Electronic Part Obsolescence – Life Cycle Optimization and Cost

Given some ability to forecast part obsolescence (and potentially forecast functional upgrade opportunities), how can this information be used to optimize the lifecycle of the product?

• Lifetime buy vs. design refresh tradeoffs (Boeing, Raytheon)
• Design refresh optimization - MOCA (University of Maryland)*
• Resource allocation decision support system – RADSS (Litton-TASC)*
• Reengineering tools (synthesis)*

*Ongoing development through Air Force Electronic Parts Obsolescence Initiative (EPOI)
Conventional Use of Obsolescence Data During the Design Stage

- The majority of the military, avionics and automotive community either ignore obsolescence risk or use it only during the component selection process at the design stage
- Some organizations use obsolescence risk information to predict redesigns
- Conventional methods of predicting the economic impact of obsolescence take into account the obsolescence risk, but do not account for part-specific obsolescence mitigation strategies
- The analysis is usually restricted to lifetime buy vs. redesign trade-offs

Basic Concept:

- If a redesign can be deferred to a future year, the net present value (NPV) of the redesign cost decreases as the redesign is postponed
- As the redesign is deferred, more parts need to be purchased (last time buy) to support production and repair of the current design, thus increasing the sustainment cost
- The optimum year for redesign is the minima in the sum of the two curves

Note, this modeling approach does not account for the performance or maintenance “value” of the redesign
Net Present Value (NPV) of Redesign Costs

NPV = Net Present Value is a way of comparing the value of money now with the value of money in the future. A dollar today is worth more than a dollar in the future, because inflation erodes the buying power of the future money, while money available today can be invested and grow.

\[
\text{Present Value} = \frac{V_n}{(1+d)^n}
\]

Present value of an investment worth \( V_n \), \( n \) years from the present with a constant discount rate (rate of return on investment) of \( d \)

\[
\text{Net Present Value} = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+d_i)^i}
\]

Present value of an annual value \( V_i = B_i - C_i \), \( n \) years from the present with an annual discount rate of \( d_i \). \( B_i \) and \( C_i \) are the benefit and cost in the \( i \)th year.

\[
\text{Redesign Cost (NPV)}_i = \frac{\text{Inflation adjusted redesign cost}}{(1+d)^i}
\]

in the \( i \)th year

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Last Time Buy vs. Redesign

(A Very Simple Example)

Total cost = redesign cost + last time buy part costs

Assumes one part goes obsolete in year 0

Example Analysis Data:

<table>
<thead>
<tr>
<th>Redesign cost (year 0)</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation rate (%)</td>
<td>3</td>
</tr>
<tr>
<td>Discount rate (%)</td>
<td>12</td>
</tr>
<tr>
<td>Number of the obsolete part needed per year</td>
<td>500</td>
</tr>
<tr>
<td>Obsolete part price at last time buy (year 0)</td>
<td>10</td>
</tr>
</tbody>
</table>
Last Time Buy vs. Redesign

The simple analysis can be expanded to include:
- Multiple obsolescence events
- Annual inventory costs
- Reliability models to predict annual product quantities

Price-Based vs. Cost-Based

Cost-Based Model:
- Incentive for the prime contractors and OEMs to defer a redesign as long as possible and let the customer pay for the both the obsolescence-driven upgrade and the performance improvements concurrently
- A lifetime buy vs. redesign analysis is a valuable tradeoff of this approach

Price-Based Model:
- Prime contractors and OEMs are allowed to “pocket” recurring cost savings that result from redesigns, thus providing an incentive to redesign as soon as it makes sense.
- Different analysis needed…
**Design Refresh Planning**

Design refreshes (redesigns) of electronic systems are performed to update functionality/performance/technology, and to mitigate electronic part obsolescence problems.

However, design refreshes of avionics systems, potentially require large expenditures for re-engineering and re-qualification.

The challenge is to determine the optimum design refresh plan that balances obsolescence mitigation with the expense of redesign.

Software tool and methodology for refresh planning: MOCA = Mitigation of Obsolescence Cost Analysis

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**MOCA Design Refresh Optimization Landscape**

Optimum location(s) of these refreshes depends on:
- which part(s) become obsolete
- when they become obsolete
- how the obsolescence is mitigated
- resulting system re-qualification requirements

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Example MOCA Design Refresh Result

- 1 year look ahead
- 20 year product life (3200 units manufactured)
- 200 component re-qualification trigger
- $136,000 full re-qualification cost

All third party buys – “Asleep at the wheel”

Best solution involves 3 redesigns
RADSS (Litton TASC*)

Part obsolescence management system based on commercially available Resource Allocation Decision Support System (RADSS)

RADSS makes optimum part obsolescence management decisions (based on known part obsolescence and discontinuance) in a resource budget constrained environment

The primary purpose of the tool is to aid the user in making financial management or investment decisions

This tool may enable “best value” decisions, i.e., value = financial, performance, customer requirements satisfaction

http://www.tasc.com  *Now part of Northrop Gumman

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RADSS - Model for Complex Obsolescence Decisions

Process:
Define the Problem
The logistics of part obsolescence decision to be made (redesign) are laid out on a spreadsheet for discussion

RADSS Template
The obsolescence decision criteria are categorized and populated into a template

RADSS Decision
Software generates an obsolescence decision based on criteria (should we redesign)

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Reengineering Tools

Objective: provide automated VHDL model generation tools, libraries of simulatable and synthesizable virtual components, and legacy software modeling:

1) Design extraction from an obsolete platform
2) Architectural design tradeoff analysis
3) Synthesize new hardware and software to replace the obsolete portion of the system
   - Redesign advisor (VP Technologies, www.vptinc.com)
   - Behavioral product reengineering tool (Synopsis)
   - Design verification test generation tool (University of Cincinnati)

These are essentially ASIC-based obsolescence mitigation solutions and thereby suffer from the ASIC problems previously discussed

Publicly Available Life Cycle Costing Tools

(Used for Military and Avionics Products)

None of the following tools model the cost impacts of obsolescence, however, all provide critical elements of the calculation

Hardware Development and Production:
   • Price-H/HL/M
   • SEER-H/I

Software Development, Maintenance and Testing:
   • Price-S
   • SEER-SEM
   • COCOMO
   • SAGE
   • ICE (Frontier)

Tool/data integration environment
When the system hardware is modified via a design refresh, the system software and/or the system’s software qualification may have to be refreshed too.

Challenge:
- Determine what software needs to be refreshed
- Figure out the cost of the software refresh
- Determine if the software needs to be re-qualified
- Figure out the cost of the software re-qualification
- Include these effects within the design refresh optimization
Standards and Specifications/Requirements Obsolescence

The standards, specifications, and/or requirements used when designing and manufacturing a system may change or be obsoleted during a system’s sustainment life, i.e., a system can no longer deliver the required performance to meet the customer’s need (e.g., insufficient memory or processor).

This type of obsolescence may result in obsoleting an electronic part’s applicability to for use in the system, i.e., the part itself is not obsolete, but its performance or reliability no longer satisfy the new system requirements.

Mitigating Standards and Specifications/Requirements Obsolescence

Standards, Specifications, and Requirements changes are expected by difficult to predict.

There are system-level strategies that allow us to mitigate the the impact of unexpected changes (e.g., “encapsulation” of the standards as much as possible so that changes in standards are transparent to the system)

This is what “upgradability” is all about, i.e., the capability to accommodate and exploit new technologies with minimum impact in order to meet evolving performance requirements
ROI/Cost Avoidance Associated with Obsolescence Management

The best (only) actual data on costs associated with electronic part obsolescence management is from a DMEA study in 1999:


This study lays out the following items associated with obsolescence mitigation alternatives:

1) Non-recurring cost factors
2) Recurring cost multipliers
3) Cost avoidance values

Comment:
This data assumes maintaining only a legacy performance capability, i.e., does not figure in functional upgrades

Non-Recurring Cost Factors for Obsolescence Resolutions in Avionics

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Low ($)</th>
<th>Average ($)</th>
<th>High ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Stock</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reclamation</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
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<tr>
<td>Alternate</td>
<td>4000</td>
<td>7000</td>
<td>9000</td>
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<tr>
<td>Substitute</td>
<td>15000</td>
<td>19000</td>
<td>24000</td>
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<tr>
<td>Aftermarket</td>
<td>41000</td>
<td>50000</td>
<td>59000</td>
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<tr>
<td>Emulation</td>
<td>55000</td>
<td>72000</td>
<td>89000</td>
</tr>
<tr>
<td>Redesign – Minor</td>
<td>82000</td>
<td>117000</td>
<td>153000</td>
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<tr>
<td>Redesign – Major</td>
<td>361000</td>
<td>433000</td>
<td>505000</td>
</tr>
<tr>
<td>Life of Type Buy</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(2001 Dollars)

* The LOT buy resolution is program specific and should be calculated by individual programs

Additional NRE Costs

The previous chart does not include the following additional NRE costs:

- **New source qualification** - $20,000 to $161,000
- **Radiation hardening qualification**
  - Dose rate $15,000-$20,000
  - Total dose $5,000-$12,000
  - Single event upset $15,000-$20,000 (microprocessors up to $50,000)
- **PEM qualification**
  - Acoustic microscopy $1,800-$1,890
  - 100% screening $13,250
  - Package qualification $27,150-$32,200


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Recurring Cost Multipliers for Obsolescence Resolutions in Avionics

<table>
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</thead>
<tbody>
<tr>
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<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Reclamation</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Alternate</td>
<td>1.0</td>
<td>2.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Substitute</td>
<td>1.6</td>
<td>5.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Aftermarket</td>
<td>5.0</td>
<td>7.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Emulation</td>
<td>10.0</td>
<td>20.0</td>
<td>30.0</td>
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<tr>
<td>Redesign</td>
<td>1000.0</td>
<td>5500.0</td>
<td>10000.0</td>
</tr>
<tr>
<td>Life of Type Buy</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
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Cost Avoidance for Obsolescence Resolutions in Avionics

<table>
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<th>Resolution</th>
<th>Low ($)</th>
<th>Average ($)</th>
<th>High ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Stock</td>
<td>629</td>
<td>1884</td>
<td>3249</td>
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<tr>
<td>Reclamation</td>
<td>2121</td>
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<tr>
<td>Alternate</td>
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<td>Aftermarket</td>
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<td>100000</td>
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<tr>
<td>Redesign – Minor</td>
<td>177600</td>
<td>299118</td>
<td>520000</td>
</tr>
<tr>
<td>Redesign – Major</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Determined by subtracting the NRE cost resolution from the next highest NRE cost resolution (1999 Dollars)


Obsolescence Management

Reactive mitigation approaches:
- Existing stock
- Substitute part
- Aftermarket supplier
- Life of type buy
- Uprate commercial part
- Emulation
- Reclamation (salvage)
- Reverse engineer
- Design refresh

ROI = 3:1

Proactive management approaches:
- Reengineering tools
- Obsolescence mitigation decision making tools
- Obsolescence forecasting
- Design and lifecycle optimization tools

ROI = 18:1
Design capture as executable specification/simulation objects (Northrop E3 AWACS)

ROI = 100:1

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