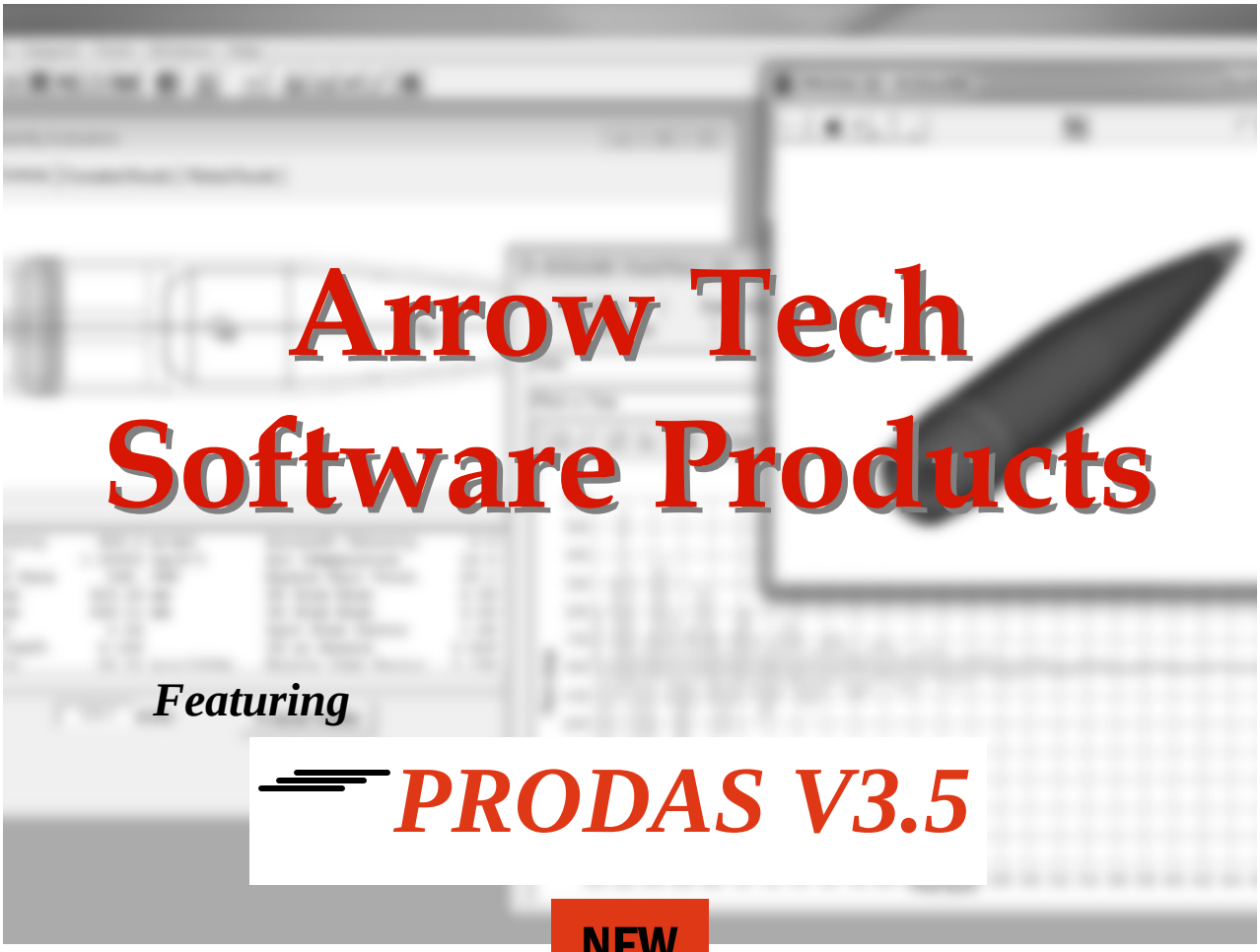

Arrow Tech Software Products

Featuring

PRODAS V3.5

NEW

- **Guidance Navigation & Control MATLAB/ SIMULINK Builder**
- **Guidance Navigation & Control Package**
- **Mac OS X and iPad Compatible**

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Table of Contents

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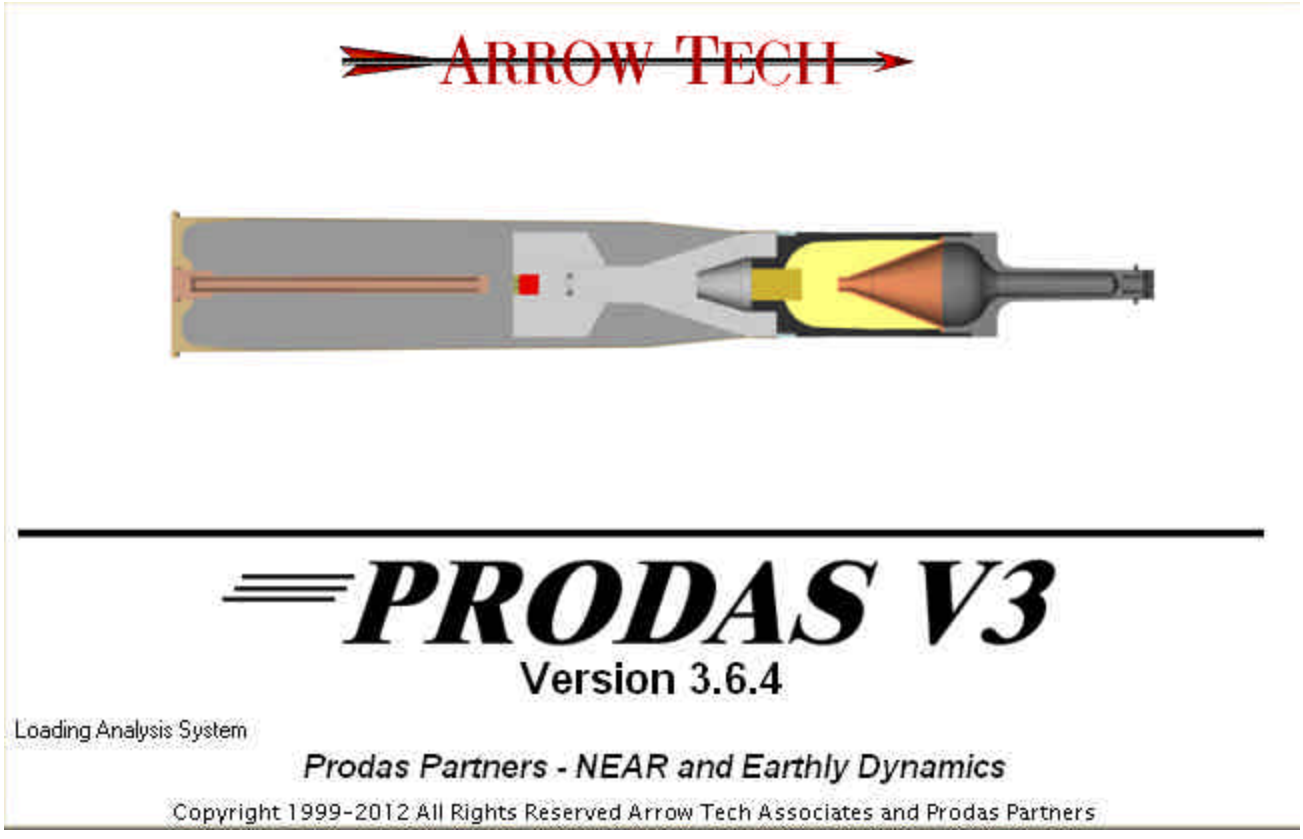
PRODAS V3.5

Projectile Rocket Ordnance Design and Analysis System Version 3

What's New ?

- New Analysis Modules
- MATLAB/Simulink Integration
- Analysis Refinements
- Enhanced User Interface

PRODAS V3.5 is under continuous development. Many new capabilities have been developed in response to the needs of our software and consulting customers. PRODAS V3.5 now blends the depth of PRODAS with the flexibility of MATLAB/Simulink enabling the engineer to transition from concept to hardware for guided projectiles.



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PRODAS V3.5

Projectile Rocket Ordnance Design and Analysis System Version 3

***PRODAS V3.5* is the world's only integrated software system specifically designed to analyze all types of projectiles.**

The *PRODAS V3.5* Main Analysis Package Includes:

- **Visual Model Editor**
- **IGES File Import & Export**
- **Mass Properties**
- **Aerodynamic Coefficient Prediction**
- **Aerodynamic Stability Analysis**
- **Muzzle Exit / Dispersion**
- **4 & 6 DoF Fixed Plane Trajectory Simulation**
- **Ballistic Match**
- **Lot Acceptance Test (LAT) Simulation**
- **Yaw Card**

PRODAS V3.5 Modules Include:

Optional Analysis Modules

- **Additional Library Rounds**
- **Analysis BOT**
- **Initial Conditions Generator**
- **Aero Manager**
- **Interior Ballistics**
- **Rocket Firing Tables**
- **Terminal Effects**
- **3D Visualization with Scene Generator**
- **Projectile Tracing Tool**
- **Firing Tables**
- **Body Fixed 6 DOF Trajectory**
- **Software Development Kit**
- **MISL 3 Aero Prediction Code**
- **Missile Datcom**
- **AP 98**

Guided Projectile/Rocket Modules

- **Rocket Motor Design Tool**
- **Controlled Trajectory**
- **Guidance Navigation and Control Prototype Tool** Updated
- **Guidance Navigation and Control SIMULINK Builder** NEW

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PRODAS V3.5 Modules Include (continued):

Structural Analysis Modules

- **Sabot Profiler**
- **Cartridge Case Analysis System**
- **In-Bore Balloting Analysis**

System Effectiveness Modules (Includes Analysis BOT Module)

- **Air to Air**
- **Air to Ground**
- **Ground to Ground**
- **Ground to Air**

Radar

- **Radar 2000 and Radar Assistant Analysis**

Computer Requirements

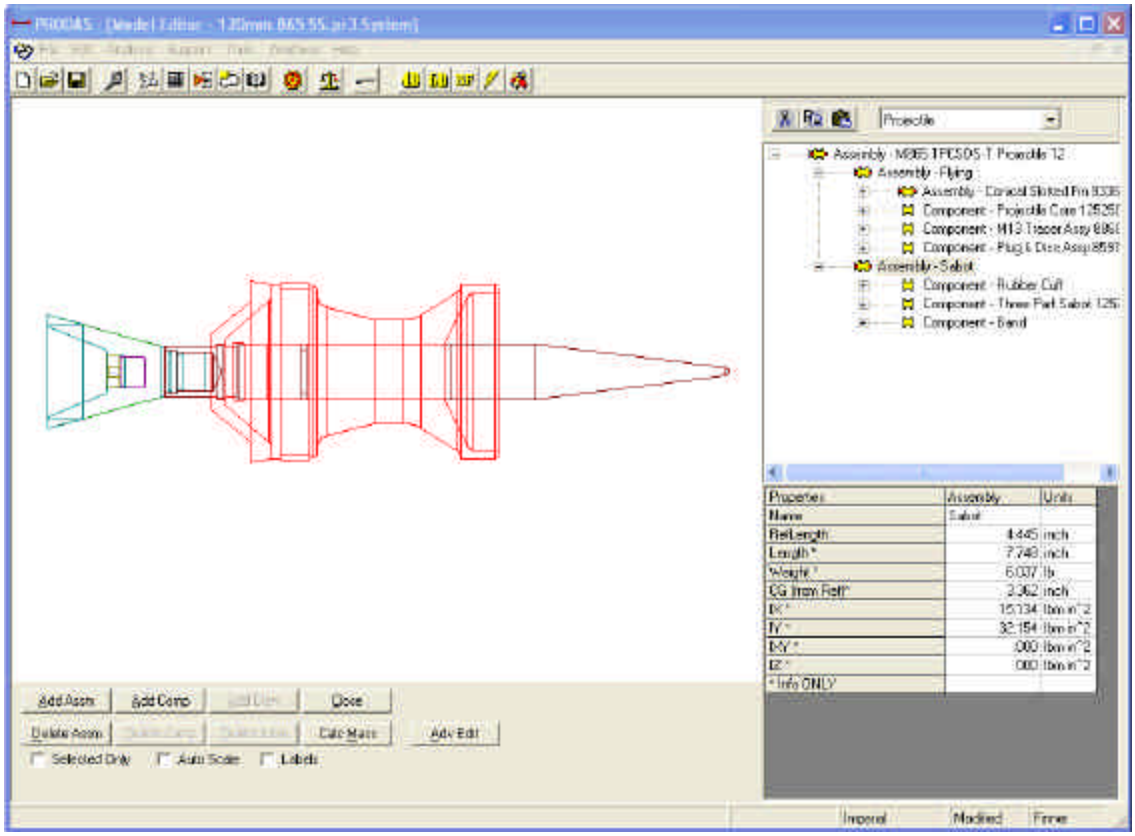
PRODAS V3.5 Requires:

- PC or Compatible
- Windows XP, Windows Vista, Windows 2007
- On a Mac or iPad using Parallels Desktop 6 or 7 using Windows 7 or XP

PRODAS V3.5 Main Analysis

Projectile Rocket Ordnance Design and Analysis System Version 3

With *PRODAS V3.5* you can create a projectile model, calculate mass properties, estimate aerodynamics and stability and simulate a test firing. Design problems can be detected before building costly prototypes, saving your company time and money.



Visual Model Editor
Input, modify, and assemble of projectile models from components. Element and component drag and drop, copy, and paste.
Create and edit a model of your projectile

- Library of Common Projectiles included
- Projectiles from 5.56mm to over 400mm

Rocket Assist, Base Burners, Tracers, Rockets

Part Numbers:
AT610 - US and Canada
AT610A - International

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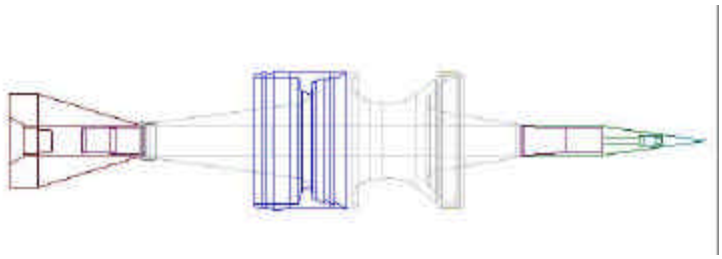
Basic Tools For Projectile Design

Mass properties Analysis
Compute the mass properties of the projectile

- Mass, Center of Gravity and Moments of Inertia
- Mass Properties for each component and subassembly

IGES and DXF File Write & Read!
PRODAS V3.5 can read your existing IGES & DXF files for instant incoming data transfer, and create IGES (V 4.0) & DXF Files for easy output to CAD Systems.



Aerodynamic Analysis
Computes a complete set of aerodynamic force and moment coefficients. Includes analysis capabilities for:

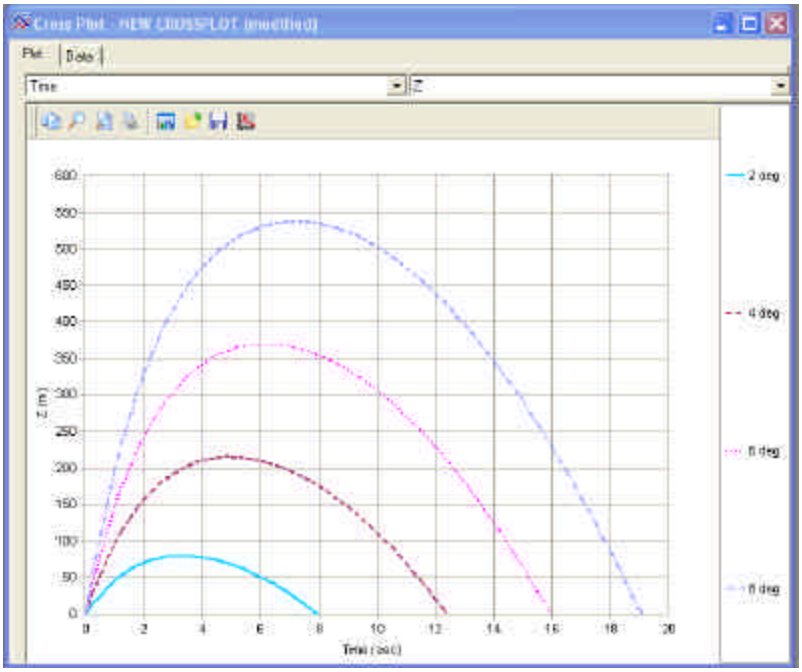
- Spin, Fin or Drag Stabilized Shapes
- Computes Attack Angle & Roll Induced Coefficients for Finners
- Calculates Dynamic & Gyroscopic Stability
- Multiple Fin Groups
- Wrap Around Fins
- Grooved Body (Buttress)
- Flare/Conical Stabilized
- Spike Nose, “Stubby”
- Aeros up to Mach 8

Basic Tools For Projectile Design

Trajectory Simulation

Compute complex trajectory effects with either a 4 or 6 degree of freedom simulation. Trajectory files can be saved for cross plotting or for use in Armor Penetration Module.

- 4DOF and 6DOF Models
- Moving Platform option
- Rocket Motor Simulation
- Aerodynamic Asymmetries
- Winds



Muzzle Exit Analysis

Estimate projectile dispersion from in-bore clearances, and/or C.G. offset.

- Dispersion Sensitivity Analysis
- Muzzle Exit Effects

Running with Macros

Reference Books

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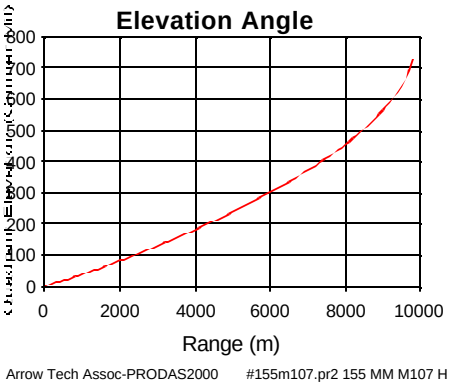
Ballistic Match

Create Range vs. Quadrant Elevation tables and estimate maximum range in minutes.

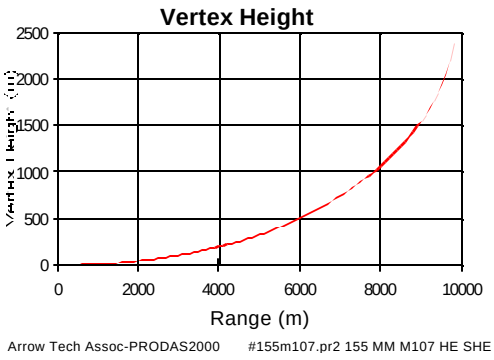
Ballistic Match greatly simplifies generalized trajectory simulations. The analysis runs a series of 4 or 6DOF trajectories between 0 and 80 degrees elevation and saves impact points, impact conditions, angle of fall, and culmination ranges and altitudes.

Ballistic Match automatically iterates the gun quadrant elevation, saving the designer tiresome iterations to make a bullet strike a target at a given range.

The required quadrant elevations and key trajectory parameters for each range interval for quick reference. Ballistic Match can be used alone, to display maximum range and quadrant elevation information, or it can be used in conjunction with the trajectory module to generate initial conditions. This module can also use custom atmospheres, varying altitude of the weapon and target, and automatically calculates the maximum range of the projectile.



Arrow Tech Assoc-PRODAS2000 #155m107.pr2 155 MM M107 H



Arrow Tech Assoc-PRODAS2000 #155m107.pr2 155 MM M107 HE SHE

This Module is sold as part of the PRODAS V3.5 Main Analysis Package (AT610 and AT610A)

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With Ballistic Match, projectile performance parameters can be quickly modified to achieve a desired Drop vs. Range

Inputs

- Muzzle Velocity
- Drag Form Factor
- Projectile Aerodynamics
- Projectile Physical Characteristics
- Fumer/Tracer Characteristics
- Meteorological Data

Outputs - Plots

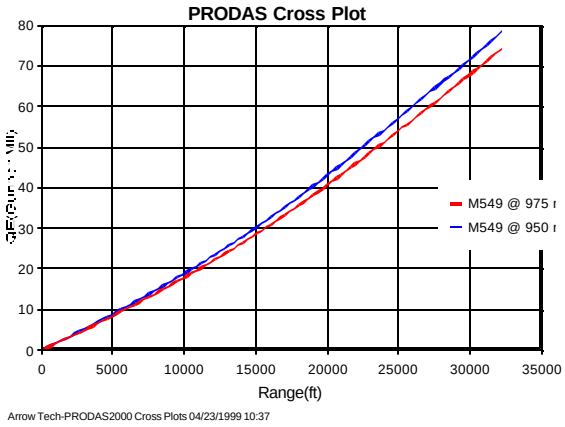
- Remaining Velocity
- Time Of Flight
- Elevation Angle
- Angle Of Descent
- Kinetic Energy
- Drop
- Drift
- Vertex Height
- Vertex Range
- Range Vs Elevation
- Cross Plots Available

Outputs - Tabular

- Formatted and Delimited Data
- Easily import into a spread sheets.

Tables Include

- Range
- Remaining Velocity
- Time of Flight
- Elevation Angle
- Elevation Angle
- Angle of Descent
- Kinetic Energy
- Drop
- Drift
- Vertex Height
- Vertex Range



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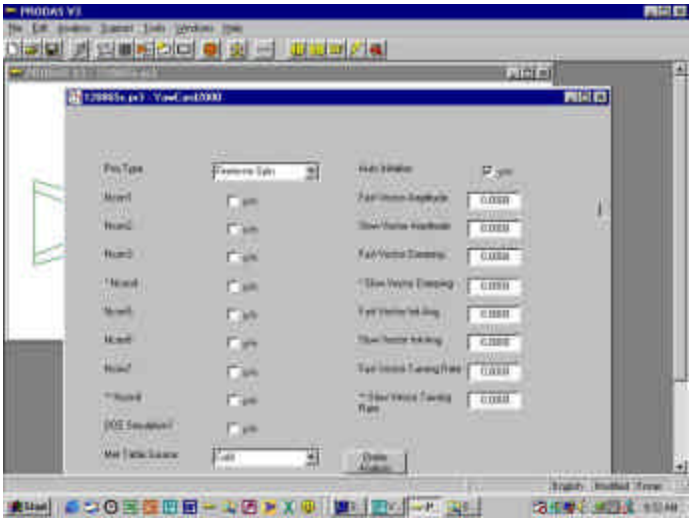
Yaw Card Analysis

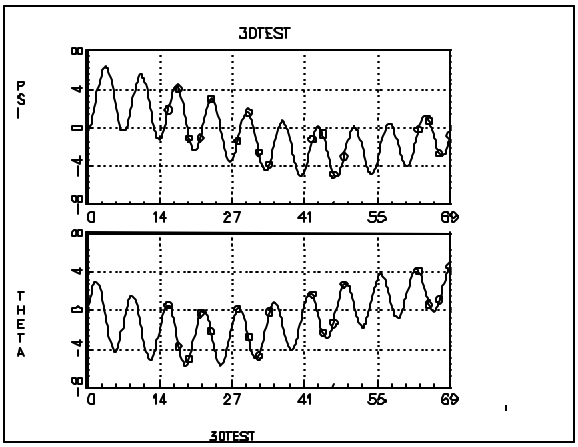
Determine $C_{m\alpha}$ and C_{mq} with no more than a tape measure, plumb bob, photographic paper, and a few 2x4's.

The Yaw Cards data reduction module is used to extract pitching moment coefficients ($C_{m\alpha}$), pitch damping moment coefficients (C_{mq}) and Magnus Moment ($C_{np\alpha}$) coefficients from yaw card data.

This includes data from spin stabilized projectiles plus statically stable bullets with either low or moderate spin.

$C_{m\alpha}$ influences the gyroscopic stability factor (especially critical at launch) and dispersion sensitivity, while C_{mq} and $C_{np\alpha}$ affects the damping of the projectile yaw motion as it travels down range.





The PRODAS V3.5 Yaw Cards analysis module determines $C_{m\alpha}$,C_{mq} and $C_{np\alpha}$ by fitting the projectile yaw angle and yaw angle orientation to the equations of motion.

This Module is sold as part of the PRODAS V3.5 Main Analysis Package (AT610 and AT610A)

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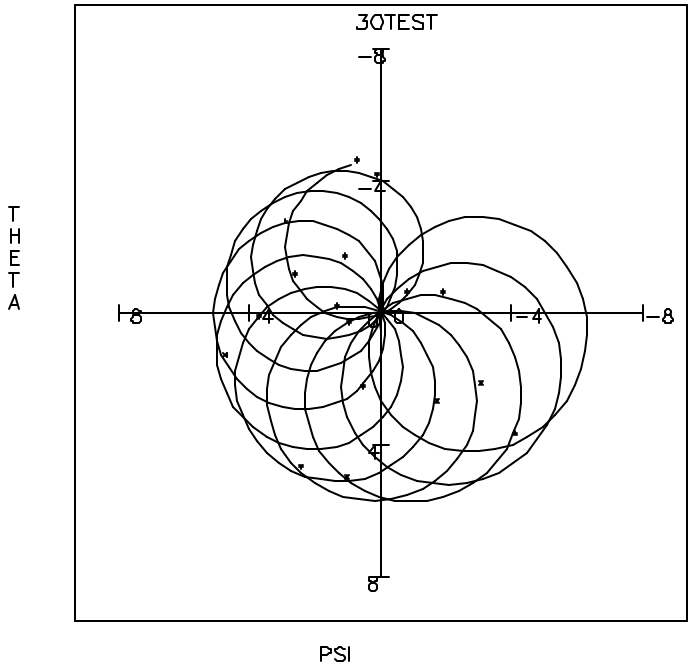
The static and dynamic stability of a projectile is crucial for optimum performance. Measured aerodynamic coefficients ensure an accurate stability assessment.

You could go to a spark range and fire your projectile through a series of fully instrumented photographic tunnel or you could fire through a series of yaw cards and use this PRODAS V3.5 optional analysis module.

Yaw Cards is a sophisticated analysis tool which allows the engineer to obtain critical design information at a fraction of the cost of other methods.



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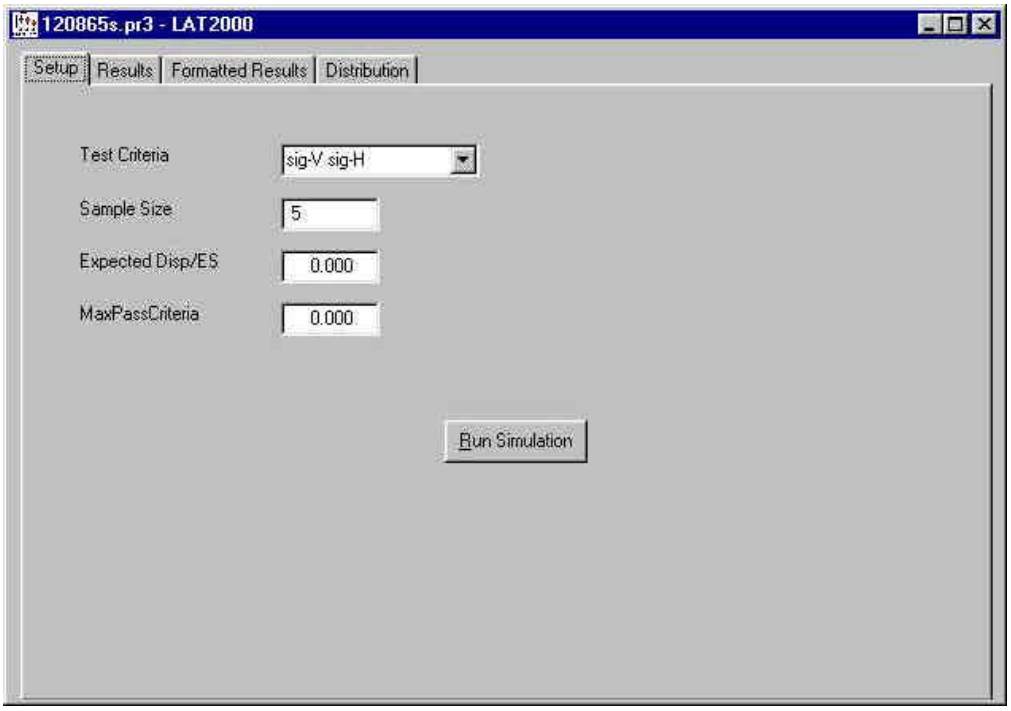
LAT Simulation

A statistical simulation for estimating the long term pass probability of lot acceptance tests with various pass criteria.

With LAT, you have the luxury of statistically simulating dispersion tests without actually expending valuable test resources. Since you can simulate the test about to be conducted, changes in sample size, design improvements, or acceptance criteria can easily be evaluated.

LAT allows the user to select any of three different standard dispersion measurement criteria (Sigma X-Sigma Y, Mean Radius and Extreme Spread), select sample size and set acceptance criteria, and enter the current projectile performance. Five thousand (5000) LAT's are simulated, and individual results are accumulated. Mean dispersion, dispersion standard deviation and probability of passing the test are output.

The standard deviation in mean point of impact (MPI) is also displayed to assist system engineers in assessing statistical variability of a burst center point as a function of ammunition dispersion and the number of rounds fired in a burst.



This Module is sold as part of the PRODAS V3.5 Main Analysis Package (AT610 and AT610A)

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Basic Optional Analysis Modules

The following optional analysis modules are the basic PRODAS modules and require the PRODAS Main Analysis in order to run.

- **Interior Ballistics - AT612 and AT612A**
- **Terminal Effects - AT612 and AT612A**
- **Firing Tables - AT613 and AT613A**
- **Rocket Firing Tables - AT614 and AT614A**
- **Library Rounds - AT616 and AT616A**
- **Body Fixed 6DOF Trajectory - AT618 and AT618A**
- **Software Development Kit - AT619 and AT619A**
- **Initial Conditions Generator - AT628 and AT628A**
- **Aero Manager - AT629 and AT629A**
- **3D Visualization Module - AT633 and AT633A**
- **3D Visualization Module with Scene Generator - AT636 and AT636A**
- **Projectile Tracing Tool - AT638 and AT638A**
- **Analysis BOT - AT639 and AT639A**
- **MISL3 Aero Prediction Code - AT641 and AT641A**

Interior Ballistics
Optional Module

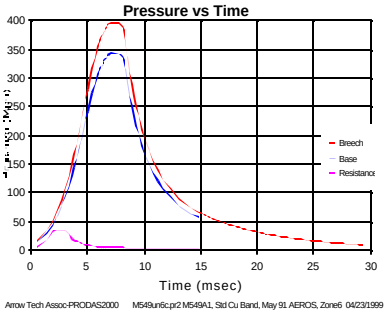
You can use the interior ballistics analyses to trade off propellant weight versus projectile weight, investigate the band wear effects of different barrel twists, even estimate the effects of propellant blending.

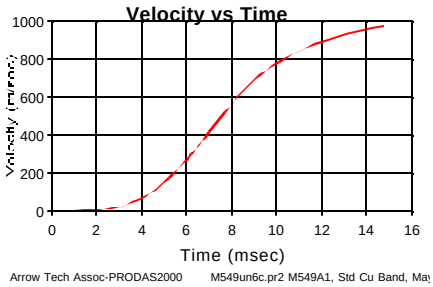
The Interior Ballistics analysis calculates the velocity, breech and base pressure, linear and angular accelerations of the projectile during travel down the barrel.

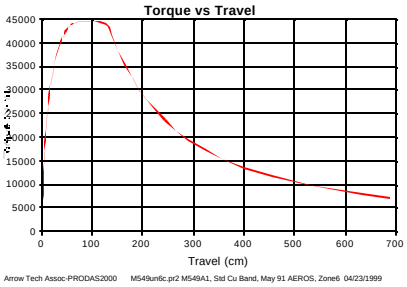
A simplifed Interior Ballistics analysis is available that is derived from the Baer - Frankle method for predicting interior ballistics, examining the burning of the individual propellant grains.

Or, if you prefer, PRODAS V3.5 has a user friendly interface for IBHVG-2.

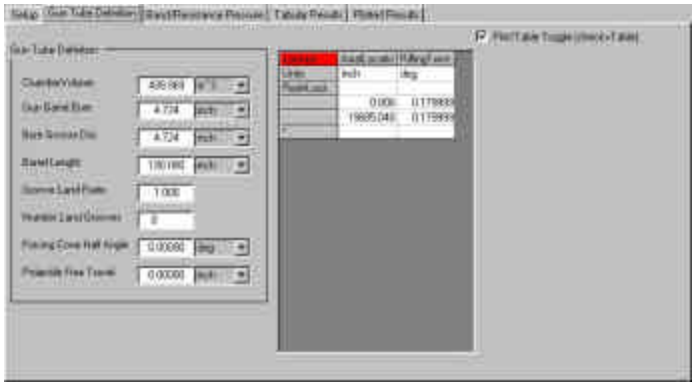
Reference libraries are provided with detailed information on propellant geometry and burn characteristics as well as igniter and gun parameters.







To allow the user to analyze the effects of start-up dynamics on projectile transverse motion, a pressure-time (P-T) expansion capability was added to PRODAS. The P-T expansion module uses the longitudinal equations of motion to compute the acceleration, velocity and in bore travel as a function of time from a digitized pressure-time history.



Part Numbers:
AT611 - US and Canada
AT611A - International

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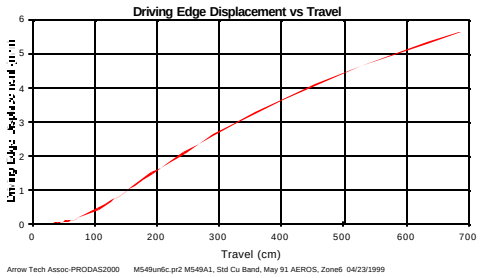
Calculate the muzzle velocity, peak chamber pressure, and band wear quickly and accurately.

Inputs

- Projectile physical parameters.
- Gun tube profile, Reference Library provided.
- Ignitor characteristics, Reference library provided.
- Resistance pressure vs. travel (via closed form computation)
- Distance to Rifling Origin
- Propellant Characteristics, extensive Reference library of propellants.
- Blend of up to three propellant types can be simulated simultaneously.

Analysis

- Adjusts various propellant characteristics to match pressure or velocity
- Rotating band analysis estimates band wear on fully spun projectiles.



Outputs

Plots vs. Time & Travel

- Pressure
- Velocity
- Temperature
- Acceleration

- Torque
- Angular Acceleration
- Driving Edge Displacement (band wear)
- Bearing Stress
- Angular Velocity
- Formatted Tabular Results

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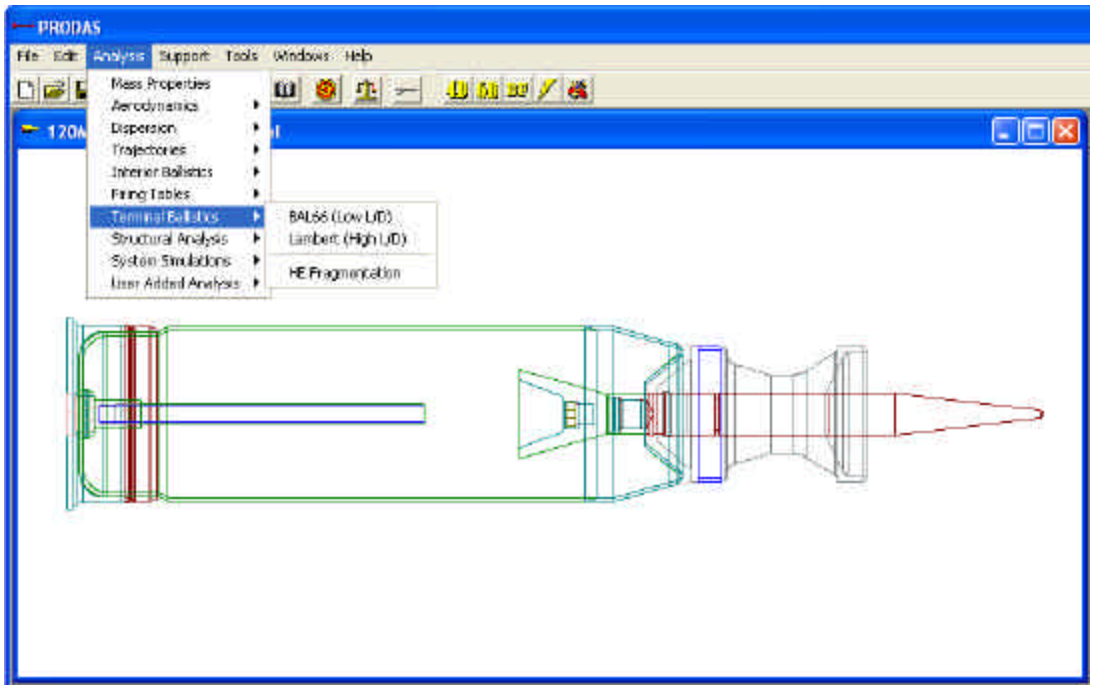
Terminal Effects
Optional Module

PRODAS V3.5 has a complete computational suite to assess the terminal effectiveness of warheads. Armor penetration of kinetic energy penetrators, and the fragmentation of high explosive warheads, can all be easily, quickly, and accurately assessed.



Kinetic Energy Projectile Penetration
Select from two closed-form penetration prediction algorithms based on the penetrator length-to-diameter ratio:

- BAL-66: L/D up to 10:1
- Lambert: L/D up to 30:1

High Explosive Fragmentation
Gurney-Mott-Sarmousakis methodology to predict the fly-off velocity, spray angle, and fragment mass distribution of naturally fragmenting projectile bodies.

Part Numbers:
AT612 - US and Canada
AT612A - International

Single Plate KE Penetration

Estimate the Penetrating Power of Kinetic Energy Projectiles from 50 caliber SLAP to 120mm Tank Killers

This module predicts the single plate penetration capability through hardened steel and aluminum armor of low length to diameter ratio (l/d) penetrators (less than 10) or high l/d ratio penetrators via two independent & validated algorithms, BAL-66 or Lambert. The Penetration analysis can also be driven from trajectories stored as cross plot files.

Inputs

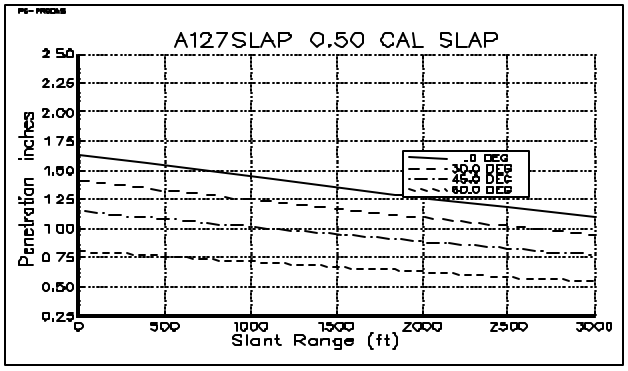
- Penetrator Diameter, weight and length
- Target Thickness, Obliquity Angle and Brinell Hardness
- Trajectory profile

Outputs - Plotted

- Penetration vs. Slant Range
- V50 vs. Target Thickness
- Cross Plots

Outputs - Tabular

- Formatted tables of results



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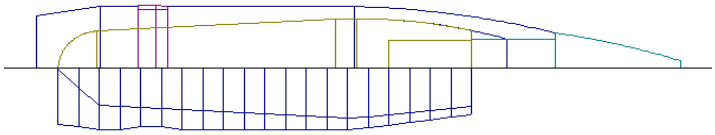
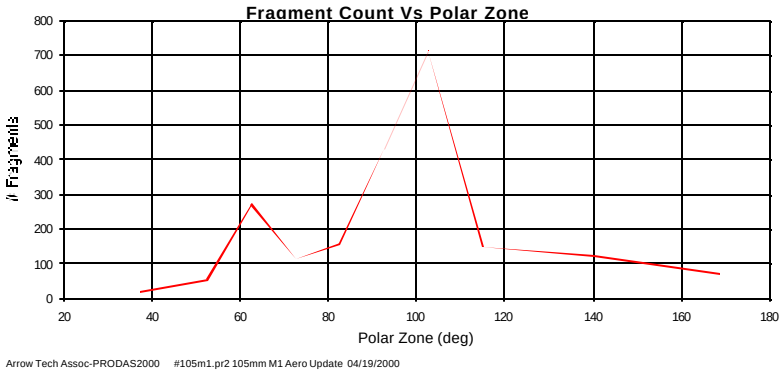
High Explosive Fragmentation



PRODAS V3.5 uses a Gurney-Mott-Sarmousakis methodology to predict the fly-off velocity, spray angle, and fragment mass distribution of naturally fragmenting projectile bodies.

With PRODAS V3.5 HE Fragmentation module, you can quickly vary the warhead wall thickness, or explosives properties and determine the effect on the mass properties of the projectile, calculate the impact on gyroscopic stability, and see what happens to the fragmentation characteristics while avoiding the need for expensive model fabrication or the tedious collection of fragments from arena tests.



Firing Tables
Optional Module

The Firing Table analysis is intended to calculate provisional firing tables for situations where standard Firing Tables are not available.

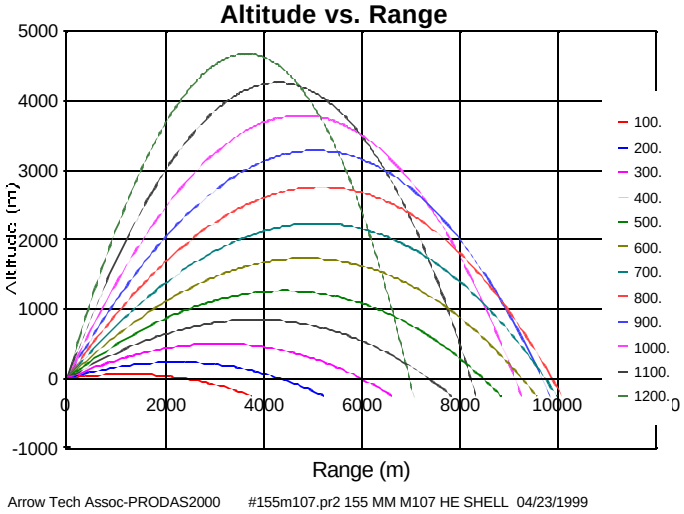
The analysis methodology used to calculate the trajectory is a Modified Point Mass Trajectory code.

In this module, a series of trajectories over a range of elevation angles and a range of parameters (i.e., winds, muzzle velocity, etc.) are computed and the point of impact, impact conditions, and culmination location are saved.

Once the Firing Table analysis is complete, either tabulated or plotted output is available.

Create Firing Tables for the following weapons
- Direct Fire
- Howitzer
- Mortar

Firing Tables, including sensitivity factors, can be generated easily in minutes.
Other Firing Tables Available:
- Line of Sight
- Line of Sight Air/Marine
- Artillery System Analysis



Part Numbers:
AT613 - US and Canada
AT613A - International

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Produce Custom Firing Tables on your computer in minutes!

TABLE F FT-Artillery

1	2	3	4	5	6	7	8	9
				BASIC DATA			PROJECTILE FUZE	
RANGE	ELEV	FS FOR GRAZE BURST FUZE	DFS PER 10 M DEC	DR PER 1 MIL D ELEV	FOR K	TIME OF FLIGHT	AZIMUTH CORRECTIONS DRIFT (CORR TO L)	CW OF 1 KNOT
M	MIL			M	MIL	SEC	MIL	MIL
0	.0	.0	.00	28	0	.0	.0	.00
100	3.6	.2	.00	28	1	.3	.1	.01
200	7.2	.5	.00	28	1	.5	.2	.01
300	10.9	.8	.00	27	1	.8	.3	.02
400	14.6	1.1	.00	27	1	1.1	.4	.03
500	18.4	1.3	.00	26	1	1.4	.5	.04
9500	642.7	39.7	.05	5	27	39.7	18.7	.46
9600	664.3	40.8	.05	4	32	40.8	19.6	.47
9700	690.4	42.1	.05	3	41	42.1	20.8	.48
9800	726.2	43.9	.05	2	65	43.9	22.4	.50
9800	855.9	49.8	.04	2	67	49.8	29.7	.57
9700	890.9	51.3	.04	3	42	51.3	32.1	.59
9600	916.6	52.4	.04	4	33	52.4	34.0	.61

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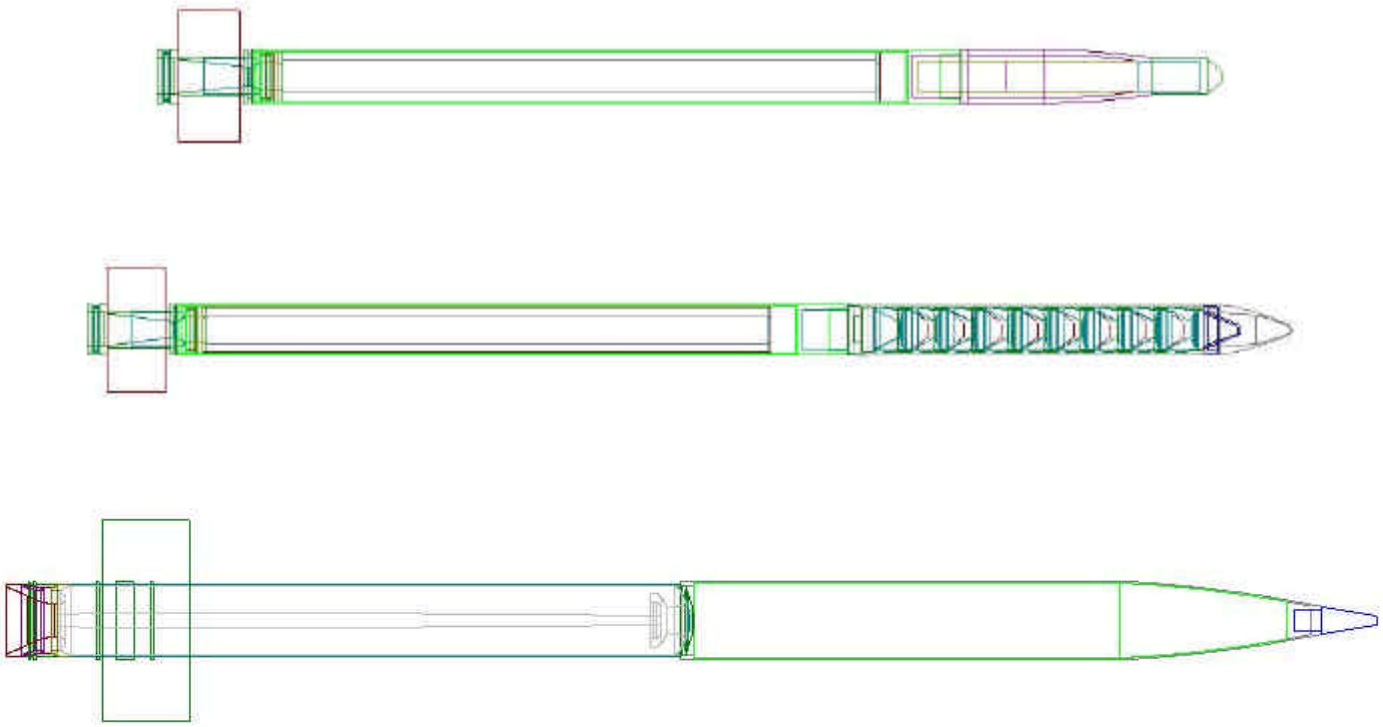
6 Degree of Freedom Rocket Firing Tables
Optional Module

Calculate Standard Rocket Firing Tables for any type of rocket

- Utilizes 6 degree of freedom trajectory simulation for accurate flight angular motion and wind sensitivity
- Input Rocket/Launcher Initial conditions - Launcher Diameter, Launcher Length, Détente release force etc
- Input Rocket System errors such as expected dispersion, Launch wind standard deviation, Thrust sigma, Impulse Deltas, Fuze errors etc.
- Produces Basic, Correction Factors, Supplementary, and wind



Part Numbers:
AT614 - US and Canada
AT614A - International

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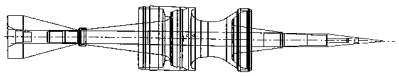
Additional Library Rounds
Optional Module



Additional projectile data files can save you time and money when beginning new designs or evaluating existing

The basic PRODAS V3.5 analysis system is shipped with 22 inventory rounds.

These files were created from known technical data and where available, actual aerodynamic coefficient data is included and supersedes the SPINNER or FINNER predictions. Known interior ballistic performance at ambient is also in the data file, providing the user with baseline launch environments.

Additional optional rounds are available from Arrow Tech with the same known performance "hard-wired" into the data file.

20mm	M220	TP-T
	M246	HEI-T
	M53	API
	M55	TP
	*M940	SAPHEI-T
	MK-149	APDS
	*PGU-27	TP
	*PGU-28	
25mm	*M791A	APDS-T
	*M792A	HEI-T
	M793	TP-T
	M910A	TPDS-T
	*M919	APFSDS-T
	PGU-20	API
27mm	27HEI	HEI-T
30mm	*PGU-13B	HEI
	*PGU-14B	API
	*PGU-15B	TP
	M788	TP
	MPDS	APDS
35mm	MSD	HEI
40mm	PGU-9	HEI-T
105mm	*M456A2	HEAT-MP
	M833	APFSDS-T
120mm	M829	APFSDS-T
	M829A1	
	M829A2	
	*M830	HEAT-T
	*M830A1	
	M831	TP-T
	M831A1	
	*M865	TPCSDS-T
	M865 SS	
155mm	M107	HE
	M483	CARGO
	M795	
	M549	HERAP
	*M864	
203mm	M650	HE
	M106	
Mortars	M934	
Small	9mmBall	
Caliber	50CALM8	
	556M193	
	762M80	

*** Projectile Data Files NOT available for Export**

PRODAS V3.5 Part Numbers:
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Software Development Kit

Optional Module

Now use our own software development tools to efficiently integrate your in-house developed analyses with PRODAS V3.5

Customize PRODAS for your business with the Software Development Kit

- Integrate your own proprietary analysis with PRODAS.
- Use the same tools Arrow Tech used to develop PRODAS.
- New modules appear on the menu, use mass properties, aerodynamics or any of the data contained in the PRODAS data file.
- Present results as text or plots, send data to cross plots or even use the visualizer to display results.
- Outputs of your new analysis will be saved as part of the Projectile File.

Three tools are provided with the Software Development Kit

- Data Manager - This tool manages the data that is contained in the PRODAS data file. When you add your own analysis, chances are there will be setup data that you will want stored in the PRODAS data files along with the regular data. The expandable architecture design of the data file allows for user-defined data without impacting other analysis modules.
- Analysis Manager - This tool defines and actually codes (in FORTRAN) the interface between the main PRODAS application, which contains the user interface, and your analysis module.
- Form Manager - This is the tool used to build the user interface for a new analysis. Everything is done with a drag and drop editor making it easy to build the required input and output windows. You define the data your user enters and what output they are presented with. Text files, spreadsheet tables or plots are quickly included in the interface with no coding required.

Part Numbers:
AT619 - US and Canada
AT619A - International

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Initial Conditions Generator
Optional Module

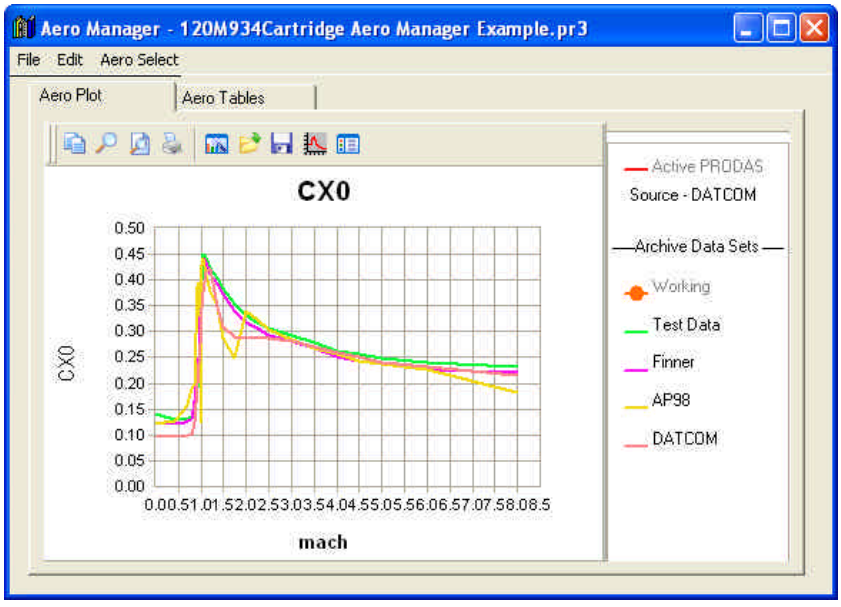
Aero Manager
Optional Analysis

Different aerodynamic estimation algorithms will produce different sets of aerodynamics. Each algorithm has its strengths and weaknesses, for example one may do a good job on drag, but another does better on normal force. But each will develop a complete set of aerodynamics. Add to this aero data generated during testing and one can quickly become overwhelmed with numbers.

The PRODAS Aero Manager was developed to help to help the aero ballistician manage this potential mountain of aerodynamic data.

Aero coefficients from different sources are cross plotted against each other. Experimental data can be added in as well. The user can then use any source as a starting set and then change all points or even individual points to better fit their engineering judgment. These modified tables can then be used to drive the other PRODAS analyses.

The Aero Manager is included at no charge when you purchase an option aero estimation code such as MISL3.



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AT629 - US and Canada
AT629A - International

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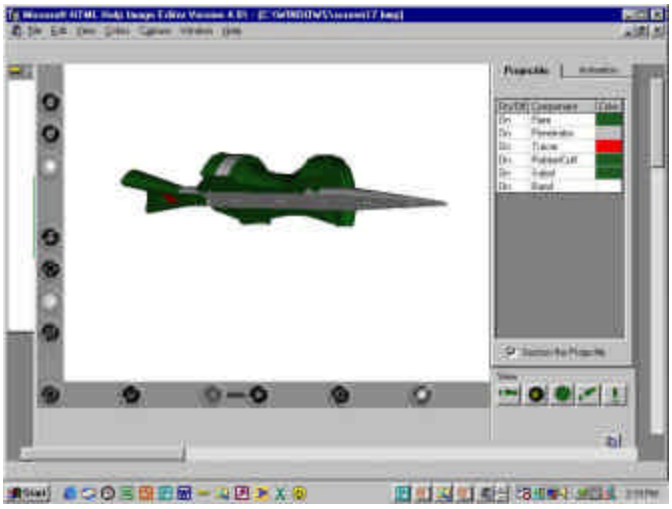
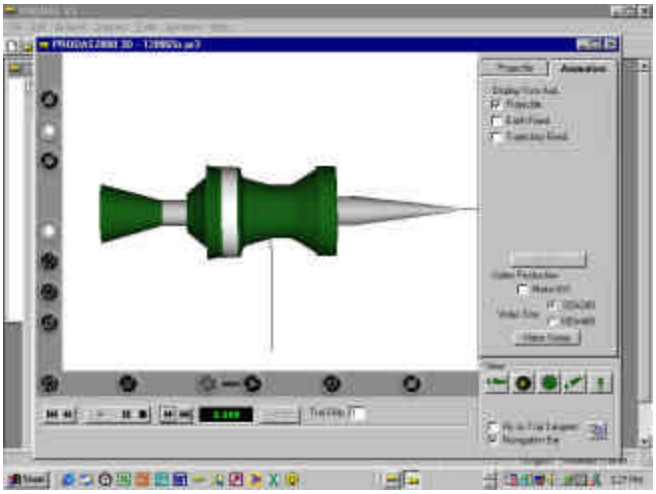
3D Visualizer
Optional Module

Generate visuals of your model in 3D solids. Position the model in any orientation, section it and produce movies of your projectile in flight. Simulated firing ranges, gunner and target images are provided to increase the impact of these movies. The 3D Visualizer has the ability to animate projectile motion in flight.

- **Quickly render 3D representation of Projectiles**
- **Cut away Views**
- **Visualize Trajectories**
- **Full Shooter to Target Videos**





Part Numbers:
AT633 - US and Canada
AT633A - International
With the Scene Generator:
AT636 - US and Canada
AT636A - International

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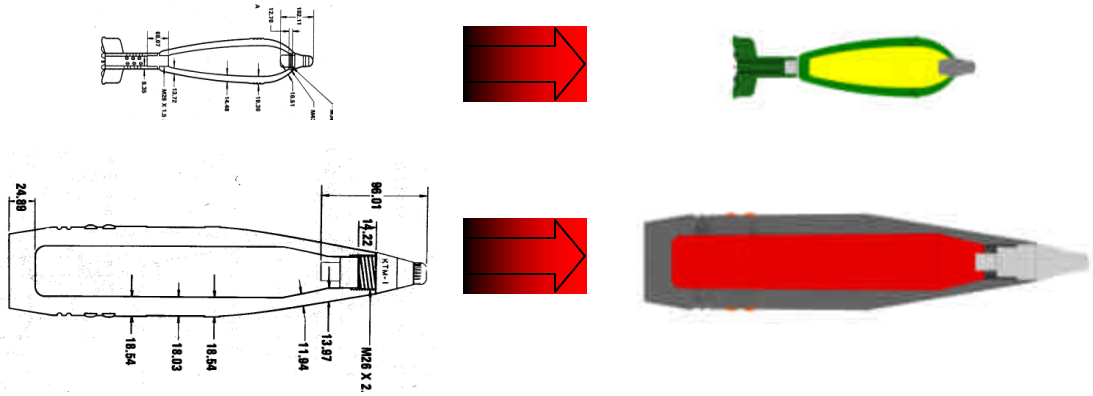
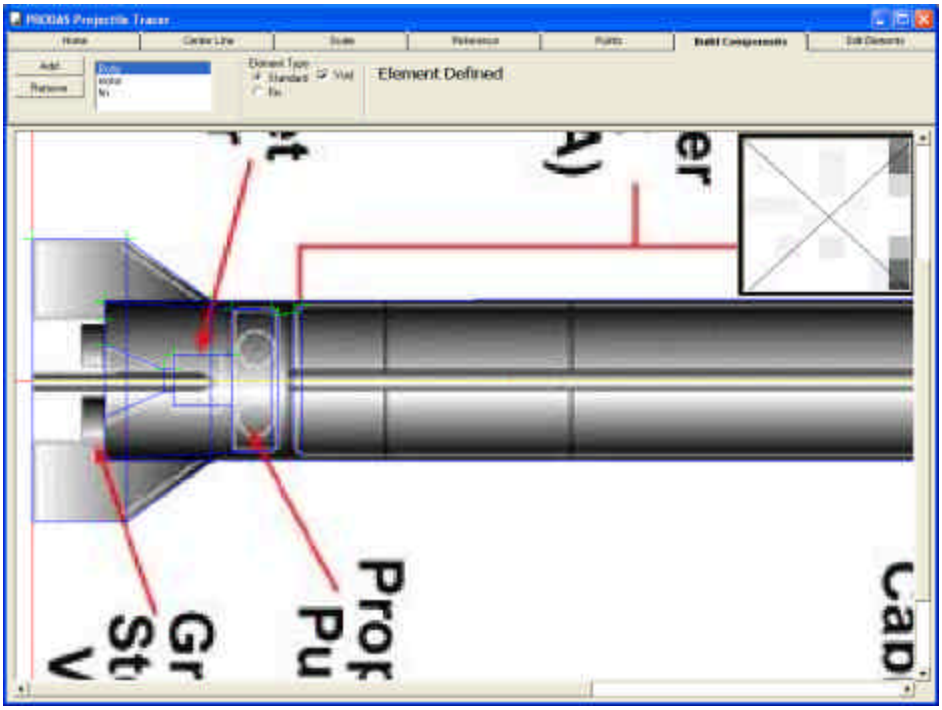
Projectile Tracing Tool
Optional Analysis

Whether the image comes from the Web, a brochure or a photograph of a sectioned projectile, you can now quickly build an accurate PRODAS model with a couple of clicks of the mouse.





Part Numbers:
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AT638A - International

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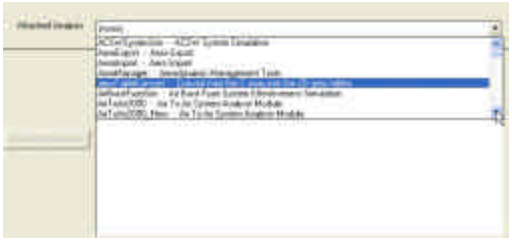
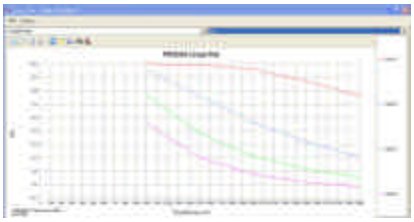
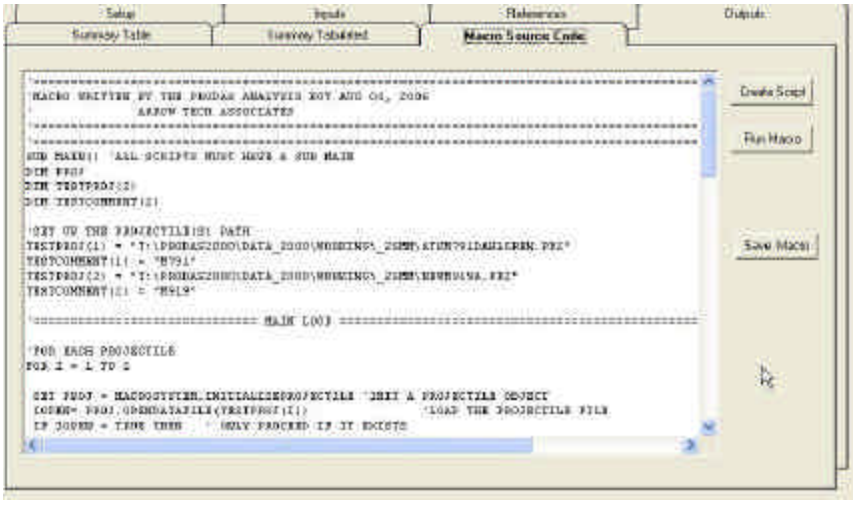
Analysis BOT/PRODAS Macro Scripting
Optional Module

Automate the entire PRODAS analysis capability! PRODAS Version 3 now supports Macro Scripting. Choose any of the PRODAS analysis modules (Aero prediction, Trajectory, Interior Ballistics, System effectiveness, Terminal effects, etc) modify any input contained within the interface, change projectile models, gather and summarize output via cross plot,





Create Macro Scripts automatically with the ***Analysis BOT***. Using the Analysis BOT interface designate the projectile models, desired analysis, input variables and desired output. The Analysis BOT will then automatically generate the Macro Script. The user can then save the Analysis BOT workbook or Macro Script for future changes or customization. The script can be accessed in the future via the "Tools" menu. The ***Analysis BOT*** is included with any of the ***Gun System Effectiveness*** modules or can be purchased separately.



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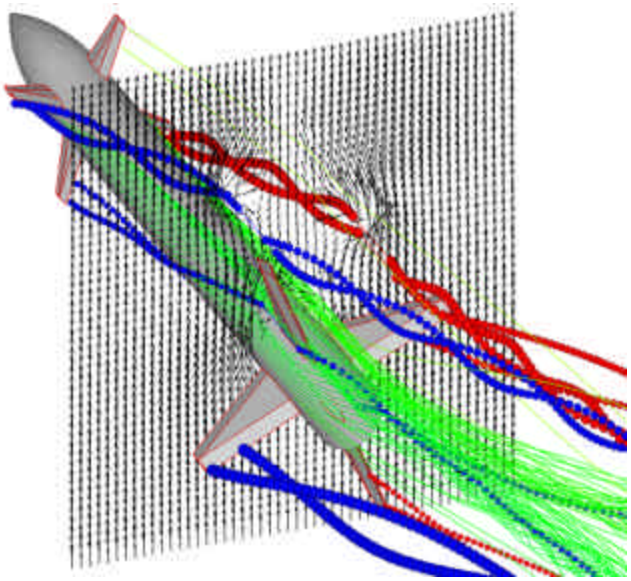
MISL 3 Aero-prediction
Optional Analysis

Along with the internal Spin stabilized and Fin stabilized aerodynamic predictive capabilities developed by Arrow Tech, PRODAS V3.5 now offers expanded aerodynamic coefficient predictive capabilities. Arrow Tech is proud to announce in partnership with NEAR Inc, the addition of MISL3. Features include:

- Full integration within the PRODAS V3.5 infrastructure
  - Modeling
  - Plots/Tables
  - Aero-Manager

MISL3 Features

- High Angle of Attack
- Angular Rates
- Non-uniform Flow Fields
- Body Flares/Boattails
- Arbitrary Interaction Between Fin Sets



Part Numbers:
AT641 - US and Canada
AT641A - International

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Trajectory Simulation Options

The following trajectory simulation options are part of the Main Analysis

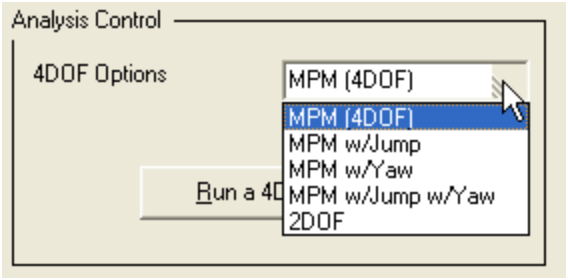
- **4 Degree of Freedom Fixed Plane Trajectory**
- **6 Degree of Freedom Fixed plane Trajectory**

The following optional analysis modules are advanced PRODAS modules and require the PRODAS Main Analysis in order to run.

- **Body Fixed 6 Degree of Freedom/Rocket with Launcher**
- **Controlled Trajectory - AT631 and AT631A**
- **Guidance Navigation and Control Prototype Tool - AT630 and AT630A**
- **Guidance Navigation and Control SIMULINK Builder- AT645and AT645A**
- **Guidance Navigation and Control Package- AT646 and AT646A (includes AT630/A and AT45/A)**

4 Degree of freedom fixed plane trajectory

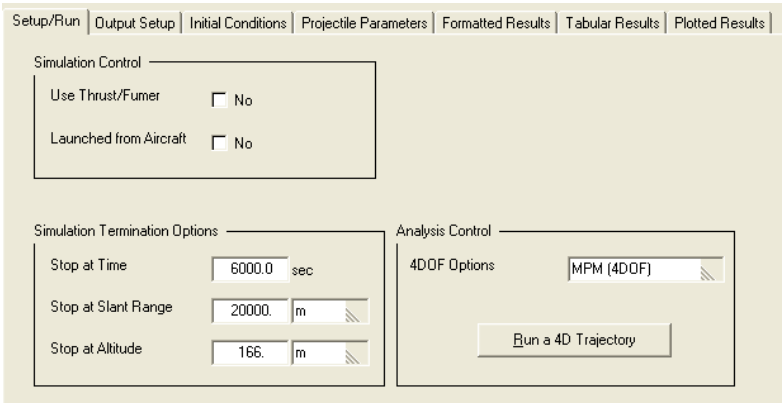
The 4 degree of freedom fixed plane trajectory simulation calculates the X, Y, Z and spin performance of the projectile as it travels downrange. The fixed plane definition means the projectile axis system is fixed (the projectile rotates within the axis system). Since the spin of the projectile is calculated any drift due to yaw of repose is also calculated. The 4DOF simulation comes with 5 options which can be accessed via a pull down menu in the setup interface window.



Options include

- MPM 4 DOF: Modified 4 DOF trajectory - (X,Y, Z and Spin) (This trajectory is used for calculating the ballistic and firing tables for non thrusting projectiles)
- MPM w/Jump: Calculates aerodynamic jump due to initial launch disturbance (ie pitch and yaw rates induced at the gun)
- MPM w/Yaw: Calculates average yaw motion (ABAR) during trajectory due to initial launch disturbance and yaw of repose.
- MPM w/ Jump & w/ Yaw: Options 2 & 3 above combined
- 2DOF: “Rock thrower”, calculates

Capabilities include modeling launch from and aircraft/moving vehicle and modeling tracer/fumer/base bleed effects and thrust vs time events. Output control via time or slant range is available along with Summary and Detailed formatted outputs and Tabulated and numerous plotted outputs.

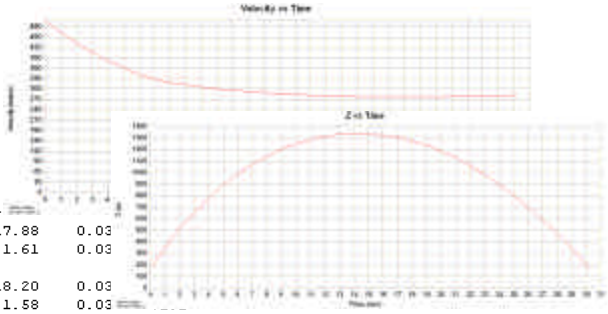



```
      Summary of 4 DOF Trajectory
  Parameter                Initial      Final
-------------------------------------------------------
Velocity                     497.6      283.4  m/sec
Trajectory Angle              22.8      -30.3  deg
Time                           0.0       30.2  sec
Range                          0.0     9091.3  m
Deflection                    0.00      -94.49  m
Altitude (re sl)            165.88      165.88  m
Slant Range                    0.0     9091.8  m
Mach Number                   1.47       0.83
Angle of Attack               0.18       0.04  deg
```

```
                    ***** 4DOF Modified Point Mass Trajectory ******

   Time       X        Y        Z      Slant    Theta    Gamma    Alpha    Drop     Gyro
   Delt     Spin      Mach     A-bar     Ve       Psi     Delta     Beta    Drift    P/V
-------------------------------------------------------------------------------------------
 0.0000      0.0     0.00    165.88      0.0   -22.83    22.83     0.00     0.00     3.31   17.88    0.03
 0.1000   1638.9    1.465      0.04    497.6    -0.09     0.00     0.08     0.00   188.69    1.61    0.03

 0.2500    113.7    -0.01    213.43    123.2   -22.57    22.57     0.00     2.37     3.41   18.20    0.03
 0.1000   1632.8    1.440      0.04    488.7    -0.10    -0.01     0.09    -0.07   191.44    1.58    0.03
```



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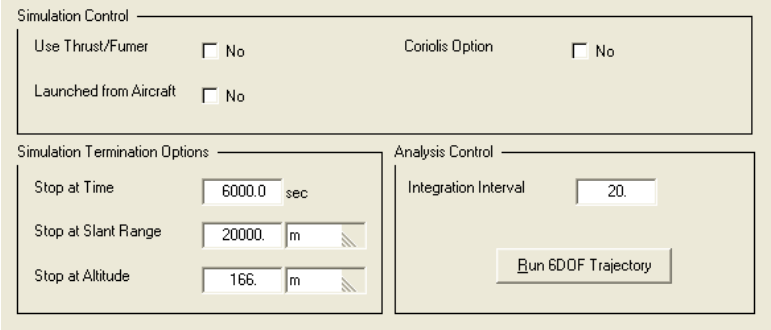
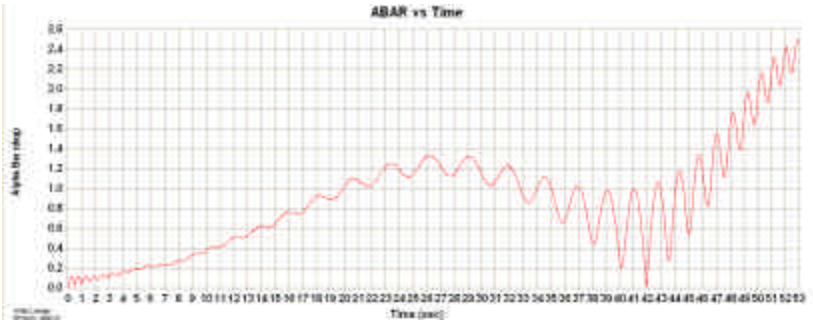
6 Degree of freedom fixed plane trajectory

The 6 degree of freedom fixed plane trajectory simulation calculates the X, Y, Z, Spin and also calculates the Pitch and Yaw motion of the projectile as it travels downrange. Along with modeling options for aircraft/moving platform, tracer/base bleed/fumaer, Thrust vs. Time and angular rates at launch, the effects of Coriolis can also be modeled.



Since the 6DOF simulation is calculating the angular motion in both the pitch and yaw plane accurate assessment of dynamic instabilities caused by spin yaw resonance or subsonic Magnus/Side Moment induced limit cycling may also be simulated or analyzed.

Along with the summary/detailed formatted output, tabular output and plotted output seen in the 4 DOF trajectory output, the 6DOF also has expanded summary outputs where the initial conditions and added body states of the projectile are part of the output. This expanded out includes slant range, Average angle of Attack (ABAR), Total drag, Radial Velocity, trajectory angles, spin, Precession and Nutation Damping Factors, and Mach #.



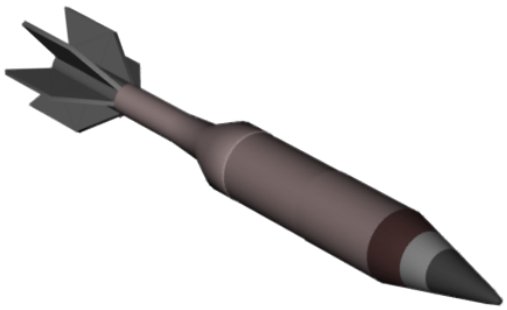
Setup/Run | Output Setup | Initial Conditions | Projectile Parameters | Aero Form Factors | Body States | Formatted Results | Tabular Results | Plotted Results

Summary/Detail Toggle (Check = Summary)

CDTOT=CXo+(CXa2+CNa)*Sin(A-bar)**2

Time	Slant	A-bar	CDTOT	Vrad	Gamma	Delta	Spin	Lambda_F	Lambda_S	Mach
0.0000	0.0	0.000	0.3959	805.00	5.00	0.00	6120.6	-0.0129	-0.0065	2.366
0.2500	187.5	0.007	0.4275	698.87	4.81	-0.01	5991.1	-0.0128	-0.0065	2.054
0.5000	351.1	0.013	0.4545	612.51	4.60	-0.02	5875.2	-0.0127	-0.0064	1.801
0.7500	495.1	0.018	0.4789	541.74	4.36	-0.02	5768.3	-0.0127	-0.0063	1.593
1.0000	623.0	0.025	0.5006	483.21	4.09	-0.04	5669.7	-0.0126	-0.0061	1.421
1.2500	737.5	0.034	0.5187	434.34	3.78	-0.05	5577.2	-0.0126	-0.0060	1.277
1.5000	840.8	0.044	0.5310	393.34	3.44	-0.06	5490.3	-0.0125	-0.0059	1.157
1.7500	934.7	0.056	0.5219	359.11	3.07	-0.08	5407.8	-0.0123	-0.0059	1.056

Additional output to a 3D visualizer is also generated within this module



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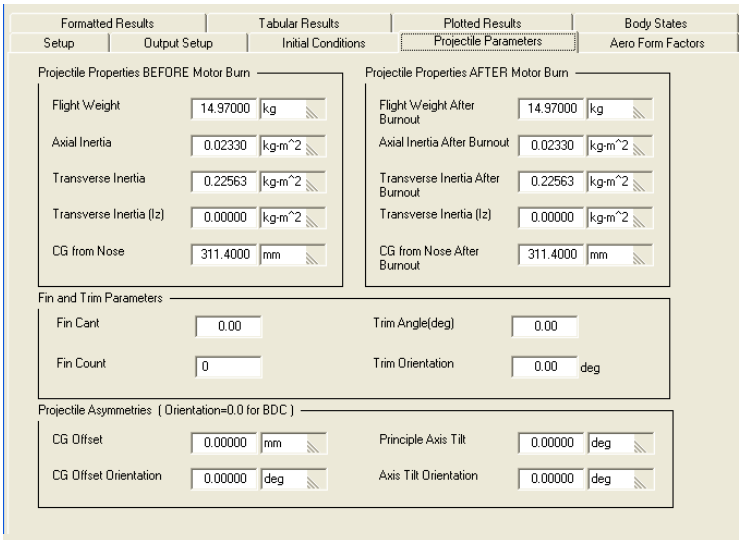
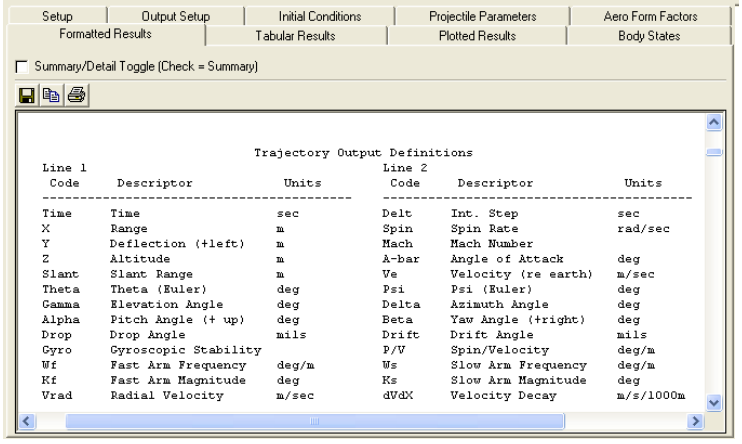
Body Fixed 6 Degree of Freedom Trajectory
Optional Module

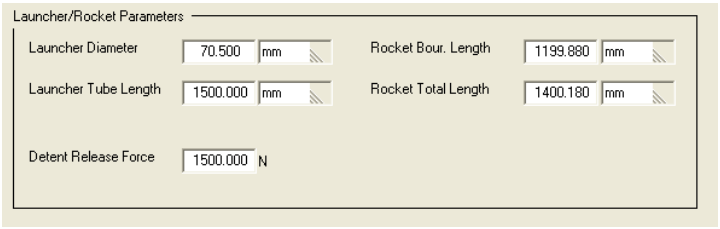
Along with the 4 and 6 degree of freedom fixed plane trajectory simulations (The projectile rotates within the axis system) PRODAS also has 6 Degree of freedom Body Fixed simulation modules. In the body fixed trajectories the projectile axis rotates with the projectile allowing simulation of asymmetric physical properties (Cg offset and Principle axis tilt), trim angles and the resulting launch and downrange effects. Outputs include the standard trajectory output and the body states of the projectile.

Additional options include rocket launcher simulation where the launcher parameters such as launcher diameter, launcher length, release détente force, rocket bourelet length, and total rocket length are input. This algorithm then calculates the in launcher velocity, spin generated by the input thrust vs. time curve or launcher rifling and angular motion at exit caused by gravity drop. These exit conditions are then transferred to the initial conditions of the Body fixed 6DOF to continue the flight simulation downrange.






```
        Launcher Exit Parameters
  Parameter (Length =     1.5000 m )
-----------------------------------------
Time                          0.078  sec
Velocity                       43.7  m/sec
Spin Rate                      51.3  rad/sec
Pitch Angle                  -0.170  deg
Pitch Rate                   -0.199  rad/sec
Tip-off Rate (Classical)      0.152  rad/sec    Spin X Thetm
```



PRODAS V3.5 Part Numbers:
AT618 - US and Canada
AT618A - International

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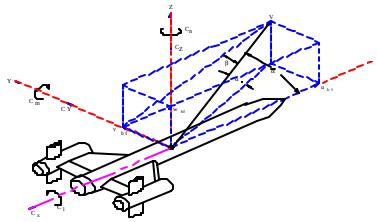
Controlled Trajectory Simulation

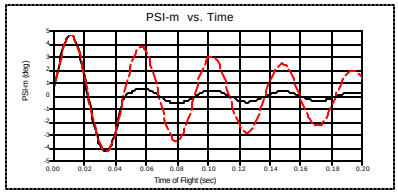
Optional Analysis

Six Degree of Freedom Control Flight Simulation Program for Fin Control, Lateral Thrust, or Impulse Control

Use a 6DOF Trajectory Simulation to evaluate response to control inputs from fins, canards and squibs. Control inputs are pre-programmed and applied during the trajectory.
Determine the efficiency and capability of a control method as implemented on your flight vehicle design. Perform this critical step in the development of a guided flight vehicle before moving on to a full guided vehicle simulation such as the Guidance Navigation and Control Simulation Module (AT 630).

The six degree of freedom (6DOF) Control Flight Simulation Program (CONTRAJ) evaluates flight performance, provide trade-offs, and design verification. Pre-programmed control phases are defined during the input phase of operation. CONTRAJ allows for two types of control concepts, (1) fin control, and (2) lateral thrust or impulse control. The flight dynamic equations of motion are developed relative to a body-fixed reference frame. Asymmetries in both mass and aerodynamics can be included.





CONTRAJ includes two 6DOF equations of motion models. The fixed plane model requires mass and aerodynamic symmetry with the exception of slight aerodynamic asymmetries such as trims or roll induced effects. The body fixed model allows both inertial and aerodynamic asymmetries such as an airplane configuration.

1. 6DOF – Fixed Plane – non rotating coordinate system
2. 6DOF – Body Fixed – rotating coordinate system

CONTRAJ can be used to assess the control authority of guided projectile with various flight control concepts, or assess the angle of attack developed and flight path deviation of ballistic projectiles subjected to external disturbances (e.g. sabot discard)

Part Numbers:
AT631 - US and Canada
AT631A - International

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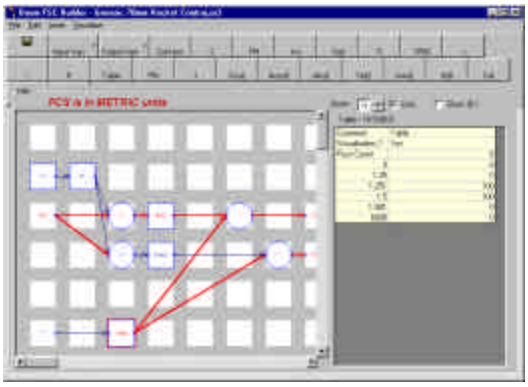
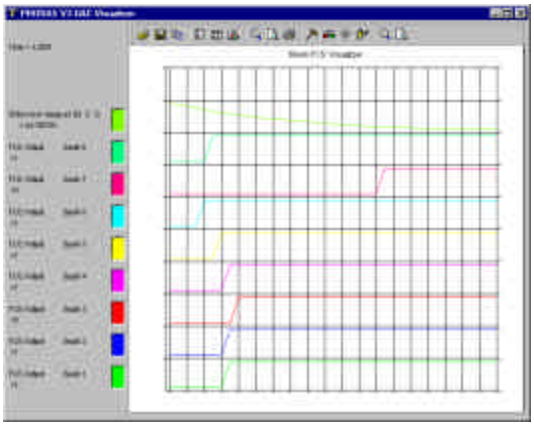
Guidance Navigation and Control Prototype Tool
Optional Analysis

This unique module combines a guidance and control simulation with a body fixed 6DOF trajectory simulation. A drag and drop editor is provided to quickly build a flight control system from common control system elements. Also provided is an "oscilloscope" feature to help design and troubleshoot the control system. This analysis module is a powerful development tool where trade studies can be completed quickly, getting you r design ready for final modeling and analysis using the Guidance Navigation and Control Simulink Builder (AT-645/A).

A wide variety of control system building blocks are available including: gain, sum, multiply, state specific filters, polynomial filters, trigonometric functions, triggers, sample and hold, accelerometers, inertial to body transformations, single axis transformations, constants, table look ups etc. The user constructs a control system by appropriately arranging control system building blocks. The software properly couples all control system elements together. Any physical parameter of the projectile model can be dynamically controlled. With this arrangement, virtually any projectile or missile flight control system can be modeled in detail.



Flight Control Simulator Builder



"Oscilloscope" Feature for troubleshooting

Part Numbers:
AT630 - US and Canada
AT630A - International (Limited Distribution)

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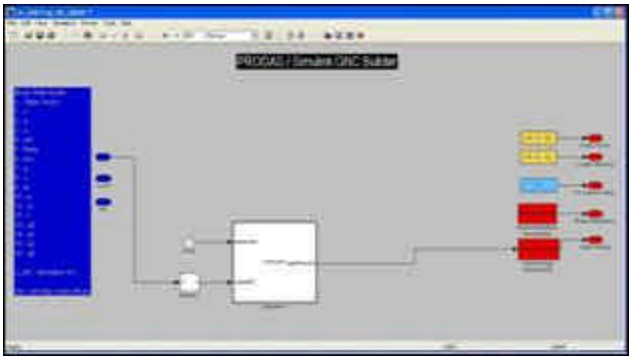
Guidance Navigation and Control SIMULINK Builder

Optional Module

NEW

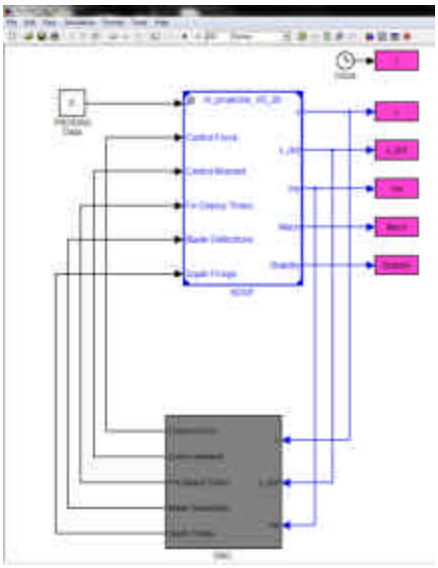
PRODAS is known for its seamless integration of analysis and simulation software tools from various disciplines in a graphical environment with a simple user interface. Now PRODAS has taken a dramatic leap forward by integrating with MATLAB® and Simulink®. The MATLAB® world is massive with general purpose programming and scientific computation and toolbox and blockset extensions for specific applications. With the integration of this powerful capability into PRODAS, a new paradigm of rapid and reliable system simulation for smart munitions is made possible.



MATLAB/Simulink Trajectory Module Features;

- **Modeling in Simulink®**
- **System Simulation**
- **PRODAS Integration**
- **Concept to Production**

Modeling in Simulink®



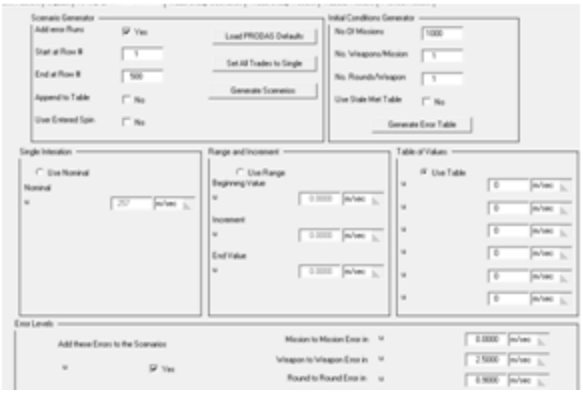
PRODAS Blockset – Leverage the highly validated PRODAS 6+DOF trajectory block as the starting point for your simulation. Use lower-level blocks to build your own trajectory module such as aerodynamics, mass properties, rocket motor, squibs, and more. Customize any PRODAS block to meet your specific modeling needs.

100% Compatibility with All Simulink® Blocksets – Use any of your licensed Math Works products to build your simulation. The integration with PRODAS does not place any restrictions on what you can do with MATLAB® and Simulink®.

Design Your Guidance, Navigation, and Control (GNC) System – Use the PRODAS blockset, the Aerospace blockset, and your own custom blocks to design the GNC system. The default template provides an empty GNC subsystem with all the connections to the 6+DOF to enable close-loop control.

Part Numbers:
AT645 - US and Canada
AT645A - International (Limited Distribution)

System Simulation

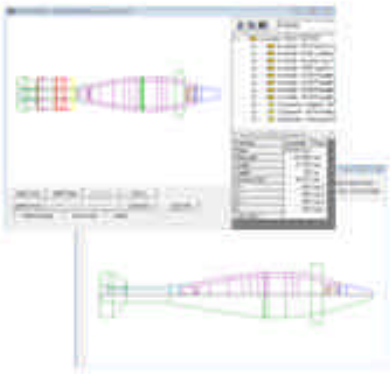


Add Subsystem Models – Drop-in subsystems modeled in Simulink® such as sensors, actuators, or physical devices.

Trade Studies – From the PRODAS GUI, setup and perform trade studies on any existing state variable or parameter or define your own. Use nominal values, ranges, or tables. Vary multiple states and parameters at once. The run matrix is created and executed automatically, and the results are collected for you.

Monte Carlo Analysis – Add random errors to any existing state variable or parameter or define your own. Perform Monte Carlo runs to determine dispersion and guided performance. Define error tables and number of runs. Compute statistics and investigate outliers.

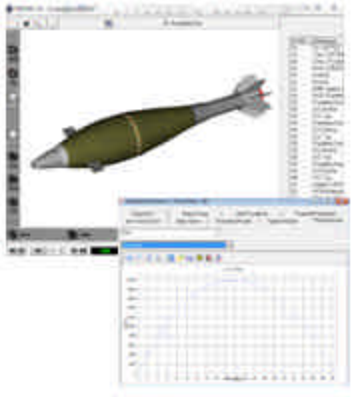
PRODAS Integration



Aero and Mass Property Predictions – Use the aero prediction capabilities in PRODAS along with mass properties in the concept development phases of your program. Replace predicted data with test data as it becomes available.

Supporting Modules – Use PRODAS to provide all the necessary supporting models including MET, rocket motor, squibs, and more.

Validate Your Model – Compare results to the basic PRODAS 4DOF and 6DOF trajectory modules for verification and validation of any custom Simulink® trajectory model.



Visualize Results – Use plots and the 3D Visualizer to analyze your simulation results. Basic plots such as position, velocity, attitude, spin rate, angle of attack, and more are available. Look at the stability properties throughout the trajectory. Watch the motion of a realistic 3D model as you play-back the trajectory.

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Concept to Production

HIL – Use Simulink® to target your simulation to a real-time Hardware-In-the-Loop (HIL) system and maintain compatibility with the PC simulation.

Code Generation – Leverage Simulink®'s auto code generation tools to create embedded software from your GNC algorithm blocks.

Fire Control – Use the simulation in test environments for fire control.

Guidance Navigation and Control Package

This module includes the Guidance Navigation and Control Prototype Tool (AT630/A) and the Guidance Navigation and Control SIMULINK Builder (AT645/A)

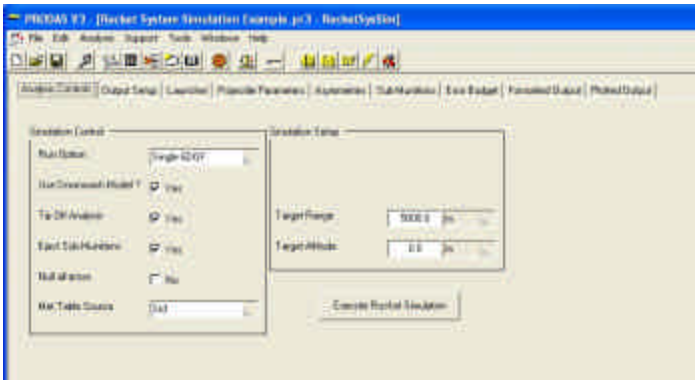
Part Numbers:
AT646 - US and Canada
AT646A - International (Limited Distribution)

Rocket System Simulation
Optional Analysis

The Rocket System Simulation Module contained within PRODAS Version 3.0 allows the user to analyze and predict overall system performance including standard deviation in X, Y and Z coordinates of rocket/sub-munition impact and deployment based on system error sources input by the user. The system utilizes a Body Fixed 6 Degree of freedom trajectory simulation, which allows analysis of not only standard error sources but also asymmetric physical properties such as Center of Gravity offset and Axis of Rotation shifts. The module also allows modeling of the rocket launcher, launch platform (aircraft, land based), downwash, meteorological conditions and sub-munition fuzing/deployment errors.

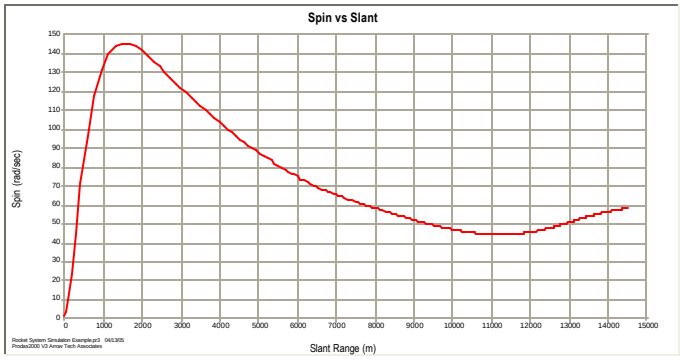
Inputs Include;

- Simulation Controls
- Launcher Description
- Projectile Parameters
- Projectile Asymmetries
- Sub-munitions
- Error Budget (Occasion to Occasion and Rocket to Rocket)



Output Data Include;

- Summary of user inputs
- Nominal 6DOF rocket trajectory output
- Nominal Sub-munition trajectory
- Error Source vs. Range and Drift Contributions
- Submunition Sensitivities vs. Range and Deflection Contributions
- Monte Carlo input
- Occasion to Occasion, Round to Round, Submunition Error summaries
- Mean Output Position including X, Y, Z and the Standard Deviation of each Per Salvo of both the rocket and the Submuntion
- Mean values of all rocket and submunition positions and Standard Deviation of MPI Salvo to Salvo



Part Numbers:
AT627 - US and Canada
AT627A - International

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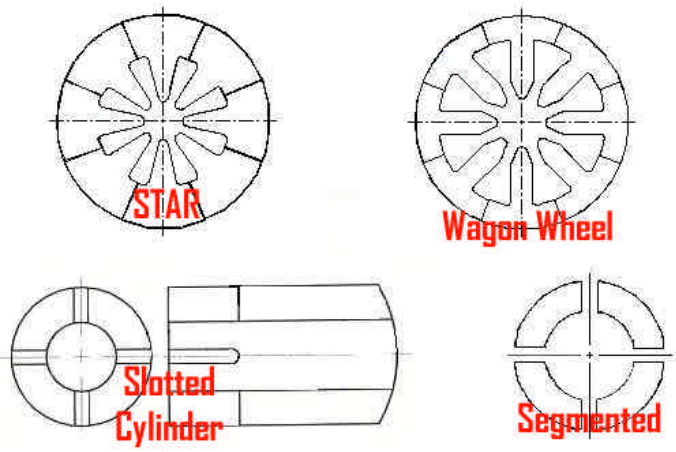
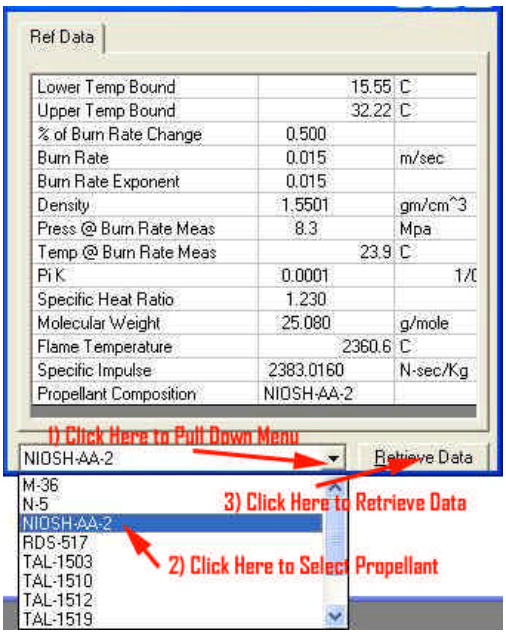
Rocket Motor Design Tool
Optional Analysis

The Rocket Motor Design Tool module of PRODAS are rocket motor interior ballistic codes written by Talley Defense which provide a transient, dynamic burn model for four (4) specific rocket motor grain geometries: Segmented, Star, Slotted, and Wagon Wheel.



Surface geometry computations, along with thermochemical and gas dynamics equations allow computation of internal combustion pressure, thrust, impulse, mass flow, surface area and web as a function of time.

Combustion properties of standard rocket motor propellant grains are loaded from a PRODAS Reference Book, as shown below:



Part Numbers:
AT640 - US and Canada
AT640A - International

Talley Defense Systems

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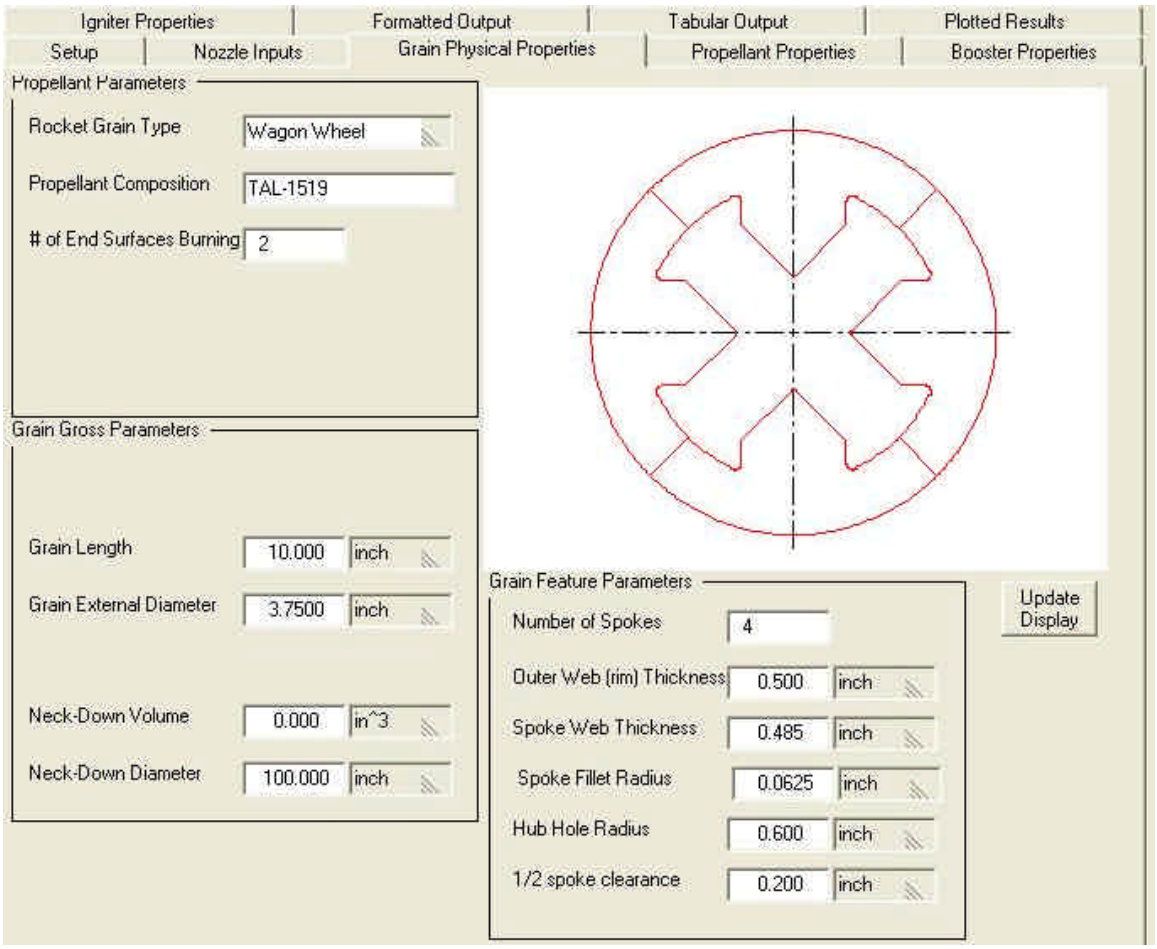


The effects of nozzle geometry, grain geometry, propellant burn rate, propellant thermochemical properties, igniter properties and booster properties on rocket motor performance can be assessed.

Hand-off of rocket motor thrust vs. time to either 4 degree-of-freedom (DoF) or 6 DoF trajectory modules is automatic within the PRODAS environment, providing the user with an accurate, close coupled simulation ideal for assessing the performance of either ballistic or guided rocket systems, including dispersion.

Structural Analysis Modules

The following optional analysis modules are advanced PRODAS modules and require the PRODAS Main Analysis in order to run.

- **Cartridge Case Analysis System - AT634 and AT634A**
- **In-Bore Balloting - AT635 and AT635A**
- **Sabot Profiler - AT637 and AT637A**

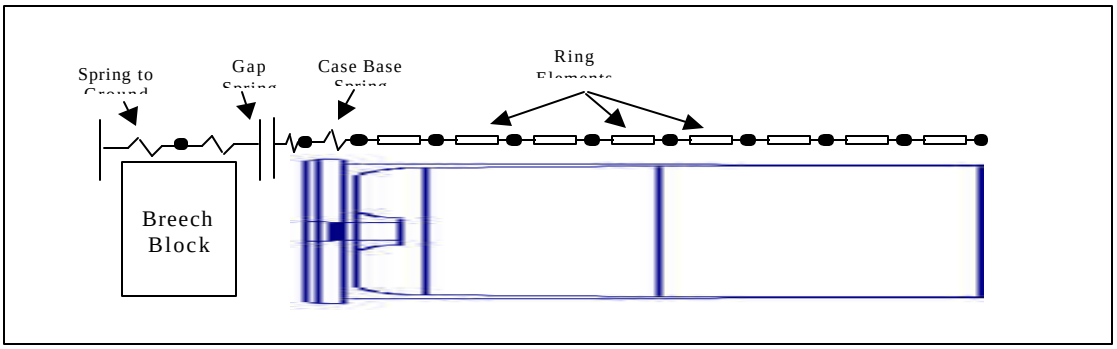
Cartridge Case Analysis System
Optional Analysis

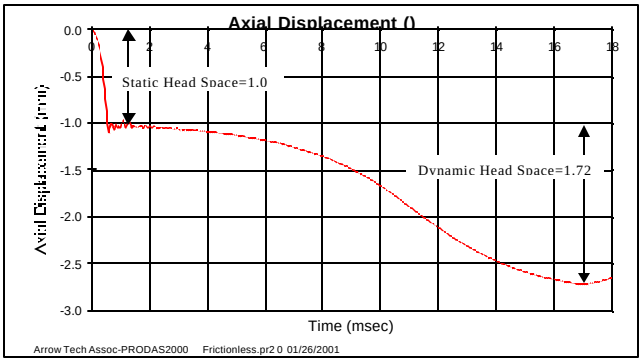
Simulate Case Deflections & Chamber Interaction during firing pressurization.

The modeling and analysis of a cartridge case requires an elastic-plastic, thermal, dynamic solution. The use of general purpose finite element programs for case analysis can be very expensive and labor intensive because the model must contain many elements to obtain stress distributions in the thin cylindrical wall region of the case and in the base region. Additionally, the case material can exceed its yield point for a large part of the interior ballistic cycle, requiring an inelastic analysis with relatively long computation times.

To improve computational and parametric design efficiency, Arrow Tech Associates, Inc. has developed an analytical tool specifically to analyze cartridge cases, called CASAS (CASe Analysis System).

CASAS is a primary analytical tool to perform the elastic-plastic, dynamic analysis (including transient heat effects) required for cartridge case design.





Part Numbers:
AT634 - US and Canada
AT634A - International

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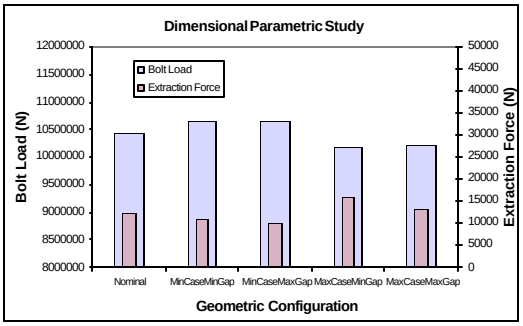
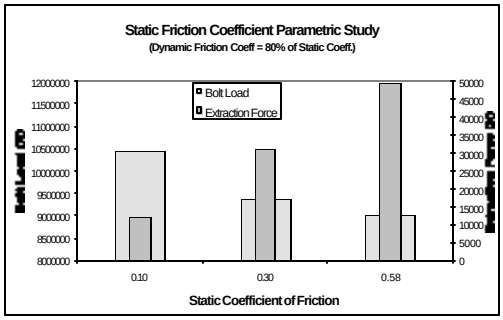
CASAS simulates the dynamic interaction of the cartridge case and gun chamber in five (5) phases of the firing cycle:

- **Initial Conditions** (definition of material properties such as modulus, density, coefficient of thermal expansion, thermal conductivity, along with case-chamber gaps & bolt stiffness.)
- **Propellant Ignition** (initial case contact with the chamber wall.)
- **Pressure Load Increase to Maximum** (maximum composite structure deflection)
- **Elastic case recovery** as the internal pressure decays to atmospheric conditions.
- **Residual Case/Chamber condition** clearance or interference between the case and the chamber, case extraction force.





CASAS is ideal to perform the following case/chamber parametric studies:

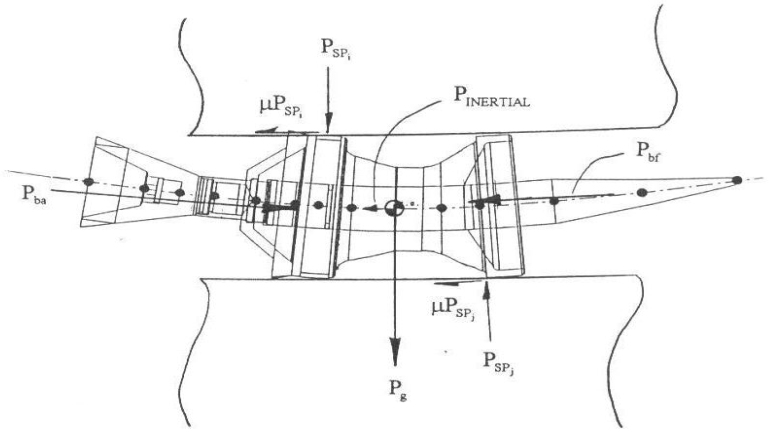
- Dimensional
- Stress-Strain Curve
- Chamber Pressure
- Friction Coefficient
- Extraction Temperature
- Case/Chamber Gap Size
- Static Head Space
- Dynamic Head Space

CASAS output includes:

- Maximum Total Plastic Case Strain (assess case failure)
- Extraction force required
- Maximum Bolt Load

In-Bore Balloting Analysis
Optional Module

Simulates the Dynamic Response and Interaction of a Flexible Projectile and a Flexible Gun Tube During In-Bore Travel



Using BALANS you can describe the projectile and tube with up to 50 lumped mass nodes and connecting beams each, compute the deflection of the projectile and gun tube during movement of the projectile from breech to muzzle exit and, determine the balloting contribution to dispersion.

BALANS analyzes the dynamic response and interaction of a statistically representative, flexible projectile and a flexible gun tube during in-bore travel., in a time step iterative solution. BALANS assumes the projectile is initially misaligned in the gun tube due to manufacturing tolerances. During firing, this misalignment produces secondary forces causing transverse displacement and yawing motion of the projectile as it travels from breech to muzzle.

The resulting yaw angle and angular rate at muzzle exit are then analyzed for their effect on dispersion.

Part Numbers:
AT635 - US and Canada
AT635A - International

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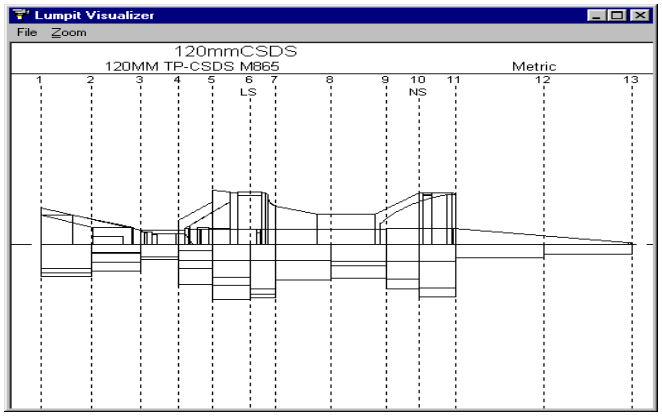
BALANS features the following:

- **Projectile Modeling**
- **Gun Tube Modeling**
- **Bore Profile Definition**
- **Forcing Function Definition**
- **Initial Condition Definition**
- **Automated Statistical Evaluation of Dispersion**
- **Gun Tube**
  - **Motion**
  - **Muzzle Exit Transverse Velocity**
- **Projectile**
  - **Motion**
  - **Shape**
  - **Stress**
  - **Projectile / Tube Interface Reaction Loads**
  - **Tube Support Reaction Loads**



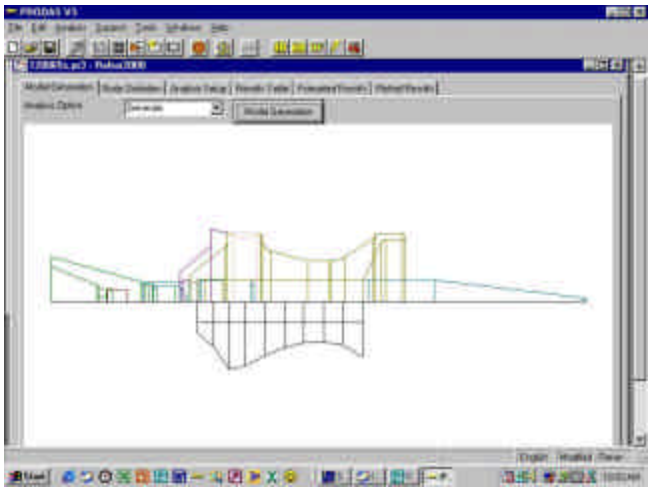
Sabot Profiler Analysis

Optional Module

Structural Analysis of APFSDS projectiles subjected to

The Sabot Profiler is a one dimensional structural analysis of the projectile/sabot system caused by longitudinal accelerations within the barrel. The software calculates the nominal axial stress distribution along the length of the projectile and can be used to optimize the the shape (mass) of the selected piece parts, primarily sabots for long rod applications. The predicted stress levels obtained are very close to those obtained by more detailed Finite Element Method (FEM) solutions. Therefore, Profiler can be used as an efficient optimization tool.

The output parameters calculated for the projectile/sabot system caused by the longitudinal accelerations within the barrel are then used to perform the In Bore Balloting analysis.



Part Numbers:
AT637 - US and Canada
AT637A - International

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System Effectiveness Modules

The following optional analysis modules are advanced PRODAS modules and require the PRODAS Main Analysis in order to run. All four of these modules includes the Analysis BOT module (AT639/A)

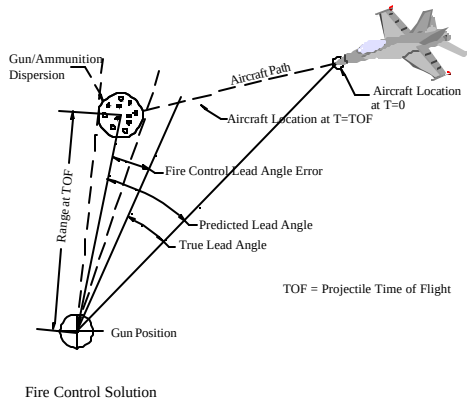
- **Air to Air - AT663 and AT663A**
- **Air to Ground - AT664and AT664A**
- **Ground to Air - AT665 and AT665A**
- **Ground to Ground - AT666 and AT666A**

Gun System Effectiveness Simulations
Optional Modules

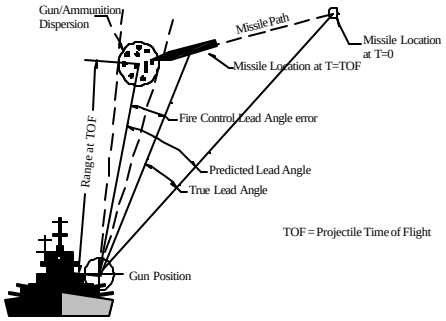
The system effectiveness series of analyzes are designed to evaluate the lethality of gun-ammunition-fire control systems against a variety of targets.
There are analysis modules designed to evaluate many different missions:

- Air Defense (ground to air)
- Anti-ship Missile Defense (ship to air)
- Ground Warfare (ground to ground)
- Air Warfare (air to air, both fixed wing and helicopter)
- Ground Support (air to ground, fixed wing, helicopter and gun ship)

Using this suite of tools, you can quickly evaluate candidate ammunition and gun systems, burst lengths, targets, sensor errors and system accuracy. Analysis output is focused on the effectiveness in hitting and killing the intended target. Subsequent analysis (maintainability, reability, affordability, life cycle) is required to determine cost effective solution parameters.



Fire Control Solution



Fire Control Solution

Ground to Air

Air to Air Part Numbers:
AT663 - US and Canada
AT663A - International

Air to Ground Part Numbers:
AT664 - US and Canada
AT664A - International

Ship to Missile

Ground to Air Part Numbers:
AT665 - US and Canada
AT665A - International

Ground to Ground Part Numbers:
AT666 - US and Canada
AT666A - International

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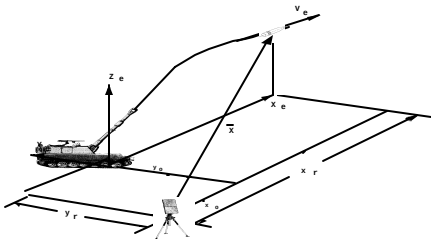
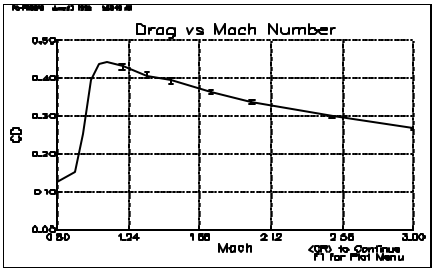
RADAR 2000 / RADAR ASSISTANT

Accurate Extraction of Drag Coefficients and Tracer Performance from Doppler Radar Data

RADAR 2000 uses the equations of motion along with non-linear drag versus Mach Number for the most accurate computation of drag coefficients possible. A powerful differential correction technique is used to rapidly converge on a combination of selected coefficients which most accurately matches the experimental radar data.

This program was developed on main frame computers and has been used to reduce radar data for both



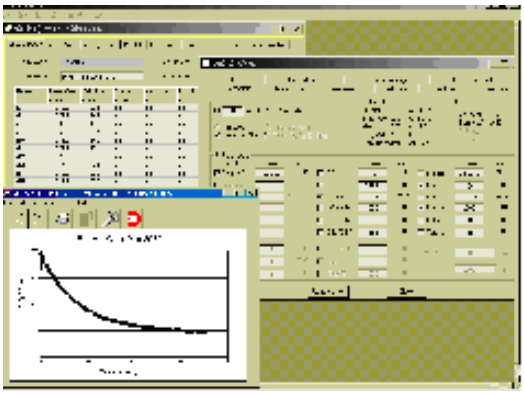


RADAR 2000 features:

- Easy to use, menu driven and designed for high speed data entry and reduction
- Support for ALL radar types using a user configured ASCII file interface including , Weible, Hawk, and Terma
- Analysis of high gun elevation angle shots (long range artillery or mortar)
- Accurate analysis of traced or base bleed projectiles
- Single shot and/or group reduction analyses
- Multiple (user controlled) raw data filters
- PRODAS V3.5 interface for inputting projectile parameters and initial coefficient estimates
- Interface to Meteorological Data file to input atmospheric data
- Impact point prediction

RADAR Assistant Features:

- Windows / VB Front End for Easy Use
- Point-point drag & decel analysis from velocity data makes it easy to spot significant trajectory events (e.g. tracer burnout, dynamic instability, submunition ejection, etc)
- Output available via tabular or plots, easy to paste into reports.



Part Numbers:
AT624 - US and Canada
AT624A - International

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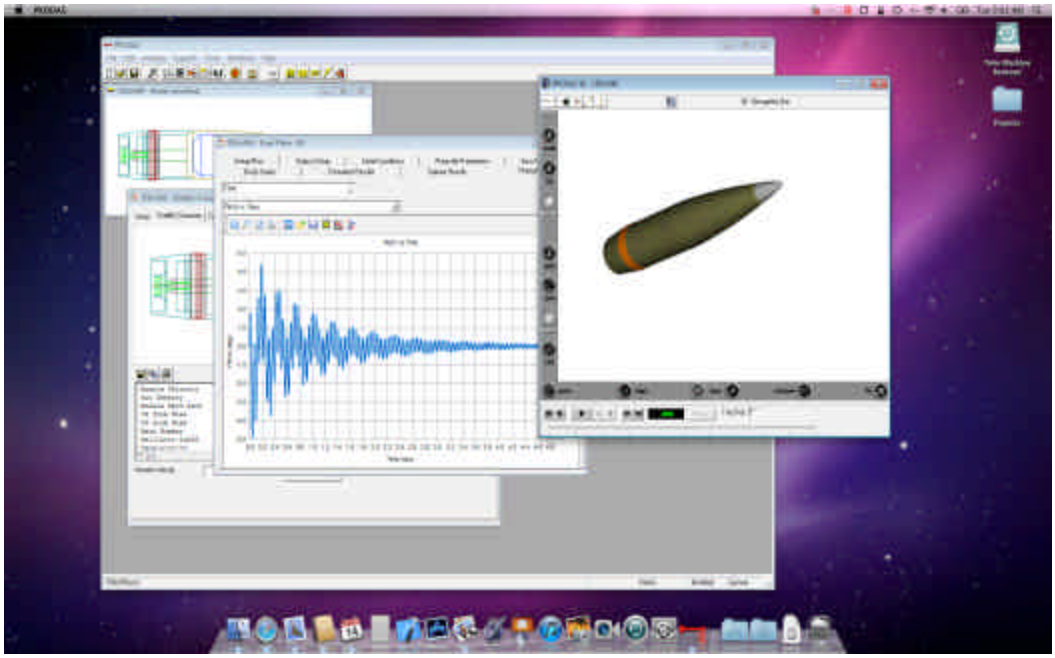
PRODAS on Mac OS X

NEW

If you are a Mac user and want to run PRODAS, there is now a solution for you. PRODAS is available to Mac users through Parallels Desktop 6 or 7. Parallels provides the capability to run Windows within the Mac operating system. PRODAS has been tested with Parallels using both Windows 7 and XP and performs exactly as on a native Windows machine. All of the PRODAS modules can easily interact with other Mac applications through copy and paste with data, plots, and graphics. Contact Arrow Tech for any setup help, and start using PRODAS today on your Mac.



PRODAS on an iPad

Using the same Parallels software discussed above, with the addition of the Mobile Module, you can now run PRODAS on your iPad. It doesn't really run on the iPad, the iPad is acting as a window into your Mac. Still you control all of the functionality, including running trajectories and predicting aeros in the palm of your hand. Great for meetings to answer that tough question definitively. Call if you would like more details.

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Arrow Tech Courses

An ARROW TECH course may be the best way to take advantage of all PRODAS V3.5 and Radar 2000 has to offer.

Courses are from 3 to 10 days in length depending on the material to be covered and the degree of expertise and number of students involved.

All Arrow Tech courses are taught by experienced aeroballistic and structural engineers currently on staff at Arrow Tech.

Courses can be held in the Arrow Tech training facility or on-site at your facility.

Each course is custom fit to the customer, but all draw from the following list of topics:

Basic Theory

- Basic Aerodynamic Theory (Definition of Forces & Moments)
- Linear Theory and Projectile Stability
- Projectile Flight; Equations of Motion
- Special Cases for Equations of Motion
- Interior Ballistic Theory & Modeling
- Structural Design Considerations & Techniques
- Dispersion Sensitivity, Balloting and Dispersion Simulation
- In-bore Transverse ; Dynamic Motion (Balloting)
- In-flight Motion of Flexible Projectile Bodies
- Radar and Spark Range Data Reduction
- Guidance Navigation and Control Instruction
- Build and integrate custom analysis software within the PRODAS Framework

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Basic PRODAS User Training

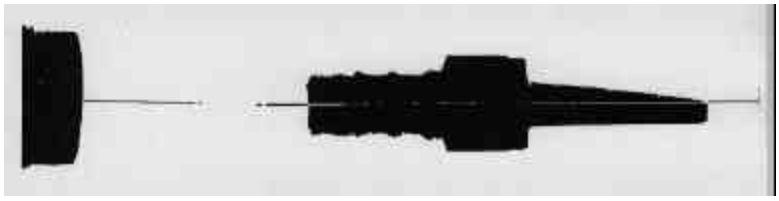
This course is designed to help the new user learn how to use PRODAS for projectile modeling and analysis. It shows the student how to execute the basic PRODAS modules as well as the basic theory behind them.

- Projectile Modeling & Editing
- Aerodynamic Coefficient Prediction and Stability Analysis
- 4 DOF and 6 DOF Trajectory Simulations
- Muzzle Exit and Dispersion Prediction
- Interior Ballistics & Band Wear
- Design Trades
- Range/Firing Tables
- Terminal Ballistics
- Controlled Trajectory Simulation
- Extracting Real Aeros
- Lot Acceptance Test (LAT) Simulation and Appropriate Sample Size
- System Effectiveness
- Target Modeling
- Special Topics

Ballistic Testing

- Design of Experiments and Interpretation of Results
- RADAR Data Reduction
- Yawsonde Data Reduction
- Spark Range Data Reduction
- Wind Tunnel Design and Analysis

Please reference the Arrow Tech Course Catalog for more information and course syllabus



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Advanced PRODAS User Training

This course is designed to help the experienced PRODAS user learn how to use the advanced features of PRODAS for projectile modeling and analysis.

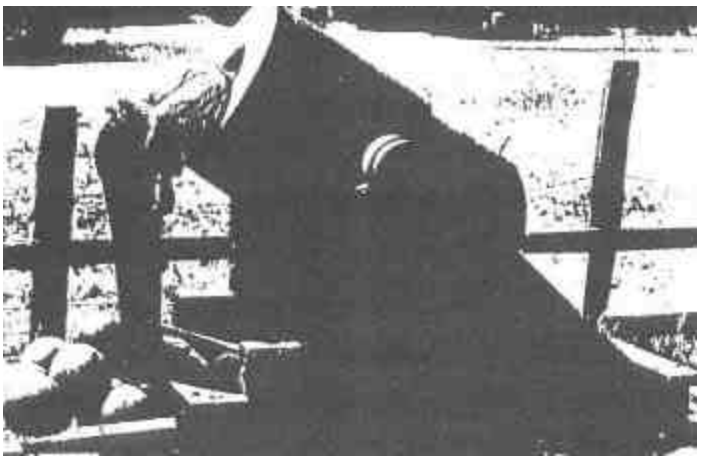
- Projectile Tracing Tool
- Analysis BOT (repetitive analysis tool)
- Multiple Aero Prediction capability
  - * Spinner/Finner
  - * Missile DATCOM
  - * MISL3
  - * Aeromanager
- System Effectiveness Analysis with Macros
- Controlled Trajectory
- Guidance Navigation and Control Overview

BALANS Training
Projectile Balloting Analysis

BALANS analyzes the dynamic response and interaction of a statistically representative, flexible projectile and a flexible gun tube during in-bore travel using a time step iterative solution. BALANS assumes the projectile is initially misaligned in the gun tube due to manufacturing tolerances. During firing, this misalignment produces secondary forces causing transverse displacement and yawing motion of the projectile as it travels from breech to muzzle.

The course provides an introduction to projectile balloting and it further instructs the user in the science of sabot profiling to achieve optimal mass sabot petals.

The course duration is 3 days.



CASAS Training
Case/Chamber Interaction Analysis

To improve computational and parametric design efficiency, Arrow tech has developed an analytical tool specifically to analyze cartridge cases. It is called CASAS (CASe Analysis System). CASAS is a primary analytical tool to perform the elastic-plastic, dynamic analysis (including transient heat effects) required for cartridge case design.

The course duration is 3 days.

SDK Training
Software development Kit

The Software Development Kit (SDK) will allow you to build and integrate your own analysis programs within PRODAS. Your analysis will draw from the PRODAS data and appear on the menu like any other module.

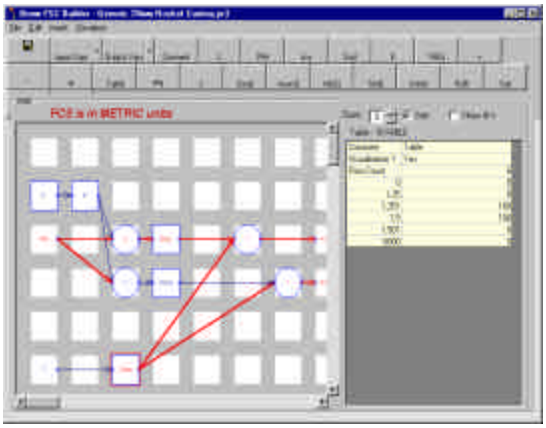
This course provides an introduction to the SDK and examines every aspect of a simple analysis which has been integrated into PRODAS. The intent is to enable the student to integrate his/her own analysis module into the PRODAS structure.

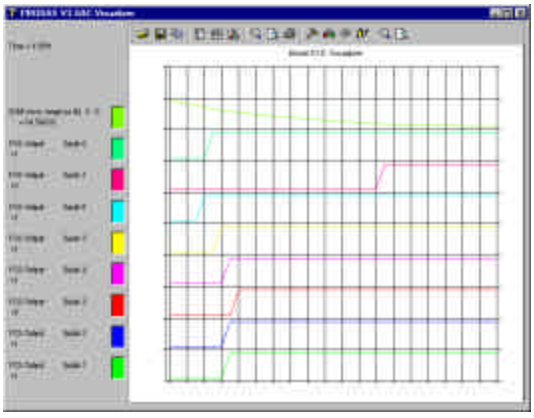
The course duration is 3 days.

GNC Training
Guidance Navigation and Control Prototype Tool

This unique module combines a guidance and control simulation with a body fixed 6DOF trajectory simulation. A drag and drop editor is provided to quickly build a flight control system from common control system elements. Also provided is an “oscilloscope” feature to help design and troubleshoot the control system.

This course provides an introduction to the GNC Module and takes you through several tasks which provide an overview of how to use the PRODAS and Guidance Navigation and Control environment to its fullest. Please be aware that Guidance and Control theory cannot be discussed with Foreign Students but the interface and its controls may.





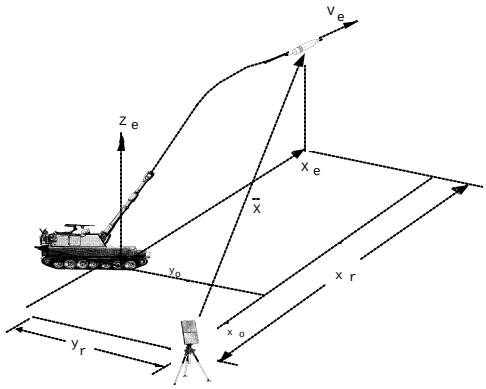
GNC Training
Guidance Navigation and Control SIMULINK Builder

Radar 2000 Training
Basic User Course

Radar 2000 uses the equations of motion along with non-linear drag versus Mach Number for the most accurate computation of drag coefficients possible. A powerful differential correction technique is used to rapidly converge on a combination of selected coefficients which most accurately matches the experimental radar data.

This course provides the user with the basic understanding of the methodology and practice of reducing data acquired from Radar observations of free and/or guided flight to aerodynamic coefficients.

The course duration is 3 days.

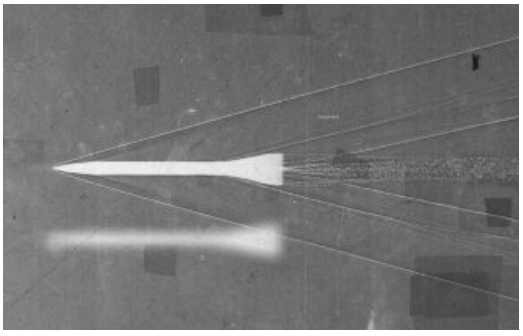


Spark Range Data Reduction
Basic User Course

The spark range is used to obtain aeroballistic coefficients to predict projectile flight. Orthogonal photographs of the model's shadoware then used to determine the spatial position and angular orientation of the test model at various instrumented sites. A chronograph system provides the times for the projectile at each station. These times together with the spatial position and orientation obtained from the orthogonal photographs provide the basic trajectory data from which the aerodynamic coefficients are extracted. These discrete times, positions, and orientations are then used by the data reduction program to determine the aerodynamic forces and moments acting on the model during the observed flight.

This course is designed to provide the user with a firm background in aerodynamic theory and data reduction methodology.

The course duration is 3 days.



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Arrow Tech
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If you can't get a Bigger Target...

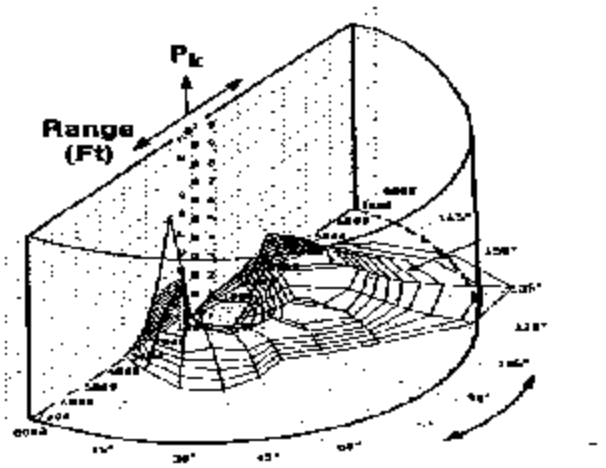
In today's shrinking marketplace, only the most efficient and technically competent companies will survive.

But how can your organization afford to maintain the requisite level of specialized expertise ?

Arrow Tech Associates was incorporated in 1987 to assist industry and government in optimizing the performance of ammunition and weapon systems.

This includes extensive experience in ammunition design, aerodynamic testing, interior ballistics and in-bore dynamics, as well as free flight simulation.

The personnel of Arrow Tech have been involved in numerous large scale ammunition development and production programs, and are experienced at understanding the critical technical design and process parameters governing the resultant performance.



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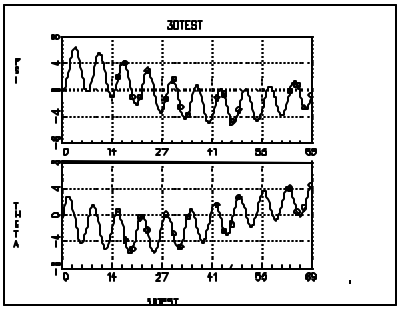
Arrow Tech has ammunition expertise that would take generations for your company to develop.

Exterior Ballistics Expertise



Projectile Design & Analysis

- Aero / Stability Evaluation
- TID / Dispersion Prediction
- Interior / Exterior Ballistic Simulation
- Guided Projectile Simulation

Spark Range Data Reduction

- Free Flight Data Reduction
- Precision Aerodynamics
- Asymmetric Configurations
- Extensive Aeroballistic Database

Radar/Yaw Sonde Data Reduction

- Long Range Operational Testing
- Downrange Stability Evaluation
- Complete test planning
- Radar Spin data reduction

You will find our rates are very competitive.

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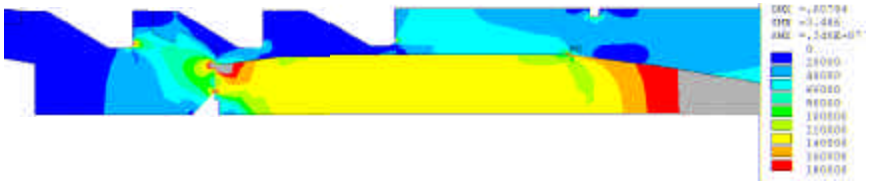
- FEM Analysis
- Chamber - Case Interactions
- Gun Dynamics
- Mesh Generation



In Bore Dynamics

- Interior Ballistics Simulations
- Rotating Band Wear Simulations
- Body Engraving Assessment
- Sabot Design Optimization
- Statistical Evaluation of Tolerances
- Rigid/Flexible Body analysis
- Rotating band / barrel interaction
- Cartridge case / chamber interaction

Gun Launch and muzzle exit is a unique structural environment involving large accelerations, high spin rates, significant dynamic pressure and short duration events.
Arrow Tech expertise can help you assess the viability of your projectile design prior to committing resources to fabrication.

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Consulting Services

Guided Projectile Simulation and Guidance Algorithm Development

Arrow Tech Associates has experience in Guidance and Control Algorithm design for both Spin Stabilized and Statically Stable Flight Bodies.

- Initial Guidance Algorithm design
- Inertial and GPS Guidance
- Sensor feedback and inputs
- Impact Point Prediction
- Electrical and Mechanical subsystem modeling
- Hardware in the loop

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Consulting Services

Weapon System Effectiveness Simulation

Arrow Tech Associates has extensive experience in assessing and simulating weapon system performance. Calculation of Probability of Hit and Probably of Kill for multiple weapon/ ammunition systems and engagement scenarios including the foloowing:

- **Ground to Ground -** Vehicle to Vehicle, Dismounted Troops, Direct and Indirect fire missions, Point Detonating and Air Burst Fuzing. Projectile and Artillery Rockets
- **Ground to Air -** Air Defense, Missile Defense, UAV Engagement, Improvised Munition Engagement
- **Air To Ground -** Helicopter, Fixed Wing engaging armored or materiel targets. Both Gun and Ground Attack Missile
- **Air to Air -** Fighter aircraft engagements with single and multi barrel systems.

Past experience includes JSF, Euro Fighter, C-130 Gunship, A-10, F-16, F-15, CIWS, Goalkeeper, PIVADS, Bradley Fighting Vehicle, M1 Abrams, M109, Crusader, 60-120mm Mortar, EFV, SMAWII, OICW, AICW, MK47, Stryker and many more.

Consulting Services

Production Expertise

Arrow Tech provides Technical Data Package reviews and production assessments to our customers to help them accurately determine program risk. This enables them to aggressively bid production contracts while maintaining adequate profit margins.
Arrow Tech engineers have led many successful Failure Analysis to root cause solution and corrective action.
In addition, Arrow Tech engineers are trained in Value Engineering, enabling them to make cost reducing manufacturing and production recommendations which have minimal and beneficial impact on performance.

Artificial Intelligence

- Expert System for Projectile Design
- Manufacturing Expert Systems
- Failure Diagnostics System
- Test Range Diagnostics

Production Engineering

- Production Readiness Assessment
- Process Control and SPC Planning
- Test Planning
- Failure Analysis

Fuze Development & Production

- Design & Analysis
- Function Environment Assessment
- TDP Evaluation
- SPC Plans & Testing
- Failure Analysis

You will find our rates are very competitive.

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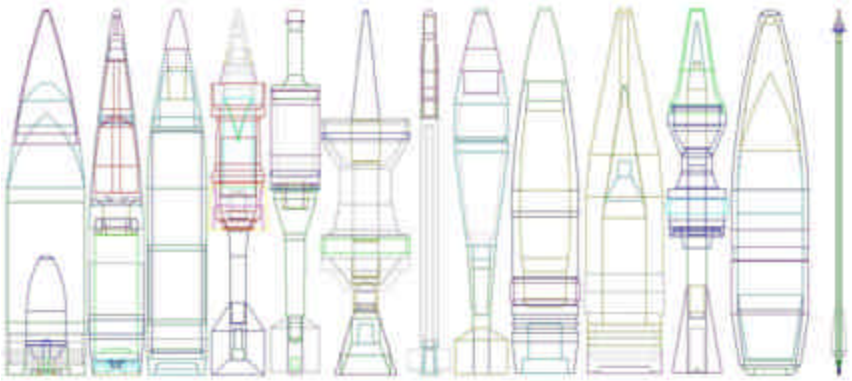

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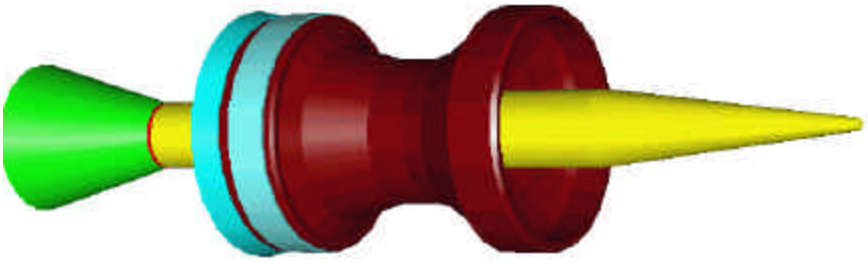

A Fully Functional Evaluation Package is available for Arrow Tech Software Products.

Call for Details.