The J2 Universal Tool-Kit v7 – Release Note

AIRCRAFT MODELLING AND PERFORMANCE PREDICTION SOFTWARE

Key Aspects

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Predicting Performance

INTRODUCTION

j2 Aircraft Dynamics Ltd. is pleased to announce the release of its latest version of the j2 Universal Tool-Kit. The release of v7 replaces the previous v6.5.2 and is a major version release unlocking a significant number of new and improved features.

As well as bug fixes and some internal changes, there are several noticeable and major improvements.

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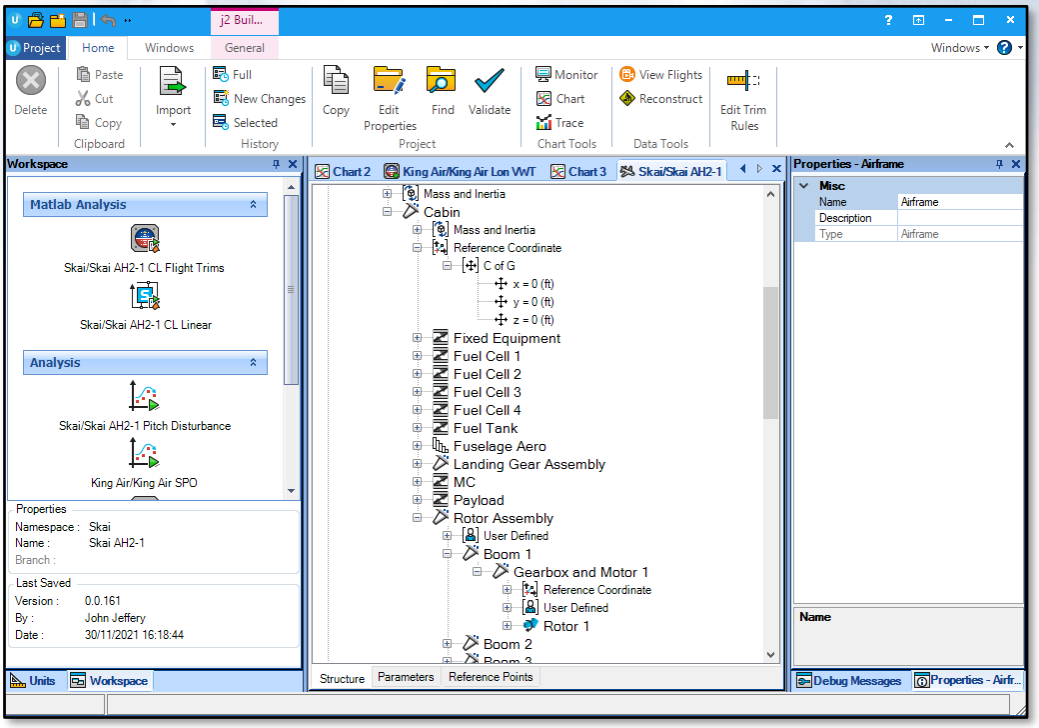
J2 UNIVERSAL FRAMEWORK

The j2 Universal Framework is the main application for the j2 Universal Tool-Kit. This provides the core framework that includes the main Graphical User Interface (GUI) components, the units system, dataset management and storage, and configuration management.

The GUI has been updated with a whole new suite of user Icons to aid in navigation. This is a major enhancement to the interface providing consistent and clearer views of all objects, operations and functions.

The GUI has been further enhanced allowing customisable colours and styles through the use of templates and style sheets.



Default Style

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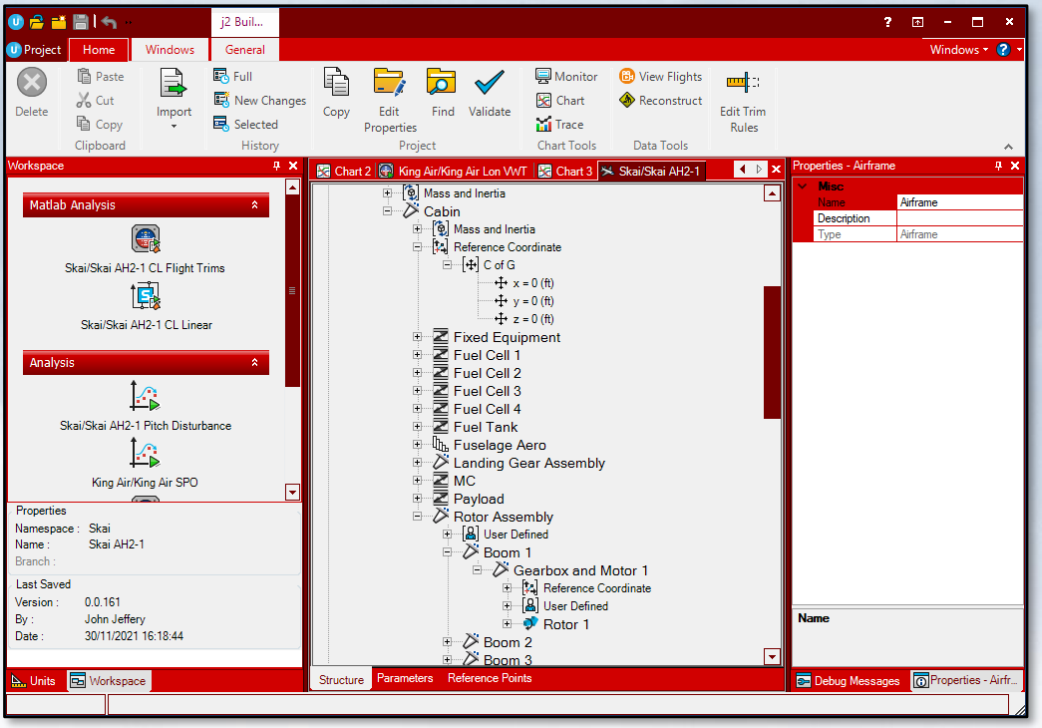
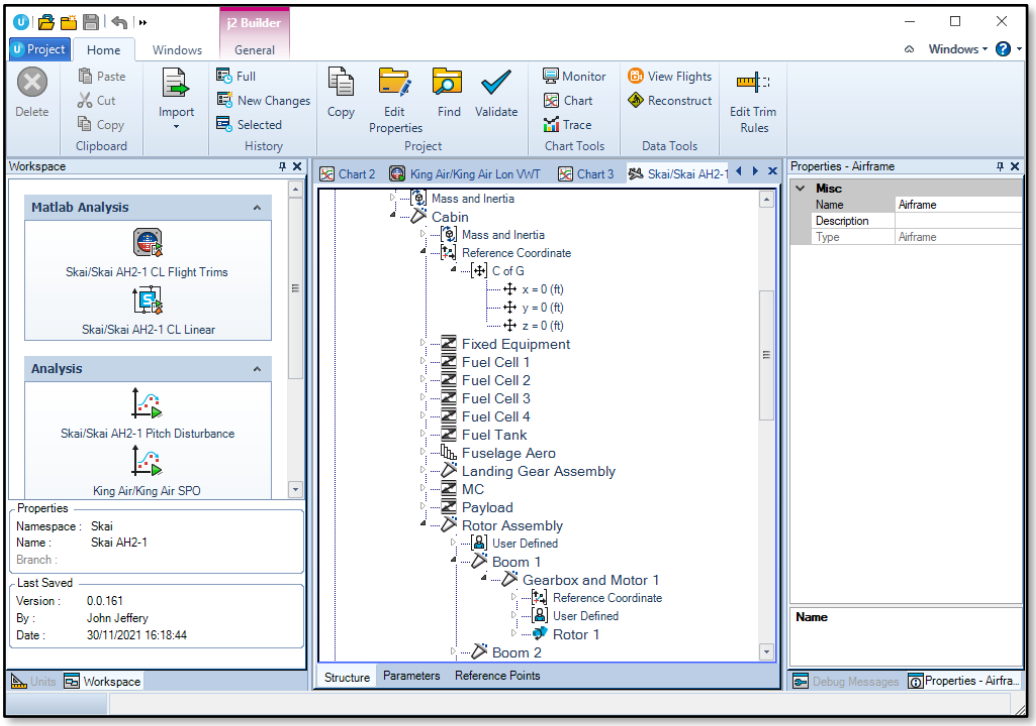


Red Style



Flat Style

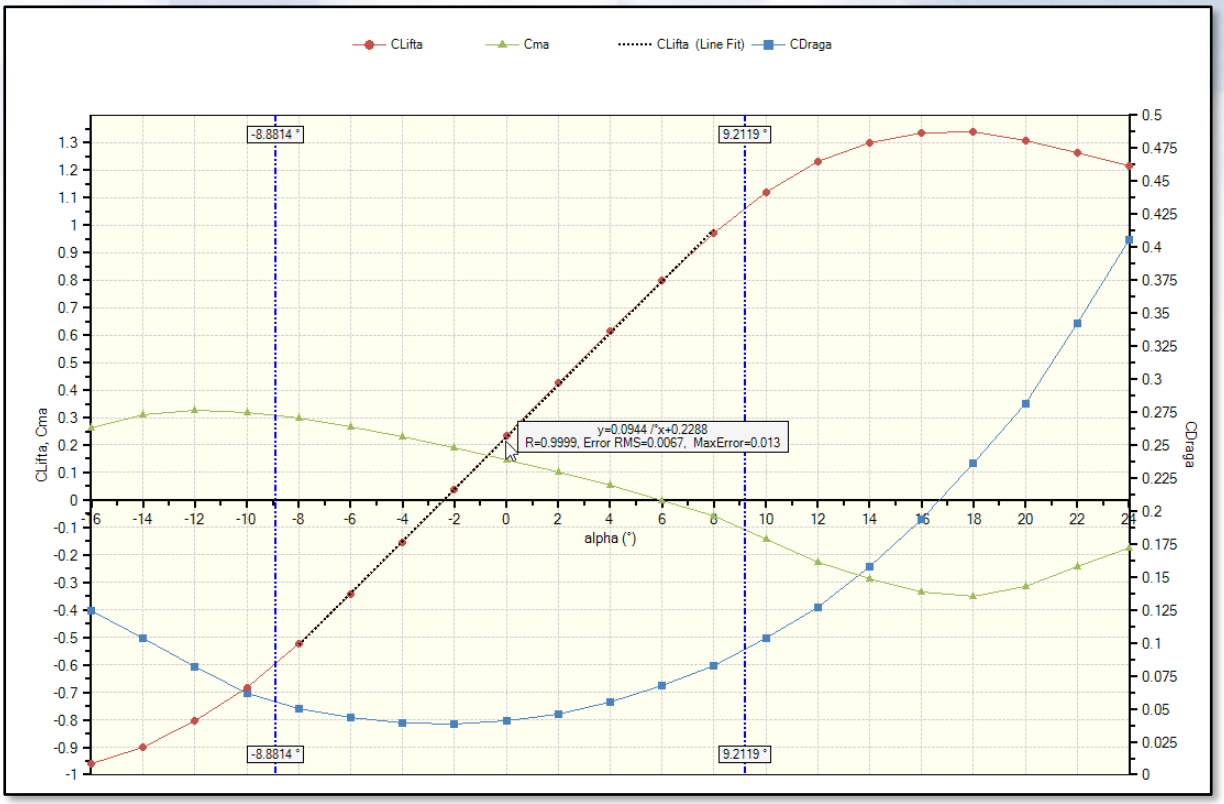
Other updated internal features include:

- The units system has been updated allowing for automatic generation of combined parameter units.
- Clearer and expanded views of dataset information in the properties window.
- Improved dataset filtering and memory retention of previous filters

J2 VISUALIZE

J2 Visualise is the powerful charting module for the j2 Universal Tool-Kit. The following improvements have all been developed and delivered as a direct result of user feedback:

- A series of default templates for each chart type have been created this means that different core styles can be applied individually for Trim, Response, and Linear Charts.
- It is now possible to copy all series data, so that where there are charts split into different groups and series, all data can be copied in a single mouse click.
- J2 have added a function fit capability which enables users to fit lines, exponential curves, and damped cosine curves (level and sloped) to data. This can provide information regarding the gradient, delay and oscillation characteristics (damping, frequency etc.) of data.



Evaluating Gradients with a Straight Line Fit

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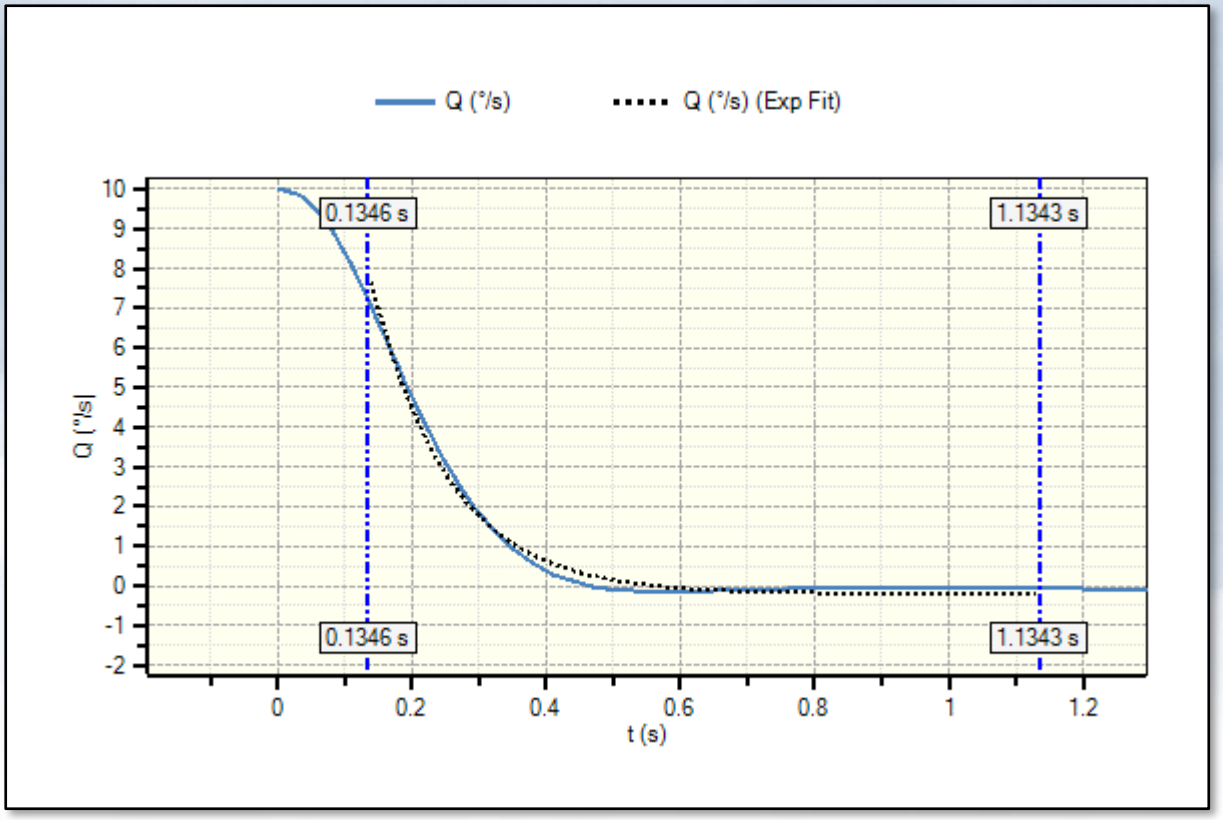
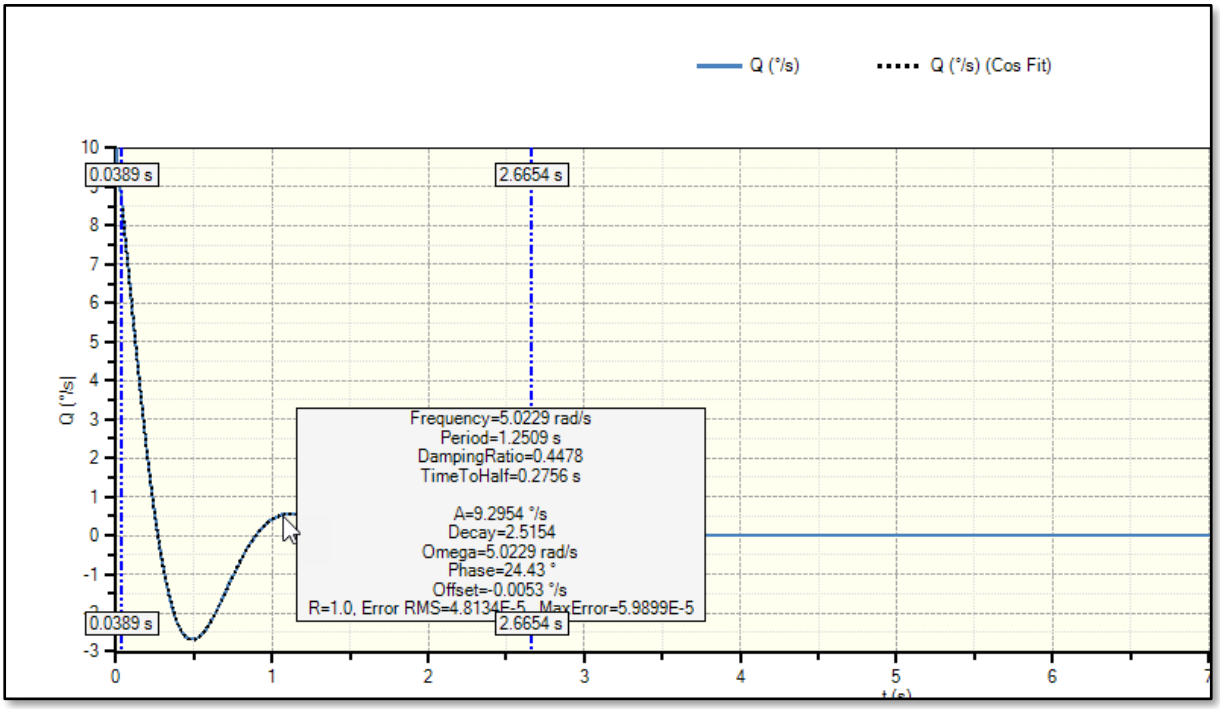
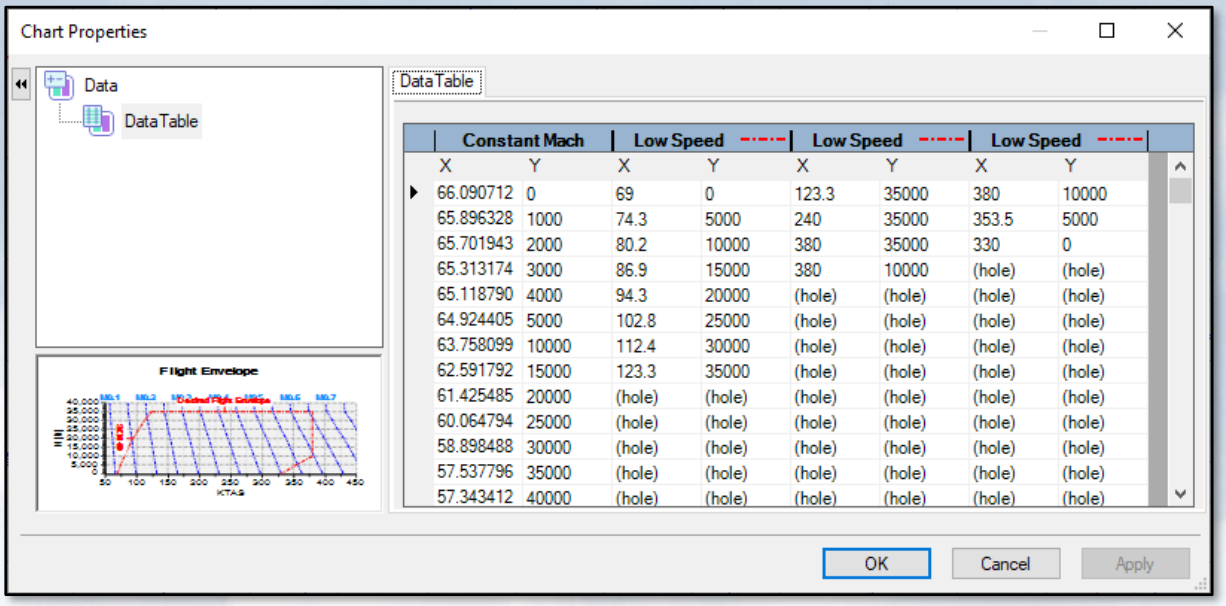


Looking at Damping with an Exponential Fit



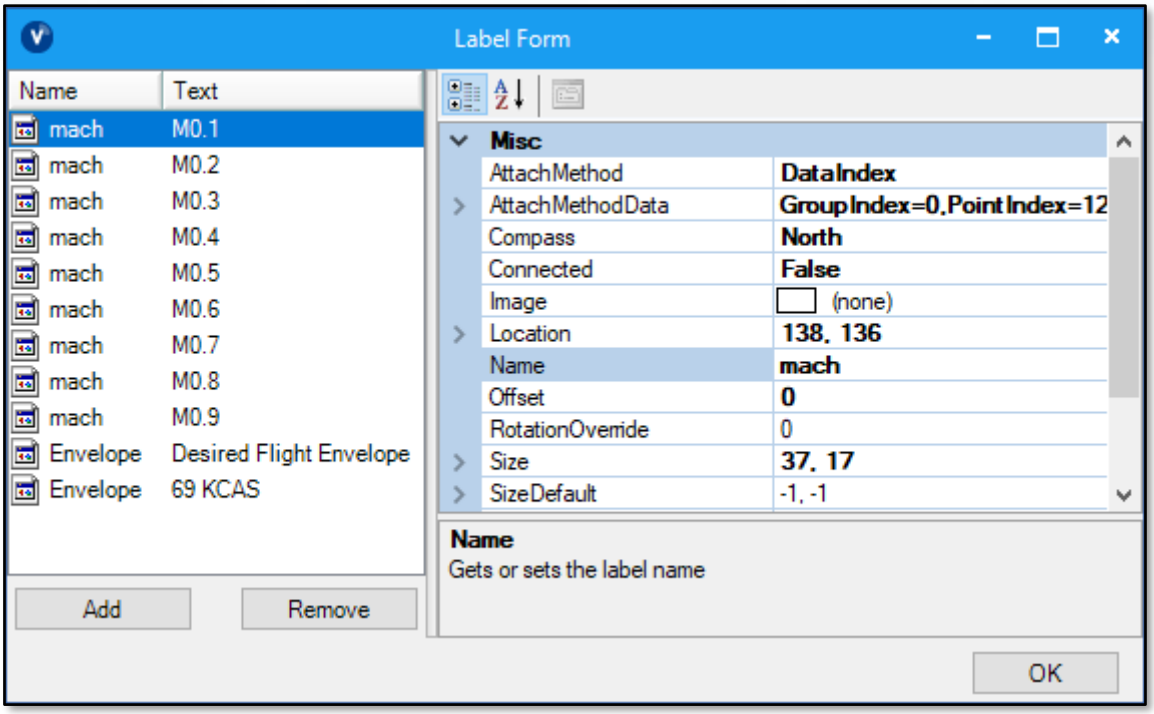
Identifying Frequency and Damping with a Cosine Fit

- User can now add boundaries and labels through the GUI

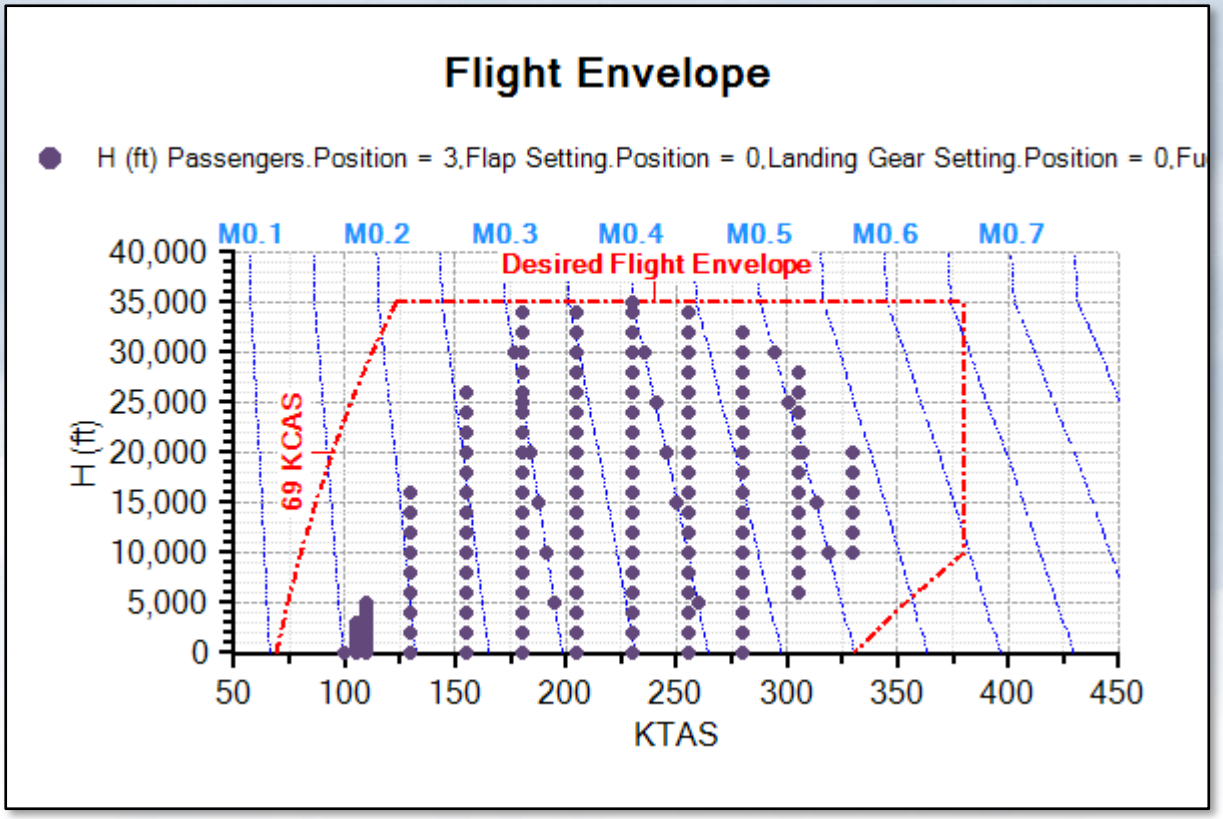


Constant Mach		Low Speed		Low Speed		Low Speed	
X	Y	X	Y	X	Y	X	Y
66.090712	0	69	0	123.3	35000	380	10000
65.896328	1000	74.3	5000	240	35000	353.5	5000
65.701943	2000	80.2	10000	380	35000	330	0
65.313174	3000	86.9	15000	380	10000	(hole)	(hole)
65.118790	4000	94.3	20000	(hole)	(hole)	(hole)	(hole)
64.924405	5000	102.8	25000	(hole)	(hole)	(hole)	(hole)
63.758099	10000	112.4	30000	(hole)	(hole)	(hole)	(hole)
62.591792	15000	123.3	35000	(hole)	(hole)	(hole)	(hole)
61.425485	20000	(hole)	(hole)	(hole)	(hole)	(hole)	(hole)
60.064794	25000	(hole)	(hole)	(hole)	(hole)	(hole)	(hole)
58.898488	30000	(hole)	(hole)	(hole)	(hole)	(hole)	(hole)
57.537796	35000	(hole)	(hole)	(hole)	(hole)	(hole)	(hole)
57.343412	40000	(hole)	(hole)	(hole)	(hole)	(hole)	(hole)

Defining Boundaries for a Chart



Adding Labels to a Chart



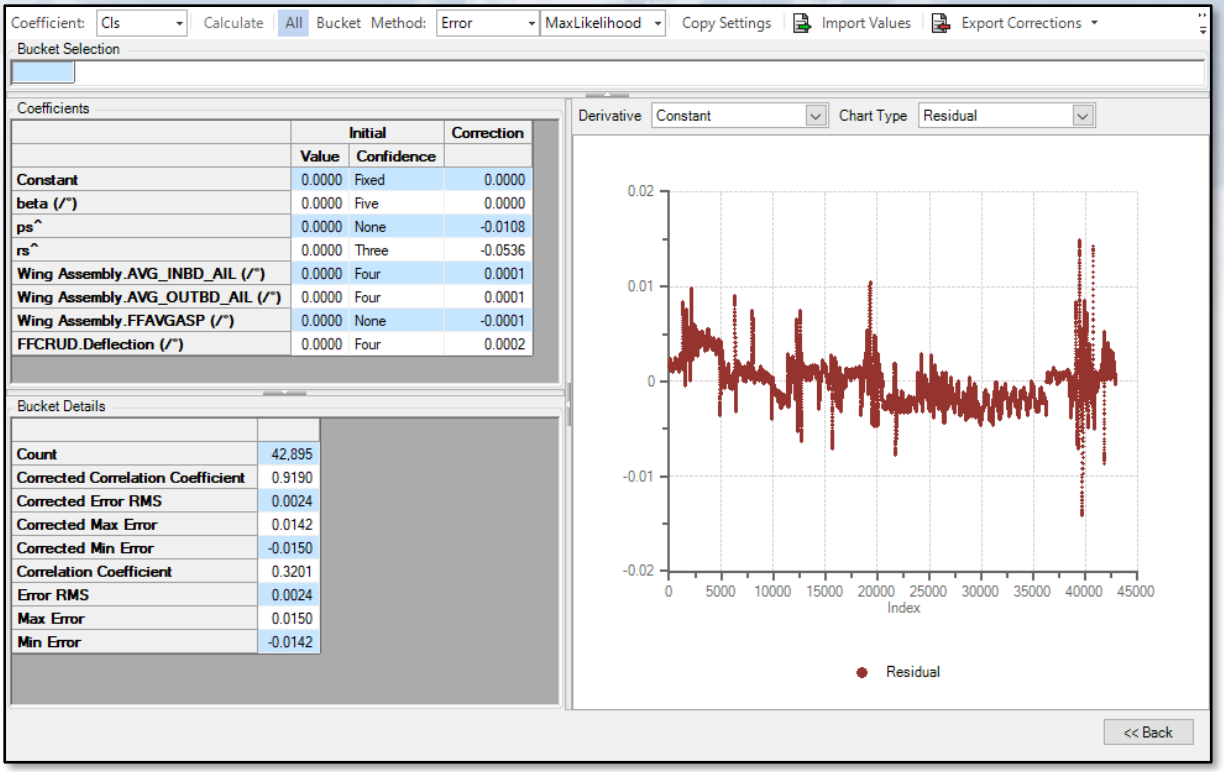
Resulting Chart with Boundaries and Labels

In addition there have been minor bug fixes including the ability to run traces on Matlab Analyses.

J2 FLIGHT

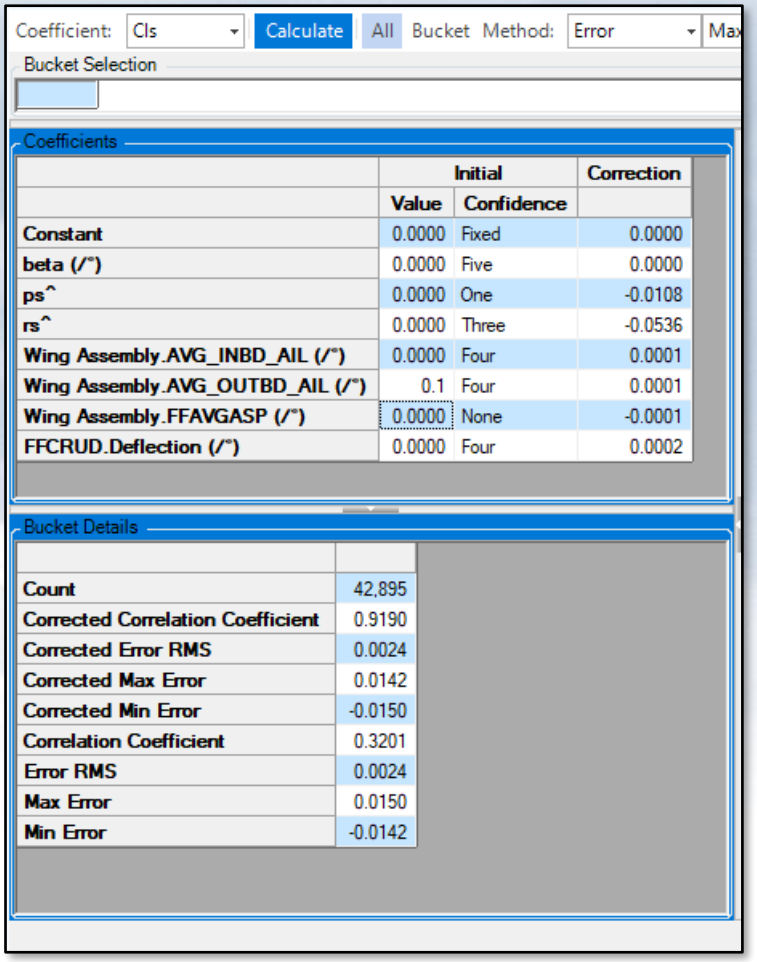
The powerful j2 Flight module, now being used globally replacing older legacy methodology and flight test data matching processes, also sees some further updates and enhancements. These changes are again as a direct response to user comments and requests.

Residual information is displayed in regression to provide further detail of the accuracy of the corrections this ensure that too accurate a solution is not being sought when the solutions fits within the maximum allowed residual values.



Error and Residual Values to Improve Matching

When making changes to values and confidence levels during Maximum Likelihood analysis there was a continual re-calculation for each change. This could cause delays when working with large quantities of tests (and subsequent data points). A calculate button has now been added so that multiple changes can be made before the user then selects to re-run the calculations. This user requested update can save a significant amount of set-up and processing time.

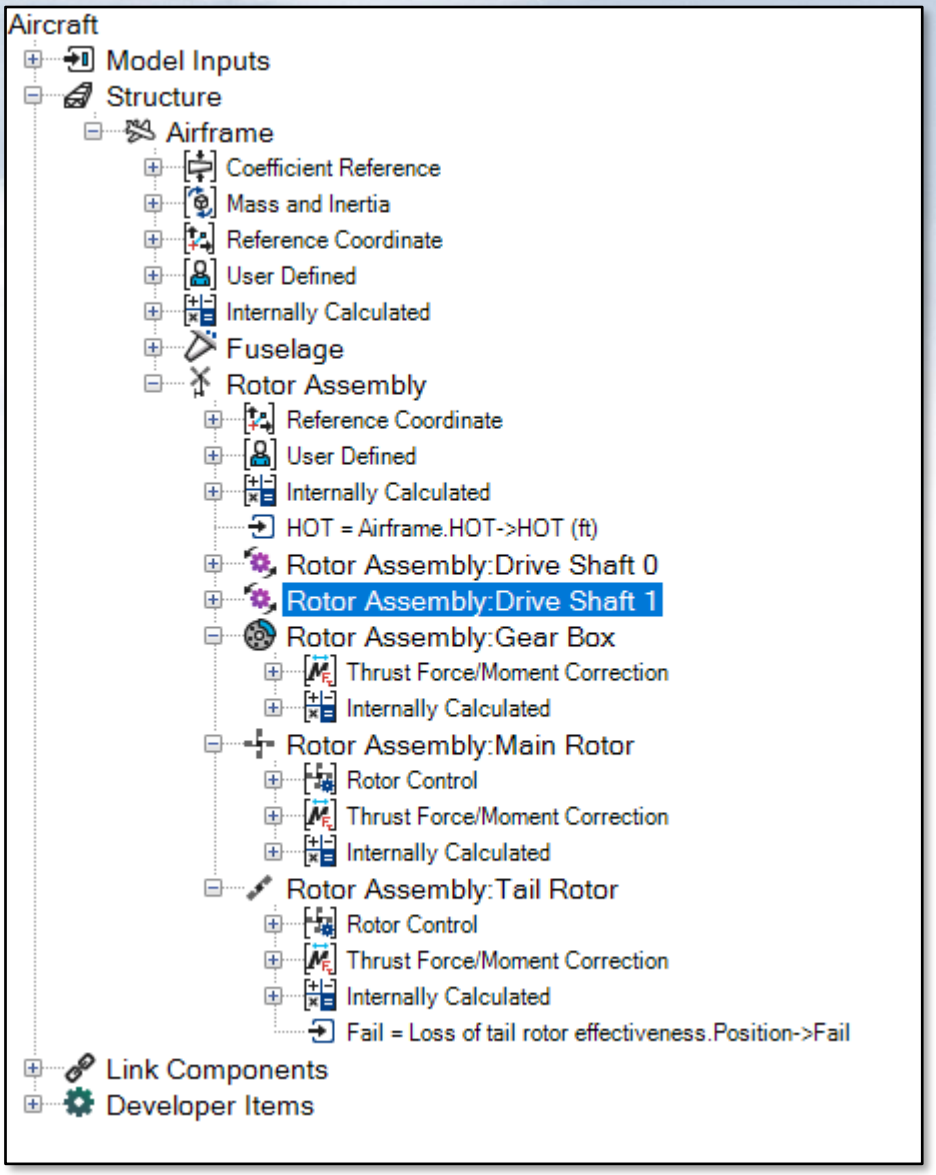


Enabling Calculate When Changes are Made

Further efficiency improvements have also led to an 30% increase in the processing speed.

J2 ROTARY

The introduction of j2 Rotary is a new module for the j2 Universal Tool-Kit. Designed specifically to meet the demands of high fidelity modelling in rotary applications and already fully commercial, j2 Rotary has its own blade element rotor model (BERM) or can interface with any other client specific BERM if required.



Adding a Rotor Assembly to Create a Rotary Wing Aircraft Model

Fuselage and Empennage are added into the model using Stripped Items through j2 Elements. This enables the addition of Dynamic Pressure Loss factors and the inclusion of the downwash characteristics to be added.

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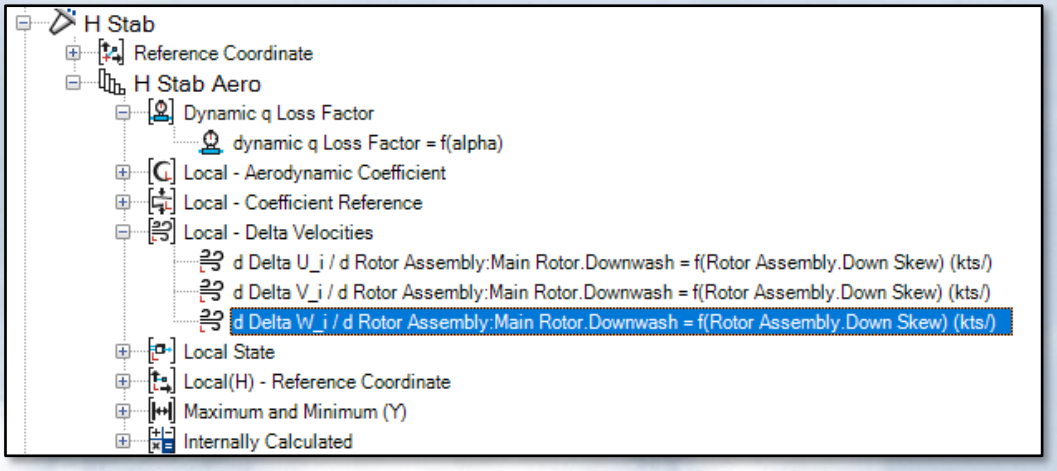
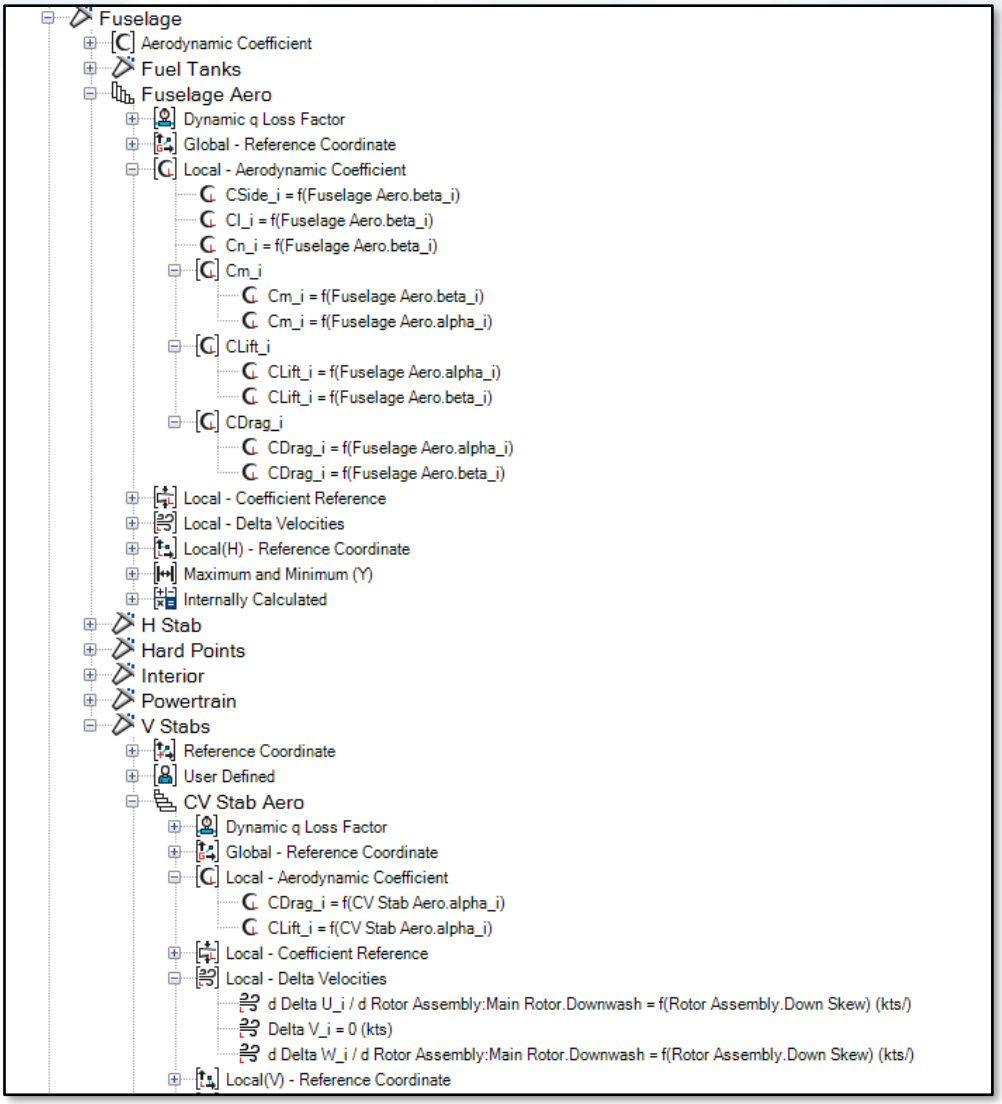


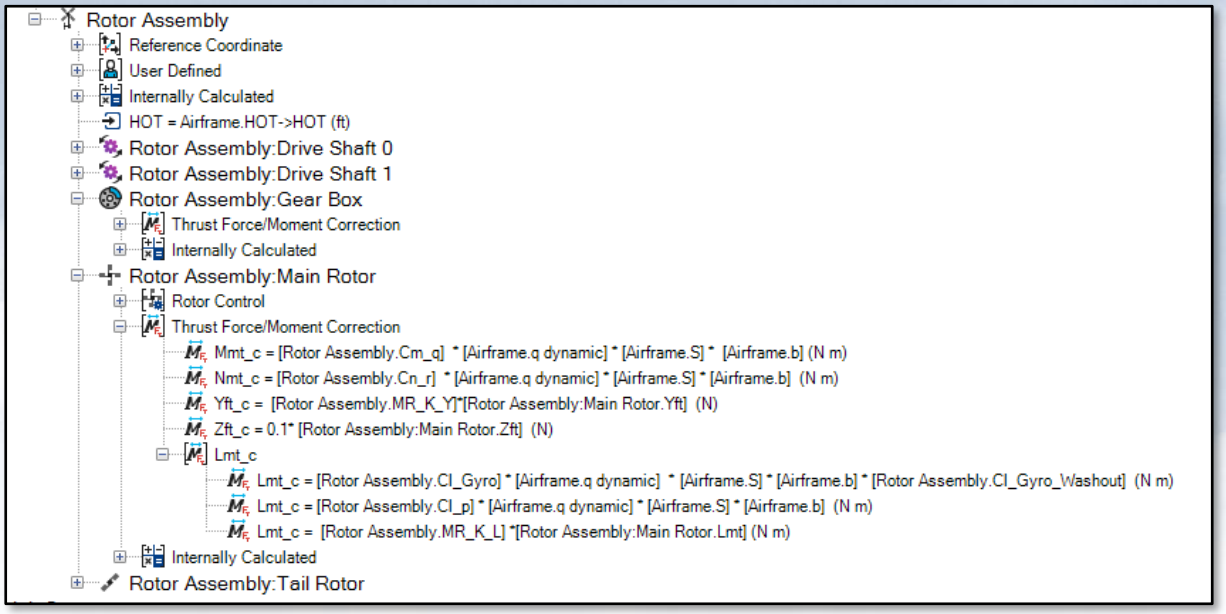
Adding Downwash Velocity and Skew Contributions to Stripped Velocities

The downwash velocity contributions are then combined with the motion of the aircraft, free stream velocities and atmospheric velocities to produce a local angle of attack and sideslip for each individual component which can then be used on the empennage and fuselage aerodynamics.



Coefficients functions of the Local Angles of Attack

J2 Rotary also allows the user to tune the rotors separately from the aerodynamics of the fuselage, providing rotary models that can accommodate the most challenging of manoeuvres required by the end user and the regulator.

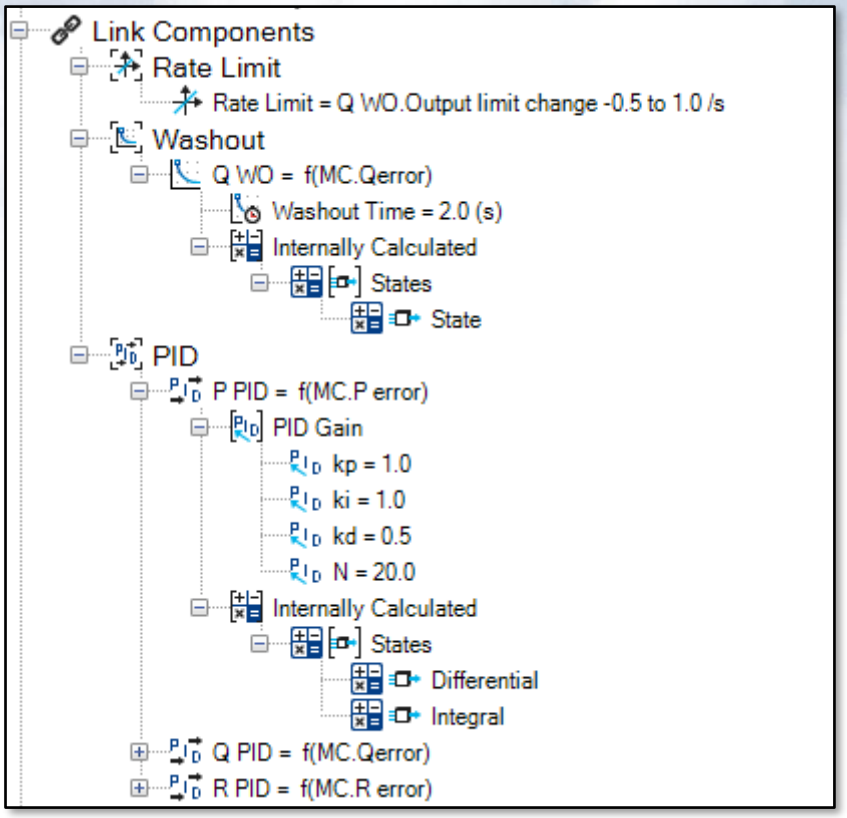


Rotor Corrections

J2 BUILDER

The j2 builder module, enabling users to build their own models from scratch from any data source with/without OEM data. As well as a new look provided by the update of over 150 icons, there are some additional features.

- Additional Link Items have been added to allow basic control system development all within the j2 model without having to integrated with external tools or components. These include
  - Proportional + Integral + Differential Controllers
  - Washout Filters
  - Rate limiters



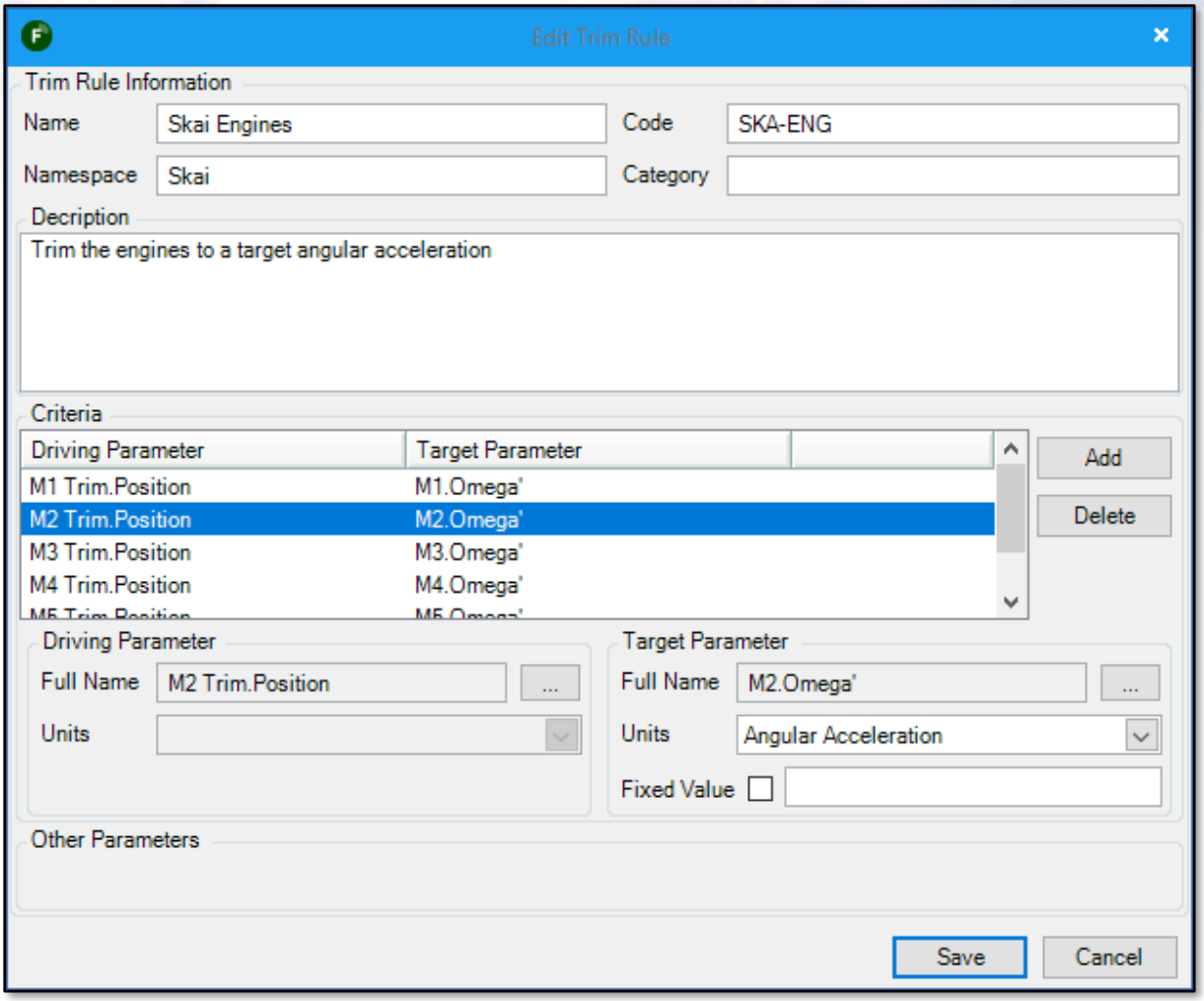
- Updates to the Parent/Child Relationships on the model hierarchy allows for a more expansive model structure, adding fidelity and detail.
- Improved Model optimisation means that objects are better sequenced in calculation order. This reduces the number of times the convergence loop is called and further speeding up the calculation process.

J2 FREEDOM

Most improvements to j2 Freedom are all internal to improve the core calculation engine of the j2 Universal Tool-Kit. These include:

- Automatic trimming of PID and Washout. With the additional states that are part of the PID and Washout components, these need to be trimmed. However, there is no requirement to create additional trim rules as these will be managed automatically to set the rates of the states to 0.
- Improved processing speed. Further threading and internal calculation techniques have enabled the processing to improve by another 25%.
- Additional debugging information to help with understanding analysis and results.

Along with new icons, the GUI changes includes the making of the Trim rule creation dialogue box more intuitive.



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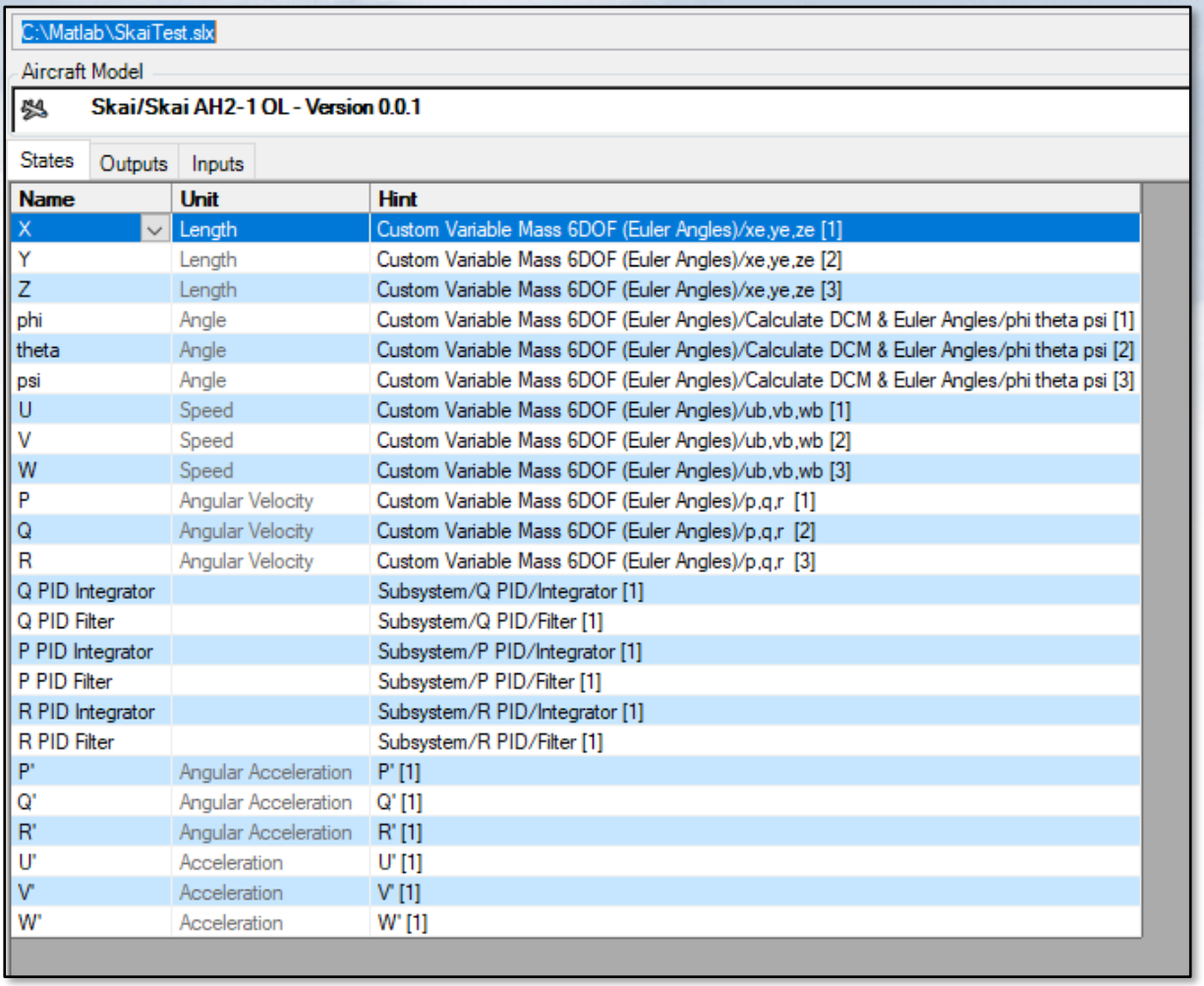
J2 MATLAB TOOLBOX

J2 have moved away from using the COM interface for links into the j2 Matlab Toolbox. By moving away from COM the installation is significantly improved and the interaction is far more robust and stable. Updates to the system enable internal states from controllers to be mapped into the j2 Aircraft Matlab Model.



Name	Unit	Hint
X	Length	Custom Variable Mass 6DOF (Euler Angles)/xe,ye,ze [1]
Y	Length	Custom Variable Mass 6DOF (Euler Angles)/xe,ye,ze [2]
Z	Length	Custom Variable Mass 6DOF (Euler Angles)/xe,ye,ze [3]
phi	Angle	Custom Variable Mass 6DOF (Euler Angles)/Calculate DCM & Euler Angles/phi theta psi [1]
theta	Angle	Custom Variable Mass 6DOF (Euler Angles)/Calculate DCM & Euler Angles/phi theta psi [2]
psi	Angle	Custom Variable Mass 6DOF (Euler Angles)/Calculate DCM & Euler Angles/phi theta psi [3]
U	Speed	Custom Variable Mass 6DOF (Euler Angles)/ub,vb,wb [1]
V	Speed	Custom Variable Mass 6DOF (Euler Angles)/ub,vb,wb [2]
W	Speed	Custom Variable Mass 6DOF (Euler Angles)/ub,vb,wb [3]
P	Angular Velocity	Custom Variable Mass 6DOF (Euler Angles)/p,q,r [1]
Q	Angular Velocity	Custom Variable Mass 6DOF (Euler Angles)/p,q,r [2]
R	Angular Velocity	Custom Variable Mass 6DOF (Euler Angles)/p,q,r [3]
Q PID Integrator		Subsystem/Q PID/Integrator [1]
Q PID Filter		Subsystem/Q PID/Filter [1]
P PID Integrator		Subsystem/P PID/Integrator [1]
P PID Filter		Subsystem/P PID/Filter [1]
R PID Integrator		Subsystem/R PID/Integrator [1]
R PID Filter		Subsystem/R PID/Filter [1]
P'	Angular Acceleration	P' [1]
Q'	Angular Acceleration	Q' [1]
R'	Angular Acceleration	R' [1]
U'	Acceleration	U' [1]
V'	Acceleration	V' [1]
W'	Acceleration	W' [1]

Additional States from Simulink PID

Initial Conditions can be added to model inputs to support the process of trimming.

C:\Matlab\SkaiTest.slx

Aircraft Model

Skai/Skai AH2-1 OL - Version 0.0.1

States | Outputs | Inputs

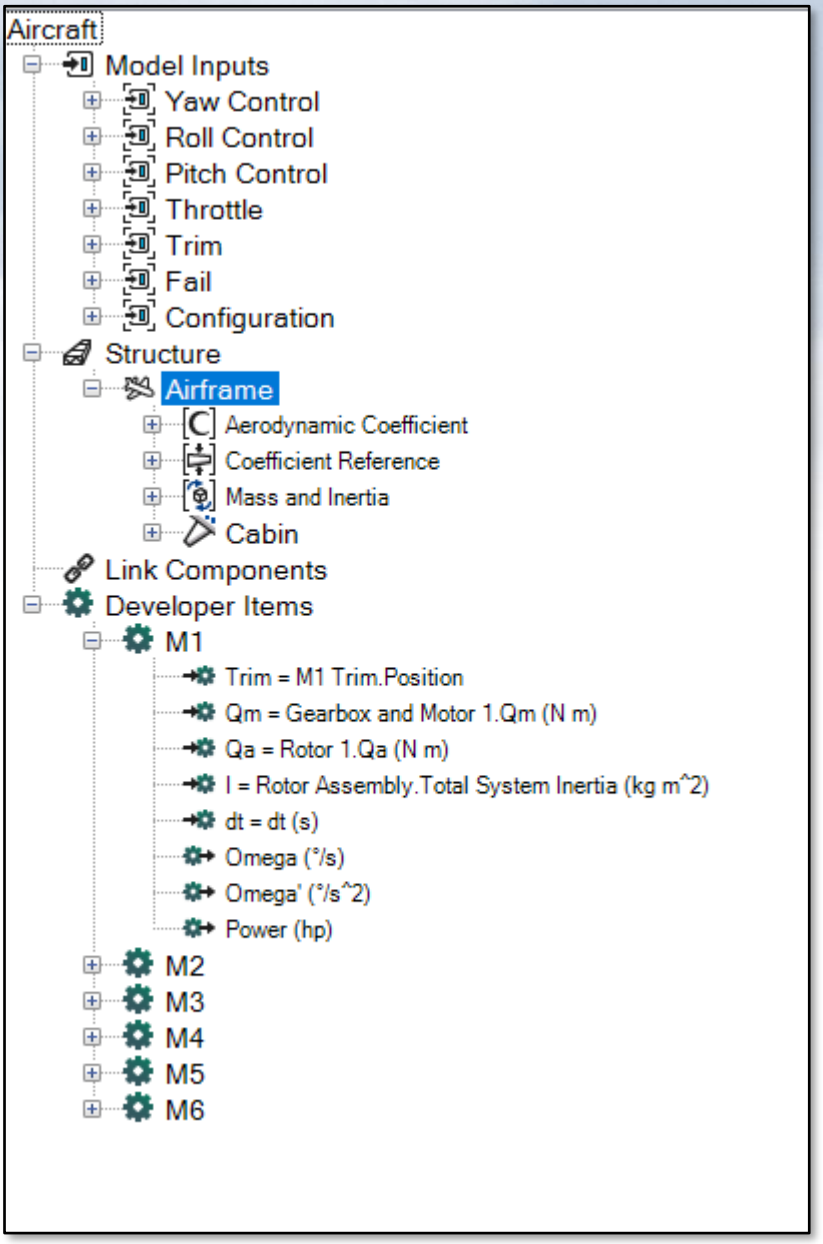
Name	Unit	Hint	Inital Value
Fuel Tank ID.Position		Fuel Tank ID [1]	0
Fuel Volume (L).Position		Fuel Volume (L) [1]	0
M1 Trim.Position		M1 Trim [1]	100
M2 Trim.Position		M2 Trim [1]	100
M3 Trim.Position		M3 Trim [1]	100
M4 Trim.Position		M4 Trim [1]	100
M5 Trim.Position		M5 Trim [1]	100
M6 Trim.Position		M6 Trim [1]	100
Payload (lb).Position		Payload (lb) [1]	
Payload Location (in).Position		Payload Location [1]	
Rotor ID.Position		Rotor ID [1]	
Pilot Throttle.Position		Pilot Throttle [1]	
Pitch Stick.Position		Pitch Stick [1]	
Roll Stick.Position		Roll Stick [1]	
Rudder Pedal.Position		Rudder Pedal [1]	
M1 Fail.Position		Faiils [1]	
M2 Fail.Position		Faiils [2]	
M3 Fail.Position		Faiils [3]	
M4 Fail.Position		Faiils [4]	
M5 Fail.Position		Faiils [5]	
M6 Fail.Position		Faiils [6]	

Setting the Initial Start Points for Trimming

Some changes to internal Matlab files have also resulted in a speed up in processing between j2 and Matlab of up to 90%.

J2 DEVELOPER

Change the developer item inputs & outputs without needing to disconnect the developer item first. Improved interfacing to minimise the possibility of non-convergence. Additional method to identify when a convergence loop has started.



Connecting Inputs and Outputs to a j2 Developer Item

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