![Arrow Tech — If you can't get a bigger target...]

PRODAS GNC Trajectory System Simulation

Jeff Siewert

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NDIA Guns & Missiles

Legacy Software Simulation

PRODAS GN&C Prototype Tool

MATLAB/ Simulink Simulation

ARROW TECH

If you can't get a bigger target…

Legacy Software Simulation

- **Pros**
  - **Detail only limited by developer**
  - **Very fast simulation**
- **Cons**
  - **Tough to validate**
  - **Can get very complex**

PRODAS GN&C Prototype Tool

- **Pros**
  - **Trajectory Engine transparent to User**
  - **Very fast simulation**
  - **Simulation Data provided by PRODAS**
  - **Can be driven by a Macro**
  - **Validated Trajectory codes**
- **Cons**
  - **Limited detail**

MATLAB/ Simulink Simulation

- **Pros**
  - **Almost unlimited details can be included**
  - **Internal equations and variables visible**
  - **GN&C can transition easily into Hardware**
- **Cons**
  - **User must build and validate Trajectory Engine**
  - **User must provide inputs and build outputs**

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ARROW TECH
If you can't get a bigger target...

Legacy Software Simulation
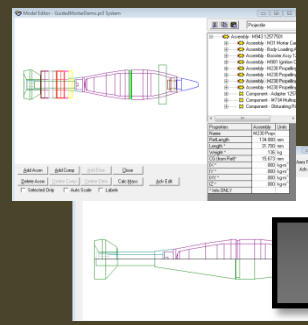
PRODAS

MATLAB/ Simulink Simulation
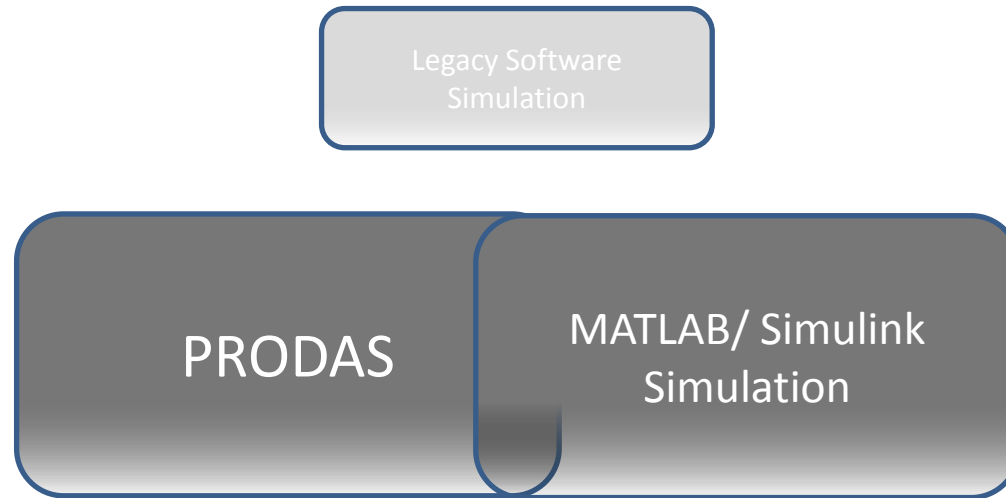
- **Pros**
  - **Validated Trajectory Engine**
  - **Simulation inputs provided by PRODAS**
  - **Unlimited details can be included**
  - **GN&C can transition easily into Hardware**
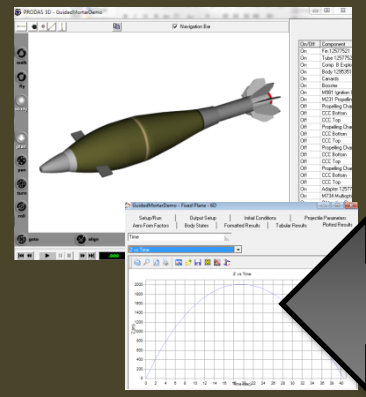
PRODAS Environment

Modeling

- Projectile Modeler
- Aero Prediction
- Mass Properties
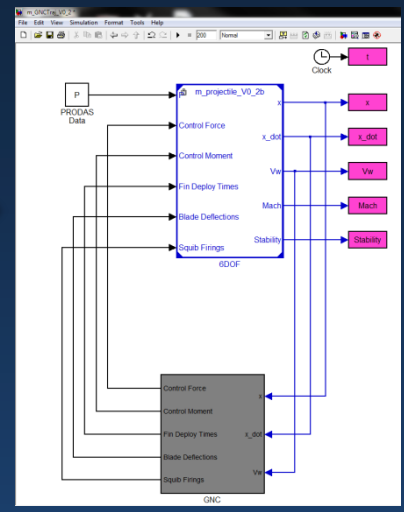- Rocket Motor
- Initial Conditions
- Error Budgets
- MET

Visualization

- 3D Animations
- Extensive Plotting

MATLAB/Simulink Environment

Development

- Leverage All MATLAB/Simulink Toolboxes and Blocksets
- Focused Effort on GNC Design

Simulation

- Validated 6+DOF Trajectory Engine
- Seamless Data Interface and Execution Between PRODAS and MATLAB

Product Tests

Hardware-In-the-Loop (HIL)

- Use the same simulation to drive the HIL fixture

Embedded Code Generation

- Automatically generate flight code from the Simulink model

Fire Control

- Simulation software is the basis of fire control software

PRODAS

- Industry standard projectile design and analysis environment
- 65+ integrated analysis modules
  - System simulation
  - Aerodynamic prediction and stability
  - Trajectory simulation and flight Dynamics
  - Guidance, navigation, and control
  - In-bore balloting and interior ballistics simulation
  - Aero-ballistic test data reduction
  - Software development kit
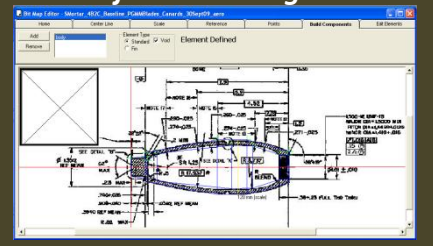- Over 500 Users at Government and prime contractors
- In use in over 25 countries
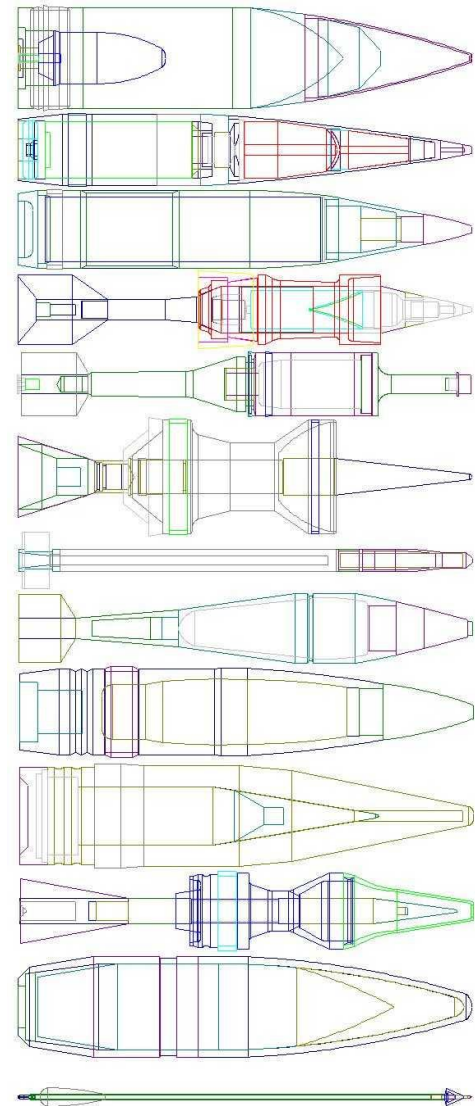
Build a Model

Simple Symmetric Model Editor
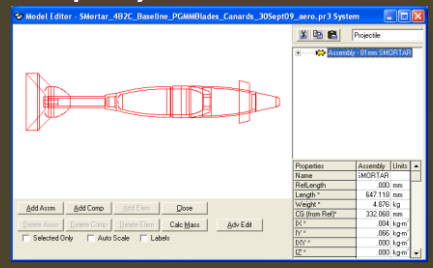
Projectile Tracing Tool

Estimate Aerodynamics

Arrow Tech Finner/Spinner
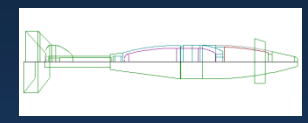
NSWC AP
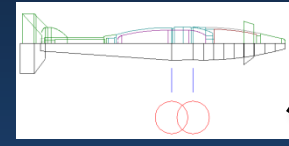
Nielsen Engr. MISL3

Test Data
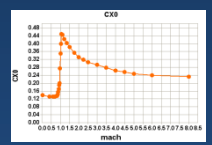
Missile DATCOM
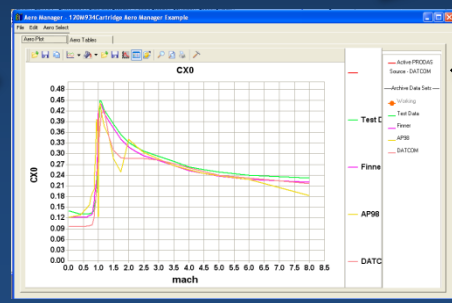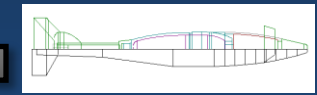
PRODAS Aero Manager

Fly It

Standard 6DOF

GN&C Prototype Tool
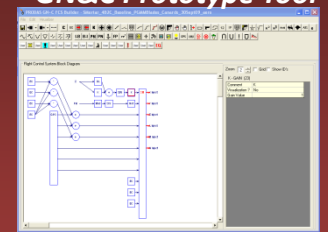
GN&C MATLAB

3D visualization

Macro Language

Software Development Kit
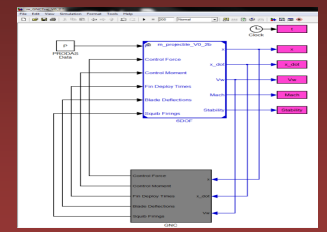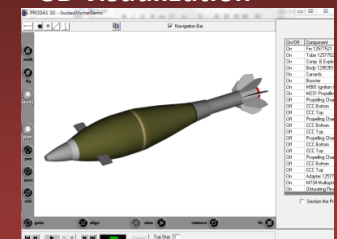
- Illustrate with a simple transformation
- Add nose and tail kit to a 60mm Mortar

Model Editor

Mass Properties
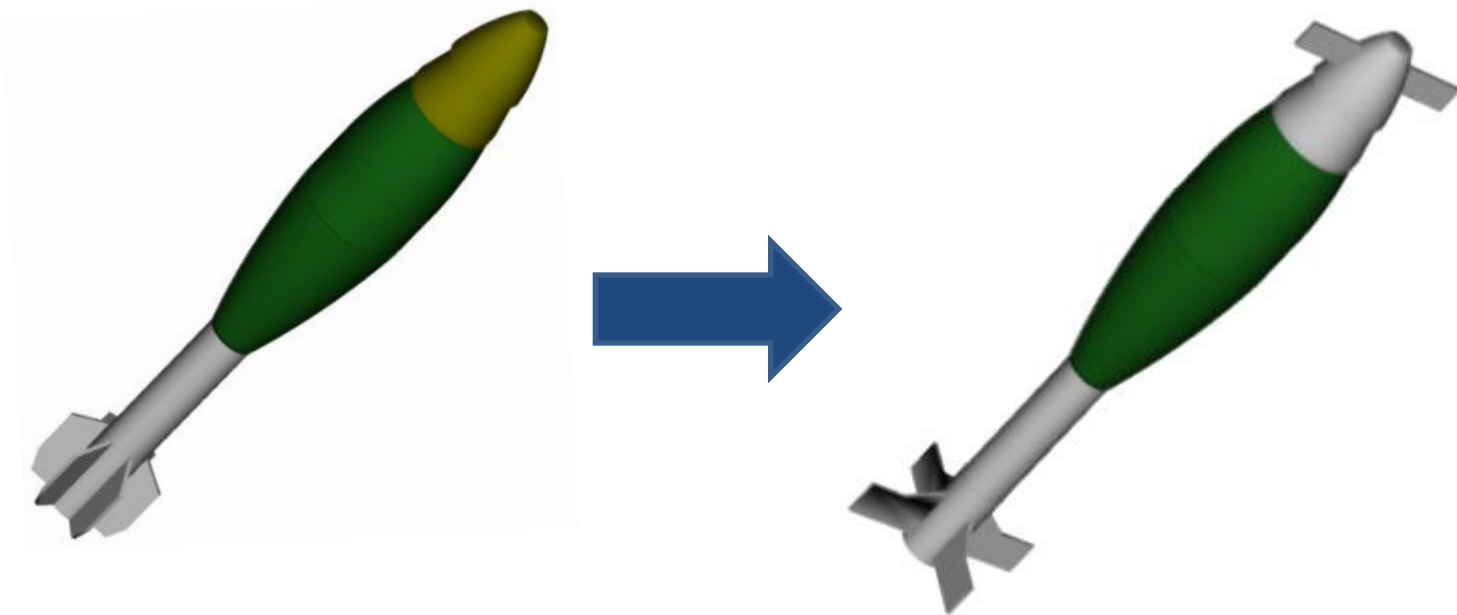
Stability Evaluation

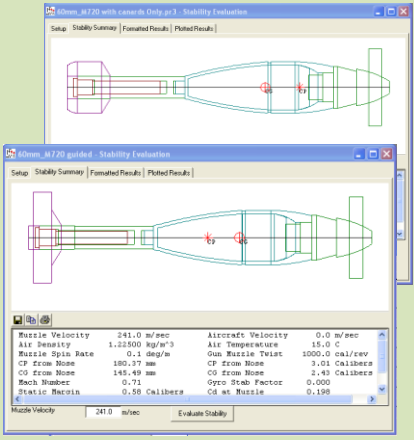**Aero Prediction**

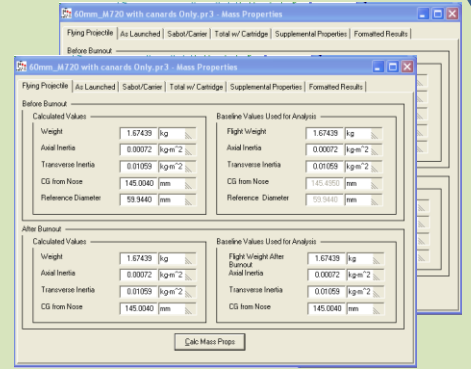- Design the air vehicle:
  – Add control surfaces
  – Update mass properties
  – Estimate Aerodynamics
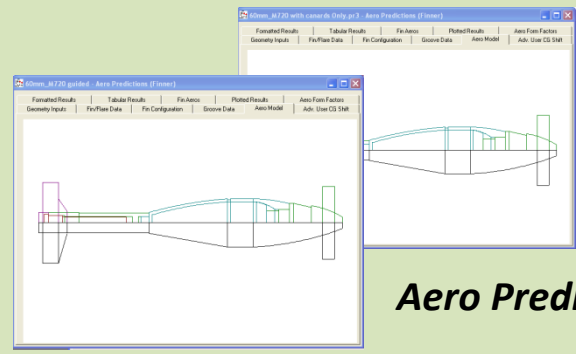 – Evaluate Stability
  – Repeat as Necessary

PRODAS

- Open Loop Controller to:
  - Deploy canards at apogee
  - Extend Range
    - Dither with roll angle
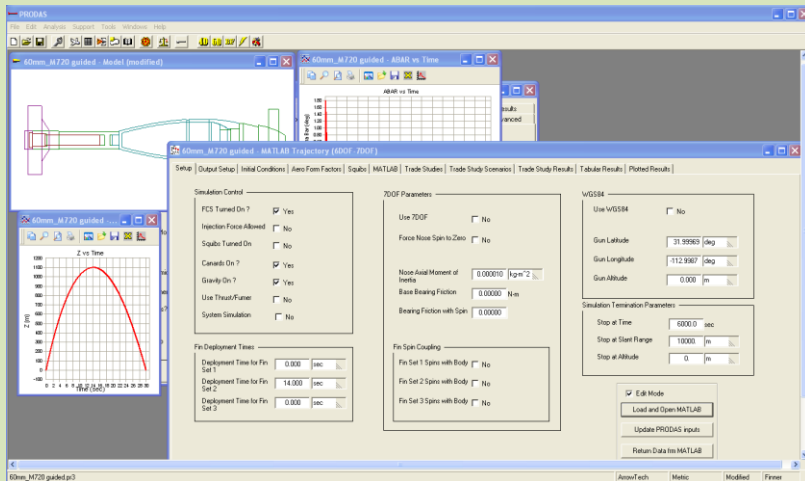
PRODAS MATLAB Interface
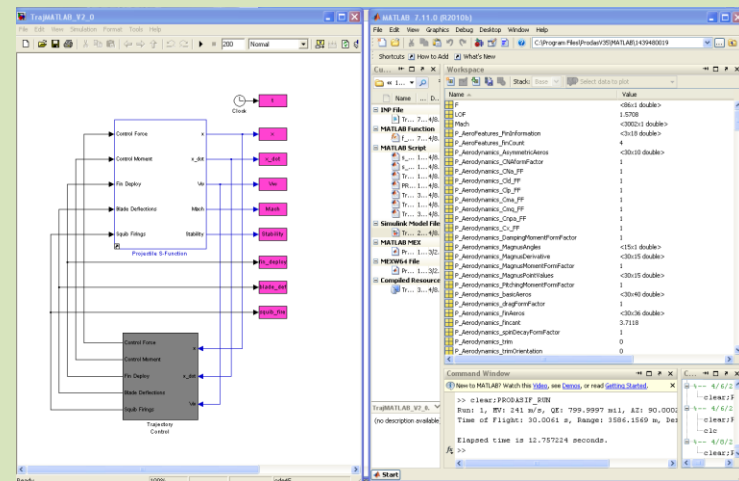
MATLAB/Simulink
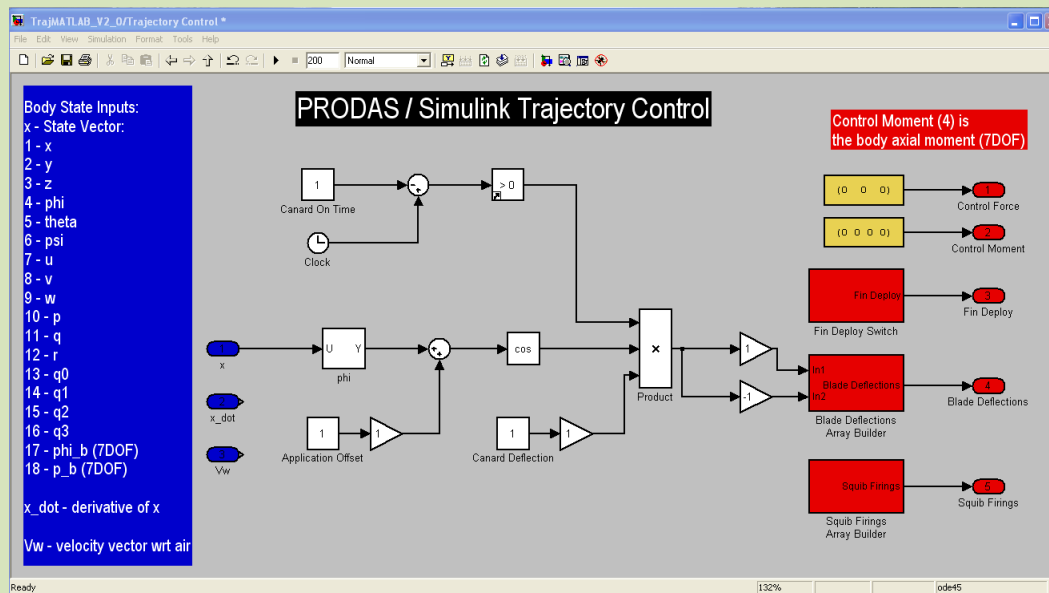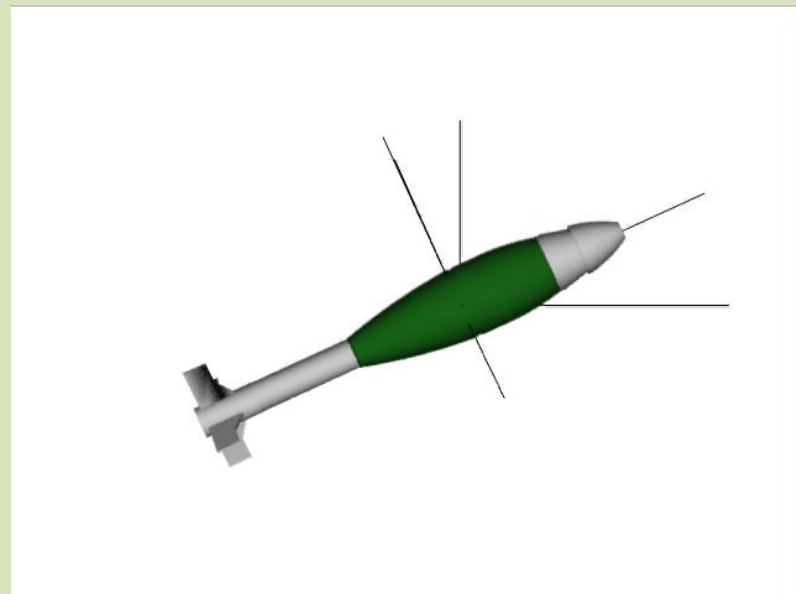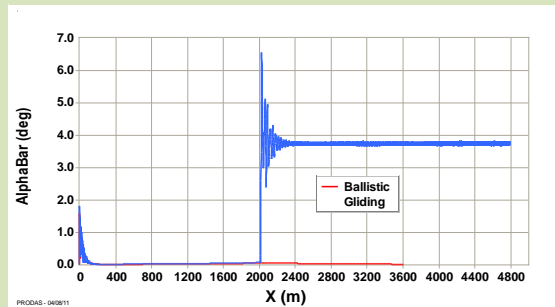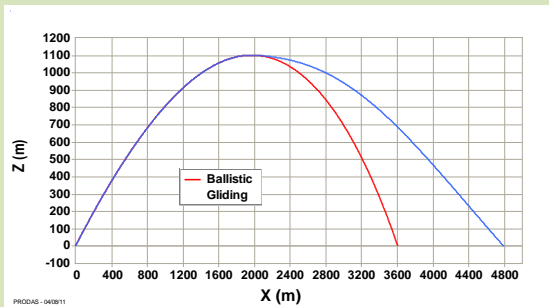
PRODAS

- Validated trajectory engine
- Automatic interface to aeros and IC's
- Design the GNC in Simulink
  - Use any Block Set
  - Inputs - Body states
  - Output - canard angle
- Model contained in PR3 file

PRODAS

- Use MATLAB plot functions or
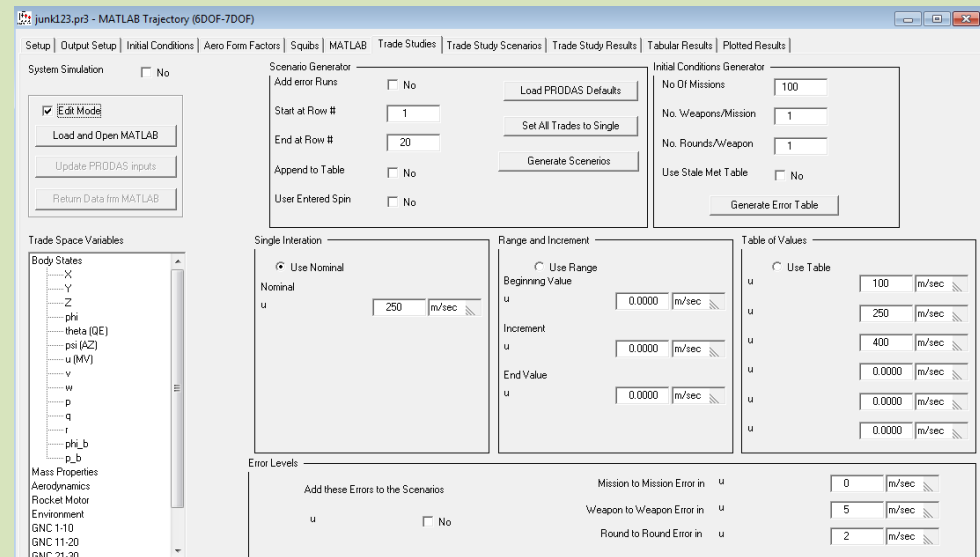- Use built in PRODAS plots and visualizations
- Cross plot against other codes
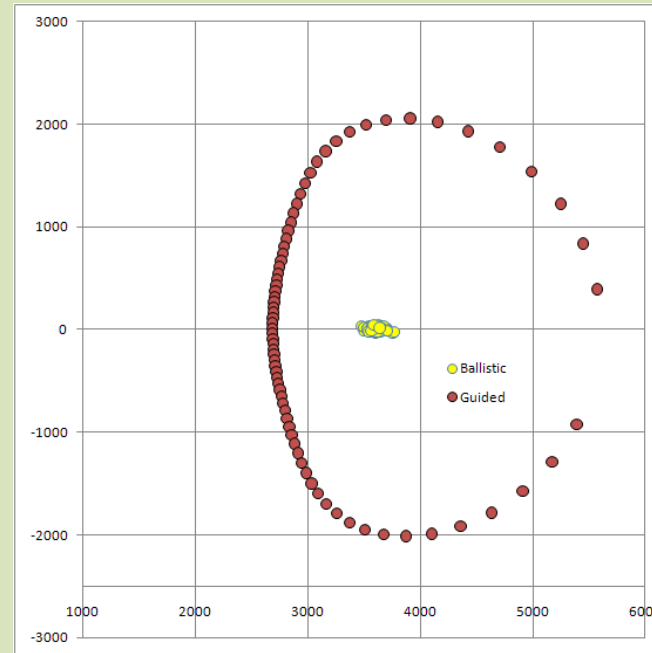
PRODAS

- Setup trade study scenarios varying:
  - Body states
  - Mass properties
  - Aerodynamics
  - Rocket Motor
  - Environment (MET)
  - 50 custom GNC parameters
- Add system errors to any variable
  - Mission-to-mission
  - Weapon-to-weapon
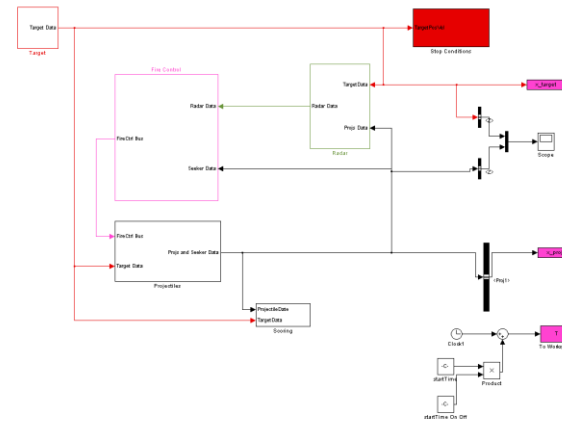 - Round-to-round

PRODAS

- Example entered errors for:
  - Muzzle Velocity
  - Mass
  - Winds
  - Temperature
  - Quadrant Elevation
- Monte Carlo Runs
  - Ballistic to validate errors
  - Open loop guidance to check control authority

PRODAS

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- Close Loop GNC

- Sensor Models

- Use 6DOF and GNC model for HIL

- Generate code for embedded processor

This then becomes the system simulation for the program

- The PRODAS tool set has been enhanced with the inclusion of the MATLAB/Simlink Trajectory Code

- Now PRODAS can be your tool from concept to final production.

- For more information on the PRODAS MATLAB/Simulink Trajectory Engine contact:
    - Dr. Mike Wilson
      (802) 865-3460 ext.14
      mike@prodas.com
    - Mark Steinhoff
      (802) 865-3460 ext.18
      mark@prodas.com