerative injury response curves and analytical methods based on actual test, explosive and armor representations***
- ***Develop a test manikin to provide operationally relevant state of the art soldier surrogate***
- ***Data input to vehicle/weapon system design parameters to improve survivability***

Original Schedule & Estimated Costs

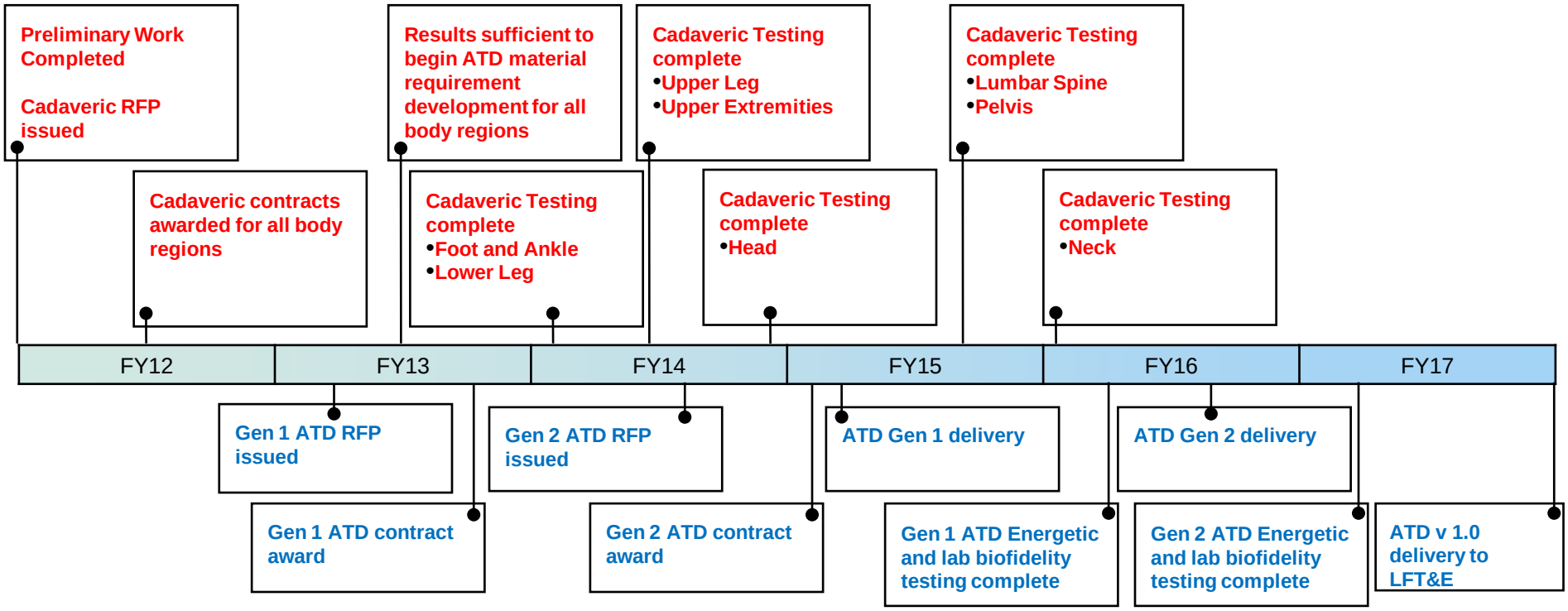


Payoff:

- ***Increased knowledge of Warrior vulnerability in under body blast events***
- ***State of the art criteria, methodologies & metrics used to assess injuries from accelerative loading sustained during under body blast***
- ***New manikin design to accurately measure vertical accelerative load events***
- ***Vehicle safety and soldier survivability enhancements***

Milestone Indicators: TRL or SRL: ◆ Milestone Timeline: ▬

Cadaveric Research and ATD Development Plan Overview



Timeline driven by cadaveric testing requirements

What is the Problem?

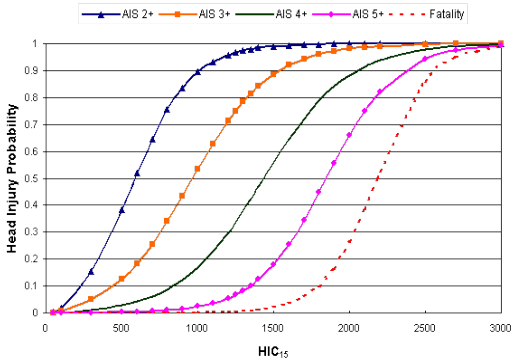
Lack of human injury response data for Under Body Blast events

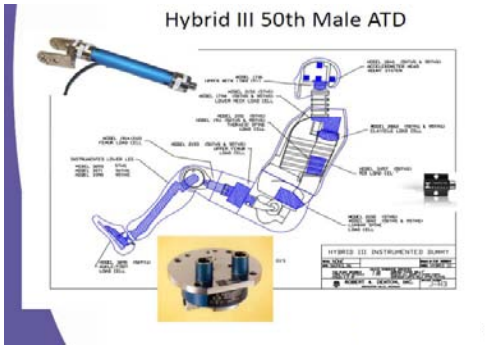
+

Blast Test Manikin (Hybrid III) that is anatomically incorrect and was not designed and validated for the extreme vertical loading

=

LFT&E that does not yield sufficient prediction of Soldier injury during Under Body Blast events





Project Background

- •Cadaveric research that defines human injury criteria for the underbody blast environment (short duration, high magnitude, high rate, primarily in the vertical direction)
- • Physical parameters representative of the current soldier population
- • Full consideration of the military operational environment
- • Instrumentation that satisfies the measurement and data acquisition requirements of the LFT&E environment
- • Analyses of injury data from theatre
- • Relevant assessment methodologies that can be extended to yield injury assessments at higher fidelities and with higher confidence

WIAMan

TARDEC POC:

Risa Scherer

Blast Mitigation

Interior and Laboratory Team Leader

U.S. Army Research, Development and Engineering Command

U.S. ARMY RDECOM

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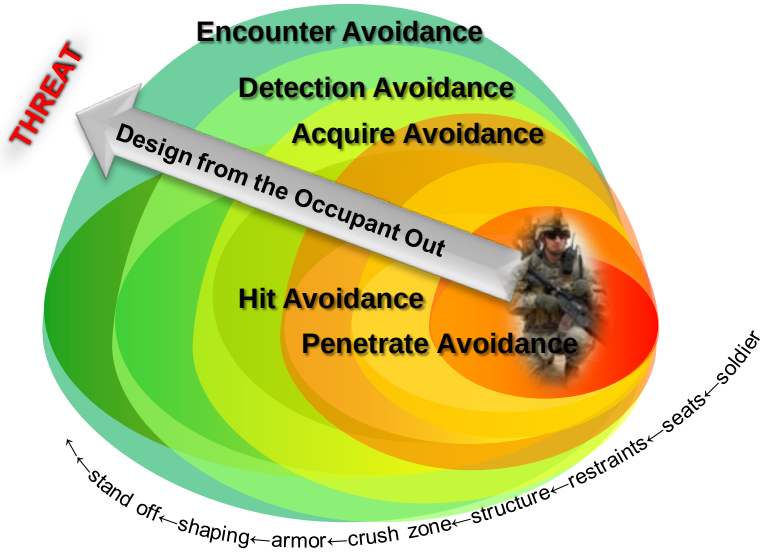
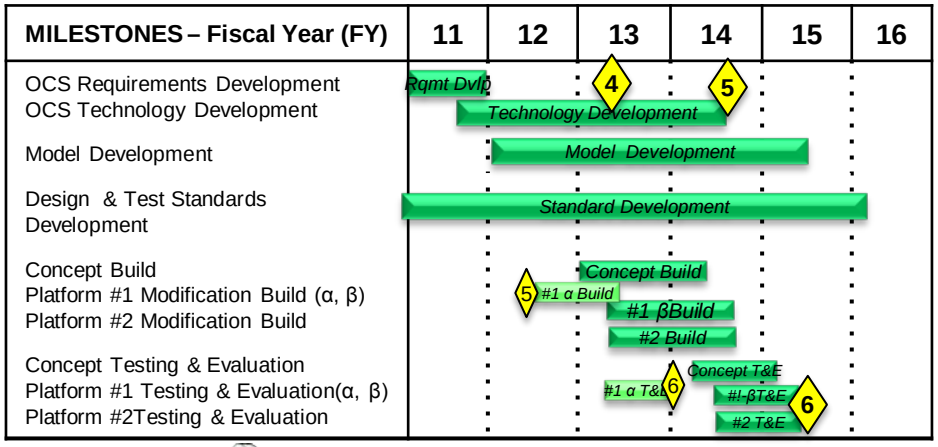
Occupant Centric Survivability (OCS) Project

Ground Systems Survivability
Occupant Centric Survivability (OCS)





Purpose:

The Occupant Centric Survivability (OCS) Project provides the mechanism to develop, design, demonstrate, and document an occupant centered Army Ground Vehicle design philosophy that improves vehicle survivability as well as force protection by mitigating Warfighter injury due underbody mine blast, underbody Improvised Explosive Device (IED), vehicle rollover, and vehicle crash events.

Products:

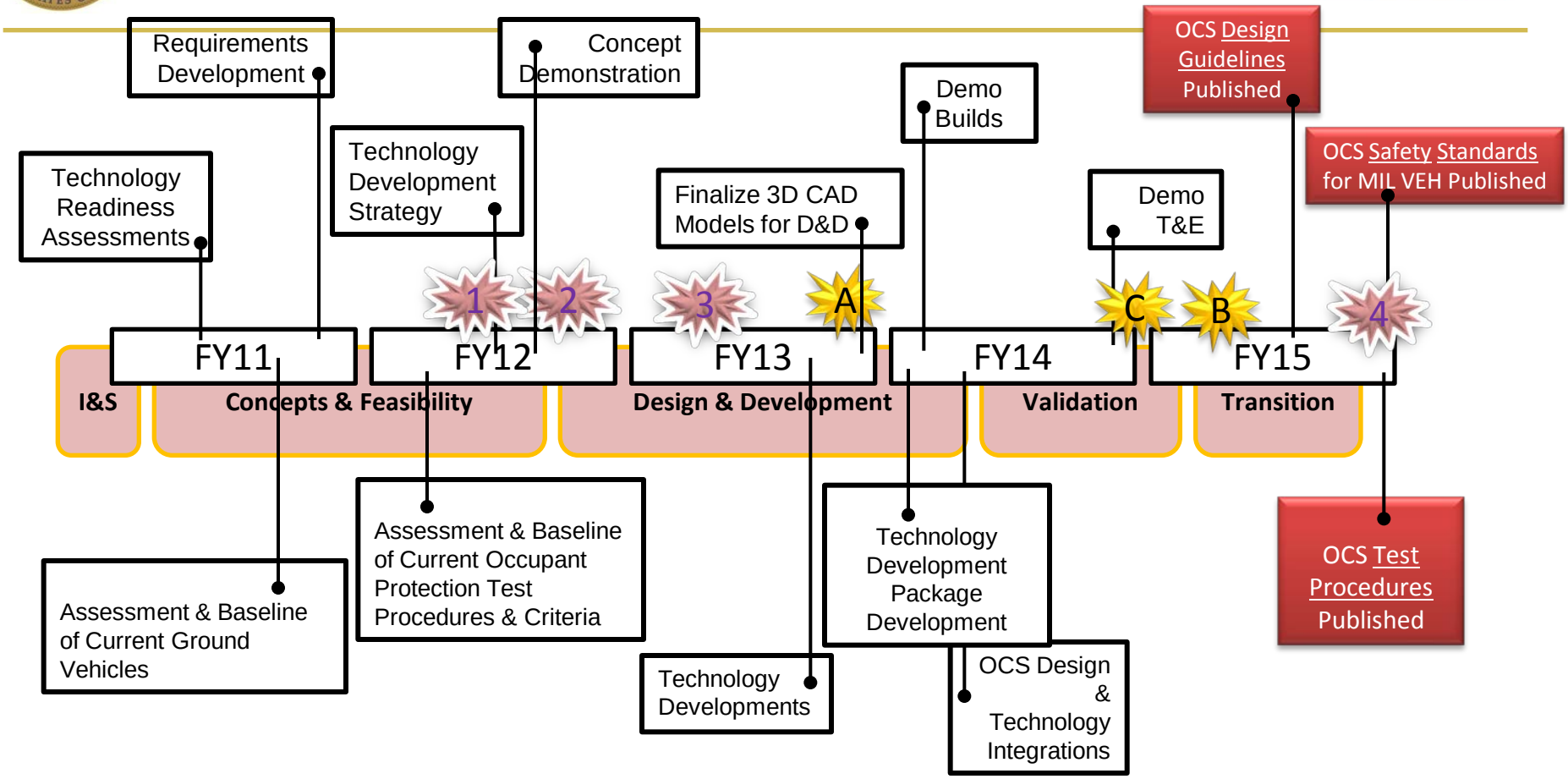
This design philosophy considers the Warfighter first, integrates occupant protection technologies, and builds the vehicle to surround and support the Warfighter and the Warfighter's mission. This is accomplished by delivering the following products.

- OCS Concept Design Demonstrator
- Platform Specific Demonstrator #1
  - Alpha (α)
  - Bravo (β)
- Platform Specific Demonstrator #2
- Published Standards: OCS for Army Ground Vehicle Design (Design Guidelines, Test Procedures, and Safety Specifications)
  - Gap Analysis
  - 1st Edition

Payoffs:

- The Occupant Centric Survivability (OCS) Project will provide increased platform survivability and active/passive protection through reduced Soldier casualties and mitigation of injuries related to underbody mine blast, underbody Improvised Explosive Device (IED), vehicle rollover, and vehicle crash events.
- Integrated Superior Occupant Protection Technology Demonstrators
- Improved Vehicle Survivability and Force Protection Quantitatively – Guidelines, Military Standards (MIL-STDs), Test Procedures

OCS Timeline at a Glance



=*Technology Drop*

= *Knowledge Drop*

= *Major Tasks*

1 Superior Sub-System Technologies

2 Design Guideline Assessment and Gap Analysis

3 OCS System Level Design Concept following PPDR

4 OCS for Army Ground Vehicle Design Guide

A Alpha Demonstrator Technologies

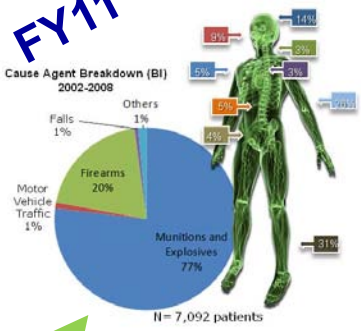
B Bravo Platform Specific Demonstrator Technologies

C OCS Design Concept Superior Technology

TARGET PROCESS

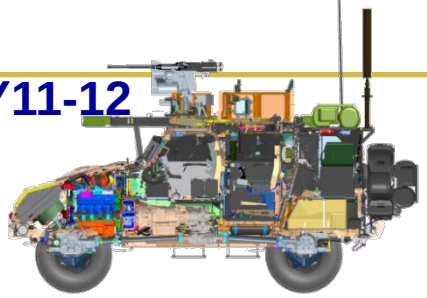
OCS Technical Approach

FY11



Use current Army Needs, Voice of the Customer, and Injury Data to Define Warfighter Needs and feed System Requirements

FY11-12



Search current and near-future technology that meets/exceeds requirements, and integrate those technologies into a digital design

FY12

Model design(s) and digitally test for performance.

FY13-14

Build OCS Concept Design Demonstrator, Integrate Appropriate Design Features to 2 Current Platforms

Test OCS Concept Designs and Integrated Platforms to Verify Results and Correlate with Modeling

FY14

Produce "Best Practices" and "Design Guidelines" for Future Platform Reference

Designed, integrated, and tested technologies that can Improve Survivability for the Soldier, and Design Guidelines that can be used for Future Vehicle Designs

Kill Avoidance

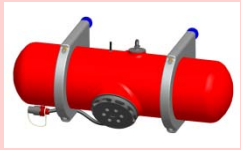
Injury Reduction

FY15 SUCCESS!

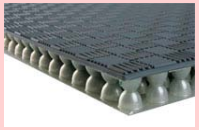
Technical Solutions to Evolving Threats

Hull Shaping and Materials - mitigate the effects of an UB event

Air Bags



Fire Suppression System



Absorption Materials – reduction of hard-points

Effective Seating - Ergonomics , Performance, Adjustability, Restraint, Reconfigurable for litter transport

Innovative Ergonomics - Ingress/Egress

Restraints

PPE and Gear

?

Novel Technologies

Challenge to integrate solutions based on:

- Legacy Vehicle Systems
- Increasing Threats

OCS Mission: D4W – Design for the Warfighter

2011 Occupant Centric Survivability (OCS) Market Survey

- Posted to FedBizOpps.com and ProcNet (24-Mar-11)
- Survey Closes (21-June-11)

The US Army Tank and Automotive Research, Development, and Engineering Center (TARDEC) Ground Systems Survivability (GSS) is conducting a market survey to identify potential traditional and non-traditional sources and the status of the state-of-the-art technology that provide occupant protection and ground vehicle survivability during an underbody mine blast, underbody improvised explosive device (IED), vehicle rollover, and vehicle crash (front, side, and rear impact). The data gathered in the market survey will help define and influence the trade space and requirements of a follow-on Request for Proposal (RFP) for technology maturation released through the TARDEC Omnibus.

TARDEC is seeking the following technologies to enhance occupant protection and vehicle survivability during underbody mine blast, underbody IED, vehicle rollover, and vehicle crash (front, side, and rear impact): personal protection equipment and gear, interior, exterior, sensing and electronics, fire suppression, retention, and other novel technologies.

Occupant Centric Survivability

To Document and Demonstrate an Occupant Centric Design Approach for increased Soldier Protection and Vehicle Survivability!

Government Point Of Contacts (POCs):

Regina M. Rogers
OCS Project Lead

Christine M. Wodzinski
OCS Project Deputy

Blast Summary

- Blast events is our major threat in theatre
- Army is expecting to quickly realize significant improvements in ability to mitigate effects of blast events on Soldiers
- We are interested in leveraging what industry has to offer