Software Cost Estimation Challenges for the Future

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Agenda

- Concept Design Center’s conceptual design approach
- Software cost estimation challenges
  - Estimating at conceptual design phase
  - Commercial Off-the-Shelf (COTS) software
  - Software reuse
  - Commercial satellite
  - Advance concept designs (in-house)
  - Multi-level security
  - Alternate life cycles
  - Information architecture
- Critical issues
The Aerospace Corporation

Concept Design Center's

Conceptual Design Approach

- Utility Level
- Mission Level
- System Performance and Cost
- Architecture Level
- Segment Level
- Propulsion and Power System Software Integration
- Launchers and Support Systems

* Conceptual Design is the first attempt to define detailed systems architecture characteristics
  - Concept of Operations (collection mechanisms, tracking, orbit, etc.)
  - First level where software is estimated as a stand-alone item

R. Yend 1996

Concept Design Center Design Activities

New Missions

- Block Changes
- Technology Integration
- Proposal Analysis

THE AEROSPACE CORPORATION

R. Yend 1996
The CDC methodology permits: (1) Quick response to leading design and cost questions, (2) Assessment of the cost and performance impact of existing and new technologies, and (3) Estimation of vital uncertainties and risks.
Software Cost Estimation Challenges

- Estimating software size and complexity for newer technologies
  - Information architecture
  - Multi-level security
  - Commercial Off The Shelf (COTS) software
- Estimating for modified acquisition approaches
  - Commercial satellite purchase
  - Alternate life cycles
- Estimating for conceptual design (2005+)
  - Software effective size, labor and licenses

Estimation at Conceptual Design Phase

- Concept Design Center conceptual designs tend to
  - Lead the estimation state of the art in some domains
  - Address the 2002-2010 time frame
  - Focus on payload and mission
    - High-level or non-existent CONOPS
    - Incomplete functionality and requirements
- Software analysis at CDC conceptual designs
  - Captures software functionality across the system
  - Predicts future COTS capabilities and associated costs
  - Provides coherent high-level CONOPS for the system
- CDC current approaches will be described
Commercial Off the Shelf (COTS) Software

- Estimating COTS costs for the 2004 timeframe
  - How much will licenses and maintenance cost?
  - Will it be easier to select, integrate and maintain?
  - Is COTS satellite application software available?
  - Will multi-level security impact COTS usage?

- CDC current approach:
  - Estimate COTS costs
    - Licenses (purchase, maintenance, site-wide per seat, etc.)
    - Labor for integration and vendor consultation
    - Training / learning curve
    - Custom code for COTS glue and adapting COTS to mission

Software Reuse

- Availability of reusable software for the mission

- Types and percentages of reuse:
  - Design, code, test
  - Documents, code, data bases, test material, algorithms

- Maintenance costs for reuse code
  - Total code, only custom code, part of the reuse code
  - Quality of code impacts maintenance costs

- CDC current approach:
  - Estimate effort equivalent to developing software
  - Use a wrap factor on KESTO for maintenance
Commercial Satellites

- Designing systems with commercial satellites
  - Flying military hardware on commercial buses
  - Actual vendor may not be known for 2005+
- Potential additional costs
  - Modifications to vendor’s software and databases
  - Changes to operational procedures for military needs
- CDC current approach for future vendor
  - Unbundling software from satellite costs
    - Estimate on-board software size for satellite operations
    - Prorate software costs over estimated sales base

Advanced Concept Demo Satellites

- Research programs approaches tend to:
  - Aim for faster, cheaper, quicker
  - Require less rigor in their development
  - Simplify software development and documentation
  - Have more tolerance for risk than military systems
  - Provide lower redundancy and reliability
  - Generate cheaper, smaller software modules
- Aerospace current approach:
  - Convert costs to staff months & review staffing profile
  - Decrease code sizes to reflect reduced functionality
  - Update cost CERs for research developments
Multi-Level Security

- Multi-level security issues can include:
  - Classified, proprietary, management, and other data
- Multi-level data warehousing creates challenges with integration of text, image, video, voice:
  - Large aggregates of data may expose sensitive information
  - Missing data may reveal sensitive information
  - Different levels of data integrity may reduce data mining efficiency
- Multi-level security impacts system performance
- CDC FY 99 research topic:
  - Identify COTS applicable for multiple security levels

Alternate Life Cycles

- Acquisition reform impacts software costs:
  - Fewer deliverable documents and formal reviews
  - Use of common processes and commercial standards
- Alternate life cycle models & acquisition strategies:
  - Spiral, modified spiral and evolutionary models
  - Informal development
  - Product line component engineering
- CDC future research:
  - Collect cost data on new lifecycle to update CERs
  - Research alternate approaches to address this issue
Information Architecture

- Components of Information Architecture (IA)
  - Data warehouse and data mining
  - Push data specific data to users
  - Allow access to all additional data
  - Trend and other data moves from the warehouse
  - Intelligent agents scan warehouse satisfying requests
  - Web interface for users in real-time data transparently
  - Virtual processing and data at any appropriate facility

- CDC current approach
  - Research is addressing this issue
  - Defining COTS costs for different IA functionality

Agenda

- Concept: Design Center’s conceptual design approach

- Software cost estimation challenges
  - Estimation at conceptual design phase
  - Commercial Off-the-shelf (COTS) software
  - Software re-use
  - Commercial satellites
  - Advance concept design satellites
  - Multi-level security
  - Alternate life cycles
  - Information architecture

- Critical issues
**Critical Issues**

- Shorter developments drive CER obsolescence
  - By the time satellite is operational data is obsolete
- Need to update CERs on a continuing basis
  - Reflect new technologies and acquisition approaches
- Develop rules on things to re-use from current models
- Identify approaches to get estimation databases faster

- Develop in-process data heuristics to aid modeling
  - 30:30:40 rule tailored for different life cycles
  - Separate out costs for formal deliverables and reviews
  - Identify CERs for building informal developments

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**Specific Critical Issues**

- Estimating COTS
  - COTS integration effort
  - COTS glue and adaptation for the mission

- Estimating maintenance for systems with
  - Intensive COTS
  - Extensive reuse (costs should vary with code quality)

- Estimating cost impacts of acquisition strategies
  - Product line component based software systems
  - Government standards (e.g., TIA, DIL, COE)

- Accurately estimating custom code
  - Tends to dominate COTS software costs