



LIGHTWEIGHT & ADVANCED MATERIALS FOR DEFENSE

Materials for Military Ground Vehicles



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Report Documentation Page

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Outline

Tactical Vehicles
FCS Structure and Materials
Advanced Reconfigurable Structure



Materials for Tactical Trucks

Material must be readily available and fully developed.

- RHA
- High hard steel
- Aluminum

Research projects are ongoing to further develop advanced lightweight armors.

- Composites
- Ceramics
- Titanium

Long Term Armor Strategy

- A + B design
- Requirements are classified





Future Combat System (FCS) Materials

FCS requirements

C130 transportable

- Transport weight not to exceed 18.5 tons
- Weight can be increased on ground
- Dimensional constraints
- Structure "A" + Armor "B" solution
- Structure selected by IPT to be 5059 Aluminum with friction stir welded 2195 Aluminum/Lithium belly
 - Fall back position 5083 Aluminum with friction stir welded 2195 Aluminum/Lithium belly
 - Fall back position 5059 complete structure
- No selection yet for "B" armor

Cost

Cover layer

Composite layer





FCS Video





FCS May 25 Guidance (+)

Emergency transport configuration

Maximum Size Envelope For Variants

- 119" Width
- 108" Height
- 263" Hull Length (excluding barrel overhang)

Unlimited time for ECC - FCC transition

C-130 ramp hinge limit

Use Non-Combat Configuration (NCC) approach for vehicle configuration

Use platform maintenance manuals as the guide for removal and reassembly

Shoring is allowed to solve rail and hinge issues

This initial guidance will be refined and updated if required NLT Jun 16



Trade Process & Conduct

- This trade was conducted in accordance with the approved FCS trade study process
- The measures in the metallic material trade process will be addressed:
 - Cost - measured in dollars
 - Raw Material, measured in dollars per kilogram
 - Integration Burdens & Allocations
 - Weight, measured in kilograms
 - Risk
 - Producibility
 - Performance
 - New Material Characterization Cost
 - Performance
 - Logistics
 - Corrosion Susceptibility
 - Mine Blast Resistance

The IPT established weighting factors as part of the formal trade process.



Assumptions (1)

Trade is for metallic portion of MGV chassis only

- Trade Alternatives are:

- Aluminum 2519
 - Aluminum 5083
 - Aluminum 5059
 - Aluminum 2519 with 2195 Al/Li friction Stir Welded Floor
 - Aluminum 5083 with 2195 Al/Li friction Stir Welded Floor
 - Aluminum 5059 with 2195 Al/Li friction Stir Welded Floor
 - Aluminum 2519 with Ti Bolt in Floor
 - Aluminum 5083 with Ti Bolt in Floor
 - Aluminum 5059 with Ti Bolt in Floor
- Trade will evaluate a MGV point design (BTA1U with updates)
 - Initial MGV configuration will be Carrier type vehicle (C2V) Initial study will be for an "A" + "B" armor integration approach where upper hull "A" has no ballistic requirement at ECC and lower side wall will work in concert with Skirt, minimum thickness to be 0.75 Al and a 4 mm. allowable deflection from lower side wall to the suspension.





Hull Aluminum Material Trade Study Results and Hull IPT Recommendations

Trade study results

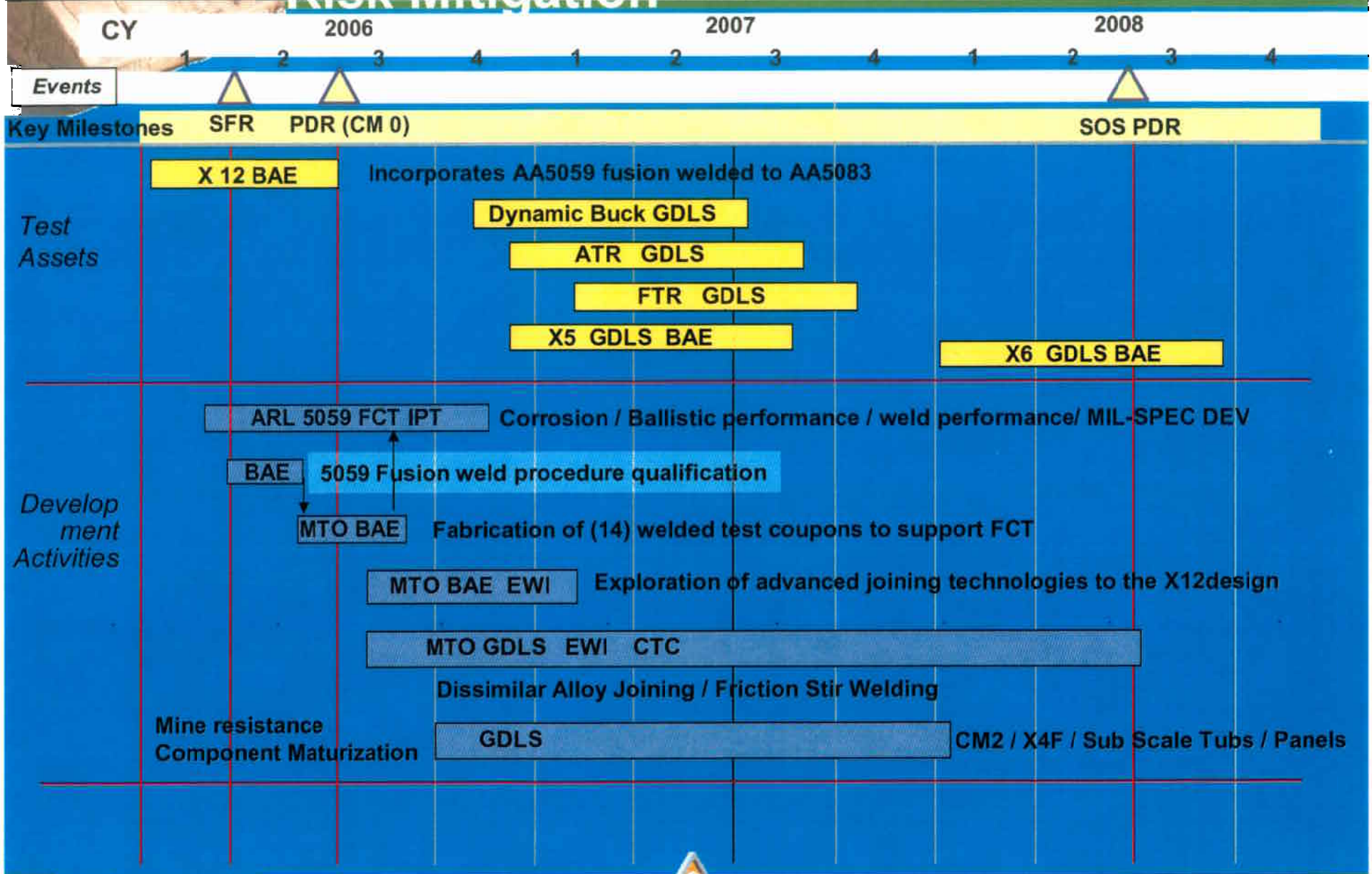
- Aluminum hull material trade study winning candidates
 - 5059/2195 - Winner
 - 5083/2195 – Close 2nd
 - 5059 - Close 3rd
- Winning triad rankings robust and not susceptible to moderate weighting alterations
- High degree of Hull IPT consensus

Hull IPT Development Plan Approach

- Baseline hull material – 5059 hull / 2195 belly plate
- Risk fall back alternate plan A – based on possibility that hybrid belly plate technology may not mature prior to PDR
 - Fall back construction #A1- 5059 hull and belly plate
 - Fall back construction #A2- 5059 hull and titanium belly plate
- Risk fall back alternate plan B – based on possibility that 5059 may not mature prior to PDR
 - Fall back construction #B1- 5083 hull / 2195 belly plate
 - Fall back construction #B2- 5083 hull and titanium belly plate



Risk Mitigation



Advantages of Structural Approaches



Space Frame

Lightest "structure only" weight
Tailorable survivability

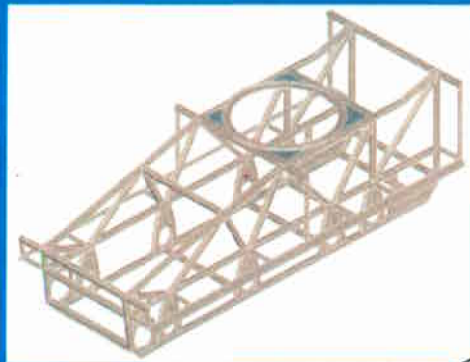
- Ballistic armor tailored to mission requirements
- Low burden integration of EMA, Signature Management, Etc.

Ease of repair

Improved transportability

Monocoque

Lightest weight approach assuming a base level of ballistic protection
Efficient integrated structural armor solutions
Maximum interior volume
Lowest cost



Space Frame



Hybrid Structures



Monocoque



X1 Ballistic Test Section



Monocoque Forward Section



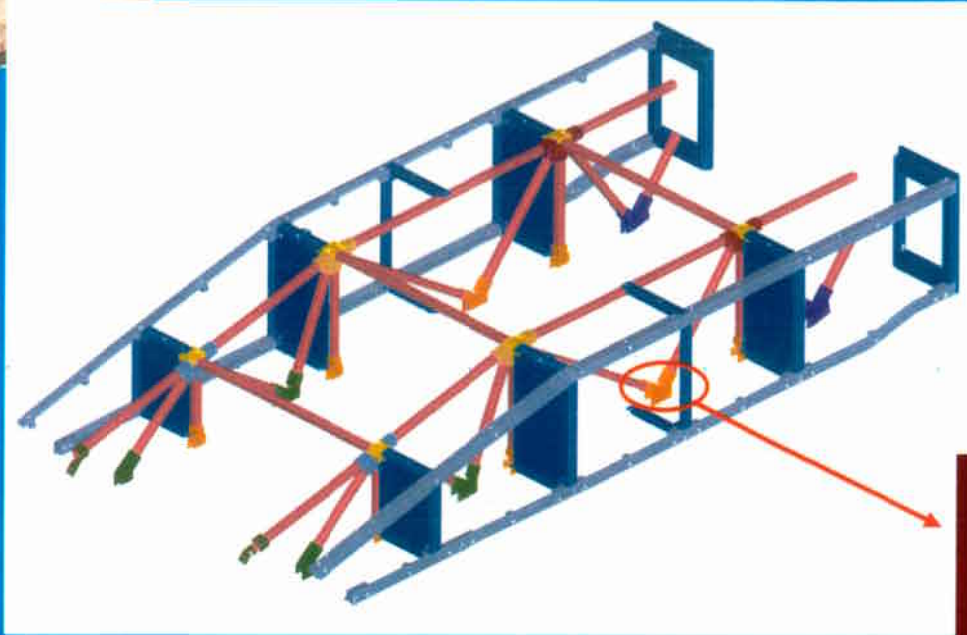
Space Frame Aft Section

- Leverages IHS concept to provide a full-scale hull survivability test bed
- Composite HMG/Frag upper hull
- Metallic lower hull with integral Medium Cannon front and ballistic armor skirts
- Aluminum space frame aft section provides easy installation of modular armor for evaluation
- EMA "integration" demonstrated
 - Enough power and energy storage on board to accommodate applique
 - Structural "sockets" or access points are designed in

Government Testing



ARES Spaceframe Nodes



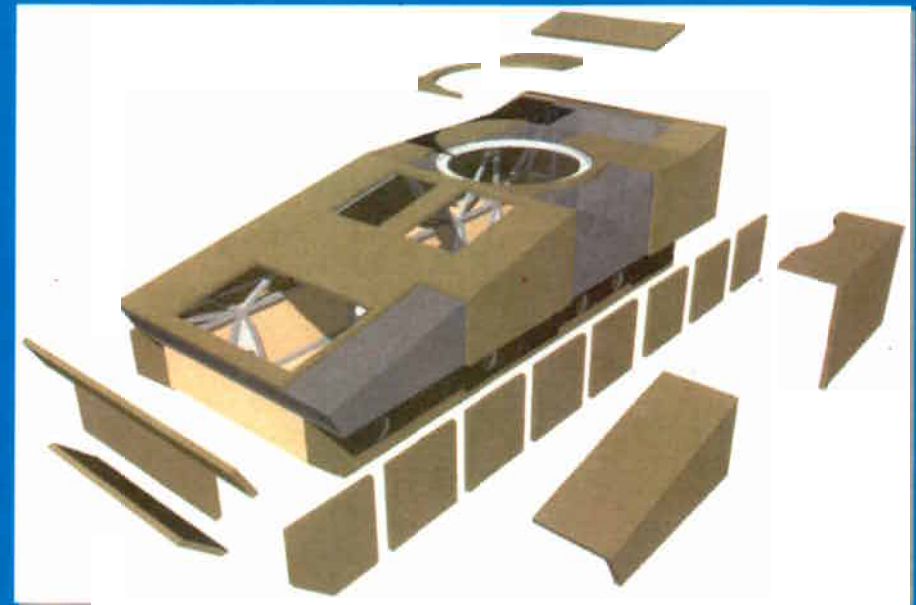
Lower Attachment Node Halves



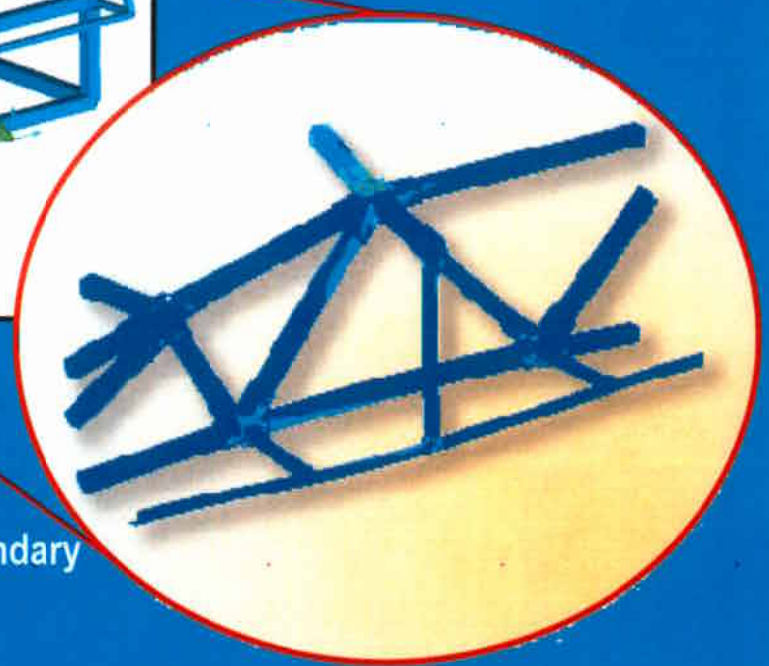
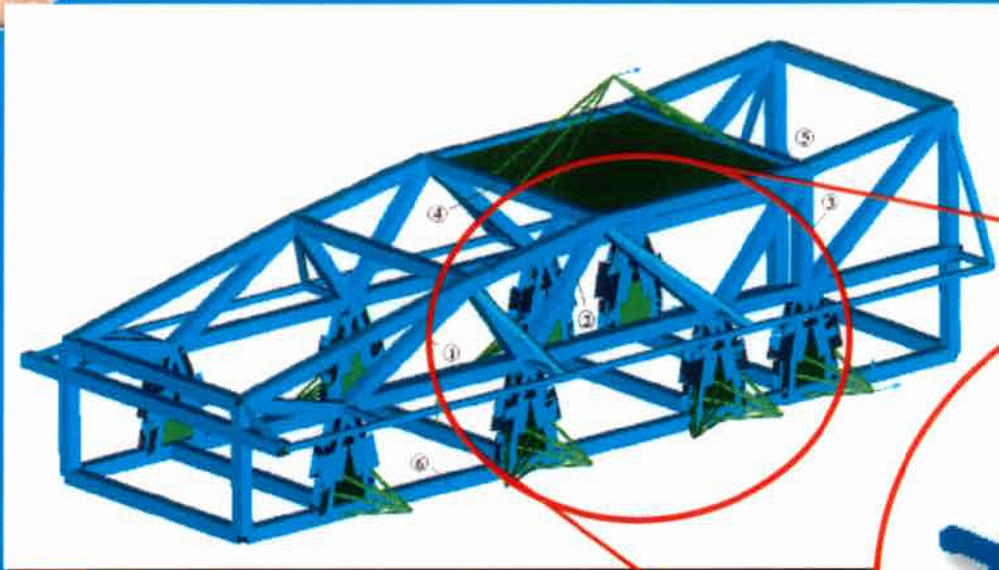
Selected Space Frame Structure

Features

- Full space frame design
- High strength frame
- Composite upper and lower shells for EMI/Environmental
- Base armor mounts to frame
- Add-on armor/survivability kits mount over base armor



FEA Model



Forces, moments and displacements are extracted from the global model and applied as boundary conditions for local model.

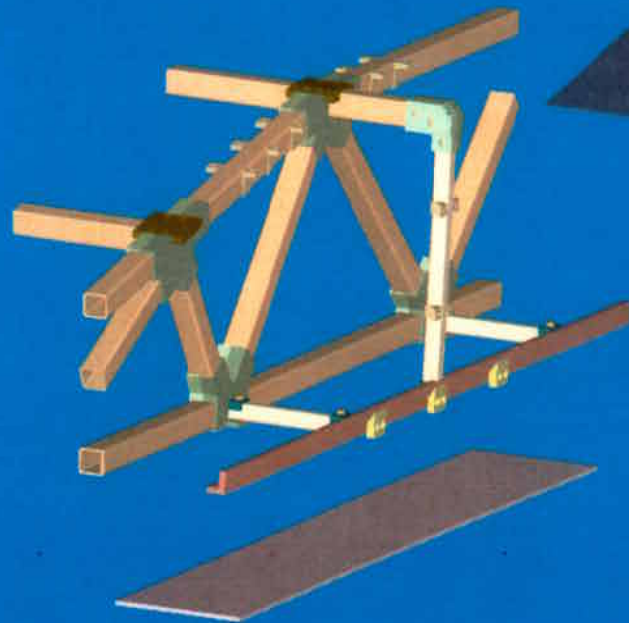
Little or no redundancy: Sponson framing not required for mobility or gun firing; supplied as practical structure for mounting



AX-0 Test Section Components



Frame Assembly



Composite Upper Skin



Armor Module



Mounting Guides



Completed January 2005

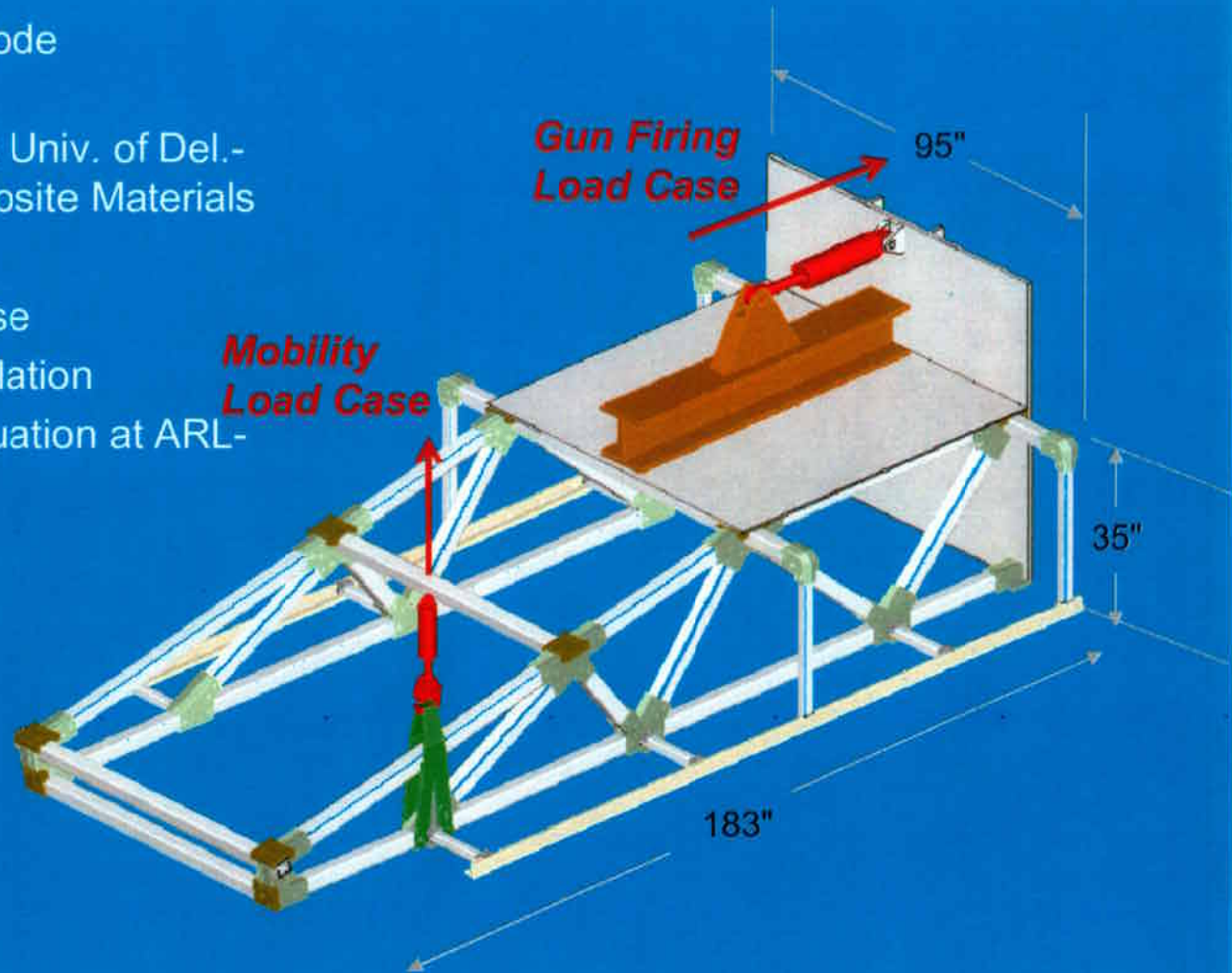




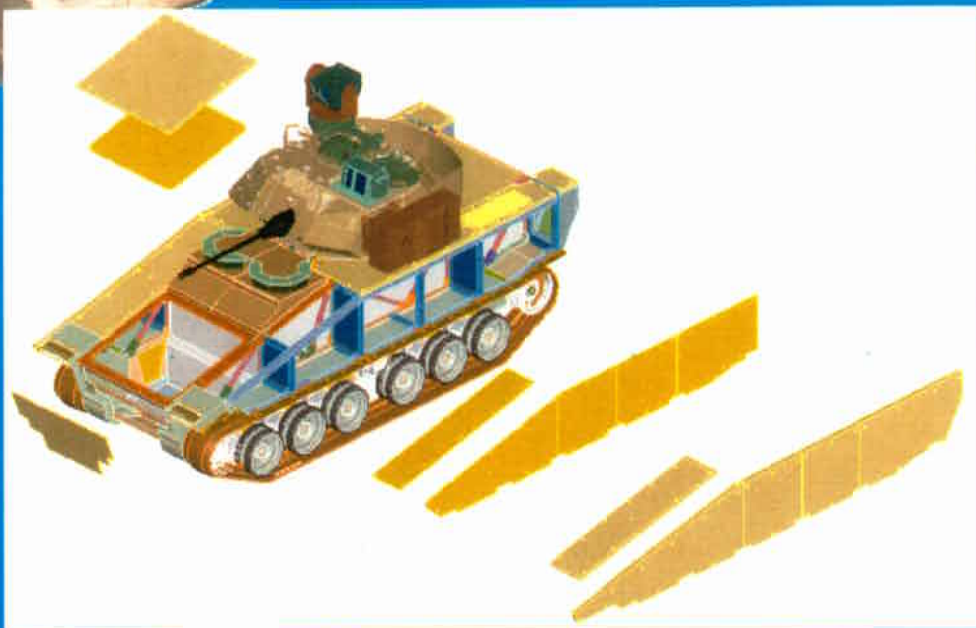
AX-1 Test Asset

Features

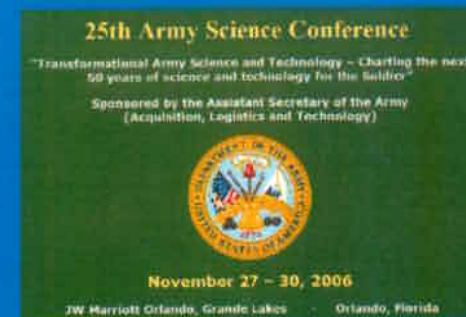
- Multiple tube and node configurations
- Structural testing at Univ. of Del.- Center for Composite Materials
- Mobility load case
- Gun firing load case
- FE Analysis Correlation
- Ballistic shock evaluation at ARL- Aberdeen



ARES Layout Option



Left Side – Armor suite and skins remove or set aside for ASC show



Right Side – Armor suite and skins attach for ASC show

