Standard Software Cost Normalization

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COCOMO Forum
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Agenda

- Background
- Our Normalization Process
- Suite of Tools
- How We Use Results
NRO CAIG Mission

- Provide Independent Cost and Schedule Analyses for all major program milestones – NABs and DNRO Reviews
- Support NRO Budget Build - IPBS and CBJB and Integrated Technical Investment Plan
- Support Sole Source Selections and Proposal Assessments for Competitive Awards
- Provide ad-hoc program support to ensure cost realism “early-on”
- Develop “Best in Class” processes and models
NRO Estimating Process

SPACE ESTIMATE
- Parametric, analogy, bottom-up
- By Work Breakdown Structure (WBS) element
- Consistency
- Software complexity, software lines of code (SLOC)
- Space hardware complexity, heritage, weight, etc.
- Ground hardware complexity, quantities, capability, etc.

GROUND ESTIMATE
- BOM analysis, parametric, analogy
- Other Program Info:
  - Proposals
  - CDRLs
  - CDR packages
  - RFIs
  - Briefing charts
  - etc., etc., etc.

Risk Analysis
- Monte Carlo, Discrete Risks

Cross-check

Document & Brief Results

Schedule Assessment

Develop Budget Spread

Analyze Model Inputs

(Contractor’s) Cost & Tech Data Sheets
- Space Hardware Data Sheets
- Space Software Data Sheets
- Ground Hardware Data Sheets
- Ground Software Data Sheets
- Operations & Maintenance

Other Program Info:
- Discussions with Program Office & Industry
- Program Office Technical Assessment
- NCG Technical Assessment
- Independent Technical Assessment
- Government Assessment
# SW Datasheets

## Sizing data – submitted in conjunction w/ USC code counter
### SW Datasheets

#### SEER complexity data

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**cost data**
SW Datasheets

Development Characteristics:

- Functional Description
- Total Effective LOC (ELOC)
- Total Delivered LOC (DLOC)
- Monthly Labor Rate
- Development Standard
- Development Model
- Physical Location of SW Development Team
- Scope SW Development Activities
- Development Computer
- Target Computer
- Anticipated Code Growth
Code Counter

❖ Size is the most important software cost and schedule driver
  • Main focus to establish objective new and reuse counts
❖ NRO CAIG uses USC’s UCC product as its standard measuring tool
  • Free, Non-executable, Maintained by familiar, active group
❖ Cornerstone of building creditable database
  • Allows us to normalize a “line of code” across programs and contractors
  • Provides consistent metrics; most of our data has been run through the USC counter
❖ Require the use of USC code counter for all programs
  • Code Counter standard a NRO CDRL item
  • Code Counter approved by NRO Security; added to NRO’s official list of approved software
  • Contractors understand need for standardized code counter
Sample Output File: Code Counter

CSCI/CSC: DP/DPAP
CSCI/CSC: DP/DPCC
CSCI/CSC: DP/DPCU
Difference Capability

- Performs a “difference” between two software source files and records the New, Deleted, Modified, Unmodified Lines of Code between baselines
  - “Diff” Tool can break down New, Deleted, Modified, Unmodified “lines” between baselines
  - USC in the midst of releasing Unified Code Counter
  - Goal is to provide a more objective ESLOC calculation based on actuals
## Sample Output File: Diff File

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**CSCI/CSC: DP/DPAP**

**CSCI/CSC: DP/DPCC**
Other Data

- Code Count Reports
- Software Data Sheets
- Monthly Staffing Data
- Software Deficiency Reports (DRs)
- Schedule
- Design Documentation
- Cost data
### Payload Flight Software CSCs

- (U) Calibration Lamp (CA)
- (U) Detector Electronics (DE)
- (U) Mechanism Control (ME)
- (U) System Interface (SI)

- (U) Heater Controller (HE)
- (U) Constants

- (U) Memory Control (MC)
- (U) Memory Manager (MM)
- (U) System Utilities (SU)
- (U) Telemetry Routing (TLM)

- (U) Tools
- (U) Transport Interface (TPI)
- (U) Command Router (CR)

- (U) Sequence Engine (SQ)
- (U) System Controller
- (U) Fault Management (FM)

- (U) Payload Clock Control (PCC)
- (U) Payload Mode Control (PMC)
- (U) Payload Telemetry (PT)
- (U) Task Manager
- (U) Time Tag (TT)
- (U) Software Initialization (SWI)

### CAIG Flight Software WBS

- (U) 1.2a.3.2.3 Payload
- (U) 1.2a.3.2.3.4 Thermal Control Flight SW
- (U) 1.2a.3.2.3.4.7 Optics Flight SW
- (U) 1.2a.3.2.3.5.7 Sensor Flight SW
- (U) 1.2a.3.2.3.12 PL Flight SW

- (U) 1.2a.3.2.3.12.1.3 Boot Code
- (U) 1.2a.3.2.3.12.2.2.3 Executive Code

- (U) 1.2a.3.2.3.12.2.3 PL Control Subsystem
- (U) 1.2a.3.2.3.12.2.4.3 PL Mgmt Subsystem
Diff Tool Results
Payload Flight Software Diff Results

- Overall, the software appears stable. New code was not modified in the later baselines; it became unmodified code once it was written.
- There were very few modified lines of code throughout the development. Code was either new, deleted or unmodified.
- The most deleted code occurred when the software was transitioning to post-FQT software.
• Each CSC has one baseline with a significant amount of development.
• The code in CSC #1 became stable after it was written – there is very little modified or deleted code after development.
• In CSC #2 and CSC #3 there were significant amounts of deleted code (57% and 21% respectively) after the new code was written, indicating requirements changes or bug fixes.
Diff Tool Results v. Staffing
A possible relationship exists between staffing and the total of new, deleted and modified code in the Pre-FQT baselines. As the headcounts increase, the changed lines of code increase in the following baseline. This suggests that there may be a time lag between when the code is developed and when it is integrated into the baseline, possibly due to additional testing.
Each staffing peak between the architecture and instrument baselines corresponds to a peak in either the new, deleted or modified code in the following baseline.
Diff Tool Results v. DRs
Diff Tool Results vs. DRs

The first peak in the total number of DRs appears to result from developing new code and modifying pre-existing code, while the second increase seems to be entirely due to developing new code.
Complexity Metrics
For some operators, there is a difference between command and control and processing. For others, there appears to be no distinction between functionality. Need to investigate if the trends exist across more data points.
Summary

- Normalizing data consistently is vital when comparing results and metrics across multiple programs and contractors.
- Developing a systematic approach aides the normalization process.
- Using a standard code counter is an important element when the largest single factor of a software estimate can be software lines of code.
- Collecting and analyzing a variety of software inputs and assesses how they relate to one another can provide new insights.