The Economic Impact of Electronic Part Obsolescence and Technology Insertion

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Objective

General: This presentation provides information that enables an understanding of the system-level cost ramifications of part obsolescence and the potential return on investment associated with reactive and proactive obsolescence management with an eye towards Total Ownership Cost minimization.

Specific: Forecasting electronic part obsolescence, and using the forecast to optimize the lifecycle of the product within an evolving technology environment.
Sustainment

Sustainment = all activities necessary to:

1) keep an existing system operational (able to successfully complete the purpose it is intended for)
2) continue to manufacture and field versions of the system that satisfy the original requirements
3) manufacture and field new versions of the system that satisfy evolving requirements

… in a world where the available technologies, materials and parts are in a continuous state of change.

Elements of Sustainment

- Reliability
- Testability
- Diagnosibility
- Repairability
- Maintainability
- Warranty/Guarantee
- Upgradability
- Obsolescence
- Technology Infusion/Insertion
- Qualification/Certification
- Configuration Control
- Regression Testing
- Cross-Platform Applicability
- Total Cost of Ownership
Examples of Sustainment Activities

- Scheduled maintenance of a commercial aircraft engine
- Warranty repair of a TV or VCR
- Technical support provided by a PC manufacturer via telephone or email
- Automobile oil changes every 3,000 miles
- Timing belt replacement in a car after 60,000 miles
- Installation of an operating system upgrade
- Addition of DRAM memory to an existing PC to support a new version of Microsoft Office™

Cost Relevance of Sustainment

- Throw-away products (computer mouse, keyboard, pager)
  - Guarantee - Replace if defective
  - Never maintain
  - Never test or diagnose
  - Never repair
  - Never upgrade
- Consumer electronics (TVs, VCRs, PCs)
  - Warranty – Repair “at convenience” on failure
  - Limited test and diagnose
  - Never maintain
  - Never upgrade
- Demand critical electronics (ATMs, servers, telecom)
  - Maintain – limited preventative maintenance
  - Limited test and diagnose
  - Repair ASAP on failure
  - May upgrade
Cost Relevance of Sustainment (continued)

• Long field life electronics (avionics, military)
  – Maintain – aggressive preventative maintenance
  – Extensive test and diagnose
  – Depot repair
  – Continuously upgraded

Great desire to move from depot repair to simpler “throw away” electronics that are never repaired if an economically viable case can be made

Long Field Life Electronic Systems

• Avionics
• Nearly all military systems
• Automotive

Key attributes may include:
  – Low manufacturing volume
  – Harsh field environment
  – Long manufacturing cycle
  – Sustainment costs are significant
  – Safety critical (requiring qualification/certification)
  – Performance requirements that evolve during product field life
  – Legislated sharing of repair costs (military systems)
Sustainment Costs of Electronic Systems

**Home PC**  
(3 year extended warranty)  

- Investment 91%  
- Sustainment 9%

**Office PC Network**  
(25 machines, 3 years)  

- Investment 21%  
- Sustainment 62%  
- Infrastructure 11%

*Full-time system administrator

Shields, P., “Total Cost of Ownership: Why the price of the computer means so little”,  

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Sustainment Costs of Electronic Systems

**Bradley M-2**  

- R&D 2%  
- Investment 14%  
- Sustainment 84%

**F-16**  

- R&D 2%  
- Investment 29%  
- Sustainment 78%

Estimate of Operating Costs

Cost model developed in [1]:

\[
\text{Cost} = \text{Tempo}^{\beta_2} \times \text{Pauc}^{\beta_3} \times e^{(\alpha + \beta_1 \text{Age})}
\]

Cost = average annual operating cost  
Tempo = average annual flying hours  
Pauc = average procurement cost  
Age = average age/100

Regression analysis results [2]

<table>
<thead>
<tr>
<th>Age</th>
<th>Cost</th>
<th>Tempo</th>
<th>Pauc</th>
</tr>
</thead>
<tbody>
<tr>
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<td>4.0</td>
<td>2.78</td>
<td>-1.97</td>
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<tr>
<td>5</td>
<td>0.98</td>
<td>2.38</td>
<td>2.50</td>
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<td>6</td>
<td>0.58</td>
<td>0.74</td>
<td>0.62</td>
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<tr>
<td>7</td>
<td>0.43</td>
<td>0.19</td>
<td>0.72</td>
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</table>


Estimate of Operating Costs - Example

Using Air Force AFTOC regression analysis on the previous slide and assuming that a $60M aircraft lasts 30 years

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<th>Cost</th>
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<td>5</td>
<td>$5,180,732</td>
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<td>$5,231,753</td>
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<td>$5,387,850</td>
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<td>30</td>
<td>$6,619,014</td>
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</table>

Sum $172,887,075

Life Cycle Phases and Associated Costs
(Long Field Life Systems - Historical)

- **R&D cost**
  - Feasibility studies, modeling, trade-off analyses, engineering design, development
- **Investment cost**
  - Fabrication, procuring primary hardware, system-specific support equipment, initial spares
- **Sustainment Cost**
  - Scheduled and unscheduled maintenance, obsolescence management, personnel, consumable and repairable materials
- **End-of-life cost**
  - Re-use/recycle/deactivate and dispose system at the end of its useful life


Sample life cycle phases for systems with long field life

R&D phase Manufacturing phase Operating phase Disposal phase

Cost R&D cost Investment cost Sustainment cost Disposal cost

**Operation & Maintenance (O&M) Cost Growth** ~40% from 1999
**Hardware O&M Cost Growth** ~50% from 1999

By 2015, average age will be 29 years

More and more money going into sustainment at the determent of new investment, which causes the fleet to age further, which causes more money to be required for sustainment, which leaves less for R&D, …

(Butch Ardis, ASC/EN, WPAFB)

Modernization Investment Declines ~35% From 2001
Life Cycle Phases and Associated Costs
(Long Field Life Systems - Target)

New paradigm in which new technology is continuously inserted

Sustainment Responsibilities

- Throw-away products (computer mouse, keyboard, pager)
  - Retailer (indirectly manufacturer or manufacturer’s subcontractor)
- Consumer electronics (TVs, VCRs, PCs)
  - Manufacturer
- Demand critical electronics (ATMs, servers, telecom)
  - Owner
  - Manufacturer
- Long field life electronics (avionics, military)
  - Customer
  - Manufacturer
  - Subcontractors (to the manufacturer)
  - Prime contractor

Any of these could be the “owner” of the equipment (i.e., “power by the hour”)
Sustainment Cost/Responsibilities
(Long Field Life Electronics)

<table>
<thead>
<tr>
<th>Sustainment Activity</th>
<th>Customer</th>
<th>Customer’s Subcontractor</th>
<th>Manufacturer</th>
<th>Manufacturer’s Subcontractors</th>
<th>Prime Contractor</th>
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</thead>
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<tr>
<td>Scheduled Maintenance</td>
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<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Unscheduled Maintenance</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Warranty/Guarantee</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Diagnosis</td>
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<td>X</td>
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<tr>
<td>Part Obsolescence</td>
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<tr>
<td>Diagnostics</td>
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<tr>
<td>Qualification/Certification</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Configuration Control</td>
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<td>X</td>
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<tr>
<td>Regression Testing</td>
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<td>Cross-Platform Compatibility</td>
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<tr>
<td>Total Ownership Cost</td>
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</table>

Acquisition Reform

- The end of the Cold War in the 1980s accelerated pressure to reduce military outlays (total defense budget is down 40% from Cold War peak, procurement budget is down 65%)
- One of the ways these budget decreases were addressed was by increasing the efficiency of military acquisitions through Acquisition Reform
- Acquisition Reform included reversal of the traditional reliance on Mil-Specs in favor of commercial standards and performance specifications*

*"Perry Directive," 1994, then Secretary of Defense William Perry
Commercial Off the Shelf (COTS)

• One of the consequences of Acquisition Reform is a shift away from “Mil-Spec” parts (which were generally qualified for harsher environmental stresses, and manufactured for long periods of time) to Commercial Off The Shelf (COTS) parts manufactured for non-military applications
• The shift to COTS parts has created significant problems in sustaining and upgrading legacy systems, as well as designing new systems

…. electronic part obsolescence…..

(The irony of acquisition reform is that the move away from Mil-Spec parts actually may have increased costs)