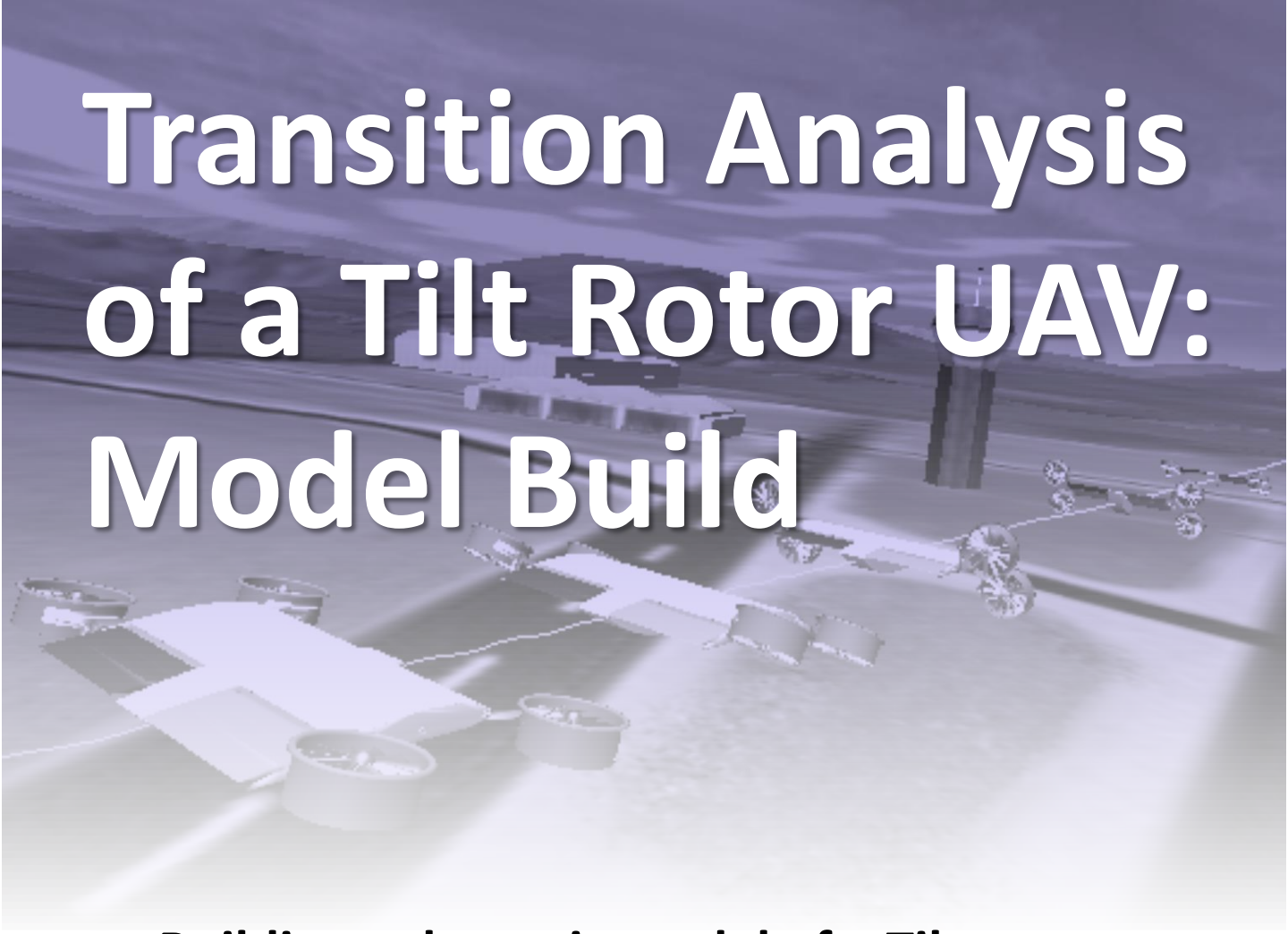
Transition Analysis of a Tilt Rotor UAV: Model Build



Building a dynamic model of a Tilt Rotor UAV complete with variations in engine thrust location and centre of gravity and payload using the j2 Universal Tool-Kit

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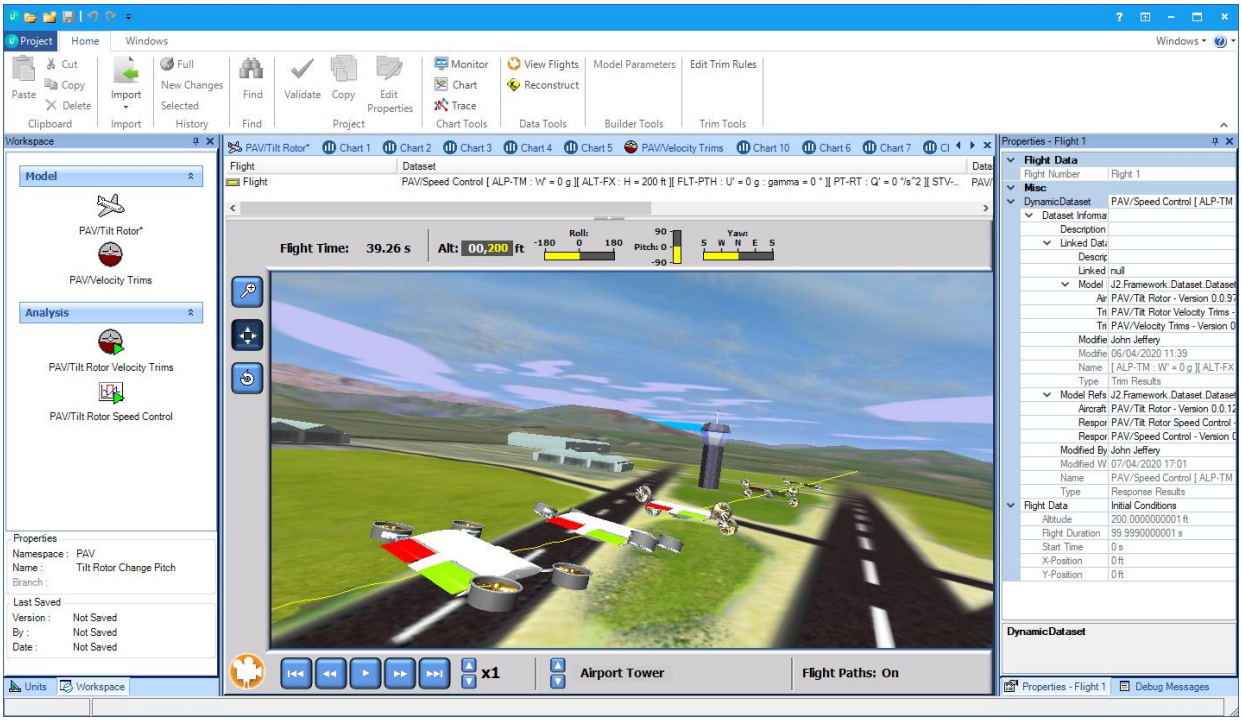
The Challenges

When considering PAV's and eVTOL aircraft, there is a critical phase in the flight path as the aircraft transitions from hover/vertical flight into forwards flight.

Whether this transition is through the tilting of the complete aircraft, or the change in orientation of the engines and the balancing of thrust as in a tilt rotor, it is important to have an understanding of the aircraft behaviour and the blending/balancing of the thrust and orientation in order to evaluate and further develop the Automatic Flight Control System (AFCS).



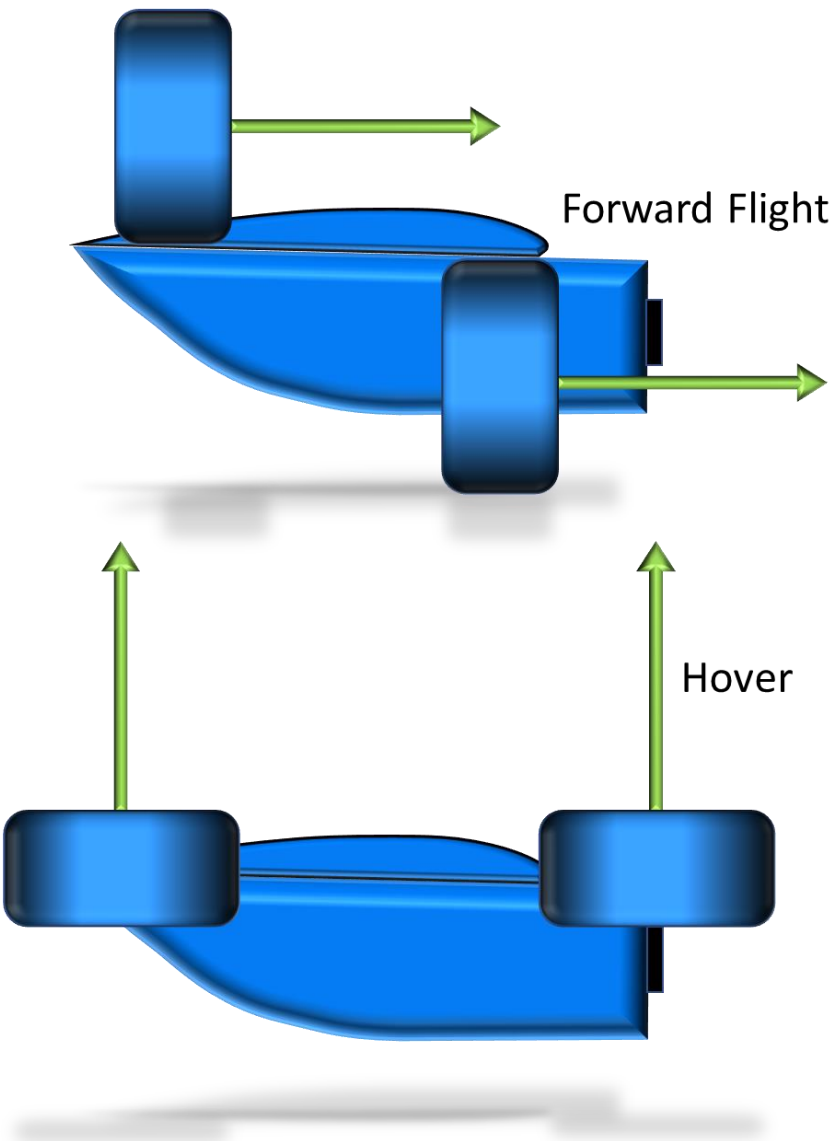
The j2 Universal Tool-Kit was used to build a complete dynamic model of a tilt rotor UAV complete with variations in engine thrust location and centre of gravity.

The Aircraft

- **Tilt-Rotor UAV**
- **Rectangular Wing with a Fuselage underneath**
- **4 Ducted Propellers located at each corner.**
- **Thrust Vector and Thrust Location Changes during rotation**

The change in engine location enables thrust differential to be used to assist stability e.g. in forward flight the engines thrust lines are located above and below the CG.

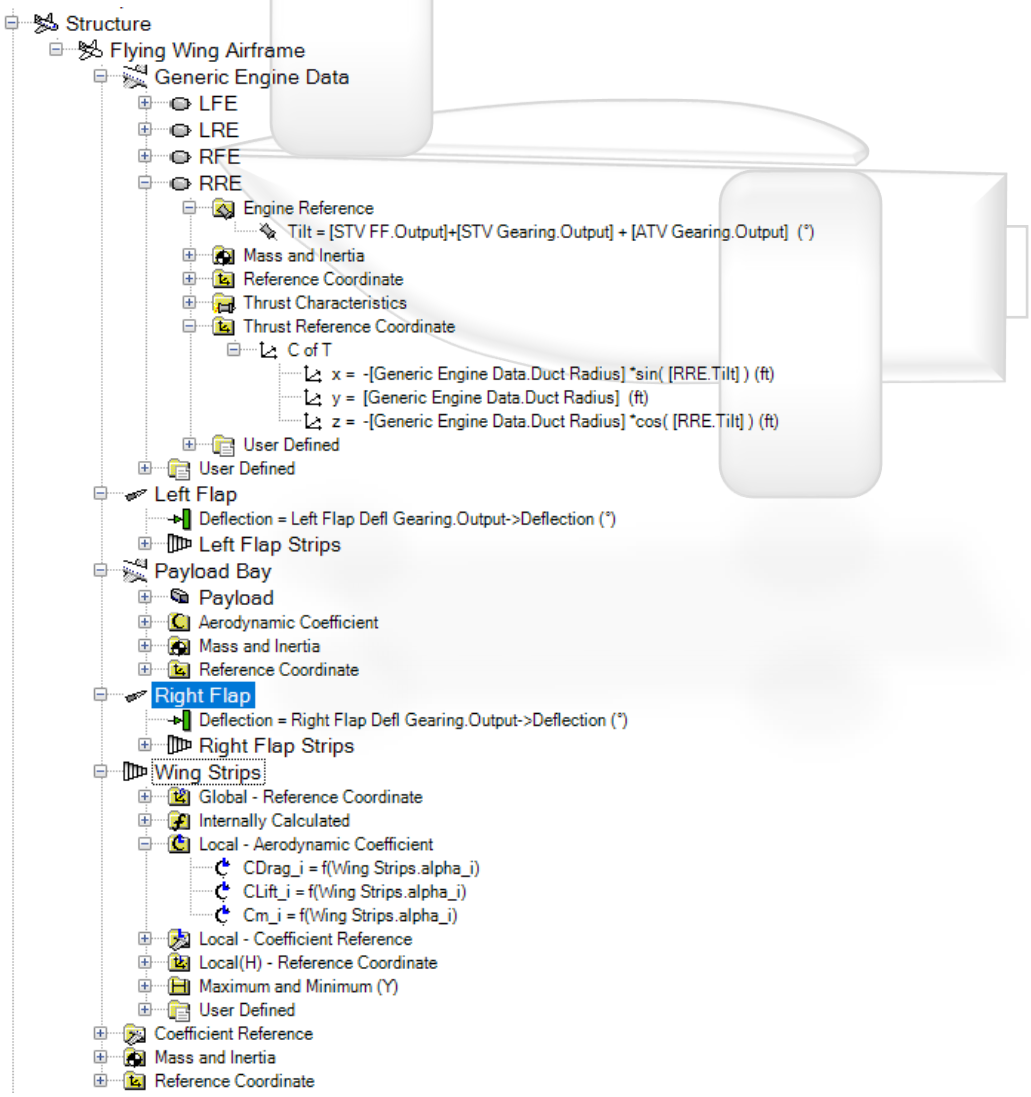
In hover, the engine thrust lines are separated further forward and aft of the cg giving a larger moment arm and a more stable platform.



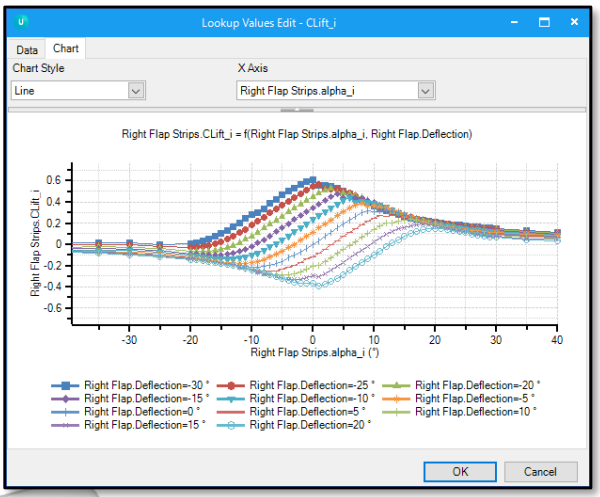
Model Building

- **Graphical Model Build Environment**
- **Use Pre-Defined Components**
- **Software Calculates Totals**
- **Automatic Thrust Vector Contributions**
- **Variable Mass and CG**
- **NO Coding, NO Script Writing**

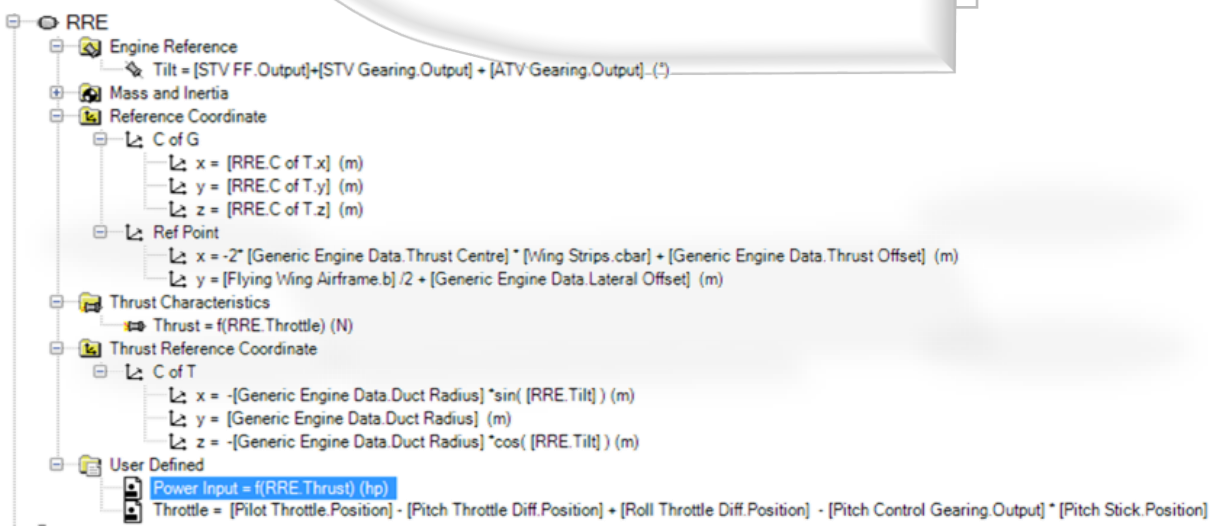
The aircraft model is constructed by building up the hierarchy of components to mimic the aircraft's structure using the Graphical Interface. Each component can be given a reference location and, aerodynamic location, mass and inertia. The j2 software can then automatically calculate all the resultant forces and moments acting on the aircraft.



Aerodynamic data can be added using the integrated Aerodynamic Strip Theory contained within the **j2 Elements** plug-in. These items are added into the hierarchy and their geometry entered to build up a profile of the lifting surfaces. The aerodynamics of the lifting surfaces added and the software uses these to calculate the total values for the aircraft based upon local conditions. Automatic calculation of dynamic derivatives



Each engine has a defined Reference Location. The Thrust Angle is calculated for each engine from the Symmetric and Symmetric Thrust Vector Angles. As the engines move, so the Centre of Thrust and Centre of Gravity move.



As everything has been located around the airframe, throughout any analysis, the changes in CG, thrust orientation and location, and their impact on the overall behaviour are calculated automatically without having to write any additional code or scripts.

The j2 Universal Tool-Kit	
j2 Universal Framework	Management System
j2 Builder	Graphical Model Building
j2 Elements	Integrated Aerodynamics
j2 Developer	External API
j2 Rotary	Integrated BERM
j2 Freedom	Static and Dynamic Analysis
j2 Flight	Flight Data Processing & Matching
j2 Classical	Classical Linear Analysis
j2 Pilot	Real-Time Flight Simulation
j2 Visualize	Charting and Templates
j2 Virtual	3-D Playback

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