



APP

**AIRCRAFT
PERFORMANCE
PROGRAM**

Introduction

APP is an aircraft-performance calculation program, specifically designed to provide a fast and easy way to evaluate aircraft performance. Another major design requirement was to impose no restriction upon the type of aircraft that can be handled by APP. Due to the simple, self-explaining user interface, no training is required to use APP and even the manual is rarely used. The program features a powerful built in post-processing and export functions to further process the data if needed.

APP can wide range of different tasks:

- Fast and easy evaluation of an aircraft design
- Comparison of different aircraft
- Competitor performance analysis
- Evaluation of design-changes
- Mission optimization
- Creating plots for flight manuals and marketing brochures
- Flight test and certification support
- Helping students to understand the impact of different parameters

APP in Italy is available from: Lista Studio srl, www.lista.it, Borgo Belvigo 33, 36016 Thiene VI

Capabilities/Functionalities

The most important capabilities and functionalities of APP:

- Computation of aircraft **point performance**
- Computation of **mission performance**
- Optimization of **mission-profiles**
- Applicable to jets, turboprops, military & civil a/c, etc.
- Easy data input and manipulation
- Built-in powerful **graphical post-processing**
- Over **60 output parameters**
- **4 unit systems** (SI, imperial, ...) for input and output
- **Export** of tables (excel) and plots (bmp, wmf)

Flight Physics/Numerics

The physical and numerical principles behind APP were chosen to achieve accurate solutions while requiring only few computational resources:

- All calculations are based on 2DOF point-mass equations
- No analytic simplifications or linearizations
- Mission integration and optimisation with Runge-Kutta (4th-order, fixed step)
- Using tabulated data depending on Altitude and Mach for thrust, C_L vs C_D , C_L vs AoA, fuel-flow, stores, ...

APP - Aircraft-Data

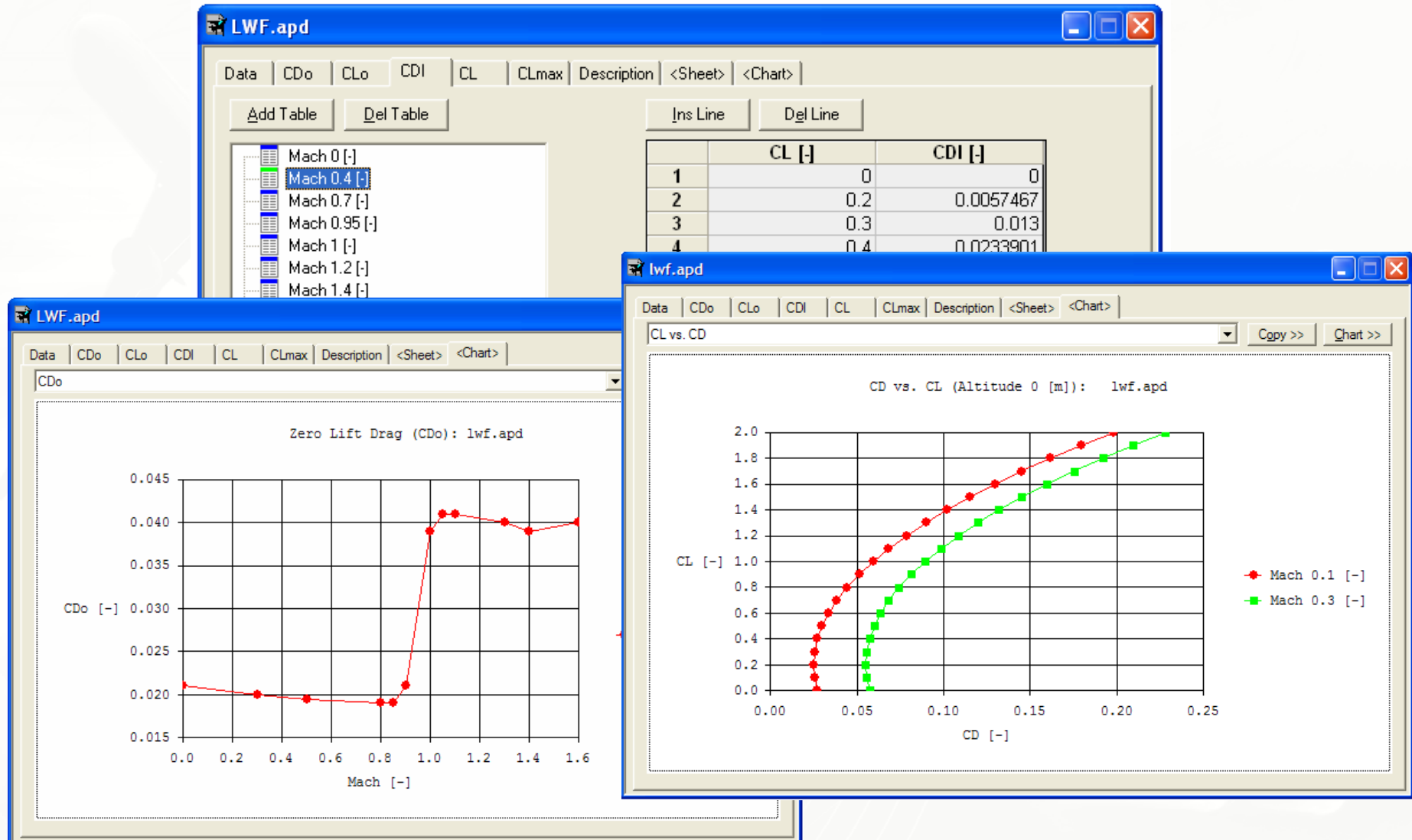
The following examples should give you an impression of the data-input interface and the level of detail possible to achieve. Shown here is the main-program window and a detailed mass break-down.

The screenshot displays the 'APP 5.10.2.1 - LWF.apc' software window. It features a menu bar (File, Edit, View, Window, Help) and a toolbar with various icons. A secondary window titled 'LWF.apc' is open, showing a 'Mass' tab with a table of aircraft mass components. The table includes input fields for various mass categories and calculated totals. The status bar at the bottom indicates 'Ready' and a 'NUM' field.

Mass	Engine	Aero	Gear	Limit	Mach Limiter	AoA-G Limiter	Description	<Sheet>	<Chart>
Structure				11023			[lbs]		
Propulsion Group				2173			[lbs]		
Equipment				373			[lbs]		
Mass Deviation				0			[lbs]	= Standard Empty	13569 [lbs]
Fixed Op. Equipment				553			[lbs]	= Empty Mass	14122 [lbs]
Unusable Fuel and Oil				93			[lbs]		
Gun				1243			[lbs]		
Removable Op. Equipment				0			[lbs]	= Basic Mass	15458 [lbs]
Usable Oil				137			[lbs]		
Crew				190			[lbs]		
Spec. Mission Equipment				0			[lbs]	= Operating Empty	15785 [lbs]
Ammunition				785			[lbs]		
Payload				13350			[lbs]	= Zero Fuel Mass	29920 [lbs]
Fuel Mass				14409			[lbs]	= Operating Mass	44329 [lbs]

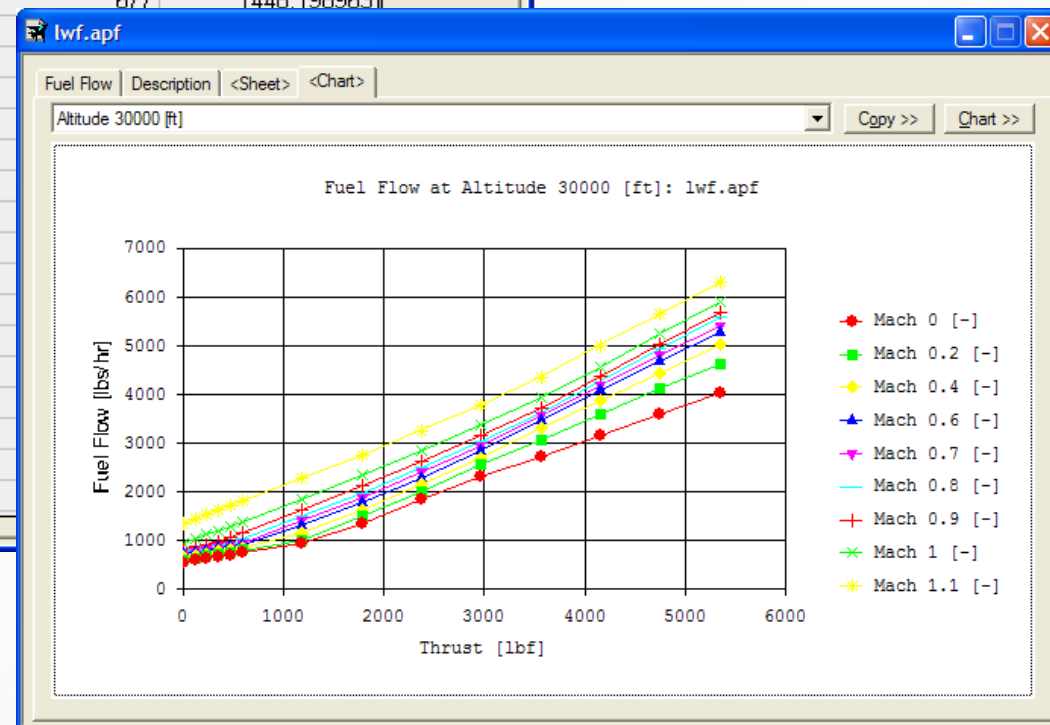
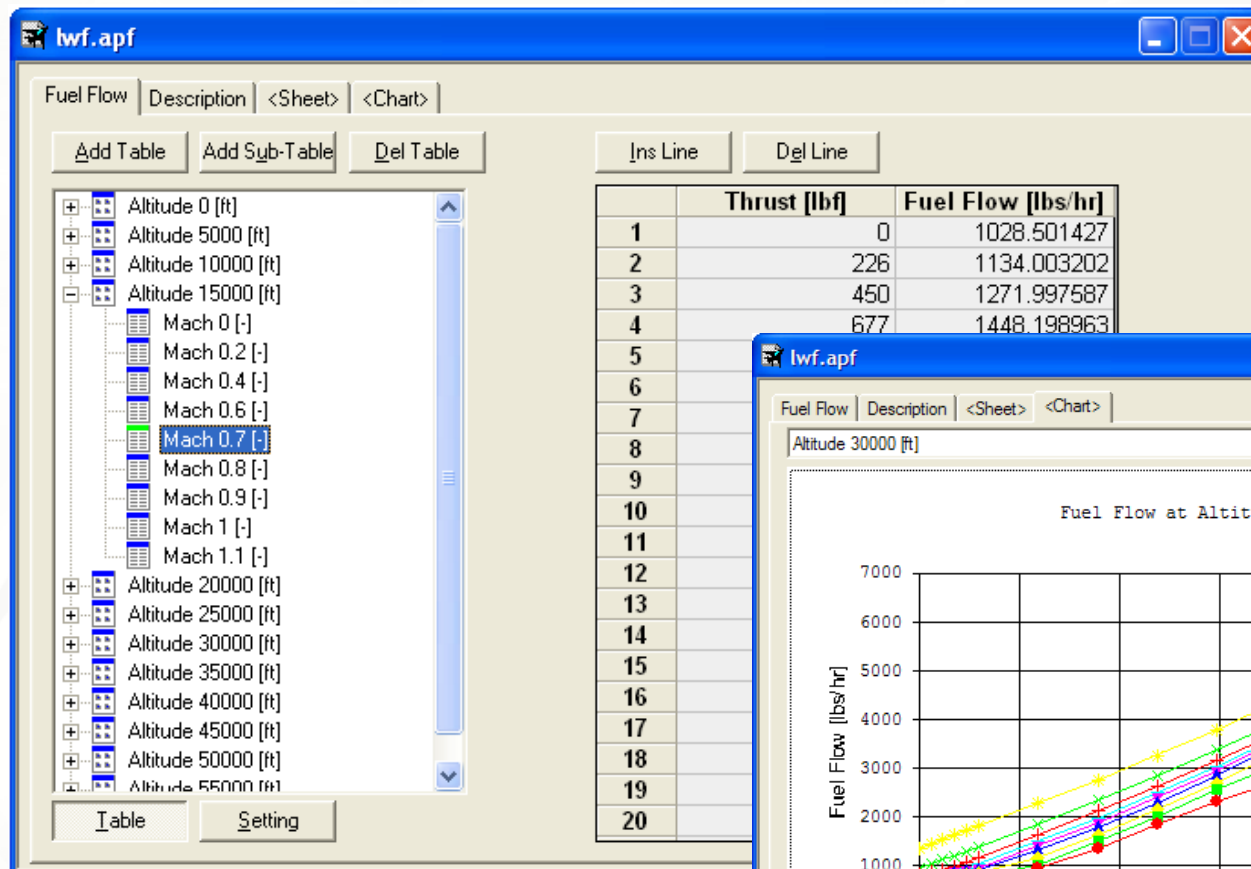
APP - Aircraft-Data

Aerodynamic data:



APP - Aircraft-Data

Fuel Flow data:



The user can choose several pre-prepared standard-charts or calculate specific performance parameters:

Performance Parameters:

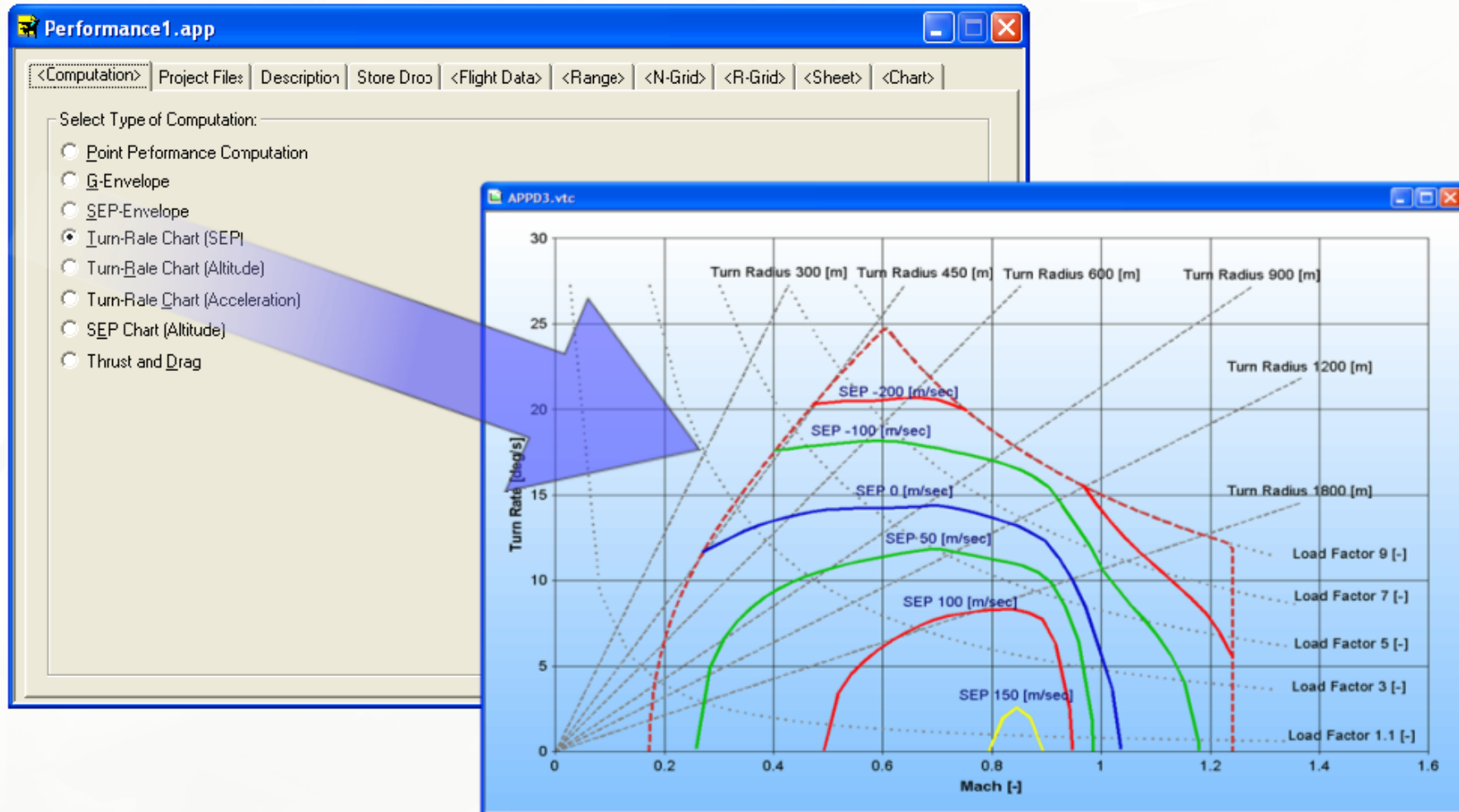
- Acceleration
- Climb (normal, best angle, best rate)
- Cruise (normal, best fuel flow, best specific range)
- Maneuver (maximum performance)
- Maximum Speed
- Stall Speed
- Specific Excess Power (SEP)
- Takeoff Acceleration

Standard Charts:

- G-Envelope
- SEP-Envelope
- Turn-Rate-Chart (const. Acc)
- Turn-Rate-Chart (const. Alt.)
- Turn-Rate-Chart (const. SEP)
- SEP-Chart (const Alt.)
- Thrust and Drag Chart

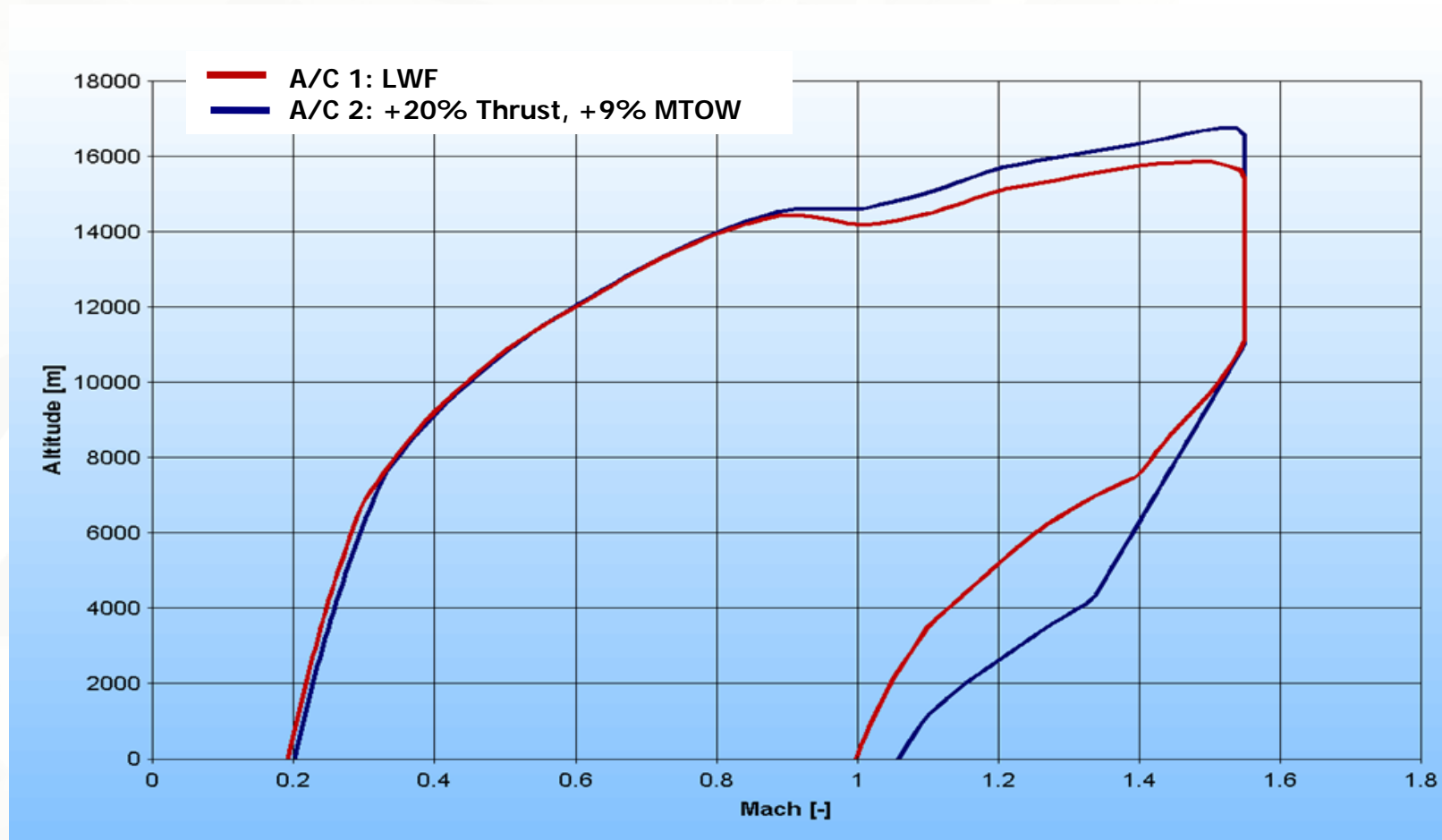
APP - Point-Performance Example

On the following pages point-performance-examples are presented, starting with a standard Turn-Rate-Chart:



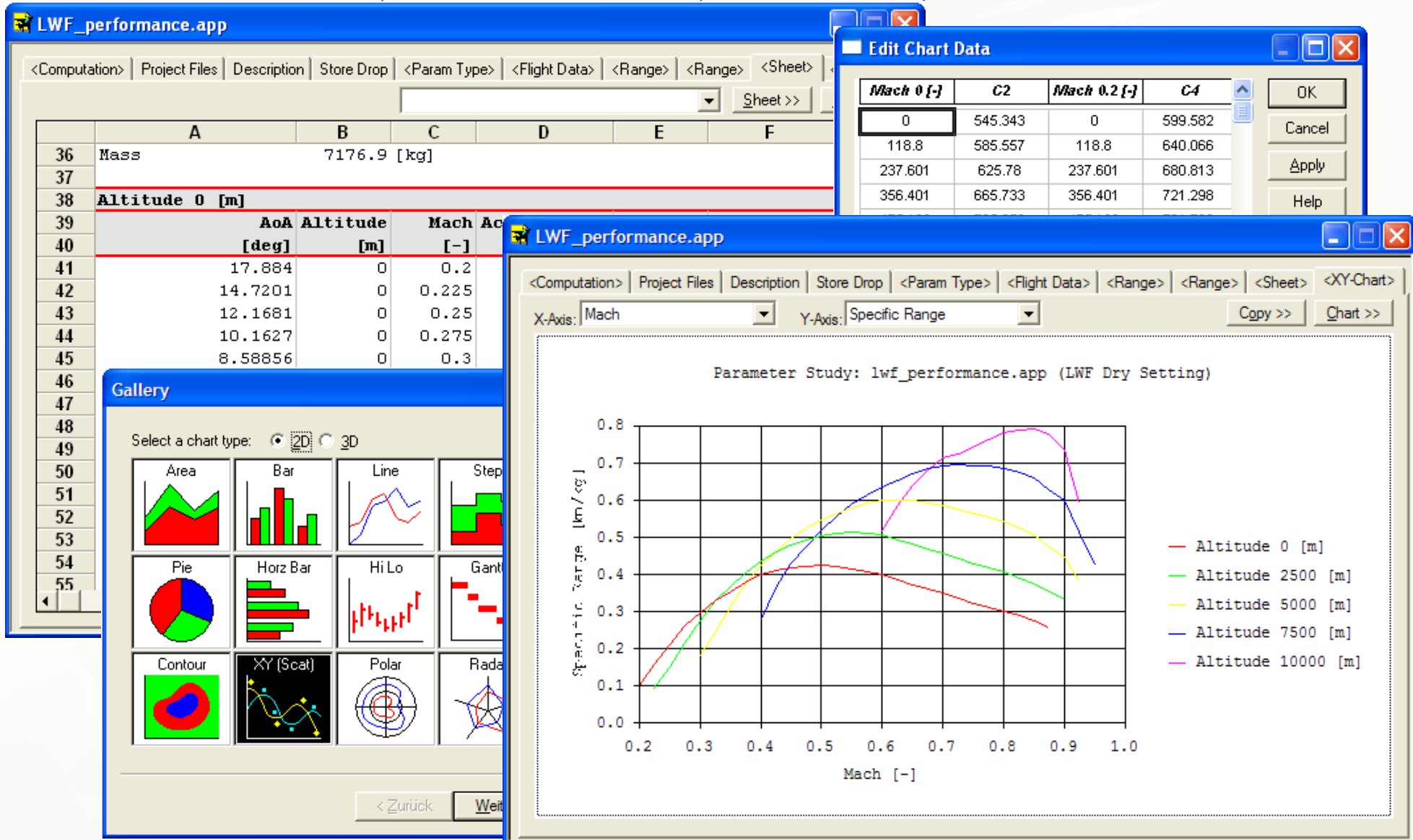
APP - Point-Performance Example

To evaluate the effects of an engine upgrade, the user just has to change the new engine-mass and specify a thrust-multiplier:



APP - Point-Performance Example

After the calculation, over 60 parameters are available to be plotted in XY-Plots or presented in tabulated form. It is



APP - Mission-Computation

APP can calculate user specified missions and optimize them. Empty Fuel-Tanks can be dropped automatically. The following segments and optimizers are available:

Segments:

- Acceleration
- Climb (best angle, best rate)
- Climb (const Ma, EAS, CAS)
- Cruise (best SR, const Ma., opt. Alt)
- Descent
- Ground Operation
- Landing Roll
- Loiter (at best FF)
- Maneuver (const N_L , max N_L)
- Refuel
- Store Drop
- Take-off
- Tank Drop

Optimizers:

- Range Optimization
- Endurance Optimization
- Maximum Operating Range Optimization

APP - Mission-Computation

To build your mission, simply choose a segment and specify the condition at which it should end. You can also specify the segment on that should be optimized by APP if you wish to do so.

Hi_i_001.apm

Optimizer Type | Project Files | Start | Segment List | Description | Optimizer | <Sheet> | <XY-Chart>

Mission Takeoff

2) Takeoff Start of F

4) Cruise at Best SR Cruise Se

6) Acceleration End of R

Start of Radius of Action (Dash In) 8) M

Cruise Segment to Optimize 11) Cruis

End of Radius of Action (Dash In) 12) C

Fuel at End of Mission 5 [%]

Fuel Mass 286.693057 [kg]

Distance at End of Mission 0 [km]

Precision of Optimizer 0.1 [-]

Hi_i_001.apm

Optimizer Type | Project Files | Start | Segment List | Description | <Sheet> | <XY-Chart>

Add Del Ins Up Dwn

Segment stops at:

Mach > 0.85 [-]

or at:

None > 0 [-]

Time Step 1 [sec]

Project for this segment:

Afterburner ☒ Integrate x-Position ☒ Integrate z-Position

Power Setting 100 [%]

Thrust 135145.8 [N]

Load Factor 1 [-]

Turn Rate 0 [deg/sec]

Climb Angle 0 [deg]

Climb Speed 0 [m/sec]

dT 0 [K]

1) Ground Operation

2) Takeoff

3) Climb at Best Angle

4) Cruise at Best SR

5) Descent

6) Acceleration

7) Cruise

8) Maneuver at Max. LF

9) Store Drop

10) Acceleration

11) Cruise

12) Climb at Mach

13) Cruise at Mach

14) Refuel

15) Climb at Best Rate

16) Cruise at Opt. Alt and Mach

17) Descent

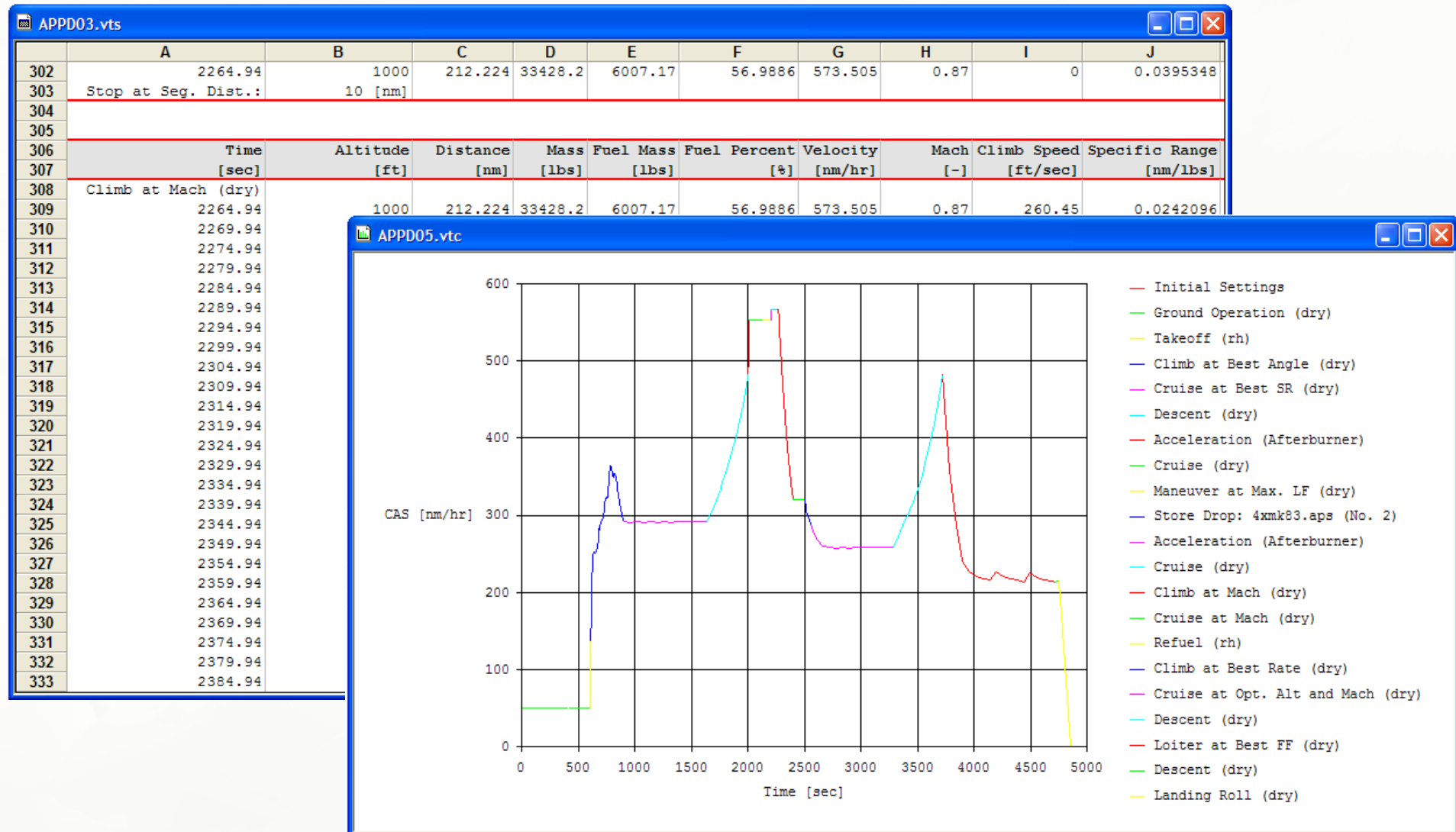
18) Loiter at Best FF

19) Descent

20) Landing Roll

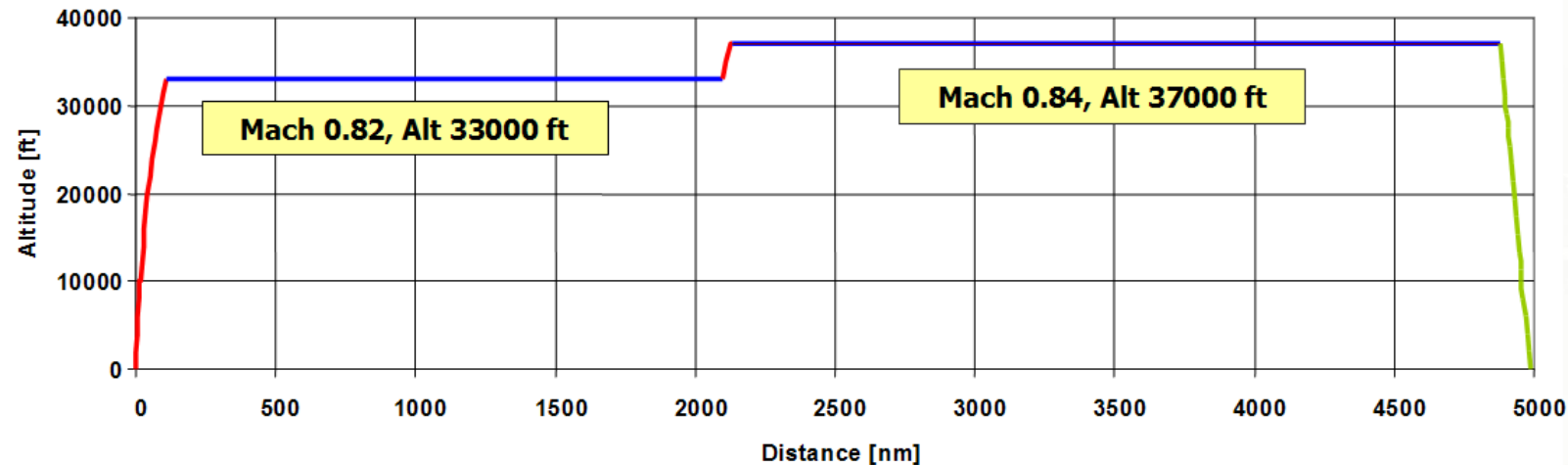
APP - Mission-Computation

The results can reviewed in tabulated form or be plotted as XY-Plots, combining any of the over 60 parameters.

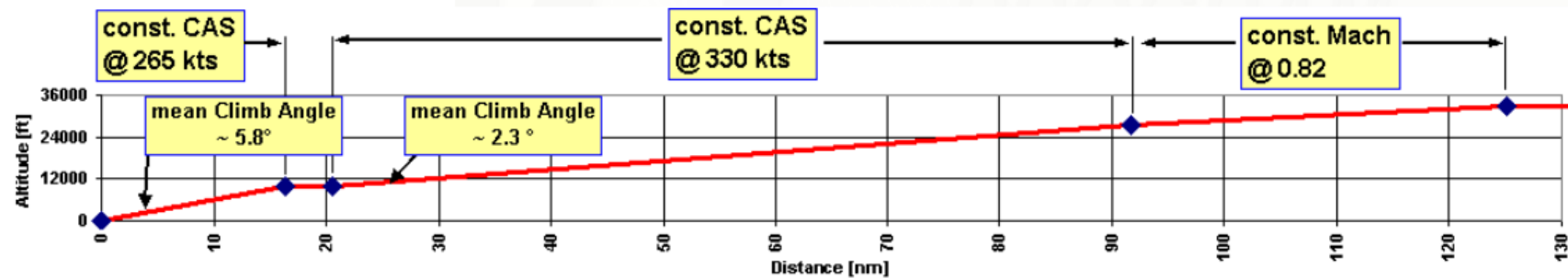


APP - Mission Example

The modular approach to define a mission enables you to easily setup complex (realistic) climb schedules:



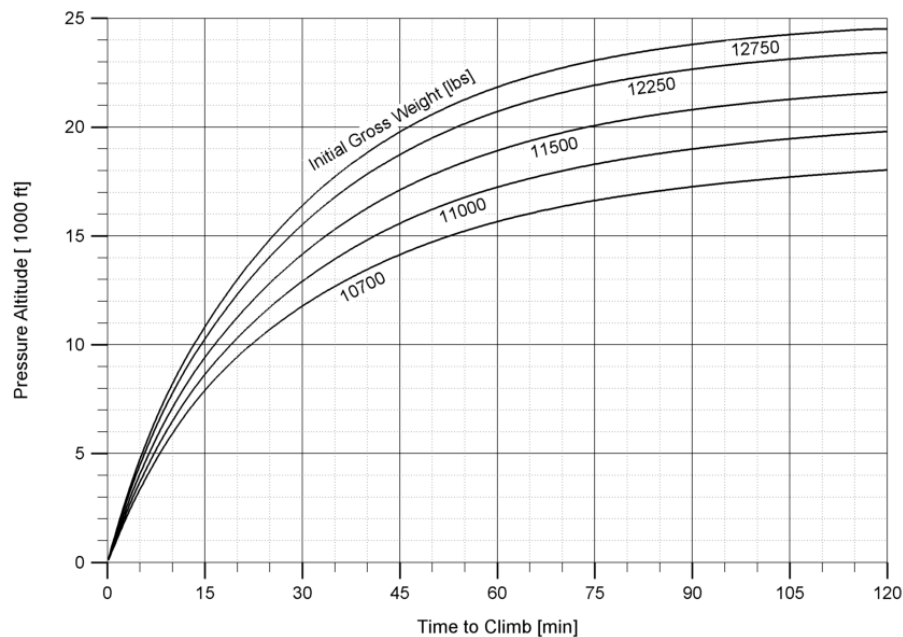
Detailed view of climb schedule:



APP - Mission Example

Due to the wide variety of charts and plots used in manuals, handbooks and so on, its not possible to have a template for all of them in APP. However, APP can significantly reduce the time required to generate such charts. The following two charts were produced by defining a mission-segment once, calculate it several times varying one parameter (payload, target altitude) and combine the results in one chart:

Time-To-Climb-Chart



Range-Payload-Diagram

