Welcome to BAE Systems

Mobility & Protection Systems, Sterling Heights, MI – October 2008
Systems Engineering in New Vehicle Development

FTTS (Future Tactical Truck Systems)

Customer: US TACOM National Automotive Center (NAC), Warren Mi

Walter J. Budd
Chief Engineer
BAE M&PS
October 2008
MSV - Maneuver Sustainment Vehicle
- 18 Month Project, Design, Build, Qualify New Vehicle
- Systems Engineering Approach
- Requirements Analysis
- Performance Parameters Linked Into Models
Requirements Analysis

- Process Began With Customer Supplied 92 Page Performance Requirement Document
- Our Engineers Developed and Tracked 408 Given and Derived Requirements

![Spreadsheet-based Tracking Diagram]

### Requirements Table

<table>
<thead>
<tr>
<th>Specification</th>
<th>Priority</th>
<th>Level</th>
<th>Parameter Name</th>
<th>Units</th>
<th>Operator</th>
<th>Threshold Value</th>
<th>Design Value</th>
<th>Normalized Weighted Value</th>
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<td>Key</td>
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**Design Gradient**

- 03-October-2008
- Property Of BAE Systems M&PS
Performance Specification (UV & MSV)

Parameter Matrix (Excel Spreadsheet)

- Hybrid Powertrain Models
- Stress Analysis (FEA)
- ILHS/MHE Models
- Mobility Models (DADS)

Parameter-based Engineering Model (Pro/ENGINEER skeleton based geometry)

Reliability, Availability, Maintainability, & Durability (RAM&D) requirements
Power Generation

Hybrid System

CAT C9
1600 RPM
1850 N.m
450 Hp

UQM
1900 RPM
600 N.m
160 Hp

Combined Peak Torque
2446 N-m (1804 ft-lbf) @ 1600 RPM

Combined Peak Power
610 HP (455 kW) @ 2300 RPM
Battery Pack

Four, 45A*h NiMH Batteries Used To Support The Hybrid Power Requirements

<table>
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<th>MANUFACTURER</th>
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<td>DIMENSIONS:</td>
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<td>L x W x H</td>
<td>MM 1900 x 600 x 310</td>
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</table>
Custom Designed Independent Suspension Axles

- Independent Suspension SLA
- Axel Differential Ratio: 2.077
- Wheel Hub Planetary Ratio: 3.55
- Hydraulic Disc Brakes - ABS
All-New Frame Was Required

Inputs from:
- Automotive Loads
- 13 Ton Load Carry
- Lift/Unload 13 Ton Cargo
Material Handling Equipment
Get supplies to the soldiers as quickly and as safely as possible
• **Load/Unload Cargo**

• **Load/Unload Trailer**

• **Load/Unload ISO Containers**
Challenge

- *Create* multibody simulation that represents several truck and suspension variants

- *Different* suspension designs (not just parameter values)

- Make it *easy* to run different trucks on all possible roads and obstacles
Mobility Models

- Model as a series of rigid bodies with joints and force elements
- Tire forces modeled for both hard and soft surfaces
- Driving scenarios to test limit handling in loaded condition
- Lane change stability test
- Predict handling stability and peak roll and lateral accelerations
- Predict roll, sliding and dynamic loads
- Verify safe operating limit for field tests
- Avoid dangerous tests that could endanger drivers and prototype equipment
Results
Results

MSV: Measured and tested to the limits
Results

MSV Core Team
• Lessons Learned
  • Value Of The Systems Engineering Process
  • Importance Of Model Validation
  • Benefits To BAE Systems
  • Benefits To The Customer