RT-26
Vehicle Systems Engineering and Integration Activities

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Overview

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• Research Thrusts
  - MPT to develop versatile ground vehicles
  - SE for Science and Technology programs
Versatility Objective: Design for Growth and Evolution

- Reduce development time & cost for enhanced capability
- Reduce manufacturing change over time & cost
- Reduce fielding time and cost
- Reduce logistics burden for platform-based product lines

Subject to
  - Poorly-understood future operational needs and context
  - Poorly understood future subsystems and their burdens
Versatile System Design

• Dimensions
  – Reserve Capacity
  – Modular Design
  – Reusable Components

• Issues
  – Formulation & Expression
  – Specification & Evaluation

• Initial RT-26 MPT Focus
  – Reserve capacity requirements formulation & expression

Versatility is central to the Army Force Modernization Concept

Versatility has historically been achieved by incremental evolution of platforms

Versatility is closely related to the Systems2020 objectives
Army Goals for Ground Vehicle Versatility

- To base a product line of mission-variants on a common vehicle platform
- To support the full range of military operations from major combat operations to humanitarian assistance, across the spectrum of terrains and environments
- To integrate new capability packages addressing operational needs identified by commanders in the field, and to integrate new technologies as they mature.
Key Lessons Learned

- Provide Soldiers protected mobility: #1 priority
- Develop fighting vehicle for complex environments including urban operations
- Reduce predictable travel on established routes: better off-road mobility required
- Design platforms with sufficient growth potential for future capabilities
- Increase platform capacity to meet evolving threat
- Obtain better C2 on-the-move capability
- Push real time situational awareness to and from Company level and below
- Connect the Soldier to the network

Greater demand on small unit operations dictates that tactical vehicles must be protected, mobile, and networked

Capability Packages

- Spin-outs + Warfighter Urgent Requirements = Capability Packages
- Provides incremental improvements delivered in two-year cycles
- Enables ARFORGEN beginning FY 11
- Incorporates capabilities requested by Commanders in the fight

Capability Package 11-12

- Persistent Surveillance
- Advanced Precision Mortar Initiative
- Ground Soldier System
- Human Terrain Teams

Provides increased near-term capabilities to the Warfighter

Future Capability Packages will include:
- More capable Unmanned Air Vehicles (greater range, loiter and payload capability)
- Larger Unmanned Ground Vehicles
- Improvements to the Network (more information and imagery at lower levels)
Study Approach

• Investigate historical vehicle programs
  – What factors are credited as contributing to versatility
  – What factors limited versatility
  – What are the different approaches to realizing versatility
  – What requirements were intended to create versatility

• Produce MPT
  – List of critical physical characteristics
  – Guidelines for physical architecture decomposition
  – Generic, parametric statements for reserve capacity requirements
The HMMWV

22 Fielded Versions

- Bolt on armor required upgraded suspension, engine, and steering
- Additional armor and cupola raise the CG and increase rollovers
- Mattracks or wheels
- Upgrades:
  - Increased cab space
  - Increased payload capacity
  - Strengthened frame
- Imbalance in cupola required motorized drive
- Base cab & flatbed with mission modules
- Upper deck space is always at a premium
- Suspension and steering for CG shift

Base cab & flatbed with mission modules
The Venerable M113
4 Block Upgrades & 12 Major Variants

- Aluminum skin vs ribbed steel for greater load-bearing strength
- Engine upgrade for increased weight
- Cooling system upgrade for larger engine
- Large “empty” passenger/cargo volume
- Stretched chassis for increased volume
- Suspension mod for mortar and cannon impulse loading
- Added roadwheel and stretched track to balance CG shift and limit ground pressure with increased mass
Stryker Family of Vehicles

2 Versions Plus 8 Mission Variants

Began as Canadian Light Assault Vehicle

Body strengthened to support cannon & turret for Armored Gun System

Large passenger/cargo volume & top deck

Top deck deconfliction remains an issue
Versatility Factors and Physical Organization

Components that Can be in Different Positions or Orientations
Isolated or Separated Compartments

Mass & Structure Properties
- Mass
- Angular moments
- Imbalances
- Load bearing wall strength
- Deck surface area
- Interior volumes*
- Interior surface areas*

* By crew station and compartment
Physical Characteristics
Enabling Versatility

• Physical Characteristics
  – Mass Properties: mass, center of gravity location, angular moments, imbalances
  – Structure Properties: Volumes, internal and external surface mounting areas, load bearing structures

• Physical Organization
  – Groups of subsystems or components that can be moved independently but are physically connected (e.g. entire vehicle, chassis+turret, turret +cupola, etc.)
  – Subsystems or components that can be moved to different fixed positions or continuously (e.g., chassis, turret, cupola, sensor pod, etc.)
  – Constrained space compartments (e.g., crew compartments, passenger/cargo compartments, engine compartment)
Example Requirements
Enabling Versatility

• The system shall be meet all performance requirements with a change in vehicle CG location of 5% of vehicle dimension (i.e., longitudinal change 5% of length, lateral change up to 5% of width, elevation change up to 5% of height)

• The system shall be meet all performance requirements with a change in turret mass of 10%

• The turret shall have 20% upper deck surface area reserve capacity

• The chassis frame shall have 50% reserve load bearing capacity

• The XYZ compartment shall have reserve volume able to add 1 component of size $H_1W_1L_1$ or 2 components of size $H_2W_2L_2$ or 3 component of $H_3W_3L_3$
Generic Parametric Requirements for Physical Characteristics Enabling Versatility

- Subsystems shall be designed with compatible reserve capacities to enable the vehicle system to perform all functions effectively and meet system performance requirements with \( X\% \) change in \(<mass\ property>\) of \(<decomposition\ element>\).

- The \(<decomposition\ component>\) shall have \( X\% \) \(<structure\ property>\) reserve capacity.

- The \(<decomposition\ component>\) shall have \( X \) amount of \(<structure\ property>\) reserve capacity.

These general statements are independent of the vehicle functions and functional architecture.

The requirements for reserve capacity in physical characteristics are not independent of the physical architecture.
MPT for DoD Ground Vehicle Versatility Requirements

- Identified the key requirements parameters
  - Mass properties
  - Structure guidelines
- Method and guidelines for physical architecture decomposition
- Generic, parametric statements for physical characteristics to enable versatile ground vehicles

**Impact:** Applying the MPT can potentially produce significant reductions in the time and cost of acquiring versatile and supportable ground vehicle platforms and product lines.
Open SE Research Issues in Acquisition of Versatile Systems

• Reserve capacity physical characteristics MPT to
  – Balance benefits vs burdens in setting requirements for reserve capacity
  – Evaluate the reserve capacity benefits and burdens of specific architectures and designs

• Modular design MPT to
  – Evaluate tradeoffs between modular and integral design
  – Evaluate modularity of architectures and designs
  – Allocate functions to subsystems

• Reusable component module design guidelines for
  – Robust interface definition
  – Function allocation
  – Scale / capacity increments for families of components