Welcome

THE SUSTAINING ENVIRONMENT

Learning Objectives

Upon completion of this lesson, you should be able to:

- Describe Operating and Support costs related to Unit Operating Costs

- Describe O&S costs related to Sustaining Support Costs

- Describe O&S costs related to Continuous System Improvement

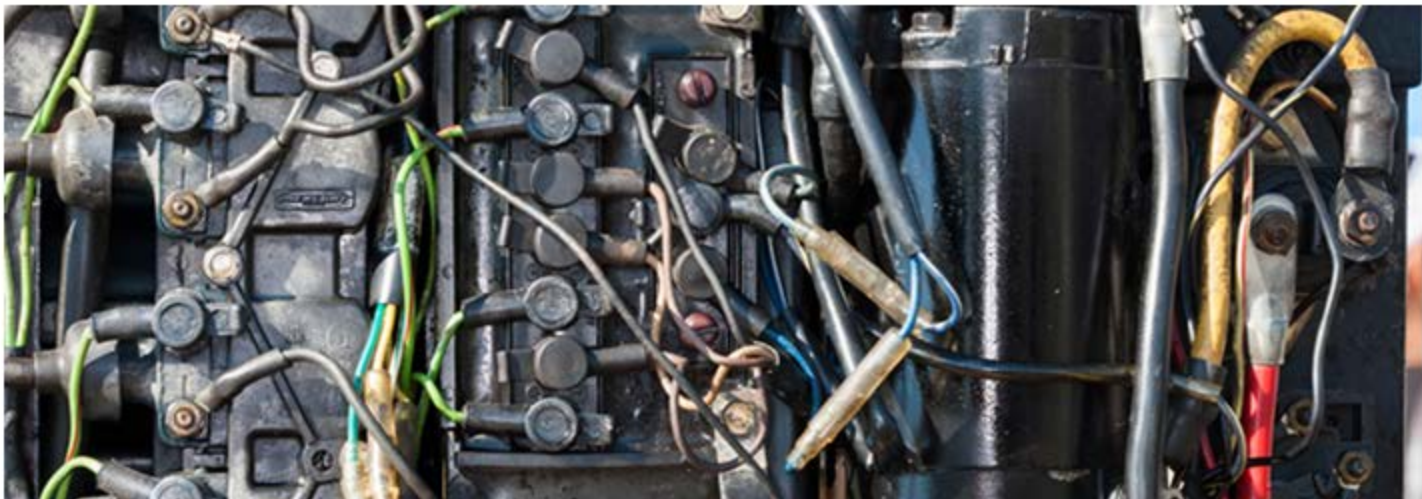- Describe software-driven sustainment O&S costs

Closed Captioning

In this lesson we'll take a look at costs associated with what cost estimators refer to as "the sustaining environment." This covers a good deal of territory, including operating costs, costs associated with sustaining a unit if not addressed elsewhere, "continuous system improvement" which encompasses issues like reliability improvement as well as system upgrades, and finally, an area of increasing importance in our software-intense weapon systems, software sustainment.

Upon completion of this lesson, you should be able to:

- Describe Operating and Support costs related to Unit Operating Costs,
- Describe O&S costs related to Sustaining Support Costs,
- Describe O&S costs related to Continuous System Improvement, and
- Describe software-driven sustainment O&S costs.

Why Is This Important?

The "sustaining environment" is where most of the O&S costs occur. As a PSM in the sustainment phase, you will assume a principal role in managing O&S costs since many of the costs being incurred will be directly impacted by the design of the support infrastructure. There are O&S costs in sustainment that may not be immediately obvious. Identifying all the O&S costs associated with sustainment is not always easy and requires a thorough understanding of the system and the operating environment.

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Estimating Operating Consumable Costs

Consumable costs are anything that gets consumed during operations.

The objectives of estimating operating consumable costs are to:

- Identify the range of operating costs that should be considered

- Explain standard methods used to estimate operating consumables

- Appropriately apply methods to estimate unit operating consumable costs

Estimating Operating Costs

Considering the operational unit employing your system, what drives cost in sustainment?

Let's look at the types of operating cost.

The two categories of Operating Costs are:

1. Costs driven by unit manning

    A. Adjust historical data on a per capita basis is appropriate
    B. i.e., administrative supplies

2. Fixed Costs

    A. No adjustment is appropriate - the cost is basically a fixed annual cost
    B. i.e., port services

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Estimating Operating Costs, Cont.

When might you need to use these costs?

Here are two example questions that might be used as indicators:

1. If your supported unit is paying "rent" as part of a Host-Tenant Agreement on an airbase, is the rent based on the number of personnel in your unit, or some other parameter?

2. Does it vary or is it the same fixed cost year after year for the life of the agreement?

The bottom line is to understand each cost and its most likely "driver".

Unit Operating Costs

Let's consider a few other areas for potential costs:

- Operating material consumed by the system (except maintenance)
    - Energy (i.e., fuel, electricity
    - Expendable training material (i.e., training ammunition, flares, chaff, racks, sonobuoys, etc.
    - Administrative consumables (administrative and housekeeping items, medical supplies, routine tools, etc.)
- Support Services
    - Purchased services (excluding maintenance)
        - Facility leases, communications, transportation of material, and administrative services or equipment

DAU

Unit Operating Costs, Cont.

- Temporary Duty
  - Training or administrative travel away from the unit's operating location related to a unit's normal peacetime operation
    - Includes transportation, vehicle rental, mileage allowances, per diem allowances, and incidental travel expenses

It might be helpful to visit pages 6-6 and 6-7 in the CAIG O&S Guide as it is a valuable resource in helping to identify these unit operating costs.

Energy Estimating Methods

Let's look at energy costs. These estimating methodologies should by now look very familiar. Added to the first four methodologies we've used pre-deployment, in the operations and support phase, we now have actual consumption data to refine our earlier estimates.

Refining estimates is important, because costs can vary significantly, and estimating costs far in the future can be a challenging exercise to put it mildly.

For example, fuel costs can have a ripple effect throughout the operating environment. A spike in fuel costs might prompt a reduction in flight hours, which in turn might drive a decrease in parts consumption and maintenance-related costs, but might at the same time drive up costs incurred for training and deferred maintenance.

- Analogies
- Cost Estimating Relationships
- Engineering Estimate
- Test Data
- Actual Consumption Data

Analysis of Alternatives

Design

Development Testing

Operational System

DAU

Estimating Fuel Costs

Fuel cost in the marketplace can fluctuate significantly. When we add the dynamics of the Working Capital Fund to those of the marketplace, we can drive in inaccuracies if using historical data. Since the Working Capital Fund cannot, by law, lose money, DLA must account for marketplace price increases incurred one year in the next year, often driving the price up to the operator much higher than the same fuel might cost on the open market.

The best approach is to base estimates on quantities required (i.e., consumption based on operating scenarios). Establish a cost base year, and then reflect future fuel costs in terms of base year dollars.

Other Unit Operating Costs

While fuel is unquestionably one of the principal components of Unit Operating cost, there are others as well. The key questions in estimating Unit Operating costs are:

- What material is consumed in carrying out the system's peacetime mission?

    o Munitions, flares, sonobuoys, etc.

    o Administrative supplies

- What unit-funded purchased services are required to carry out the system's peacetime mission?

    o Equipment rental, software leases, rental vehicles

    o Alongside utilities (ships)

- Does the operating concept require any special funding?

    o Unit travel

    o Transportation or airlift

Knowledge Review

Members of your unit need to travel to another location to train other personnel on how to fix broken equipment. They need transport, per diem, and other incidentals for the trip. These costs might be listed as _____.

- [ ] Equipment rental costs

- [✓] Temporary Duty costs

- [ ] Support costs

- [ ] Consumable costs

Check Answer

This qualifies as a **Temporary Duty cost.**

Sustaining Support Costs

We need to understand the differences between operating support costs and sustaining support costs.

Select each type of support to learn the differences.

Operating Support

Sustaining Support

Popup Text

Operating Support

Operating Support costs <u>exclude</u>:

- Services **not** unique to a specific system
- Recruiting, basic training, family support
- Basic pilot training

Sustaining Support

Sustaining Support costs include:

- Material and services which can be identified to a weapon system that are provided by centralized (not deployed) support activities
    - System specific training
        - Primarily crew and maintenance personnel
    - Support equipment replacement
    - Sustaining engineering and program management
    - Special support activities
        - i.e., Test ranges, special environment costs

Estimating Sustaining Support Costs

So how do we estimate sustaining support costs? The following usual methodologies apply:

- Determine what's included
- Understand the influences that affect the estimate
- Decide which of the common estimating methods is most appropriate

Estimating Training Materials

Training material is typically estimated based on training level which is driven by operational tempo (OPTEMPO). A careful consideration of OPTEMPO data is critical in estimating the training materials.

Here are some scenarios that make estimating training materials complex:

- Often only one metric (miles, hours, etc.) is available

- Not all training consumption has to be related to that one metric
    - For example, rounds fired by a tank. Do we believe rounds fired is "driven" by miles?

- In some cases, it will be necessary to gather data on the training requirements of both the analogous and new systems and do a bottom-up estimate

System Specific Training

In addition to estimating the training materials expended, we also have to estimate the cost of system-specific training. This includes the cost to train operating unit personnel with system-unique skills and operating crews and maintainers.

Two Basic Approaches to estimating the training materials expended are:

1. Estimate the costs of the training organization

    A. Typically done for crew training

    B. Include operating and support costs of the training unit as if it were an operating unit (unique staffing, OPTEMPO)

2. Estimate training costs on a per student basis

Note: A small "technical" problem with phase-in is it "should" include costs of first operational unit staff. In practice, the costs of training the first operational unit staffs is often overlooked because they occur prior to the traditional start of the O&S period.

Support Equipment Replacement

Another area of sustainment cost is Support Equipment. Support equipment can be considered a "mini system." The same cost drivers for the system as a whole frequently apply to test equipment as well. Although some areas may list only one cost driver, such as replacing damaged or worn out equipment, each IPS element ought to be examined to see if there are any costs incurred and whether they are applicable to your system's O&S cost.

Popup Text

Support Equipment

Support Equipment is the common and peculiar equipment needed to enable systems to conduct operations or perform support tasks. Support equipment should be considered as almost a "mini-system" in itself. The same cost drivers for the system as a whole frequently apply to test equipment as well.

- Organization, Intermediate, and Depot
- Examples: tow bars, auxiliary power sets, work platforms, test equipment (O/I/D), special tools, weapons loading equipment (aircraft), etc.

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Estimating Replacement Costs

Let's explore two methods of estimating replacement costs for support equipment.

The two Estimating Methods are:

1. Use analogy

   A. Sometimes it is hard to find the info because the use of common vs. peculiar support equipment is not consistent from one program to another.

   B. Adjust for new system differences

2. Determine the procurement cost of the authorized support equipment

   A. Find the total support investment for that system

   B. Calculate costs by equipment item from "TO&E"

   C. Calculate replacement cost as an annual percentage of new procurement cost - vary rate by class

Remember that all support equipment is not created equal; different classes will have different replacement rates.

Sustaining Engineering/Program Management

Sustaining Engineering spans those technical tasks (engineering and logistics investigations and analyses) to ensure continued operation and maintenance of a system with managed (i.e., known) risk.

This includes:

- Collection and triage of all service use and maintenance data

- Analysis of safety hazards, failure causes and effects, reliability and maintainability trends, and operational usage profiles changes

- Root cause analysis of in-service problems (including operational hazards, deficiency reports, parts obsolescence, corrosion effects, and reliability degradation)

- The development of required design changes to resolve operational issues

- Other activities necessary to ensure cost-effective support to achieve peacetime and wartime readiness and performance requirements over a system's life cycle

All these activities must be examined to determine O&S cost.

WARNING

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Sustaining Engineering/Program Management, Cont.

Many of the activities related to sustaining engineering may be performed by contractors or other activities. The costs related to those activities may be accounted for elsewhere.

Be careful not to double-count!

Be careful to avoid duplicating SE/PM contract support. Take note that:

- O&S phase SE/PM costs are those unique to post deployment sustainment

- Contract support for post deployment modifications and software support are accounted for elsewhere

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Other Sustaining Support

Systems can require unique support provided by centralized activities.

For example:

- Special test ranges for stealth systems

- Simulator training centers whose costs are not included elsewhere

Where these costs are significant, relative to the total program O&S cost, they should be included in the overall O&S cost.

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Knowledge Review

You're explaining the O&S Cost KSA to a member of your team. He's confused about how life cycle cost (LCC) is different from Operating and Support (O&S) cost. You explain_____.

✔️ O&S cost is one of the Sustainment KSAs and is part of LCC.

☐ LCC is independent of O&S cost.

☐ O&S cost only sustains a few maintenance factors.

☐ LCC plays a key role in defining infrastructure that will drive cost.

Check Answer

Life cycle cost (LCC) consists of research and development costs, investment costs, operating and support (O&S) costs, and disposal costs over the entire life cycle. **Operating and Support (O&S) cost is a Key System Attribute (KSA) of life cycle cost (LCC).**

Estimating Continuing System Improvement Costs

Once a system is fielded, it rarely remains static in terms of design.

Given the growing service life length of many of our weapon systems, they must be continuously upgraded to deal with technology advances and changes to the threat environment.

In O&S cost estimating terms, this is referred to as "Continuing System Improvement" and encompasses both hardware and software.

The objectives of estimating continuing system improvement costs are to:

- Identify the range and types of costs included
- Identify and understand the influences that affect estimates of continuing system improvement costs
- Identify and apply methods used to estimate continuing system improvement costs

Continuing System Improvement Costs

Continuing System Improvement (CSI) Costs include:

- Hardware modifications
    - Design, test, fabrication, installation
    - R&M modifications, safety modifications, continuing system improvements
- Software modifications
    - Design, test (Software Integration Laboratories (SILs)), fabrication, retrofit
    - Correction of deficiencies, upgrades
- Significant field retrofit costs should be included

Continuing System Improvement (CSI) Costs do not include:

- Upgrades that fundamentally change the mission of the system
- Block changes designed to go into production systems as well as deployed systems

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Continuing System Improvement Costs, Cont.

For various reasons, it is not always easy to define what "fundamentally changes the mission of the system" so there is occasionally some debate as to whether a particular modification, or "mod," represents a CSI cost or not.

Reliability and maintainability changes driven by engineering analysis of operational data are clearly in the "included" category.

Why Estimate Future Modifications?

The three important points related to CSI are:

1. DoD acquisition strategies (Pre-planned Product Improvement (P3I) and incremental development) create an environment of continuous system improvements.

2. The Investment portion of LCC estimates do not include any post deployment costs. These costs have to be identified and estimated as O&S costs in the LCC estimate.

3. System modification costs have become significant. The cost to keep aging weapon systems viable against challenges posed by threats, changing concepts of operation, and technology can be substantial.

Estimating Modification Costs

To estimate modification costs, gather data on modification costs of analogous systems. Picking appropriate analogies is often not as simple as it sounds.

- If available, gathering data by major subsystem class (structure, propulsion, electronics, etc.) may provide a better basis

- Pick appropriate analogies
    - For example, C-5 avionics may not be a good surrogate for C-17; one is analog and the other digital

- Try to find data from more than one system

- Try to find data on modifications over the life of the program
    - Mod costs for single systems tend to fluctuate over time

Cautions for Estimating Modification Costs

There are a couple of things you need to keep in mind when calculating modification costs including:

- O&S costs not defined by appropriation categories
  - Most costs are in O&M and MILPER accounts
- Continuing system upgrades may be funded from R&D and procurement accounts
  - O&S phase accounts for all costs identified with a specific system that are incurred after the procurement phase is complete

Note: It isn't always crystal clear when the O&S counter starts. Close coordination with your program's financial and legal staffs can help avoid any pitfalls.

Knowledge Review

A weapons system has been in service for more than eight years and has been tasked for upgrades. However, on the paperwork you have been given, it is not listed as a CSI. That is because _____.

✔ The modifications are listed as changing the mission of the system.

☐ The service period is too long.

☐ O&S cost only sustains a few maintenance cycles.

☐ Only a software upgrade is required.

Check Answer

Upgrades that fundamentally change the mission of the system are not listed as Continuous System Improvement costs.

Categories of Software Support

Let's take a look at the three categories of software support. **Select each category to learn more.**

Corrective	Adaptive	Perfective

Our software lines of code, or SLOC, are minimally affected by the Corrective and Adaptive categories, but still can be cost drivers. Far more important for our cost estimating purposes is the Perfective category, which makes perfect sense when we couple it with the hardware improvements we're making to lengthen our weapon systems' service lives.

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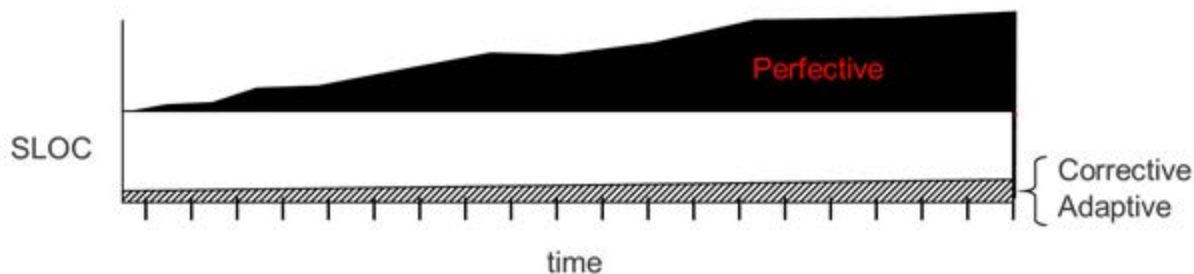
Popup Text

Corrective

Corrective and emergency.

"Fix stuff that is broken." Breaks can be from flaws that were hidden at the time of testing or flaws that were introduced by other changes.

Adaptive

Upgrades, changes in conditions and growth.

Keeping up with the changes that occur external to the system. These can be new equipment that has to be interfaced, changes in operating systems, or changes in support tools.

Perfective

Growth and enhancements.

Changes to the functionality of the system.

Long Description

Graphic showing how the different types of SLOC affect cost over time. The Corrective and adaptive categories go from left to right increasing slightly while the perfective seems to increase much more significantly.

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Upgrades

Patch updates are rarely seen in software updates associated with weapon system upgrades. However, when they do happen, they usually happen in blocks. As with many other aspects of O&S cost estimating, you as the PSM will not be doing the actual estimating. Your role is to make sure all costs are accounted for. Also, make sure that estimates for integration testing are included. When a software upgrade is introduced for a sub-system, for example, we need to make sure it plays well with the rest of the system. And of course, there's a cost associated with that.

Click the boxes below for some additional information on Block and Patch updates.

Block Updates

Patch Updates

Popup Text

Block Updates

Most software support updates are supported in block updates
- Example from B-1 software support estimate
    - o Three concurrent blocks
    - o Each block requires 3 years (average) from start to completion of testing
    - o New block released on an annual basis
- Requires an expert software cost estimator to accurately breakdown and estimate the costs
- Remember to include cost of operating the final test system and possibly the test range

Patch Updates
-
    More common in Major Automated Information System (MAIS) programs
- Updates released as available

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Key Software Support Cost Elements

The team needed to maintain code is structured exactly like the original development team EXCEPT that it is usually much smaller. Costs are pro-rated based on lines of code.

Traditionally Pro-rata costs are based on Software Lines-of-Code (SLOC). This includes:

- Technical And Management Resources
  - Technical support and management
  - Programmers
  - Quality Control
  - Configuration Management

- Development Facilities and Equipment
  - Facilities and equipment used to program, debug, and development testing of the software

Development Team

Maintenance Team

Further Discussion of Cost Elements

There is also the possibility of needing a test facility that may not be the same facility used in development.

The change in test facility may be due to change in contractors, a shift from contractor testing to government testing, or because of the nature of the system being developed.

Cost factors to be considered are:

- Often event driven or annual
- May require a Software Integration Laboratory (SIL)
    - When using analogous data, verify how SIL costs were collected
- Usually independent of SLOC
- Estimate personnel like development
    - Usually FTE based
    - Or Level of Effort

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Fixed Level Of Effort: An Approach

In some situations, it may be necessary to make an educated guess about upcoming costs. Using a Level Of Effort approach for these situations may work. However, there are pros and cons to be aware of.

Pros and Cons

- Advantage – the approach is a relatively simple method and is consistent with how resources are managed by the government in the short run

- Disadvantage – the approach does not recognize growth in SLOC over the system life cycle

In using the LoE approach, you must:

- Determine the number of programmers and management in staff-years
- Use historical experience from analogous programs
    - Adjust for differences in SLOC
    - Adjust for differences in development methods

Software Models

As with any other cost estimating, there are models we can use to estimate software costs.

A key point here is to use the same model to estimate O&S software costs as that used for development.

This is because different models can generate widely divergent estimates.

What are the pros and cons of using this method?

- Advantage: Model estimates can accommodate both SLOC annual change rate and SLOC growth

- Disadvantages:

    o Can be complex

    o Different models generate widely varying estimates of costs

DAU

Popup Text

Models

COCOMO II, REVIC, SASET, SEER-SEM, PRICE-S, SLIM, SoftCost, Check Point.

Widely Divergent Estimates

In comparison of five models, 20 year support period costs ranged from $35M to $100M for the same system. The study could explain difference in models, but could not normalize models to achieve similar results.

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Other Sustaining Support

Systems can require unique support provided by centralized activities. A few examples are:

- Special test ranges for stealth systems
- Simulator training centers whose costs are not included elsewhere

When these costs are significant relative to the total program O&S cost, they should be included in the cost estimate.

Knowledge Review

A PSM is given the task of maintaining a database for an application shortly after its release. In addition to the technical and management resources, the PSM needs to estimate the pro-rated costs of maintenance based on _____.

☐ Block upgrades

☐ Patch updates

☑ Lines of code

☐ Test ranges

Check Answer

Maintenance costs in this case are pro-rated based on **lines of code.**

What Have We Missed?

We've only touched on a few of the most significant aspects of the sustaining environment.

However, **every** Integrated Product Support element should be examined to see if there are significant O&S costs associated with them during sustainment.

While the cost estimator expert will do the actual estimate, identifying potential costs and evaluating assumptions and parameters are critical parts of the PSM's job.

Lesson Summary

To summarize, in this lesson you learned the following:

- The PSM assumes a principal role in managing O&S costs since many of the costs being incurred will be directly impacted by the design of the support infrastructure

- The PSM must consider and understand many O&S costs including consumable costs, material and support costs, and energy and fuel costs in order to properly estimate the costs for each operating unit.

- A PSM is tasked to know the difference between operating support costs and sustaining support costs.

- Support Equipment is an important area of Sustaining Support costs. Using the procurement cost as well as using analogies are the two common methods used for estimation.

Lesson Summary, Cont.

- Systems must be continuously upgraded to deal with technology advances and changes to the threat environment. This is referred to as "Continuing System Improvement" and encompasses both hardware and software. A PSM should understand how to properly estimate cost for upgrades and modifications in this category.

- Software driven support falls into three categories, adaptive, corrective and perfective. As with any other cost estimating, there are models we can use to estimate software costs. A key point is to use the same model to estimate O&S software costs as that used for development.

Lesson Summary, Cont.

Congratulations! Now that you have completed The Sustaining Environment lesson, you should be able to:

1. Describe Operating and Support (O&S) costs related to Unit Operating Costs.

2. Describe O&S costs related to Sustaining Support Costs.

3. Describe O&S costs related to Continuous System Improvement.

4. Describe software-driven sustainment O&S costs.

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Lesson Completion

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