Modeling and Simulation for Assessing a "Go Anywhere and Shoot" Capability for Trident II
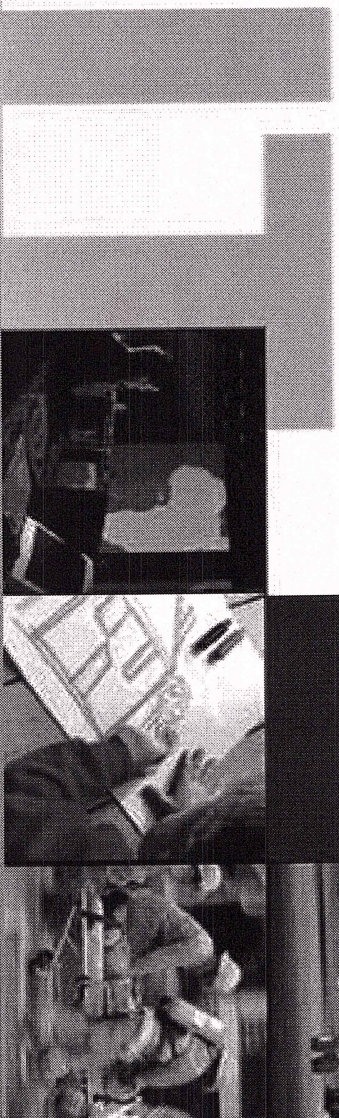
October 30, 2002

James Cutler   Mavis Driscoll
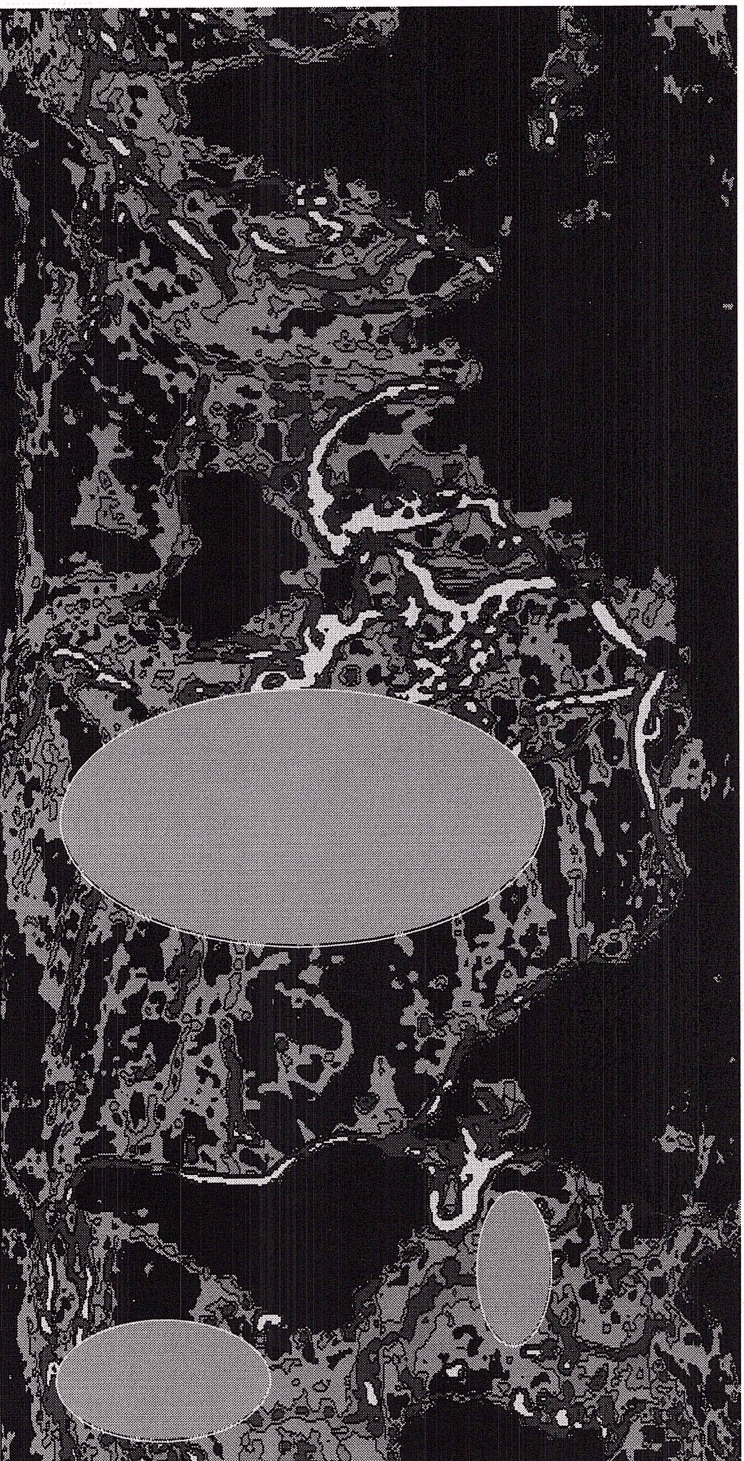
David Frank   John Ladik

David Marcus   Richard Sailor

- **Introduce the SWS community to SSP/Northrop Grumman Information Technology modeling and simulation resources**

- **Show the benefit of using low-cost modeling and simulation techniques to assess operational issues**

- **Illustrate how modeling and simulation can be used to examine the possibility of increasing the patrol region of the Trident II (D-5) Strategic Weapon System**

  —Provides an assessment of accuracy for a "Go Anywhere and Shoot Capability"

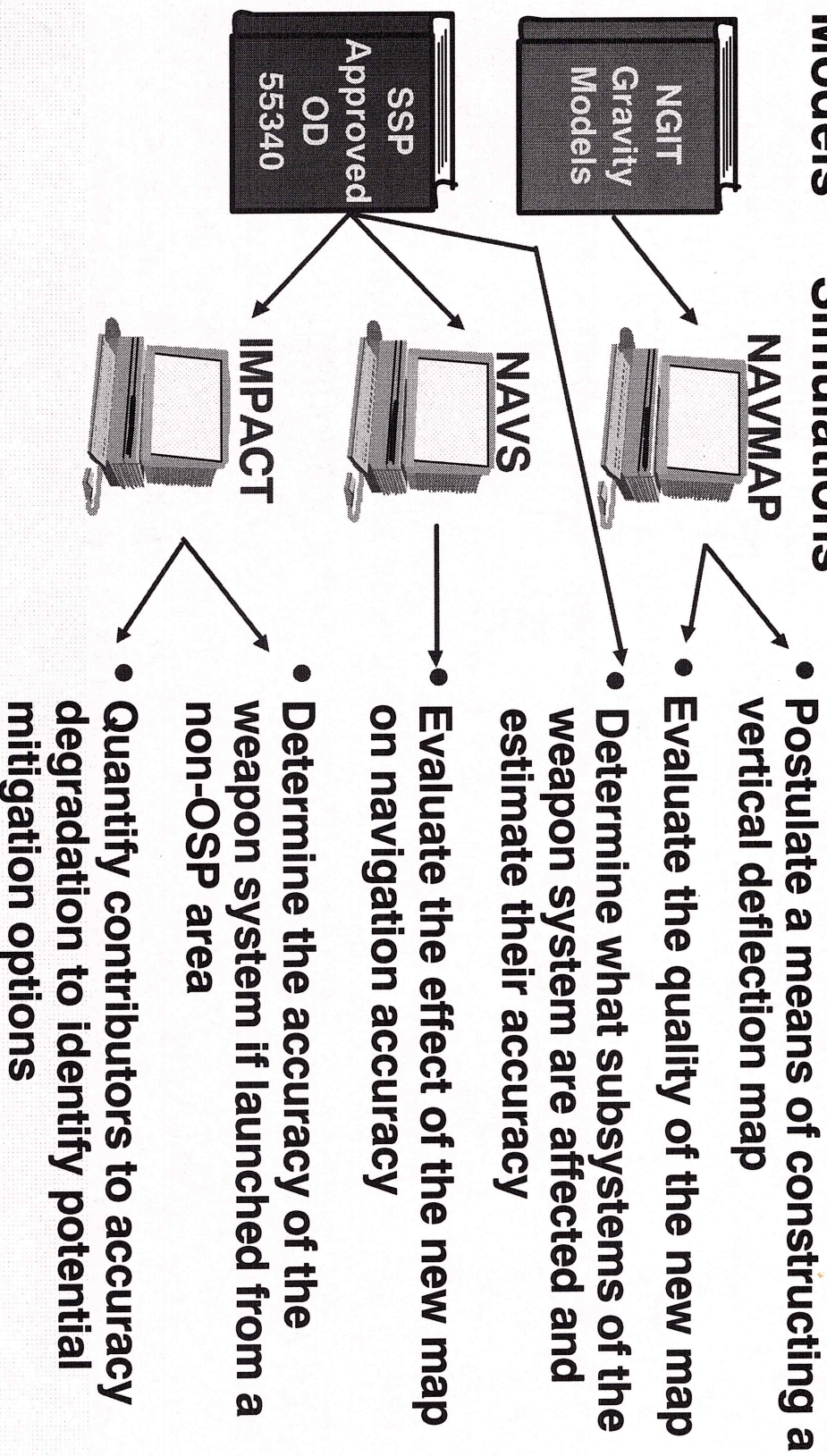 —Examines alternate operational scenarios for maintaining tactical accuracy

- **What is the potential accuracy degradation if the SWS operates outside the nominal OSP regions?**

- **What can be done to mitigate the degradation?**

Notional OSP Operating Area

Models   Simulations

Technical Challenges

NGIT Gravity Models

SSP Approved OD 55340

NAVMAP

NAVS

IMPACT

- Postulate a means of constructing a vertical deflection map

- Evaluate the quality of the new map

- Determine what subsystems of the weapon system are affected and estimate their accuracy

- Evaluate the effect of the new map on navigation accuracy

- Determine the accuracy of the weapon system if launched from a non-OSP area

- Quantify contributors to accuracy degradation to identify potential mitigation options

Satellite Altimetry

- **Satellite sends radar pulse to sea surface**
  - Measures travel time of reflected pulse to observe sea surface topography
  - Satellite's height relative to ellipsoid is known from satellite tracking

- **Sea surface topography is very close to the geoid**
  - **Observations show that vertical deflection maps can be made from altimeter data**

Orbit

Orbit Altitude

Satellite

Measured Height Above Sea

Altimeter Footprint

Ellipsoid

Geoid (Sea Surface)

Undulation

OD 55340 Weapon System System Accuracy Model
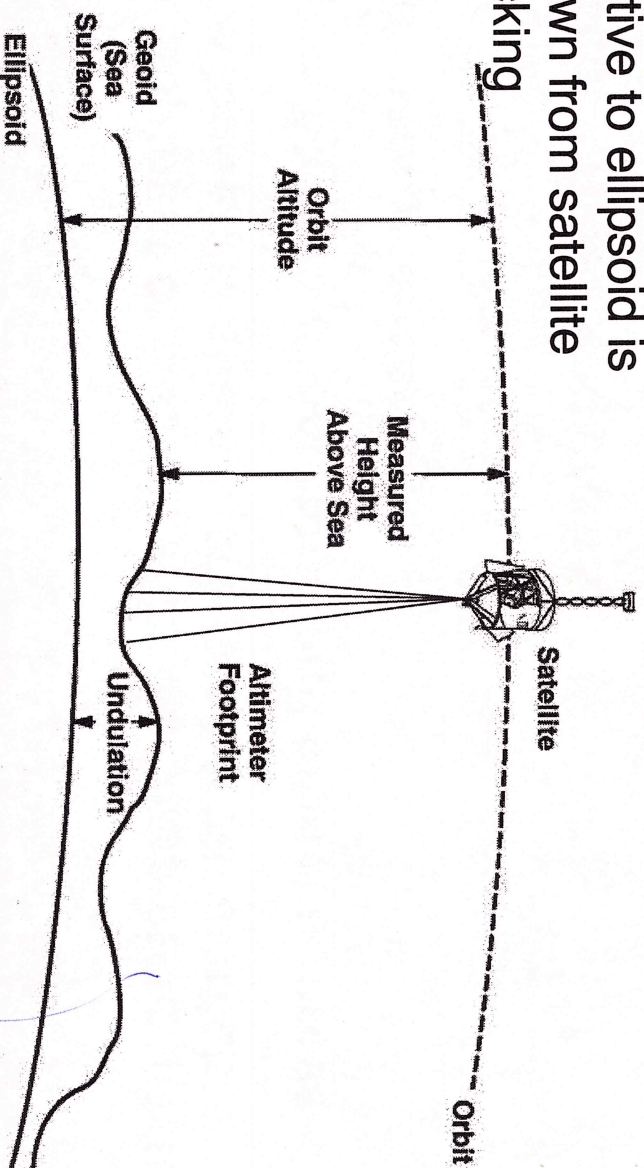
Overview

- Comprehensive accuracy model for the Trident II (D-5) weapon system

- Three primary uses

  - Prediction

    - Provide tactical accuracy predictions to planners
    - Perform tradeoff studies of alternative configurations
    - Predict accuracy of tests

  - Mechanization – Portions of the accuracy model are embedded in tactical software

  - Evaluation

- SP2012 is SSP's "Keeper-of-the-model"

  - Maintains, documents and distributes system-level accuracy model

Determine How Gravity Affects Weapon System

SSP
Approved
OD
55340
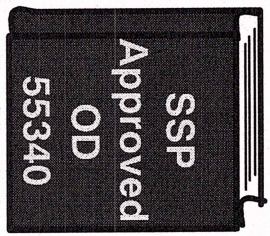
- **OD 55340 provides information on system mechanization and how gravity influences subsystems**

Prelaunch
Fire Control/Guidance

Guidance Initialization,
Target Preset, Inflight Gravity, and
Weighting Matrix Errors

In-Flight Guidance
IMU and Stellar
Sensor Errors

Deployment
Deployment
Velocity Errors

Environment
Gravity and Weather
Data Errors

Navigation
Ship Position,
Velocity, Tilt and
Heading Errors

Reentry
Aerodynamic and
Fuzing Errors

**Total System
Error**

Aim
Point

Items highlighted in red are significantly influenced by
vertical deflection error

Evaluate Navigation Error

SSP
Approved
OD
55340

Trident II Navigation
Subsystem
Error Model

Trident II OSP
Map Model

Geosat VD
Map Model

NAVS Simulation

- Navigation Subsystem
  Covariance Analysis
- Navigation Error Covariance
  Matrix (NECM) Computation

Error Model for
Navigation
Subsystem,
NECM
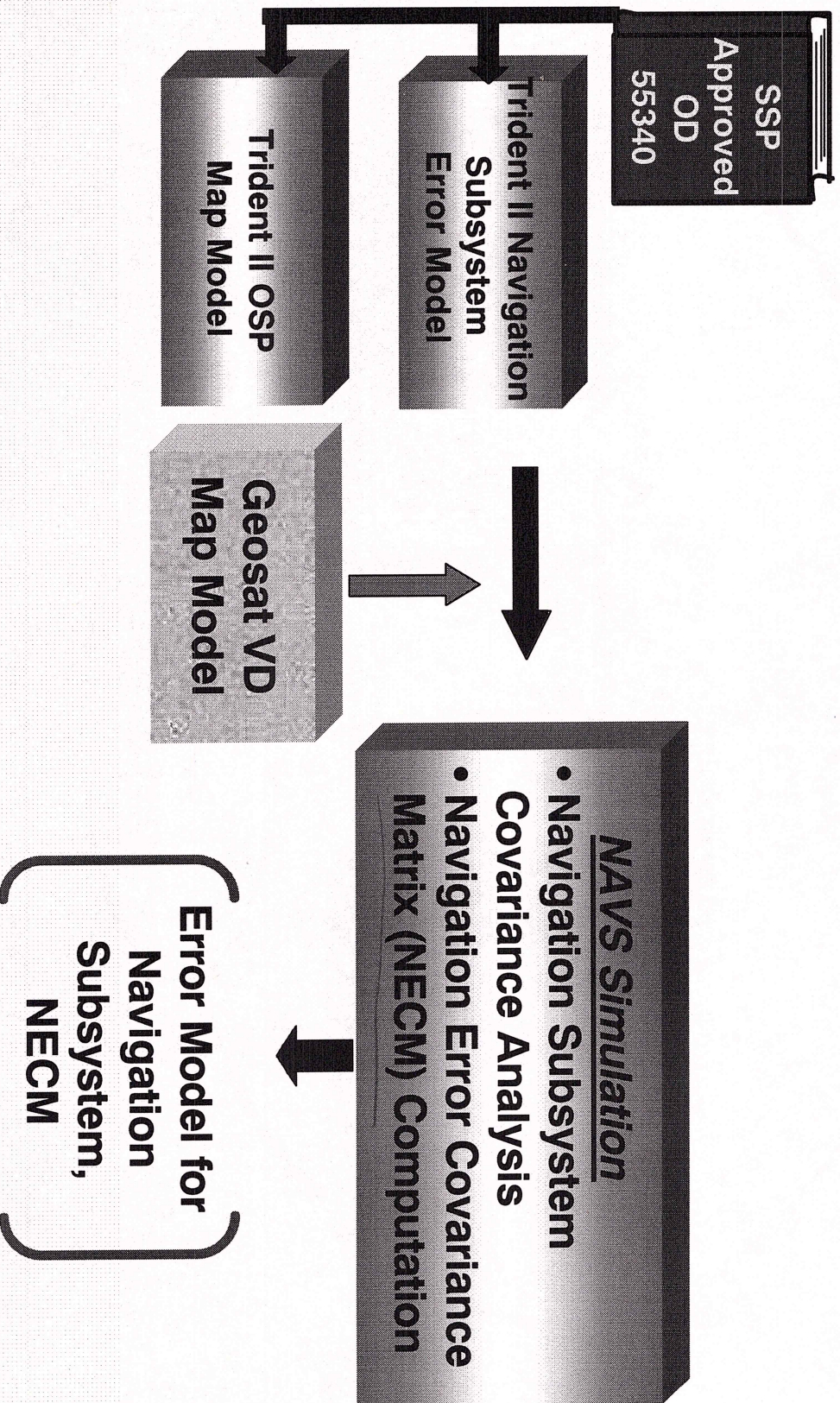
→ Selected subsystem reflect parameters selected.

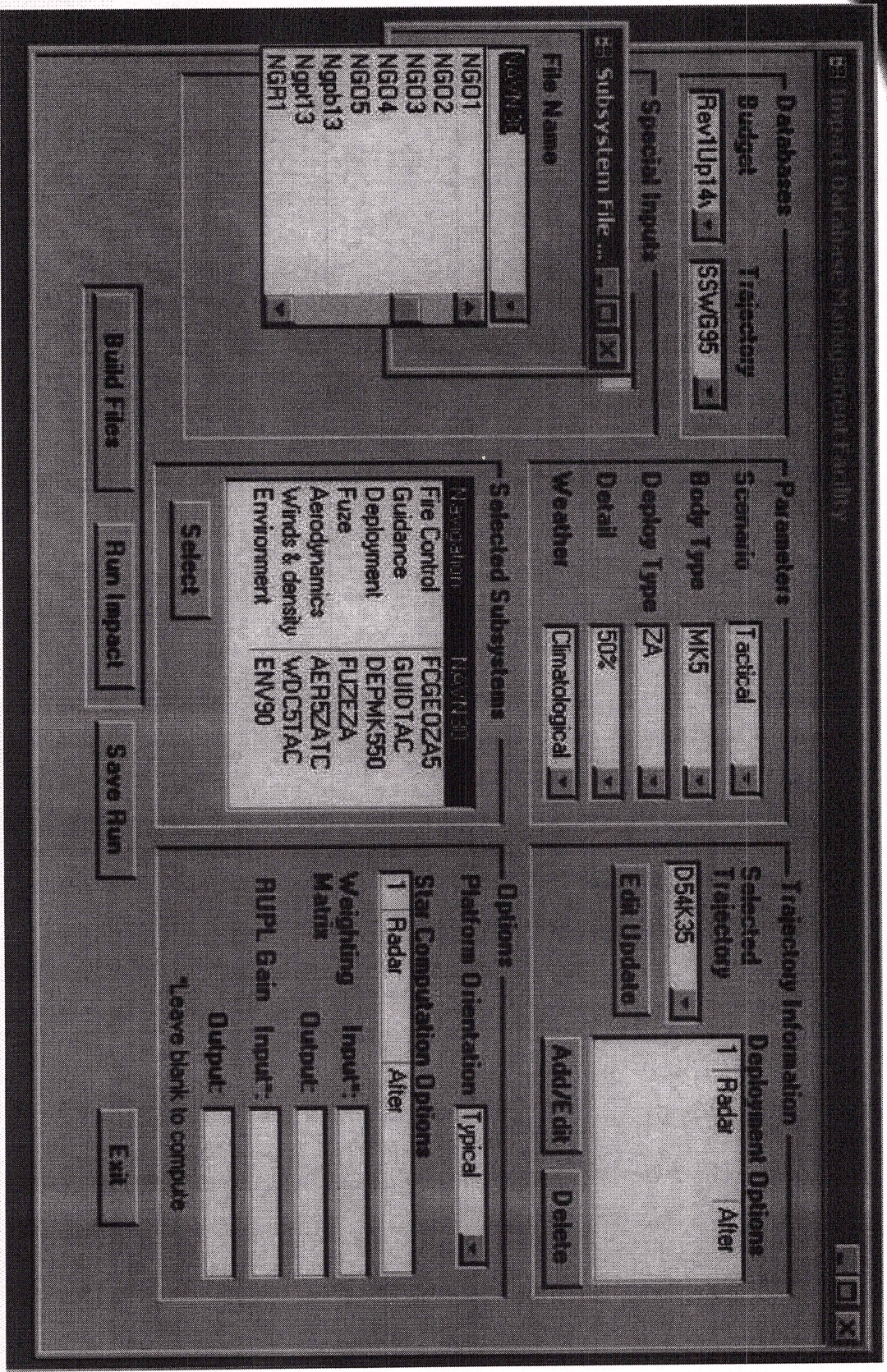**Determine Database Management Facility**

Databases
Budget — RevTUp14x ▾   Trajectory — SSWG95 ▾

Special Inputs
☐ Subsystem File... ▢ ▢ ✕

File Name
NG01
NG02
NG03
NG04
NG05
Ngpb13
Ngpt13
NGR1

[Build Files] [Run Impact] [Save Run]

Parameters
Scenario — Tactical ▾
Body Type — MK5 ▾
Deploy Type — ZA ▾
Detail — 50% ▾
Weather — Climatological ▾

Selected Subsystems
NAV90
Fire Control — FCGE0ZA5
Guidance — GUIDTAC
Deployment — DEPMK550
Fuze — FUZEZA
Aerodynamics — AER5ZATC
Winds & density — WDC5TAC
Enviroment — ENV90

[Select]

Trajectory Information
Selected Trajectory — D54K35 ▾
[Edit Update]

Deployment Options
1 | Radar | After

[Add/Edit] [Delete]

Options
Platform Orientation — Typical ▾

Star Computation Options
1 | Radar | After

Weighting Matrix   Input*:   Output:
RUPL Gain   Input*:   Output:

*Leave blank to compute

[Exit]

- **Provided an overview of modeling and simulation tools used to study weapon system accuracy and an example of how they are used**

  — Accuracy model

  — Gravity Models

  — Navigation Simulation

  — Weapon System Accuracy Simulation

- **Plan to make NAVS and IMPACT available to SSP approved users**

  — Plan to demonstrate tools at the April 2003 System Synthesis Working Group (Modeling Support) meeting