What's New In AAA?

Advanced Aircraft Analysis Version 2.2

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AIRPLANE DESIGN AND ANALYSIS

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In the long-standing tradition of maintaining customer satisfaction and developing the most intuitive and airplane design and analysis tool available, DARcorporation is proud to announce the release of **Advanced Aircraft Analysis (AAA), Version 2.2**. Those of you already familiar with the versatility and clarity of AAA will be even more pleased with the introduction of Version 2.2. New features and submodules will become quite evident to AAA users accustomed to Version 2.1 while dozens of improvements and modifications heighten the program's efficiency and precision.

Through customer feedback, AAA users have supplied ideas for new features. Some requests involve entirely new analysis modules while others seek the extension of existing ideas. All of these new features are described in Parts II and III of the User's Manual.

Section 1 shows the major enhancements made to AAA. Major enhancements are new modules and new calculations. Section 2 describes modifications to AAA. These contain changes to make the program user-friendlier and more consistent. The last section contains bug fixes. Many of these bug fixes deal with extreme cases such as division by zero or square roots of negative numbers when non-conventional configurations are designed.

Table of Contents

1. Enhancements

A module by module overview of the differences between AAA 2.1 and AAA 2.2 is listed below.

1.1 Weight

1. Refueling flight segment is now available in **Weight Sizing**,
2. The fuel used per segment is now displayed as an output in the Mission Profile Table in **Weight Sizing/Take-off Weight**.
3. A **Class II Weight/Center of Gravity** calculation has been added. Also, an option for copying Class I center of gravity locations from the Class I Detailed center of gravity tables to the Class II Empty Weight Table table has been added.

1.2 Aerodynamics

1. User defined airfoil selection is possible in airfoil maximum lift calculation.
2. The **Drag/Class II Drag/Subsonic, Transonic** and **Supersonic** submodules have been removed. The flight condition dialog is used to determine the speed regime.
3. A new module, **Drag/Class II Drag/Tailboom**, has been added.
4. A new module, **Power Effects**, has been added to calculate the changes in the horizontal tail dynamic pressure ratio and downwash angle, and in the airplane lift and moment coefficients. The calculations are applicable for a tail aft configuration with a single propeller located at the nose and in the plane of symmetry.

1.3 Geometry

1. A new module **2-Dimensional/Wing/Fuel Volume** has been added to calculate the wing maximum fuel tank volume.
2. The interface with Aero-CADD has been added.

1.4 Stability and Control

1. A new module, **Derivatives/Long.Stability/A.C. Shift/Tailbooms**, has been added.
2. Stability and Control calculations can be performed for ‘flying wings’.

1.5 Dynamics

A 'Print' button has been added in the message that displays the transfer functions in the **Dynamics/Longitudinal (Lateral-Direct.)/Transfer Function** modules.

1.6 Cost

The cost escalation factor, CEF, calculation has been updated to the year 1998.

1.7 General

1. The **Dialog Boxes** have been modified and rearranged in a more user-friendly layout. The Configuration Tab now has Configuration, Engine, Controls, Wing, Gear and Structure Dialog Boxes.

Configuration Dialog Box:	This new box contains the definition of the lifting surfaces, nacelles, stores, pylons, tailbooms, speed brake, spoiler, fuselage pressurization and hull type.
Engine Dialog Box:	The number of propellers and number of blades have been added. In addition, all the data in the box can now undefined by selecting "none" in the powerplant.
Controls Box:	This new box contains only information related to control surfaces located on the lifting surfaces.
Wing Box:	It has been rearranged to contain information related only to the wing configuration.
Gear Box:	Only the layout has been modified in this dialog box.
Structure Box:	This is a new dialog window where the lifting surface cross-section structure type is selected.
Certification Tab:	This new tab has the Certification and Classification as separate Dialog Boxes.
Setup Tab:	In the Options box, by selecting the appropriate box, the WMF file can be saved directly to a specific file. In addition, the time interval for the program to save the recovery file can be selected.
Flight Condition Box:	Only the layout has been modified in this dialog box.

2. Flying Wings (no horizontal tail, vertical tail or canard) can now be analyzed.
3. All the symbols and the help system have been updated for consistency and clarity.
4. The software can be installed as a floating license on a network of computers.

2. Modifications

Many of the modifications implemented in AAA Version 2.2 are the result of extensive AAA customer responses, by phone, fax, mail and e-mail. These modifications are listed below module by module.

2.1 Weight

1. In **Weight Sizing/Mission Profile**, the **Fuel Fraction** submodule has been removed. The calculations are performed automatically in the **Weight Sizing/Take-off Weight** module. Users can now size the airplane without specifying the mission profile of the airplane for missions without refueling or payload expenditure.
2. The **Weight Sizing/Take-off Weight** inputs have been simplified.
4. A new column is added into the Mission Profile table in the **Weight Sizing/Take-off Weight** module to tabulate the fuel weight available at the beginning of each flight segment, $W_{F_{begin}}$.
5. In the **Weight Sizing/Take-off Weight** module, the iteration accuracy for the empty weight, ΔW_E, has been deleted as an input for user convenience. The value is now set in the iteration.
6. The **Weight/Center of Gravity** submodule has been moved to **Weight/Class I Weight/ Center of Gravity**, since class I methods are used for the calculations.
7. The **Class I Weight/Weight Estimate/Weight Fractions/Weights** has been moved to **Class I Weight/Weight Fractions/Weights**.
8. The component weights in **Class I Weight/Weight Fractions/Weights** are now displayed in a table.
9. The **Class I Weight/Weight Estimate/Empty Weight** has been moved to **Class I Weight/Center of Gravity/Empty Weight**. In addition, this submodule has been divided into two. The first option, **From Fractions**, uses the component weights previously calculated in the **Weight Fractions** submodule. The second option, **Detailed**, contains the submodules of **Structure**, **Powerplant**, **Fixed Equipment** for a more detailed empty weight computation.
10. The **Class I Weight/Weight Fractions** contains a table now with initial weight estimates, weight adjustments and the final component weight.
11. In **Class I Weight/Center of Gravity/Empty Weight/Detailed Powerplant** and **Fixed Equipment**, the outputs have been renamed.

12. In the **Class I Weight/Center of Gravity/C.G. Excursion** modules for the X-, Y- and Z-directions, separate variables have been created for component and airplane coordinates.
13. In **Class II Weight**, all the component weights are now calculated from the airplane take-off weight, W_{TO}, instead of the airplane estimated take-off weight, $W_{TO_{est}}$.
14. In the **Class II Weight/Structure/Horizontal Tail** module, the program checks that the horizontal tail is defined so that the result obtained by Torenbeek method is now correct.
15. In the **Class II Weight/Structure/Fuselage** module for Commercial airplanes, the definition of the fuselage weight factor, K_f, has been modified. Its value now depends on whether the airplane is a freighter with or without rear fuselage mounted engines. The factors that account for pressurization and gear attachment are now added internally.
16. In the **Class II Weight/Structure/Fuselage** module, the option of having an amphibious airplane has been added.
17. The Torenbeek method in the **Class II Weight/Structure/Fuselage** calculation for a Commercial airplane has been deleted for an airplane configuration with no horizontal tail and no canard since it is not applicable.
18. In **Class II Weight/Structure/Fuselage**, the variable *Altitude* is taken off the input list since it is not used for the calculation.
19. A new module, **Class II Weight/Structure/Tailboom**, has been added.
20. In the **Class II Weight/Structure/Nacelle** module for General Aviation airplanes, new inputs have been created for user convenience.
21. In the **Class II Weight/Powerplant/Engine** module for Turbocharged or Supercharged Piston engine, the program checks that the manifold pressure is greater or equal to the ambient pressure. The ambient pressure has been added as an output.
22. In the **Class II Weight/Powerplant/Engine** module for supercharged piston-driven airplanes, a design maximum altitude has been added to replace the altitude.
23. In **Class II Weight/Powerplant/Fuel System** for General Aviation airplanes, the Torenbeek method has been added to the calculations.
24. The mission fuel weight, W_F, has been replaced by the maximum fuel weight limited by the fuel tank volume, $W_{F_{max_W}}$, in the calculation of the fuel system weight in **Class II Weight/Powerplant/Fuel System** and in the calculation of the flight control system in **Class II Weight/Fixed Equipment/Flight Control**.
25. In the **Class II Weight/Powerplant/Fuel System** module, the user can now specify the value of the fuel density, ρ_F, for the calculation.
26. In **Class II Weight/Powerplant/Fuel System** module, the mission fuel weight factor, K_{fsp}, has been replaced by the fuel density, ρ_F.

27. In the **Class II Weight/Powerplant/Fuel System** module, the mission fuel weight, W_F, is replaced by the maximum fuel weight limited by the fuel tank volume, $W_{F_{\max_w}}$.
28. In the **Class II Weight/Powerplant/Air Induction** module for jet-driven airplanes, the altitude and design equivalent diving speed are replaced by the design dive Mach number.
29. A new variable, K_{OilSys}, has been added to the **Class II Weight/Powerplant/ Propulsion System** module for the calculation of the oil system weight.
30. In the **Class II Weight/Powerplant/Propulsion System** module for a Commercial or a Military airplane, the engine type correction factor for oil system and oil cooler weight, K_{OilSys}, has been added as an input for calculating the oil system weight.
31. In **Class II Weight/Fixed Equipment/Flight Controls** module, $W_{TO_{est}}$ is no longer included as an input parameter for Bomber method because it is not used. For all airplane types, the mission fuel weight factor, K_{fsp}, has been replaced by the fuel density, ρ_F. Also, the mission fuel weight, W_F, has been replaced by the maximum fuel weight limited by the fuel tank volume, $W_{F_{\max_w}}$, to exclude the refueling fuel, $W_{F_{refuel}}$, which is included in W_F.
32. In **Class II Weight/Fixed Equipment/Flight Control** for Commercial airplanes, the calculation of flight control system weight according to Torenbeek method, $W_{fcs_{Torenb}}$, has been modified to account for leading edge devices and lift dumpers (spoilers or speed brakes).
33. The inputs of speed and altitude have been replaced by the design equivalent diving speed, $V_{D_{eas}}$, in the **Class II Weight/Fixed Equipment/Flight Control** module for Military Transports and Bombers.
34. In the **Class II Weight/Fixed Equipment/Flight Control** module for the Military Bomber category, the inputs are now the areas of the control surfaces.
35. In **Class II Weight/Fixed Equipment/Instr/Avion/Elec** for General Aviation and Commercial airplanes, the empty weight, W_E, is now an input instead of being calculated.
36. In **Class II Weight/Fixed Equipment/Electrical Syst.** for General Aviation and Commercial airplanes, the empty weight, W_E, is now an input instead of being calculated.
37. The inputs of design equivalent diving speed and altitude have been replaced by the design dive Mach number in the **Class II Weight/Fixed Equipment/Airc/Press/Icing** module for unpressurized Commercial and General Aviation airplanes.

38. The inputs of altitude and speed have been removed in the **Class II Weight/Fixed Equipment/Airc/Press/Icing** module for the categories of US Air Force Fighter and Military Bomber. Those inputs are not needed for the calculations.
39. In the **Class II Weight/Fixed Equipment/Airc/Press/Icing**, the cabin pressure differential, ΔP_c, has been deleted from the inputs. The selection for pressurization is now in the Configuration Dialog box. The module has been rearranged depending on the pressurization of the airplane.
40. In the **Class II Weight/Fixed Equipment/Oxygen System** module for General Aviation airplanes, Commercial Transports and Military Bombers, new inputs have been created for user convenience.
41. In the **Class II Weight/Fixed Equipment/Furnishings** module for General Aviation airplanes, extra variables, V_{pax} and V_{cargo}, have been removed for single-engine airplanes. For multi-engine General Aviation airplanes $N_{SeatRow}$ has been removed. The calculations remain the same.
42. Due to the refueling option addition, the calculation of the **Class II Weight/Fixed Equipment/Furnishings** for Commercial airplanes has been modified.
43. In the **Class II Weight/Fixed Equipment/Furnishings** module for General Aviation airplanes, the Torenbeek method has been corrected to use the number of passengers plus the number of crew instead of the number of passengers only.
44. The user can no longer go into the **Class II Weight/Fixed Equipment/Armament** module for General Aviation and Commercial airplanes.

2.2 Aerodynamics

1. In the **Lift/Wing/Airfoil** $\boldsymbol{c_{l_{max}}}$ module, the airplane stall speed, V_S**,** has been moved from the output list to the input section.
2. In **Lift/Flaps/Flap Sizing** for Type II double-slotted flap, the flap deflection ratio, $\left(\frac{\delta_{f1}}{\delta_{f2}}\right)$, is now calculated from the flap deflections, δ_{f1} and δ_{f2}.
3. The **Class II Drag** calculations are now flight condition dependent.
4. In the **Drag/Class II Drag/Vertical Tail** module, the calculation of the vertical tail wetted area, S_{wet_v}, has been improved to account vertical tail area immersed in the fuselage.
5. The **Drag/Class II Drag/Total** module includes components that have been defined in the configuration dialogs only.

2.3 Performance

1. In **Sizing/Stall Speed** module, the airplane maximum lift coefficient, $C_{L_{max}}$ **,** has been replaced by a new variable, $C_{L_{max_S}}$ **,** the maximum airplane lift coefficient for that flight condition at which the stall speed is evaluated.
2. In **Analysis/Take-off Distance** for piston engines, the propeller disk-loading at take-off (static), $\frac{P_{TO}}{ND_{prop}^2}$**,** is now included as an output.
3. Due to the addition of the refueling option, the mission fuel weight, W_F, has been replaced by the maximum fuel weight limited by the fuel tank volume, $W_{F_{max_W}}$, in the calculation for the Payload-Range Plot in the **Analysis/Cruise/Payload Range** module.

2.4 Stability and Control

In **Analysis/Class II/Long.Trim**, the steady state pitch attitude has been added.

2.5 Loads

The **V-n Diagram** has been updated to account for changes in the FAR's.

2.6 Cost

1. The class I engine weight, W_{eng1_I} , input has been replaced by the engine weight, W_{eng} , in the **AMPR Weight/Detailed** and the **Operating Cost/Direct/Maintenance** modules.
2. The **Operating Cost/Indirect** module has been divided into two, depending on the accuracy of the method.

2.7 General

1. The 'Help' button in the calculator has now been changed to 'Info', since it provides information about a particular variable
2. The variables used in the **Atmosphere** window are no longer shared with other modules.
3. The number of flight conditions per project has been limited to 95.
4. The date and/or time can be switched off on printouts.
5. Installation from CD-ROM has been improved.

3. Bug Fixes

Many of the "bugs" and problem fixes in AAA Version 2.2 are the result of extensive AAA customer responses, by phone, fax, mail and e-mail. These corrections, listed below for each module, are implemented in AAA Version 2.2.

3.1 Weight

1. The calculation using the General Dynamics method for cantilever wing in the **Class II Weight/ Structure/Wing** module for Commercial airplanes has been corrected to include the wing weight correction factor, F_{corr}.
2. In **Class II Weight/Structure**, the calculations of the horizontal tail weight, the vertical tail weight, the canard weight and the fuselage weight have been corrected. The calculation is no longer dependent on the airplane aerodynamic center location. Instead, it is using geometric parameters only.
3. In **Class II Weight/Structure/Vertical Tail** for a Commercial Airplane, the General Dynamics method has been corrected for airplanes without horizontal tail.
4. The Cessna method for the fuselage weight calculation in the **Class II Weight/Structure/ Fuselage** module has been deleted from the output list for pressurized General Aviation and Commercial airplanes since it is not applicable.
5. In **Class II Weight/Structure/Fuselage** for General Aviation airplanes, the Cessna method calculation has been corrected.
6. In the **Class II Weight/Structure/Nacelle** module for a jet driven airplane, the calculation using the General Dynamics method has been corrected.
7. In the **Class II Weight/Structure/Nacelle** module for General Aviation and Commercial airplanes, the calculation has been corrected so that the program now checks if the gear retracts into the nacelle.
8. The **Class II Weight/Structure/Landing Gear** according to General Dynamics method for Commercial airplanes has been corrected.
9. The General Dynamics method for calculating the fuel system weight for Commercial airplanes has been omitted in the **Class II Weight/Powerplant/Fuel System** module.
10. In **Class II Weight/Powerplant/Air Induction**, the General Aviation method calculation has been corrected.
11. The **Class II Weight/Powerplant/Air Induction** weight is no longer calculated for General Aviation airplanes with a turboprop or a propfan since it is already included in the nacelle weight.

12. The calculation of the engine control weight in **Class II Weight/Powerplant/Propulsion System** has been modified to correctly account for the location of the engines.
13. In the **Class II Weight/Fixed Equipment** submodules listed below, some inputs have been modified to avoid a flight condition dependency calculation:
    - **Inst/Avion/Elec** for Commercial airplanes
    - **Electrical Syst** for General Aviation jet-driven airplanes or Commercial propeller driven airplane
    - **Airc/Press/Icing** for General Aviation jet-driven airplanes
    - **Furnishings**
    - **Structure/Wing and Canard** for Commercial airplanes
14. In the **Class II Weight/Fixed Equipment/Airc/Press/Icing** module, the calculation for unpressurized Commercial and General Aviation airplanes has been corrected.
15. In the **Class II Weight/Fixed Equipment/Furnishings** module for commercial airplanes, the calculation of the maximum zero-fuel weight has been corrected.
16. The **Class II Weight/Total Weight** calculation has been corrected so that Class I variables are not used for Class II calculations. Inputs have been modified.
17. The **Class II Weight Iteration** has been corrected to include the fuel weight and the trapped fuel and oil weight values in the iteration.

3.2 Aerodynamics

1. The **Lift Distribution** calculations for all the lifting surfaces have been corrected to prevent mathematical errors.
2. In **Lift/Flaps/Flap Sizing** and **Flap Lift** for a plain and a split flap selection, the lifting surface thickness ratio calculation has been corrected. It is now calculated at the lifting surface mean geometric chord instead of at the average chord location.

   This calculation has also been corrected in the **Class II Drag/Wing** module in the transonic speed regime, in the **Class II Drag/Flap module** and in all the wetted area calculations.
3. In **Drag/Class II Drag/Fuselage, Nacelle and Store** modules for transonic speed regime, the calculation has been corrected so the wave drag is no longer included for $M_l < 1.0$.
4. In the **Drag/Class II Drag/Fuselage** supersonic module, the calculation of the fuselage drag due to lift has been modified to correctly use the airplane angle of attack.
5. In the **Drag/Class II Drag/Trim** subsonic module for a configuration without a flap, unnecessary inputs and outputs have been removed from the lists.

6. In **Aero. Center**, the calculation of the X-coordinate of the vertical tail aerodynamic center has been modified: the computation of the effective vertical tail aspect ratio, $AR_{v_{eff}}$, for a single vertical tail configuration has been corrected to use the vertical tail taper ratio based on a vertical tail span measured from the fuselage centerline.

3.3 Performance

4. In **Sizing/Landing Distance** module, for FAR 23 airplanes, the landing field length, S_{FL}**,** has been incorrectly used in matching plot calculation and is now replaced by the landing distance, S_L.
5. In **Sizing/Landing distance**, for FAR 25 airplanes, the landing field length, S_{FL}, is now computed from the landing distance, S_L.
6. In **Analysis/Take-off Distance**, the take-off distance calculation has been corrected for lift-off speed equal to zero.

3.4 Geometry

The **Vertical Tail** Sizing using **Volume Method** now accounts for Twin Vertical Tails.

3.5 Propulsion

1. In the **Inlet Design/Inlet Area** module, the computations of the inlet area, A_c, engine mass flow rates ($\dot{m}_a$, $\dot{m}_{cool}$, $\dot{m}_{gas}$, $\dot{m}_{blb}$) are corrected to match their definitions: they are inlet and mass flow rates per engine.
2. In the **Inlet Design/Inlet Area** module for a supersonic regime, the necessary inputs to complete the calculation have been added.

3.6 Stability and Control

1. In **Derivatives/Long. Stability/Speed/**$C_{T_{x_u}}$, the program now checks if the propeller pitch is defined.
2. In **Derivatives/Long. Stability/Angle of Attack/**$C_{m_{T_\alpha}}$ module, the calculation of $\left(\frac{dC_m}{dC_L}\right)_{TL}$ is corrected. The number of propellers is now accounted for.
3. In **Derivatives/Lat.-Dir Stability/Sideslip/**$C_{n_{T_\beta}}$ module, the computation of $C_{n_{T_\beta}}$ is corrected because an intermediate parameter, l_p, was incorrectly computed.

4. In **Derivatives/Lat.-Dir Stability/Roll Rate and Yaw Rate**, the contribution of the flap has been isolated from that of the wing.
5. In **Derivatives/Lat.-Dir Control/Rudder & Rudder Tab**, the vertical tail aspect ratio used in $\frac{(\alpha_\delta)_{C_L}}{(\alpha_\delta)_{C_l}}$ calculation has been replaced by the effective vertical tail aspect ratio.
6. In **Analysis/Class II/Lat.-Dir. Trim**, the computation of $\frac{\partial F_r}{\partial \beta}$ is corrected.
7. In the **Analysis/Trimmed Lift** module for a configuration without flaps, unnecessary inputs and outputs have been removed from the lists.
8. The calculation of the effective vertical tail aspect ratio, $AR_{v_{eff}}$, for a single vertical tail configuration has been corrected to use the vertical tail taper ratio based on a vertical tail span measured from the fuselage centerline.

3.7 Dynamics

1. In **Dynamics/Lateral-Directional/Flying Qualities/Roll Performance** module, the software now requires $\phi_{actual_{23}}$ to be at least 60^0 before Level $t_{R_{23}}$ is met. The correction is made according to FAR 23 regulation.
2. The **Dynamics/Roll Coupling Plot** for $(C_1 < 0, D_1 < 0)$, which is only yaw divergence, the hash marks were on the wrong side of the line.

3.8 Cost

1. The calculation of the number of engine maintenance hours needed per block hour per engine, $MHR_{m_{eng_{blhr}}}$, in the **Operating Cost/Direct/Maintenance** module for civil airplanes has been modified to correctly account for the number of engines per airplane.
2. For civil airplanes, unnecessary inputs have been deleted in the **Operating Cost/Direct/ Depreciation** module depending on the powerplant selection.

3.9 General

1. In AAA Version 2.1, if the *Win.ini* file or NT rights is set to be read-only, the program would lock up while trying to exit. The problem is now fixed.
2. Users are no longer allowed to type in the Date and Time Format dialog box, instead, a selection from a list of options must be made.