Issues in Total Ownership Cost Modeling for DoD Systems

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Research Background

• NPS participating in research and development of Next-Generation, Full-Coverage Cost Estimation Model Ensembles for DoD Systems Engineering Research Center.

• Beginning with space domain with USAF/SMC and the Aerospace Corp. to research and develop an ensemble of cost estimation models covering the systems engineering, development, production, operations, sustainment, and retirement.
Total Ownership Cost vs. Lifecycle Cost

- **Total Ownership Cost (TOC)** is the total cost of acquisition, development and operating costs.
  - All direct and indirect costs of a product, product line, system, project or program.
- **Life-cycle cost** consists of research and development costs, investment costs, operating and support costs, and disposal costs over the duration of a program.
- **Total ownership cost** is broader in scope. It includes the elements of life-cycle cost, as well as other infrastructure or business process costs not normally attributed to a program.
**Cost Modeling Across Domains**

- Structuring canonical TOC tools to address multiple DoD domains efficiently.
  - Included phases, activities, cost sources depend on domain
- Cost model architecting is similar to product line engineering
  - Identify multi-domain commonalities and variabilities (e.g. cost factors, product structures, lifecycle phases, activities)
  - Identify fully, partially sharable commonalities
  - Develop model interfaces and extensions for variabilities
- Comparing MIL-STD 881 Work Breakdown Structures (WBS) to find commonalities and variabilities across DoD domains, and identify suggested improvements.
  - Some domains have 1-n repeating system structures (e.g. spacecraft networks), others are single system
  - Example “Common Elements” include Systems Engineering and Management
Product Line TOC Modeling

- Will extend models and tools to analyze Total Ownership Cost (TOC) for a family of systems. The value of investing in product-line flexibility using Return-On-Investment (ROI) and TOC is assessed with parametric models adapted from the Constructive Product Line Investment Model (COPLIMO).
  - Spacecraft and ground system application focus
- Models are implemented in separate tools for 1) System-level product line flexibility investment model and 2) Software product line flexibility investment model. The detailed software model includes schedule time with NPV calculations.
Systems Product Line Model

Systems Product Line Flexibility Value Model

Welcome SERC Collaborator

System Costs

Average Product Development Cost (Burdened $M) 5
Ownership Time (Years) 3
Annual Change Cost (% of Development Cost) 10
Interest Rate (Annual %) 7

Product Line Percentages Relative Costs of Reuse (%)
Unique % 40 Relative Cost of Reuse for Adapted 40
Adapted % 30 Relative Cost of Reuse for Reused 5
Reused % 30

Investment Cost

Relative Cost of Developing for PL Flexibility via Reuse 1.7

Results

<table>
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<tr>
<th># of Products</th>
<th>Development Cost ($M)</th>
<th>Ownership Cost ($M)</th>
<th>Cum. PL Cost ($M)</th>
<th>PL Flexibility Investment ($M)</th>
<th>PL Effort Savings</th>
<th>Return on Investment</th>
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Return on Investment

Product # 6
Sensitivity Analysis Example

ROI by Ownership Duration

ROI

# of Products

0 Years
3 Years
6 Years
• Multi-mission needs of ground systems and others call for extension of the top-level COPLIMO model to handle subsystems

• Each subsystem has respective cost factors and product line characteristics including
  – Fractions of system fully reusable, partially reusable and cost of developing them for reuse
  – Fraction of system variabilities and cost of development
  – System lifetime and rates of change
Extended Product Line Model

For Set of Products:

For each subsystem:

- Average Product Cost
- Annual Change Cost
- Ownership Time
- Percent Mission-Unique, Adapted, Reused
- Relative Cost of Developing for PL Flexibility via Reuse
- Relative Costs of Reuse

As Functions of # Products, # Years in Life Cycle:
- PL Total Ownership Costs
- PL Flexibility Investment
- PL Savings (ROI)