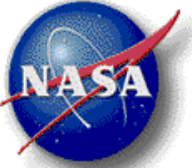


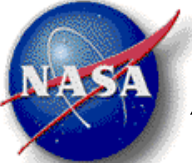
*Software Development  
Cost Estimation  
Executive Summary*

*Dr. Jairus Hihn  
JPL*

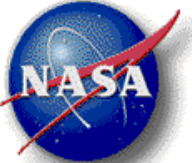
*Dr. Tim Menzies  
West Virginia University*



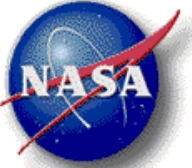
- ✦ Experience has shown that if a project's development costs are under-estimated then developers will be forced into many quality-threatening cost-cutting measures.
- ✦ A major reason for poor software cost estimation is that, all too often, NASA's software managers don't have information they need
  - ✦ Not enough relevant data
  - ✦ Current models are brittle and improperly tuned



- ◆ Identify 'simple' fully validated cost models that provide estimation uncertainty with cost estimate
  - ◆ Based on COCOMO variable set
- ◆ Use machine learning techniques to determine
  - ◆ Minimum number of cost drivers required for NASA domain based cost models
  - ◆ Minimum number of data records required
  - ◆ Estimation Uncertainty
- ◆ Build a repository of software cost estimation information
  - ◆ Coordinating tool development and data collection with
    - ◆ Tasks funded by PA&E Cost Analysis
    - ◆ IV&V Effort Estimation Task
    - ◆ NASA SEPG activities



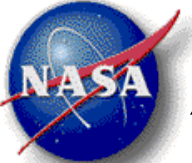
- ◆ Data at JPL indicates that
  - ◆ flight software planned effort grows by
    - ◆ 75% from Initial Confirmation
    - ◆ 55% from Confirmation Review
  - ◆ Schedule slips by 20% from Confirmation Review
  - ◆ Allocated budgets are seriously out of line with software team estimates
- ◆ The products of this research task will enable the ability to
  - ◆ improve our performance against these metrics
  - ◆ Develop 'reasonable' estimates for IV&V resource allocation to verify NASA mission software



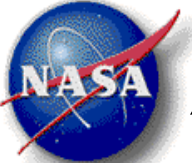
# RELEVANCE to NASA

- ◆ NASA even at the center level has very limited knowledge of its actual software cost performance and will be doomed to repeat the past if cannot learn the lessons from its past
  
- ◆ NASA must establish the capability to
  - ◆ Update estimates quickly as designs evolve
  - ◆ Have sufficient basis of estimate to defend reasonable software cost estimates
  - ◆ Understand the risk and uncertainty within our estimates and budgets





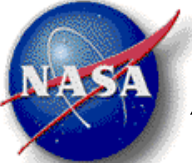
- ◆ July 2005 Verified analysis approach yields useful results
  - ◆ Completed initial analysis of 1980's NASA dataset to verify analysis approach
    - ◆ Feature Subset Selection Can Improve Software Cost Estimation, PROMISE 05, May 15 2005, St Louis, MS.
    - ◆ Simple Software Cost Analysis: Safe or Unsafe?, PROMISE 05, May 15 2005, St Louis, MS.
    - ◆ Validation methods for calibrating software effort models, ICSE 2005 Proceedings, May 2005, St Louis, MS.
- ◆ Processed and delivered contemporary flight software data for analysis and model development
  - ◆ 60 records



# ACCOMPLISHMENTS



- ★ July 2006 have documented key weaknesses in current estimation practices and initiated new research directions
  - ★ Large variance problem creates significant difficulties with local calibration and stratification as tuning techniques
- ★ Processed and delivered 123 contemporary flight software data records for analysis and model development of which 93 have complete data
  - ★ COCOMO81 and COCOMO II versions
  - ★ Current data collection activities documented in report
  - ★ Contributions from MSFC, GRC and JPL so far
- ★ Developed COSEEKMO Tool prototype to support analysis

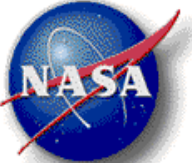


# ACCOMPLISHMENTS



- ★ Past years publications
  - ★ "Evidence-Based Cost Estimation for Better-Quality Software, IEEE Software, July/August 2006 Menzies and Hihn
  - ★ Studies in Software Cost Model Behavior: Do We Really Understand Cost Model Performance?, Proceedings of the ISPA International Conference 2006, Seattle, WA (Best Paper Award)
  - ★ Specialization and Extrapolation of Software Cost Models, Proceeding in Automation in Software Engineering Conference, Nov 2005,
  - ★ Finding the Right Data for Software Cost Modeling, IEEE Software, Nov/Dec 2006 (B. Boehm co-author).
  - ★ Improving Current Practices in Software Effort Estimation, Accepted (4/06) by IEEE Transactions On Software Engineering subject to revision
- ★ Two presentation at the USC COCOMO and Cost Modeling Workshop
- ★ Scott Chen (Dr. Boehms graduate student at USC) redirected his dissertation to incorporate our methodology for model development and data analysis as a result of our presentations.





- ◆ Working various approaches to reduce large variance problem.
  - ◆ Nearest neighbor
  - ◆ Expert judgment based rejection rules
  - ◆ Add new functional forms
- ◆ Improve efficiency of COSEEKMO
  - ◆ bagging
- ◆ Transfer technique to JPL for use in internal model calibration
- ◆ Pilot training program to be presented at Hawaiian International Conference on Systems and Software (HICSS)
- ◆ Continue to coordinate with IVV&V task with IPAO Analogy Based Software Cost estimation task
- ◆ Continue to engage other NASA Centers to contribute more data

The research described in this abstract was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government.