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What's New in AAA?

Version 2.1

In the long-standing tradition of maintaining support customer satisfaction and developing the most intuitive and unconstrained aircraft design and analysis tool available, DARcorporation is proud to announce the release of **Advanced Aircraft Analysis (AAA), Version 2.1**. Those of you already familiar with the versatility and clarity of AAA will be even more pleased with the introduction of Version 2.1. New features and submodules will become quite evident to AAA users accustomed to Version 2.0 while dozens of improvements and modifications heighten the program's efficiency and precision.

1. New and Improved

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 Part II of the User's Manual.

2. Additions and Modifications

A result of numerous customer concerns and preferences is the new version of AAA, Version 2.1. The implementation of these concerns and preferences into AAA is aimed at providing the user with an unconstrained and intuitive tool for aircraft design and analysis. A module by module synopsis of the differences between AAA 2.0 and AAA 2.1 is listed below.

2.1 Weight

1. The **Center of Gravity** module accounts for the structure, powerplant, fixed equipment weights, and current loading to calculate the total center of gravity. The structure, powerplant and fixed equipment weight and balance tables are moved from the **Class I Weight/Weight Estimate** module to the Center of Gravity module.
2. **Lateral Tip-Over** angle calculation is implemented.
3. **Class II Weight/Weight Iteration** has a user defined column allowing for user defined input.
4. The **Class II Landing Gear Structure Weight** calculation now allows more than one pair of main gear struts.
5. The minimum allowable value for **Weight Sizing Regression Coefficient B** is now 0.0.

2.2 Aerodynamics

1. In the **Lift** module, for the Wing, Horizontal Tail, Vertical Tail, and Canard, the menu option labeled **Lifting Line** is now called **Lift Distribution**.
2. The **Moment** module is added. It plots the spanwise pitching moment distribution for the wing, horizontal tail, vertical tail, and canard.
3. The **Lift/Ground Effect** and **Moment/Ground Effect** modules are added. The **Ground Effect** modules calculate the change on lift coefficient, pitching moment coefficient and the downwash angle at the horizontal tail and the canard due to ground effect.
4. The **Aerodynamic Center** module is added. It calculates the X- and Z-locations of the aerodynamic center of each lifting surface and the whole airplane.
5. The **Drag/Drag Distribution** module is added. It plots spanwise drag coefficient distribution for the wing, horizontal tail, vertical tail, and canard.

6. The **Lift/Flaps/Drooped Ailerons** module is added. This module calculates the change in angle of attack, $\alpha_{\delta_{da}}$, as well as the increment in the wing maximum lift coefficient due to drooped aileron deflection, $\Delta C_{L_{w_{\delta da}}}$.
7. In **Class II Drag**, the Speedbrake and Spoiler are now accounted for separately.
8. In **Class I Drag**, the type of the drag polar (Takeoff Gear Down, Clean, etc.) is now shown on the calculation modules. It is also shown in an active window printout of the input/output and plot windows.

2.3 Performance

No changes

2.4 Geometry

1. An **Aero-CADD** module is implemented which allows geometry data to be exchanged with Aero-CADD.

2.5 Propulsion

No changes

2.6 Stability and Control

1. In **Longitudinal Stability**, a new module is added to calculate Steady State derivatives.
2. In the **Longitudinal Stability/Speed** module, calculation modules for the thrust-coefficient-due-to-speed-derivative, $C_{T_{x_u}}$, and the thrust pitching moment coefficient due to speed derivative, $C_{m_{T_u}}$, are added.
3. In the **Longitudinal Stability/Angle of Attack** module, a calculation module for the thrust-pitching-moment-coefficient-due-to-angle-of-attack-derivative, $C_{m_{T_\alpha}}$, is added.
4. In the **Lateral-Directional Stability/Sideslip** module, a calculation module for the yawing-moment-coefficient-due-to-thrust-in-sideslip-derivative, $C_{n_{T_\beta}}$, is added.
5. In the **Longitudinal Control** module, calculation modules for the Elevator Tab and the Canardvator Tab are added.

6. In the **Lateral-directional Control** module, calculation modules for the Rudder Tab and the Aileron Tab are added.
7. In the **Hingemoment** module, calculation modules for the Elevator Tab, Rudder Tab, Aileron Tab, and the Canardvator Tab are added.
8. The **Analysis/Class II Trim Diagram** has two added options to replace the option of Current Flight Condition, these are: Current Class I and Current Class II, allowing for use of Class I or Class II drag polars.
9. In **Lateral-Directional Control Derivatives**, the relative position of horizontal and vertical tails, $\frac{x}{c_v}$, is now calculated from available geometric data. The variable can also be calculated in the **Aerodynamic Center** submodule in the **Aerodynamics** module (see Section 2.2, Item 4).
10. All **Stability and Control Derivative** calculations now account for any lifting surface aspect ratio greater than 1.0. The upper limit of aspect ratios, which was 14, is removed.
11. All **Stability Derivative** calculations now account for flap effects when applicable.
12. In **Lateral-Directional Control Derivatives**, the calculation of the rolling-moment-coefficient-due-to-aileron-deflection-derivative, $C_{l_{\delta_a}}$, now accounts for differential aileron deflection.
13. In **Lateral-Directional Control Derivatives**, the calculation of the yawing-moment-coefficient-due-to-aileron-deflection-derivative, $C_{n_{\delta_a}}$, now accounts for differential aileron deflection and frise aileron.
14. In **Longitudinal Stability Derivatives**, two new output columns are added to the A.C. Shift tables.
15. In **Class II Stability and Control Analysis**, geared tabs are accounted for in both longitudinal trim and lateral-directional trim calculations.

2.7 Dynamics

1. In the **Longitudinal/Calculate T. F.** menu the option None is added. The user is no longer required to define a control surface.

2.8 Loads

1. The **Structural** module has been implemented to analyze internal forces and moments in the following structural components of the airplane: the fuselage, wing, horizontal tail, canard, and vertical tail.

2.9 Structure

1. The entire **Structures** module is added for a Class I Structural sizing and for inputting material properties.

2.10 Cost

1. The cost escalation factor, CEF, is updated to Year 1997.

2.11 General

1. The airfoil lift curve slope at the mean geometric chord of wing, horizontal tail, canard and vertical tail at zero-Mach ($c_{l_{\alpha_{w|M=0}}}$, $c_{l_{\alpha_{h|M=0}}}$, $c_{l_{\alpha_{c|M=0}}}$ and $c_{l_{\alpha_{v|M=0}}}$ respectively) can now be calculated from the airfoil lift curve slope at the tip and root chord ($c_{l_{\alpha_{wr}}}$, $c_{l_{\alpha_{wt}}}$, $c_{l_{\alpha_{hr}}}$, $c_{l_{\alpha_{ht}}}$, $c_{l_{\alpha_{cr}}}$, $c_{l_{\alpha_{ct}}}$, $c_{l_{\alpha_{vr}}}$ and $c_{l_{\alpha_{vt}}}$).
2. Variables Z_w, Z_h and Z_c, that used to be input parameters, are now calculated from available geometric parameters.
3. The minimum value for the aspect ratio of wing, horizontal tail and canard is reduced to 1.0. The minimum value for the vertical tail aspect ratio is reduced to 0.01.
4. **Flight Condition** window: the current X-location of the center of gravity, X_{cg}, is added as well as the button **New** for adding a flight condition.
5. Import and Export options are added to the File menu at the top of the screen allowing the user to import and export geometry files used in Aero-CADD. The options also allow the user to import and export ASCII files to be used by ACE!IT, by Tecolote Research. In addition, the user can export stability and control data as an ASCII file for all the flight conditions of the current project.
6. The **Landing Gear** dialog is restructured for clarity.
7. Variable labels throughout the dababase have been made consistent.

8. A **Theory** button is added to the I/O window. Users are able to access the theory used in the calculation by clicking on this button. The theory is also available by clicking the Help button in the main toolbar.
9. A **Copy WMF** button is added to the toolbar. With this feature, users are able to copy the active window into the Windows Clipboard as a Windows Metafile. The contents of the clipboard can then be pasted into word processing or drawing programs. The button has been removed from the plot window toolbar.
10. A small **Help** button and a small **Notes** button have been added to each variable. The Help button gives users quick access to the variable info without going through the calculator. The Notes button enables users to add remarks to each variable. The buttons are located on the right hand side of each variable. They can be turned on or off in the Options function in the setup toolbar.
11. A **Notes** button has also been added to the main toolbar for general notes about the project.
12. Atmosphere calculates Mach number and dynamic pressure for a given speed.

3. Bug Fixes

Many of the "bugs" and problem fixes in AAA Version 2.1 are the result of extensive AAA customer responses, by phone, fax, mail and e-mail. These corrections, listed below by modules, are implemented in AAA Version 2.1.

3.1 Weight

1. The **Weight Sizing/Sensitivity Coefficient** calculation is corrected. Users are now able to fix the value of the mission fuel fraction not corrected for payload expenditure, $M_{ff_{uc}}$.
2. In **Class II Weight/Powerplant/Fuel System**, the value of the mission fuel weight factor, K_{fsp}, in S.I. unit can now be correctly selected from the variable info.
3. The **Class II Weight/Structure/Vertical Tail** calculation is corrected for cruciform tail or T-tail configuration.
4. The **Read Off** function is now working in **Class I Weight Sizing Regression Plot**.
5. The input data table in **Class I Weight/Weight Estimate/Empty Weight** is now saved when the I/O window is closed.

3.2 Aerodynamics

1. In **Drag/Class II Drag** module for the Horizontal and Vertical Tails, the calculation now checks whether the lifting surface span is greater than the fuselage diameter.
2. The **Drag/Class II/Subsonic/Fuselage** calculation and **Drag/Class II Drag/Plot** now checks that the fuselage wetted area, S_{wet_f}, is greater than the fuselage wetted area exposed to the laminar flow, $S_{wet_{flam}}$.
3. In **Lift/Flaps/Flap Sizing/Plot**, while using the **Read Off** function, the position label along the span and along the chord length were identified as 'X' and 'Y', respectively. Spanwise coordinates are now identified as 'Y', and chordwise as 'X'.

3.3 Performance

1. In **Analysis/Cruise/Maximum Speed**, for a propeller airplane, the maximum cruise speed calculation now checks whether the power required, P_{req}, is greater than the power available, P_{av}.

2. In **Analysis/Cruise/Payload Range** for Constant Speed and Constant Altitude, the floating point error which occured for $\eta_p = 0$ is corrected.

3.4 Geometry

1. The program now recognizes whether a panel is inside the fuselage and also checks that all panels lie within the lifting surface span.

3.5 Propulsion

No bugs are found/fixed in this module.

3.6 Stability and Control

1. In **Lateral-Directional Control Derivatives**, the calculations of the rolling-moment-coefficient-due-to-rudder-derivative, $C_{l_{\delta_r}}$, and the yawing-moment-coefficient-due-to-rudder-derivative, $C_{n_{\delta_r}}$, now account for the vertical placement of the rudder on the vertical tail.
2. In **Longitudinal Stability Derivatives/Dynamic Pressure Ratio**, the horizontal tail dynamic pressure, η_h, calculation is corrected. The perpendicular distance from the centerline of the wake to the horizontal tail aerodynamic center, $z_{h_{wake}}$, and the half-width of the wing wake perpendicular to the centerline of the wake, Δz_{wake}, were miscalculated and are now corrected.
3. In **Hingemoment Derivatives**, the calculation for rudder-hingemoment-coefficient-due-to-sideslip-derivative, $C_{h_{\beta_r}}$, is corrected for sign.
4. In **Class II Longitudinal Trim/Pull Up**, the airplane product of inertia in the body XZ-axis, I_{xz}, is excluded from the module since it is not used.
5. The calculation of **Zero-angle-of-attack Lift Coefficient**, C_{L_o} , is corrected. The effect of horizontal tail downwash has been accounted for. The extrapolation from Figure 8.42 from Airplane Design Part VI is also corrected.
6. In **Lateral-Directional Control Derivatives**, the calculation of the sideforce-coefficient-due-to-rudder-derivative, $C_{y_{\delta_r}}$, is corrected.
7. In **Analysis/**C_{m_o} , the wing incidence angle, i_w, is accounted for in the calculations of the Increment in Wing Pitching Moment Coefficient due to Leading Edge Flap, $\Delta C_{m_{w_{LE}}}$,

and the Increment in Wing Pitching Moment Coefficient due to Trailing Edge Flap, $\Delta C_{m_{w_{TE}}}$.

8. In **Analysis**/C_{m_o}, the Wing-fuselage Zero-angle-of-attack Pitching Moment Coefficient, $C_{m_{o_{wf}}}$, calculation is corrected. The wing-fuselage lift curve slope, $C_{L_{\alpha_{wf}}}$, and the airplane clean zero-lift angle of attack, $\alpha_{o_{A_{clean}}}$, are replaced by the wing-fuselage zero-angle-of-attack lift coefficient, $C_{L_{o_{wf\,clean}}}$.
9. The **Hingemoment Derivative** calculations now recognize if the control surface is bigger than the lifting surface.
10. In **Lateral-Directional Control Derivatives**, the lowest allowable value of $\sigma_{\beta_{wf}}$ is reduced to –1.0 from 0.0.
11. In **Lateral-Directional Control Derivatives/Sideslip Rate**/$C_{n_{\dot{\beta}}}$, the allowable range for the static margin is now –100.0% to 100.0% . The static margin is used in the calculation of the yawing-moment-coefficient-due-to-yaw-rate-derivative.
12. In **Longitudinal Stability Derivatives/A. C. Shift/Stores**, the Y-location of the store nose, $Y_{nose_{store_i}}$, is now allowed to be negative. It is used to calculate the airplane aerodynamic center shift due to the store.
13. In **Hingemoment Derivatives**, the maximum allowable value for the thickness ratio of the rudder, aileron, elevator and canardvator at the inboard and outboard stations ($\left(t/c_f\right)_{r_r}$, $\left(t/c_f\right)_{r_t}$, $\left(t/c_f\right)_{a_r}$, $\left(t/c_f\right)_{a_t}$, $\left(t/c_f\right)_{e_r}$, $\left(t/c_f\right)_{e_t}$, $\left(t/c_f\right)_{c_r}$ and $\left(t/c_f\right)_{c_t}$) is raised from 20% to 100%.
14. In **Lateral-Directional Stability/Roll Rate**/C_{n_p}**,** the limits set for the flap size are increased to account for smaller inboard and larger outboard flap stations.
15. The calculation in **Long. Stability**/C_{m_α} is corrected so that if the input η_h is missing, a value will not be assumed for the calculation.
16. In **Lat-Dir Stability/Sideslip Rate**, the calculation of $C_{l_{\dot{\beta}}}$ is corrected with proper extrapolation from Figures 10.30 to 10.33 from Airplane Design Part VI.

3.7 Dynamics

1. In the **Control/Root Locus** option, a pole that always appeared at the origin is now removed.
2. The **Roll Coupling** stability boundary curves are now plotted correctly.

3. In **Lateral-Direct./Flying Qualities**, the Roll Performance for FAR 23 in take-off is now calculated correctly.

3.8 Loads

1. The **V-n Diagram** for FAR 23 commuter category is now calculated correctly.

3.9 Cost

No bugs are found/fixed in this module.

3.10 General

1. Deleting a flight condition no longer causes a problem in the flight condition table database.
2. The number of decimals in the plot window axis labels is not reset to default when the window is closed.
3. A project saved with specific print settings is now reopened with those same settings.
4. The problem encountered while printing an active window using a 800x600 resolution is fixed.

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