Technology Transition and Issues in Developing Roadmaps for Maritime Energy & the Next Generation Integrated Power System

Electric Machines Technology Technology Symposium
May 19, 2010

Norbert Doerry
Technical Director, SEA 05 Technology Group
SEA05TD
Norbert.doerry@navy.mil
202-781-2520

Approved for Public Release
NAVSEA Priorities

• Sustain Today’s Fleet Efficiently and Effectively
• Build an Affordable Future Fleet
• Enable our People

VADM McCoy
COMNAVSEA

RDML Eccles
SEA 05
Agenda

• Technology Transition
• NGIPS Roadmap (then and now)
• Maritime Energy Roadmap
Technology

“The practical application of knowledge especially in a particular area”

Merriam-Webster Dictionary
Technology Transition

“Transfer of knowledge from those people that create it, to those people that require the knowledge to impact a change on a ship.”

– People have to be paid
– People generally are in different organizations

• Two aspects of Technology Transition
  – Transfer of Knowledge from one organization to another
  – Transfer of Fiscal Responsibility from one organization to another
Not all technology is worthy of transfer

- Technology must be
  - Useful
  - Legal and moral
  - Predictable (required for design)
  - Affordable
  - Producible
  - Able to be integrated into existing systems and processes (or replace them completely)

- Technology Transition must be
  - Legal (Intellectual Property Laws)
  - Affordable
  - Receptive by involved individuals / organizations
Getting a new technology Component / System on a ship

- **New Construction**
  - Written into Ship Specifications
  - Engineering Change Proposal
  - Written into Component Specification / Standard

- **In Service**
  - Ship Change Document (Planned configuration change)
  - Alteration equivalent to Repair (AER)
  - Fit Form Function replacement of a repair part
    - Via Stock System
  - Alteration during Depot Maintenance
  - “requirements” for consumables (MRCs, TMs, etc.)
Getting a new Process / Tool Invoked

- Modify Process Documentation
  - Standards and Handbooks
  - Work Instructions and Standard Practices
  - Modify SOWs and specs
- Modify infrastructure
  - Tools
  - Software
  - Workspace layout
- Train Workforce
- Monitor and act on relevant metrics
Reasons to Adopt a new Technology

• Gap (Best way to fulfill an unmet operational requirement)
  – Advances in adversary capabilities
  – Changes in CONOPS
  – Changes in law and regulations
  – Loss of industrial base to reproduce existing system

• Opportunity (Perceived benefits outweigh the risks)
  – Acquisition Cost Reduction
  – Total Ownership Cost Reduction
  – Enable new CONOPS

• Risk Management
  – Improve Flexibility to react to potential future gaps (Requirements Risks)
  – Mitigate risk of disappearing Industrial Base or source of raw materials
  – Mitigate risk of a technology for another more critical program
Technology Transition Interactions

- Gaps
- Resource Sponsor
  - Priority & Funding
  - Opportunities & Portfolio Risk Mitigation
  - Science & Technology
- Technology
- Industry
  - Systems
- Fleet
- Acquisition & Engineering
  - Funding, Specifications & Standards
- Requirements & Funding

May 2010
Approved for Public Release
Doerry
Technology Transition

**SHIP ACAT PROGRAM MILESTONES:**

- **A:** Material Solution Analysis
- **B:** Technology Development
- **C:** Engineering & Manufacturing Development

**Technology transitions**

1. **Technology Creation**
2. **Product Development**
3. **Ship Integration**

**References**

- DoDD 5000.01 20 Nov 2007
- DoDI 5000.02 12 Dec 2008
- DoD FMR 7000.14-R (June 2006)
- Manufacturing Readiness Level Deskbook Draft 3 Jan 2010

**DoD FMR 7000.14-R**

- **TRL 1 to 2**
- **TRL 2 to 3**
- **TRL 4 to 5**
- **TRL 5 to 7**
- **TRL 8**
- **TRL 9+**

**Manufacturing Readiness Levels**

- MRL 1 to 2
- MRL 2 to 4
- MRL 4
- MRL 5-7
- MRL 8
- MRL 9-10

**ONR**

- TRL 1 to 2
- TRL 2 to 3
- TRL 4 to 5
- TRL 5 to 7
- TRL 8
- TRL 9+

**PEO / SYSCOM**
Traditional Technology Transition Model

- **Observations**
  - Serial (long) Process
  - Does not promote commonality across platforms
• Product Lines are the ability to create and produce specific applications when needed.
• Product Lines promote Commonality across Ship classes.
• Technology Development Roadmaps facilitate communication across Technology Development boundaries.
Product Lines

- Decouple S&T from specific ship applications
  - Eliminate churn in aligning S&T and ship acquisition programs.
- Capture knowledge in Specifications, Standards, Handbooks, Design Data Sheets, Rules, etc.
Technology Transition Enablers

- Technology Transition Agreements
- Relationship Managers
- Metrics

• “The agreements put in writing the technology and business-related expectations, such as specific cost, schedule, and performance characteristics that labs must demonstrate.”

• “The agreements also may require documenting manufacturing costs or specifying whether certain lab scientists will be loaned to the product line to provide continuity in technical knowledge.”

DEFINES A RELATIONSHIP BETWEEN TECHNOLOGY CREATION AND PRODUCT LINE DEVELOPMENT

SHOULD INCLUDE MUCH MORE THAN A COMMITMENT TO FUND FURTHER DEVELOPMENT
Relationship Managers

- Communicate across the labs and product lines to address transition issues.
- Ensure the right knowledge gets to the right person to make the final product a success.
- Facilitate feedback from the product development back to the technology developers to guide the creation of new technology.
Metrics

- DOD Metrics
  - Technology Readiness Level
  - Manufacturing Readiness Levels
- Commercial Industry Metrics
  - More Inclusive of all aspects of Technology Transition

<table>
<thead>
<tr>
<th>MRL</th>
<th>Definition</th>
<th>Phase</th>
<th>BA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic Manufacturing Implications Identified</td>
<td>Pre Materiel Solution Analysis</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Manufacturing Concepts Identified</td>
<td>Pre Materiel Solution Analysis</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing Proof of Concept Developed</td>
<td>Pre Materiel Solution Analysis</td>
<td>2-3</td>
</tr>
<tr>
<td>4</td>
<td>Capability to produce the technology in a laboratory environment.ILTER</td>
<td>Materiel Solution Analysis(MSA)leading to a Milestone A decision.</td>
<td>2-3</td>
</tr>
<tr>
<td>5</td>
<td>Capability to produce prototype components in a production relevant environment.</td>
<td>Early Technology Development Phase</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Capability to produce a prototype system or subsystem in a production relevant environment.</td>
<td>Prior to completion of Preliminary Design and the start of Contract Design</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Capability to produce systems, subsystems or components in a production representative environment.</td>
<td>Late Technology Development Phase leading to Milestone B</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Pilot line capability demonstrated. Ready to begin low rate production.</td>
<td>Engineering &amp; Manufacturing Development (EMD) leading to a Milestone C decision.</td>
<td>5 - SCN</td>
</tr>
<tr>
<td>9</td>
<td>Low Rate Production demonstrated. Capability in place to begin Full Rate Production.</td>
<td>Production &amp; Deployment leading to a Full Rate Production (FRP) decision.</td>
<td>5 - SCN</td>
</tr>
<tr>
<td>10</td>
<td>Full Rate Production demonstrated and lean production practices in place.</td>
<td>Full Rate Production/ Sustainment</td>
<td>SCN</td>
</tr>
</tbody>
</table>
Developed in 2007
  - Coincident with establishing the Electric Ships Office

What it Did
  - Defined the state of the technology
  - Defined the Need
  - Defined Architectures
  - Listed technology developments needed
  - Proposed a Business Model

What it Did Not Do
  - Define an Execution Plan
Figure 1: NGIPS Technology Development Roadmap
Business Model proposed a “Product Line” approach

Knowledge Creation (BA-1 through BA-3)

Product Line Definition & Development (BA-4, BA-7)

Product Dev & Ship Int
BA-5, BA-7, SCN, OPN

Product Dev & Ship Int
BA-5, BA-7, SCN, OPN

Production
SCN, OPN

Production
SCN, OPN

Ship
Design

Ship Detail Design & Construction

Ship
Design

Ship Detail Design & Construction

Generic Multi-Platform Technology

Specific Application Technology

Ship Design & Construction

OPERATIONAL ARCHITECTURE

TECHNICAL ARCHITECTURE

Spiral Development

Operational Requirements

Derived Requirements

SYSTEMS ARCHITECTURE

MODULE Development

System Design & Engineering

Gov PM Oversight

NDI Modules Procurement

Life Cycle Support

 FOR

Ship Power and Propulsion Systems

May 2010

Approved for Public Release

Doerry
Lessons Learned

• Engagement of all stakeholders important
  – ONR
  – PEO’s
  – Technical Warrant Holders
  – Industry
  – OPNAV

• Stakeholder alignment as important as the document.

• Distribution Statement A important.
  – Facilitated a shared vision through out academia, industry, and the Government
Another look 3 years later

• The technology descriptions are still good.
• Progress has been made in achieving the roadmap objectives.
  – The plan allowed for decentralized execution.
  – Industry, ONR, NAVSEA, and Academia have aligned much of their Power Systems R&D with the roadmap.
  – IEEE standards development has been very productive.
• Good and Bad with not including Execution Plan
  – Good: Stakeholder could agree on what needed to happen as long as they didn’t have to commit to funding it.
  – Bad: Many tasks were not funded
• Progress in implementing the Business Model has been slow.
• The focus on new design ships is not in alignment with current acquisition approach to relying on modified repeat designs.
2010 Update to NGIPS Technology Development Roadmap

- Reflect evolution of the 30 year shipbuilding plan
- Directly address legacy Low Voltage Distribution systems
- Increase coverage of Hybrid Electric Drive
- Updating of tasks
- Refinement of Business Model
- Separate Program Plan being Developed
Navy Maritime Energy Roadmap

- Ongoing effort to support Task Force Energy
- Characterizing Technology is straightforward
  - Many captured in INEC 2010 Paper “Energy and the Affordable Future Fleet”
- Stakeholder involvement challenging
  - No organization analogous to the Electric Ships Office to focus efforts
- Technology Transition and Business Model Challenging
Navy Maritime Energy Business Model

Issues

- Technology Transition processes currently optimized for filling “Gaps”
- Energy efficiency improvements are typically “opportunities”
- Responsibility is diffused among many organizations.
- R&D “Valley of Death” hinders ability to transition S&T to the fleet

May 2010
Approved for Public Release
Doerry
Summary

- Technology Transition
- NGIPS Technology Development Roadmap
- Maritime Energy Roadmap