NASA/Air Force Cost Model

NAFCOM

Science Applications International Corporation

Propulsion for Space Transportation of the 21st Century
May 15, 2002

SAIC
An Employee-Owned Company
The NASA/Air Force Cost Model (NAFCOM) is a parametric estimating tool for space hardware. It is based on historical NASA and Air Force space projects and is primarily used in the very early phases of a development project. NAFCOM can be used at the subsystem or component levels.
NAFCOM Database

- NAFCOM is based on spacecraft data from the Resource Data Storage and Retrieval Library (REDSTAR)
- REDSTAR is NASA's major repository of cost, technical, and programmatic information including over 25,000 documents
  - 540 companies, government agencies, universities, and aerospace societies represented
  - Total program to subcomponent cost data
  - Information on spacecraft bus, attached payloads, engines, launch vehicles, upper stages, scientific instruments, aircraft, DoD, cost models and cost estimating, schedules, ground and launch operations, mission operations, Lessons Learned
- The normalized database includes 122 missions with:
  - 76 unmanned earth orbiting, 24 unmanned planetary, 11 launch vehicles, 8 manned, 3 engines
NAFCOM Evolution

NAFCOM

NASA

Department of the Air Force

United States of America

NAFCOM Evolution

NASCOM Database Hardecopy

NASCOM Version 3.0 (April)

NASCOM Version 4.0 (October)

NAFCOM96 Restricted & Unrestricted Release (February)

NAFCOM (April)


NASCOM Automated Database (December)

NASCOM Version 5.0 (August)

NAFCOM99 (November)
NAFCOM Features

- Subsystem-level Complexity Generators
- Process-based Schedule Estimating
- Time Phasing of Cost
- Cost Trades
- Enhanced Engine Estimating
- Integration into CEC
- Quick estimate startup with use of template wizard
- Expert knowledge of database embedded in template selection process
NAFCOM Features

- **Subsystem Level Complexity Generators**
  - Application of multiple cost drivers
  - The equations follow the form:
    \[ \text{Cost} = C \times \text{Weight} \times \text{Inheritance} \times \text{Technology} \times \text{Management} \times \text{Z} \]
  - Data driven, statistically based
  - Documents estimating assumptions
  - Minimizes the use of subjective inputs
  - Repeatable and verifiable
  - Nine new complexity generators have been developed including SRM, propulsion (less engines), OMS, TVC, recovery, landing, thermal control, crew accommodations, and ECLS.
Process-based Schedule Estimating

- SAIC identified the processes for currently defined common subsystems and system integration elements and tied these processes to schedule estimating algorithms.
- The methodology considers cost and technical parameters in the calculation of the schedule baselines.
- Three levels of schedules are generated:
  - System level by Stage
  - Stage level by Subsystem
  - Subsystem level by Process
**NAFCOM Features**

- **Time Phasing of Cost**
  - Developed using schedules generated in process-based module
  - Cost is spread at the subsystem level
  - DDT&E and flight unit cost are shown separately
  - User may select either fiscal or calendar years
  - Beta distributions can be changed for DDT&E and flight unit
NAFCOM Features

- **Cost Trades**
  - Allows the user to perform "what if" scenarios based on global changes to technical factors:
    - Weight
    - Manufacturing management
    - Engineering management
    - New design
    - System Test Hardware
  
  - One, all, or a combination of the factors can be increased or decreased by a percentage to determine the effect these changes have on total cost
NAFCOM Features

- Enhanced Engine Estimating
  - Fully integrated versions of a liquid rocket engine model and a combined cycle propulsion model
  - Algorithms from the U.S. Air Force jet engine cost model
NAFCOM Features

- Integration into collaborative environments
  - NAFCOM estimates are saved as Excel spreadsheets allowing easy manipulation of inputs external to the application

<table>
<thead>
<tr>
<th>Elements</th>
<th>Weight</th>
<th>STHQty</th>
<th>EUPer</th>
<th>ManiMgmt</th>
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NAFCOM Sample Screens
NAFCOM
NASA/AIR FORCE COST MODEL

WARNING: This document contains classified data release subject to restrictions by the Arms Export Control Act or the Export Administration Act of 1965, as amended. Violation of these export laws are subject to penalties imposed under the act.
A SINGLE screen dynamically changes based on Mission and Vehicle Type providing the capability to estimate hundreds of possible vehicle configurations.

- **Vehicle Types**
  - Single-stage to Orbit
  - Two-stage to Orbit
  - Two-stage Bimese
  - Three-stage to Orbit
  - Four-stage to Orbit
  - Shuttle-derived
New Interface

- Toolbar provides easy access
- WBS is generated based on wizard but allows addition of lower level elements
- Data and reports on screen change based on WBS element selected
- Various on-screen reports are provided
- Major cost drivers allow quick changes to template defaults on simple screens
- Funding profiles can be selected at the subsystem level
- Status bar provides dynamic view of cost estimate
Detailed Inputs will include all non-global inputs available for a WBS element on one screen.

The analogous missions can be changed below.
Estimating Method will determine whether Complexity Generators or Conventional CERs are used.

Mission Type, Data Level, and Element Type will determine what part of the database is available.

Database Filters will change based on the Mission, Level, and Element selected. The database screen will change as filters are entered.

Detailed Technical Descriptions will be provided for the selected item in the database.
Sample On-screen Outputs

Lost Report

<table>
<thead>
<tr>
<th>Elements</th>
<th>D&amp;A</th>
<th>STH</th>
<th>DOT&amp;E</th>
<th>Flight Unit</th>
<th>Production</th>
<th>Total</th>
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</table>

Reaction Control Subsystem

- ATP
- PDR
- CDR
- Delivery
  - Preliminary Design
  - Detailed Design
  - Fab & Assembly
  - Integration & Test
Planned Release and Training

- Public release of NAFCOM is not planned
- Requests for NAFCOM will be controlled through NASA software usage agreement
- Launch Vehicle version was released in April 2002
- Unmanned Spacecraft version is planned for release this June
- Training will be completely revamped
  - Class time will be reduced to one day
  - Emphasis will be on model usage not estimating theory
  - Training will be scheduled beginning in early Summer
  - Training will be conducted using the unmanned spacecraft version of NAFCOM