



NASA - Software Estimating Tool



**N-SET** - A NASA Research project

## NASA Cost Symposium

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Pasadena CA



## Presentation Topics

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- Background
- Goals/Objectives
- Approach
- Usages and Applications
- N-SET Design Details
- Schedule
- Challenges
- Summary



## Background

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Research Task initially awarded in FY05

**Problem** – *NASA is unable to estimate software size/cost early in a project because the software requirements/architecture are not complete and cost model inputs, primarily size, are not available*

**Purpose** - *To develop a high level software estimation capability that does not use Lines of Code as an input value*

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## Goals/Objectives

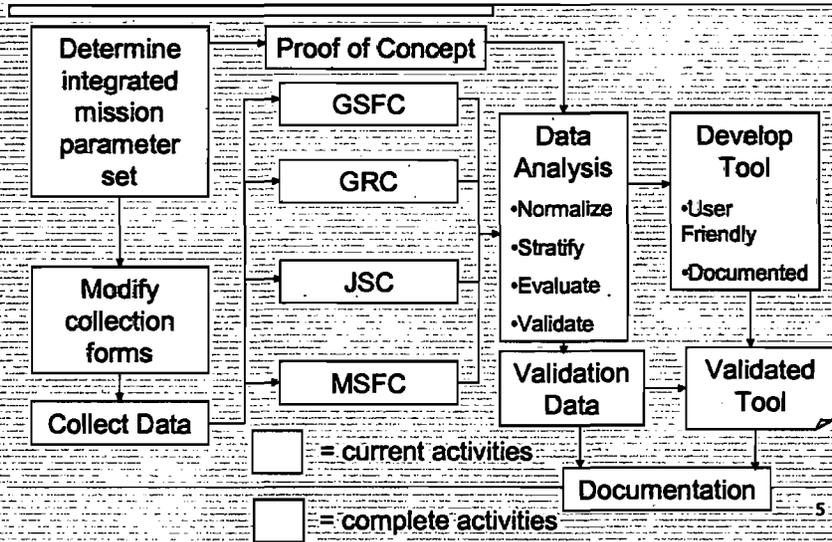
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- To use NASA historical experience for creating software estimates
  - To provide a user friendly, high level software estimating tool
  - To improve the software estimating within NASA
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# Approach



# Usages and Applications

- Rough Order Magnitude (ROM) estimates
  - Early "should cost" to establish budget
  - Starting point when no data is available
- Compare to contractor estimates
- Can supplement other methodologies
- Not intended to compete with fidelity of commercial models



## Strengths

- Contains NASA data
  - Unique in how we do business
  - Different than DoD
- Uses statistical techniques
- Is self-calibrating
- Easy to use
- Does not require lines of code as an input parameter
- Available at no cost

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## Beneficiaries and Benefits

<b>Beneficiary</b>	<b>Benefit</b>
<b>IPAO</b>	Data and metrics for use in Independent Cost Estimates (ICEs) and Source Selection evaluations. Tool consistent with CADRe data.
<b>NASA HQ</b>	Can be used to develop "Should Cost" estimates.
<b>NASA Centers</b>	Will help with analogy for proposals and other types of estimate preparation.
<b>NASA Support Contractors</b>	Will provide general information about historical programs so that they can do a better job of preparing their products and estimates for NASA.

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## N-SET Design Details

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- No SLOC data required, but part of the internal database
  - Based on basic COCOMO algorithms
    - Quantitative responses
    - "Nearest Neighbors" concept
  - Iterative process – "training" and "testing" for sensitivity
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## N-SET Design Details – Artificial Intelligence Agents

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- Takes a "partial description" of a project
    - E.g. analyst capability (in COCOMO 81 "acap=1")
  - Goes to database of projects
    - E.g. NASA93 COCOMO 81 database
  - Find projects "near" the partial description(s)
    - E.g. find the 20 "nearest neighbors" in database
  - Build cost models from the 20 "nearest neighbors"
  - Compare cost models to other "partial descriptions"
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# N-SET Details – Input Selections

Estimate Status	NASA Center	Operating Environment	Mission Type	Primary Application
New	HQ	Flight - Manned Spacecraft	Astrophysics - Structure & Evolution of Universe	Artificial Intelligence
Draft	Wallops	Flight - Unmanned Spacecraft	Astrophysics - Origin of Universe & Life	Command/Control
Final	KSC	Flight - Instrument/Payload	Astrophysics - Sun-Earth Connection	Communications
	JSC	Flight - Manned Aircraft Avionics	Interplanetary - Inner Solar System Exploration	Databases
	SSC	Flight - Missiles and Unmanned Aerial Vehicles	Interplanetary - Outer Solar System Exploration	Data Mining
	GRC	Ground - Mission Critical	Interplanetary - Mars Exploration	Data Warehousing
	LaRC	Ground - Mission Non-critical	Earth Observation - Climate & Weather	Diagnostics
	JPL	Unknown (All)	Earth Observation - Oceanography	Expert System
	ARC		Military - Photo-reconnaissance	Graphical User Interface
	MSFC		Military - Combat System	Graphics
	GSFC		Military - Cargo Delivery	Mathematical & Complex Algorithm
	APL		Military - Crew Transportation	Management Information Systems
	Unknown (All)		Commercial - Cargo Delivery	Network Management
			Commercial - Crew Transportation	Object-Oriented Database
			Exploration - Cargo Delivery	OS/Executive
			Exploration - Crew Delivery	Relational Database
			Unknown (All)	Report Generation
				Robotics
				Simulation
				Software Development Tools
				Testing Software
				Training/Computer-based Training
				System & Device Utilities
				Flight Systems
				Mission Planning
				Radar
				Signal Processing
				Unknown (All)



# N-SET Details – Input Selections

Programming Languages	Software Class	Default Flight WBS	Default Ground WBS
Ada	Class A	Guidance, Navigation & Control (Attitude Control)	Tracking, Telemetry, Command and Monitoring Subsystem
Assembly	Class B	Command & Data Handling	Spacecraft Analysis Subsystem
Basic	Class C	Structures & Mechanisms	Instrument Analysis Subsystem
FORTRAN	Class D	Propulsion	Navigation Operations Hardware and Software
C	Class E	Telecommunications	Science Planning Subsystem
C++		Thermal	Mission Planning Subsystem
COBOL		Power	Sequencing Subsystem
JAVA			Simulation Subsystem
JOVIAL			Data Management and Archiving Subsystem
Matlab			Radio Science Subsystem
PASCAL			Science Analysis Subsystem
Shell languages (Csh, Bash, etc.)			
Scripting languages (Perl, awk, etc.)			
Unknown (All)			



# N-SET Details - Output Screen

Project WBS Summary | Project Name: Test Data Set | Date Last Updated: 11/02/98 11:52:36 AM

**LOCOSMO Results: Distribution of Estimates**

WBS #	Element Type	Level 1	Level 2	Date Last Updated	Estimate Status	Est. Effort (person-months)	Est. SLOC (KLOC)	Constant a	Exponent b	MSRE (%)	Effort-Weighted
1.0	Flight	Autonics Software (AVIS)		11/13/98 9:19 AM	Draft	428,123	614.03	535.96244	110.194343	28.08	0.6099108
1.0.0	Flight	Flight and Ground Interface (F&G)		11/02/98 11:46 AM	Draft	383,496	620.59	419.533905	88.2927307	42.17	0.5389952
1.0.0.0	Flight	Guidance, Navigation, and Control (GNAC)		11/02/98 11:46 AM	Draft	433.8	689.28	388.962523	118.599470	9.78	0.5344011
1.0.0.0.0	Flight	High Level Subsystem (HLS)		11/02/98 11:46 AM	Draft	405.823	699.42	507.127445	82.3189712	32.88	0.5722786
1.0.0.0.0.0	Flight	Infrastructure (INF)		11/02/98 11:46 AM	Draft	408.803	699.42	507.127445	82.3189712	32.88	0.5722786
1.0.0.0.0.0.0	Flight	Power Mobility (MCH)		11/02/98 11:46 AM	Draft	479.641	768.28	578.232256	116.11783	36.20	0.5499407
1.0.0.0.0.0.0.0	Flight	Payload and Actuation (P&A)		11/02/98 11:46 AM	Draft	452.211	658.31	631.846810	111.264781	21.18	0.5771791
1.0.0.0.0.0.0.0.0	Ground	Ground Data System		11/02/98 11:46 AM	Draft	2056.805	3871.924	1088.000000	1.000000	1.000000	0.5000000
1.0.1	Ground	Activity Planning and Scheduling Subsystem (APSS)		11/13/98 9:19 AM	Draft	418.976	606.84	598.048773	837.058912	58.18	0.4584189
1.0.2	Ground	Data Acquisition and Control Subsystem (DACCS)		11/02/98 11:46 AM	Draft	354.389	641.74	817.413982	1323.101348	83.06	0.4592053
1.0.3	Ground	Data Management and Accounting Subsystem (DMAS)		11/02/98 11:46 AM	Draft	492.262	718.71	641.143781	811.828251	32.05	0.6112860
1.0.4	Ground	Operational Products Generation Subsystem (OPGS)		11/02/98 11:46 AM	Draft	428.853	617.44	608.437699	1713.07013	107.18	0.3424411
1.0.5	Ground	Mission Control Subsystem (MCS)		11/02/98 11:46 AM	Draft	428.853	617.44	608.437699	1713.07013	107.18	0.3424411
1.0.6	Ground	Mission Design and Navigation Subsystem (MDNS)		11/02/98 11:46 AM	Draft	327.178	609.82	648.182463	817.210294	89.22	0.4551614

**LOCOSMO Summary**

Estimated Effort (person-months)	10.1	120
Mean Estimated Effort (person-months)	519.12	
Standard Deviation (person-months)	36.41	

**LOCOSMO Equation**

$$E_{pm} = a \cdot SLOC^b \cdot f_{multi}$$

**Plot of LOCOSMO Equations**

Notional Data



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Notional Data



## Schedule

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- Data Collection – on-going
  - Effort to collect Manned System data
- Complete re-programming activity – Sept 07
  - Validate to UNIX version
- Beta release – Sept 07
- Conduct Focus Group – Oct/Nov 07

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## Data Collection Details

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- CADRe data, on a limited basis
- JSC
  - Database
- GRC
- MSFC
  - Chandra
- GSFC - TBD

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## Challenges

- Re-programming AI scripts into Visual Basic
  - AI Agents operate in UNIX
  - Requires additional operating software
  - Not user friendly
- Need more data



## Deployment Decisions

- Currently programming for stand alone capability
- Integrate into other products
  - NAFCOM
  - ACEIT
  - NICM
- Stand alone interfaced to other products



## Summary

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- Need more (good quality) data
- User input is very important to us
- Seeking additional participants for Focus Group
  - Will incorporate as many improvements as funding allows
- Anticipate Beta release version by the end of the fiscal year