• Warfighter Needs Must Still Be Met Despite Common Expectation Of Declining Resources

• Challenge To Maximize The Value Of Defense Science And Technology Efforts Requires Their Relevance To The Acquisition Community Mission

• Systems Engineering Techniques Can Be Leveraged As An Effective Tool To Assist In Making Difficult Decisions

• Two (2) TARDEC Systems Engineering Group Support Efforts Are Summarized As Examples Of The Above
RDECOM Technical Process

Current Capability

Establish Operational Requirements
- VOC Pugh HOQ Benchmarking
- M&S Operational & Technical

Develop Design Requirements & Functional Configuration
- ID Viable Technologies

Develop Preliminary Designs and ICDs
- M&S Design & Performance Simulation

Develop Detailed Designs
- M&S Design & Virtual Build & Test Limited Comp Tests

Fabricate Hardware
- CAE/CAM

Integration Assembly & Check-out
- Bench Test
- Subassembly Test Limited System Test

Static Demonstrations
- Component Arena Test Demos
- Arena Test
- Rope Test Flight Test

System Test
- Gun Firings
- Sled Test

Transition & Close-out

Future Capability

Requirements Verification
- Effectiveness Models & Empirical Performance Data

Integrated Demonstrations
- Component Arena Test Demos
- Arena Test
- Rope Test Flight Test

Integrated Demonstrations
- Gun Firings
- Sled Test

Rope Test
- Sled Test

Flight Test
- Sled Test

Arena Test Demos
- Arena Test

Component Arena Test Demos
- Arena Test

Vehicle Integration Focus

Needs Definition Focus

Technology Development

Technology Refinement
Example Tasks

• **Task 1 (May-Oct 10):** Using a specific vehicle and mission set, develop a repeatable process and necessary toolset to analyze the benefits of capability package proposed technologies and evaluate tradeoffs between performance and constraints
  – Overall effect on system performance
  – Ability to close capability gaps and meet user requirements
  – Applied to capability package (CP) 11-12

• **Task 2 (Nov 10 – Present):** Assist the TARDEC Ground Domain Planning and Integration (GDP&I) Team in technology needs analysis to guide decisions on S&T programs
**Trade to Host CP 11-12 Equipment**

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**TARDEC Ground Vehicle Technology Integration and Assessment Process**

**Example Trade Study Criteria Matrix**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
<th>Scoring Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Burden (SWAPC)</td>
<td>Low</td>
<td>Complexity</td>
</tr>
<tr>
<td>Ease of Integration</td>
<td>Med</td>
<td>Impacts</td>
</tr>
<tr>
<td>Testing Required?</td>
<td>High</td>
<td>Easy</td>
</tr>
<tr>
<td>Production</td>
<td>Med</td>
<td></td>
</tr>
<tr>
<td>MRL - Material Availability</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Ease of Production Cut-In</td>
<td>Med</td>
<td></td>
</tr>
<tr>
<td>User Priority</td>
<td>Nice to have</td>
<td>Mission Essential</td>
</tr>
<tr>
<td>User(s) Priority</td>
<td>Mission Essential</td>
<td>Mission Critical</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics</td>
<td>14</td>
<td>Significant Impact</td>
</tr>
<tr>
<td>Ease of Retrofit</td>
<td>Impact</td>
<td>Minimal Impact</td>
</tr>
<tr>
<td>Field Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Cycle Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field implemented Fixes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistic Footprint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;S (log)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>8</td>
<td>&gt; 25% of total vehicle cost</td>
</tr>
<tr>
<td>Technology Cost</td>
<td></td>
<td>5% - 20% of total vehicle cost</td>
</tr>
<tr>
<td>O&amp;M (log)</td>
<td></td>
<td>&lt; 5% of total vehicle cost</td>
</tr>
<tr>
<td>Schedule</td>
<td>18</td>
<td>Fielded in &gt; 180 days</td>
</tr>
<tr>
<td>Schedule to Field</td>
<td></td>
<td>Fielded 61-180 days</td>
</tr>
<tr>
<td>Field Implemented Fixes</td>
<td></td>
<td>Fielded in &lt; 60 days</td>
</tr>
<tr>
<td>Performance</td>
<td>15</td>
<td>Increase with significant negative impact on other areas</td>
</tr>
<tr>
<td>System Effectiveness</td>
<td></td>
<td>Increase with minimal negative impact in other areas</td>
</tr>
<tr>
<td>Threshold Threats</td>
<td></td>
<td>Significant increase w/o negative impact on other areas</td>
</tr>
<tr>
<td>RAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**Systems Engineering Analysis of Alternatives Process**

1. Receive Requirements From Customer
2. Identify AoA Participants/Resources
3. Discuss Desired AoA Outcomes/Level of Detail with Customer POC Using Examples
4. Customize Data Collection Matrix with Requirements (Eng, Programmatic, Weighting (Octs), etc.)
5. Collect Technology Alternatives Data for Each Required Technology
6. Determine Level of Integration of Required Technologies
7. Conduct Trade Study Based Upon Customer Requirements
8. Issue AoA and Trade Study Findings
9. Trade-off Analysis
10. Technology Maturation
11. System Technology Demonstration
12. Technology Transition
13. Operational Analysis
14. Cost/Price Analysis
15. Vehicle/Technology Analysis
16. Concept & Analysis
17. Needs Analysis
18. Requirements

**Scoring Rationale**

- Low
- Med
- High
CP 11-12 Approach

Objective:
- Maximize performance based on weighted parameters

Subject To:
- Burdens
- Cost
- Risk
- Growth Potential

Target Result:
- Best suite of technologies for the CP11-12 host vehicle
• Better Strategy Required For Gathering Data Across Multiple Organizations (e.g. multiple Program Executive Offices (PEOs) and Program Managers (PMs)); Data Gaps Necessitated Use Of Notional Data For Demonstration Purposes

• The Trade Study Team Needs To Be A Central Part Of Integration Team And Drive The Data Gathering Activities And Analysis

• The Trade Study Should Also Be A Part Of Interim Reviews For All Subject Matter Experts (SMEs)
Needs Analysis Task Summary

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• Streamline The Process For Collecting Needs Data (Eliminate Re-invention Of New Lists Each Year)
• Contribute To Driving Out Requirements By Decomposing Needs To Enable Appropriate Action
• Assist In Obtaining Metrics Data To Evaluate How Well Programs Meet Needs By Working With SMEs & PM Partners
• Propose Needs Commonality Across PM Platforms
• Facilitate Needs Alignment With Programs
• Provide A Template/Spreadsheet For Needs Data
• Configuration Control Of The Needs Within The Database (Traceability)
• Provide Traceability Of Needs To TARDEC Programs And PEO/PM Capability Gaps IAW Priorities & Budget
• Generate Reports To Support Program Decisions
TARDEC GDP&I Planning Process

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TARDEC SEG Focus

Strategic Needs Analysis
- Gather, Analyze, Integrate Needs
- Identify and Prioritize Ground Domain Gaps aligned to Strategic Vectors and time-phased needs.

• Identify and Prioritize Gaps

Balance Portfolio to align with Ground Domain Priorities

Align Investments to Meet Ground Domain Priorities:
- Combat Vehicles
- Tactical Vehicles
- Robotics
- Base Camps

Strategic Project Planning
- Coordinate Tech Gaps
- Align Acquisition/ST&T Plans and Schedules
- Develop Ground Strategic Technology Plans & Roadmaps
- Annual POM Planning
- Annual Guidance

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Project Execution Management
- TARDEC Evaluation
- Project Management Best Practice Standardization
- Earn Value Management Training
- Project Governance
- Project Health Dashboard

Manage and Execute Project Plan

Portfolio Assessment
- Assess Balance and Alignment to Strategy
- Refine Recommended Strategy

Portfolio Assessment
- Analyze portfolio balance and alignment for leadership and tech developers.
- Monitor portfolio health and assess impacts from changes.
Integrated Needs Analysis

- Gather, Analyze, Integrate Needs
- Identify and Prioritize Ground Domain Gaps aligned to Strategic Vectors and time-phased needs.
Decompose Needs into Requirements

- Identify and document Functions, Performance, Constraints, Interfaces
- Verify with product and tech area SMEs
### GDP&I Needs Analysis Process

<table>
<thead>
<tr>
<th>TARDEC Needs Analysis Team</th>
<th>PEOs/PMS (Facilitated by Needs Analysis Team)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate Need Capabilities</td>
<td>Collect and Use Needs Data Using TARDEC/PM</td>
</tr>
<tr>
<td>Align Need With An Existing Capability Gap</td>
<td>Collect and Use Needs Data from TARDEC/PM for the Need</td>
</tr>
<tr>
<td>Add To Needs Matrix</td>
<td>Collect Needs Decompositions/Gap Overview</td>
</tr>
<tr>
<td>Identify Updates To Current needs</td>
<td>Facilitate ID of Engineering Capability Gap</td>
</tr>
<tr>
<td>Confirm Correct Necessitate</td>
<td></td>
</tr>
</tbody>
</table>


- Needs list (timeframes, commonality, etc.)
- Needs trace to gaps, programs, WFOs
- Required capability metrics vs. current capability metrics

### DOORS Export to Excel

<table>
<thead>
<tr>
<th>SID</th>
<th>TECH AREA</th>
<th>FAMILY</th>
<th>PRODUCT</th>
<th>TFT</th>
<th>UNIQUE NEED ID</th>
<th>NEED TITLE</th>
<th>NEED TIMEFRAME (DRAFT MOD SCHEDULE FOR DATE)</th>
<th>PHASE 2 - DATA ASSESSMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RED - No data submitted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gold - More engineering analysis is required for an actionable Need based on information submitted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Green - There is substantial evidence that the Need will become actionable with further collaboration with the PM and tech area SME</td>
</tr>
</tbody>
</table>

### Generate Reports

- Needs list (timeframes, commonality, etc.)
- Needs trace to gaps, programs, WFOs
- Required capability metrics vs. current capability metrics
Needs Analysis Lessons Learned To Date

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• Systematic Needs Analysis Aids Alignment of Warfighter (Customer) Requirements to R&D/S&T Portfolio

• Needs Analysis Conducted Across Multiple PEO/PM Communities Can Identify Common Programs To Deliver Most “Bang for the Buck”

• Long Term Technology Development Might Not Match PM time frame of interest, normally focused to the POM Cycle
• Warfighter Needs Must Still Be Met Despite Common Expectation Of Declining Resources

• Challenge Is To Maximize The Value Of Defense Science And Technology Efforts To Ensure Their Relevance To The Acquisition Community Mission

• Systems Engineering Techniques Can Be Leveraged As An Effective Tool To Assist In Making Difficult Decisions

Questions?
Systems Engineering Applied to Decision Making
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