Analytical Tools for Affordability Analysis

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**Abstract**

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What is “Affordability Analysis”? 

- Starting with 2010’s “Better Buying Power” memorandum, OSD has issued policy requiring acquisition programs to present affordability analyses at Milestone reviews.
- This requirement is now part of Department of Defense Instruction 5000.02.
- The *Defense Acquisition Guidebook (DAG)* was updated in July 2013 to reflect the new requirement and provide guidance.
Affordability Analysis shows each program’s planned development and production costs over time, in the context of:

- The cost and schedules of the other programs in the relevant acquisition portfolio
- The projected available funding over the life cycles of those programs

This task is assigned to Service leadership:

- Not the program’s responsibility
- Should reflect Service long-term planning
What Tools do Affordability Analysts Need?

- Reconcile inconsistent submissions
- Predict annual costs for alternative plans
- Estimate the consequences of various possible funding levels
- Assess affordability risk
  - For the portfolio
  - For each program
Reconciliation of Inconsistencies

- Which programs are in the portfolio?
- How much total funding is available?
- How much of that total will each program get year by year?
- How many units will that buy?

If Service plans or estimates have changed, need to be able to propagate those changes to other portfolios as well
If the current plan is...

...then what would the annual costs be if instead we do...

This is a hard problem.
Why Is It Hard?

- Cost progress (aka “learning curves”)
- Fixed costs at contractor and program levels
- Nonrecurring and non-end-item costs
- Production rate effects and incentives
- Causal ambiguity in historical data
  - Schedule changes cause cost changes
  - Cost changes also cause schedule changes
  - Technical / management issues can cause both
Competing Theories and Models

- Fixed/Variable apportioning (e.g., Balut et al.)
  - Plant capacity varies with workload
  - Program share of fixed costs is proportional to variable costs, some of which have learning

- Cobb-Douglas production function (Womer)
  - Unit cost as a function of learning and rate

- Learning with forgetting (Benkard)
  - Learning depreciates over time

- Discretionary capital investment (Rogerson)
If there isn’t enough money in the budget to do what we had planned, what happens?
- Programs stretch – lower production rates
- If necessary, some may be canceled

In order to predict the impact of a given schedule, we need a heuristic that can estimate how the portfolio manager would react to the new budget
- Requires costing ability described above
- Should also work for unexpected surplus funds
Affordability is often treated as a yes/no question, but reality is messier
- Cost estimates are uncertain
- Program outcomes are uncertain
- Budgets are uncertain
- Service priorities change over time
- New programs start

The question of interest is not “Is this program affordable?”, but rather “What is likely to happen if this is the plan?”
Risk Assessment Support

- **Sensitivity analysis**
  - Vary one input at a time, see what happens
  - Does not directly answer “What is likely?”

- **Monte Carlo estimation**
  - Vary all uncertain inputs according to user-specified probability distributions
  - Analyze the distribution of outcomes
  - Requires credible driving distributions for many parameters and program characteristics
• Organize programs into portfolios
  • Multiple alternative ways to partition the world

• Coordinate across multiple data sources
  • SAR / DAES / PB / POM
  • Individual program affordability analysis submissions

• Perform what-if and sensitivity analyses
  • Alternative schedules
  • Alternative budgets
  • Revised cost estimates
  • New programs
APASS: the Acquisition Portfolio Affordability Support System

- Web application
- SQL Server database
- Migrating to D3 graphics from Google API

Data from multiple (conflicting) sources, organized by portfolio sets for analysis at the portfolio level

To date, MDAP and pre-MDAP data only
A Portfolio with Budget

Acquisition Portfolio Analysis Support System

Dollars
- Then-Year Dollars
- Base Year: 2013

Show
- By Budget Category
- Equipment Portfolio Set
- Affordability Portfolio Set

Categories
- RDT&E
- Procurement
- O&M
- MILCON

Years to Show
- Start Year: 1995
- Earliest: 1995
- End Year: Latest: 2026
- Max Dollars: $0

Include
- Show Actuals
- Budget
- Fit to budget

Source: SAR: 2013-12-25

Service: Army
Portfolio Set: Equipment
Portfolio: Aviation
Source: SAR: 2013-12-25

Chart Type
Data
Workspace: Projections
Reload

Total FY2013 Dollars

Fiscal Year

Source: SAR: 2013-12-25
Results of Fitting to Budget

FY2013 Procurement Dollars

- Budget
- UH-60M Black Hawk
- MQ-1C Gray Eagle
- CH-47F
- AH-64E Remanufacture
- AH-64E New Build

Fiscal Year

Budget
FY 2030:
$1500M
Actual
- We are developing software tools to support Affordability Analysis (and oversight of Affordability Analysis)
- The current focus is on near-term ability to view and compare disparate data sources and alternative scenarios
  - Spot discrepancies
  - Produce reconciled views
  - Provide “what if?” assessment of alternatives
- Secondary focus on estimating the impact on portfolios of alternative budgets
BACKUP
What is “Affordability”?

- Since the late 1990s, the military services have all spent large sums of money on programs that did not deliver their intended military capability.
- Many of these programs spent billions and delivered nothing at all.

“The purpose of Affordability Analysis is to avoid starting or continuing programs that cannot be produced and supported within reasonable expectations for future budgets.”

DoDI 5000.02, Enclosure 8, “Affordability Analysis and Investment Constraints” (2015)
Procurement + RDT&E Portfolios

$B

POM14-18

FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19 FY20 FY21 FY22 FY23 FY24 FY25 FY26 FY27 FY28 FY29 FY30 FY43
\[ C_n \equiv \text{average unit cost in year } n \]
\[ L_n \equiv \text{production quantity in year } n \]
\[ T_1 \equiv \text{theoretical first unit cost} \]
\[ \beta \equiv \text{learning rate parameter} \]
\[ \delta \equiv \text{annual forgetting rate} \]
\[ \gamma \equiv \text{production rate parameter} \]

\[ C_n = T_1 L_n^\gamma \left( \sum_{k=1}^{n} L_k \delta^{n-k} \right)^\beta \]