Version 5.3 Update Notes for Piano-5 Users

• About Piano 5.3

Piano version 5.3 is a general update to consolidate a series of gradual improvements. Note for very recent (Sept 2014) customers: These changes are already included in your copies and it is not necessary to reinstall this formal release. If you are uncertain about how anything in this document might apply to your own particular setup, please do not hesitate to contact me directly as usual. The interface and 'look and feel' of Piano remain the same.

The aircraft database has grown to more than 500 files. All of your own existing aircraft and engines can be loaded into v5.3 safely and will continue to yield the same results (other than for any minor differences explicitly stated in these notes).

• How to install

Before installing you should move or rename your existing '**data**' folder (and preferably also make a backup of everything), to ensure a clean installation for v5.3. The '**data**' folder is where all planes, engines and other files used by Piano are located. If you are unsure how to find it, do the following:

- Start your existing copy of Piano and select '**Load Plane**'.
- Look at the filepaths usually shown near the top of the dialog. The location of the '**data**' folder is one level above the '**planes**' folder and below the '**Piano**' folder. You can create a convenient shortcut on your desktop.
- Quit Piano, then find and move or rename your '**data**' folder manually.

You can now install v5.3 by double-clicking the **Piano** installer exec that you have received with this update note. Finally, move any of your own planes and engines from your old '**data**' folder to the new one as necessary.

The new features are as follows:

• Approach and Landing Climb Gradients

The output produced by the landing report (see *Report -> Field Lengths*) now includes calculated values for the All Engines Operative (AEO) landing climb gradient and the One Engine Inoperative (OEI) approach climb gradient, generated according to the requirements of FAR 25.119 and 25.121d.

The All-Engines case is calculated using the current value of **landing-flap-deg** and with the u/c down. A warning will be shown if the AEO gradient falls below the required minimum (3.2%).

For the Engine-Inoperative case (approach climb), the undercarriage is retracted and the flap setting is allowed to be reduced iteratively until the stall speed becomes 110% of the original stall speed corresponding to **landing-flap-deg**. Climb speed is then also iteratively set to its optimum value for best gradient subject to the requirement that it must not exceed 1.5 Vstall. A warning will be shown if the calculated OEI gradient falls below the required minimum (2.1% for twins, 2.4% for three-engined and 2.7% for four-engined types).

The above procedure for the OEI case clearly assumes that the approach flap setting is infinitely variable ('dial-a-flap' logic, just as is already used during takeoff calculations of second-segment gradients). If only discrete flap settings are available, the user might want to check that the automatically chosen approach flap does not fall below some predefined figure (if known). It is worth keeping in mind the inaccuracies inherent in all estimates of low-speed aerodynamics and the fact that manufacturers' quoted flap 'deflections' often refer to purely nominal geometries.

• Tyre speed restrictions

Takeoff reports (and also plots produced by *Study -> Required TOFL)* will now include a warning if calculations suggest the possibility of maximum tyre speed becoming a restriction. The trigger level for the warning is currently set at 235 mph. Given the limited relevance of this operational restriction to a tool like Piano, I did not think it meaningful to introduce a user-controlled variable for tyre speed rating. The value can still be changed through the patches file (contact me for details).

• Additions to 'Range Modes'

New buttons are available under Flight Levels for selecting the standard RVSM (*reduced vertical separation minima*) cruise FLs in addition to the old-style semi-circular IFR rules (both Westbound and Eastbound). A 'mix' button lets you set mixed 2000 ft step intervals.

• Variable cruise Mach in 'Build a Sequence'

Recall that whenever the Mach number selection under '*Range Modes*' is set to '99% max SAR', Piano will run its standard range calculations using a constant Mach number that yields 99% of max SAR at a representative condition.

Previously, that same Mach number would also be used to generate the corresponding detailed flight profile via '*Flight -> Build a Sequence*'.

The logic of '*Build a Sequence*' has now been changed to implement a continuously varying cruise Mach number. Provided that '99% max SAR' has been selected under '*Range Modes*', the detailed sequence generator will automatically determine the appropriate instantaneous Mach for '99% max SAR' throughout all cruise segments.

A similar enhancement applies when the Mach number is set to 'max SAR'.

'*Build a Sequence*' therefore now incorporates the most accurate possible ways of establishing 'Long Range Cruise' (LRC) and 'Maximum Range Cruise' (MRC) Mach number schedules.

Note that standard range calculations ('*Report -> Range*', '*Study -> Mission @Range*' etc) are not affected, only detailed missions generated through '*Flight -> Build a Sequence*'.

• Other refinements in 'Build a Sequence'

The sequence generator will now restrict the top-of-climb scheduled Mach number (if applicable) to a value that does not exceed cruise Mach (as predetermined by standard range calculations), to minimise the need for any deceleration. Similarly, the top-of-descent Mach number is restricted to a value not exceeding the final cruise Mach number to avoid the need for any acceleration.

The output from the sequence generator now includes precise values of BRGW (brake release gross weight) and LGW (landing gross weight) in the final block summary.

• Parameter for 'methodology calibration'

A new parameter called **methodology-calibration** has been created (you can find it in the 'methods' palette). It is intended to be a convenient 'catch-all' for handling future changes to Piano's internal methodologies that may alter any predictions of aerodynamics, weights or performance. In general, you should not disturb it from its default. If you change its setting, results for your current plane may differ, but all other planes will remain unaffected.

For the moment, the only settings are the default and a 2014 minor update which only modifies the calibration of some zero-lift drags. All the planes in the database and all your existing files use the default setting and there is no need to change anything. If at some point you define a completely new plane from scratch, you could choose to apply the '14 setting from the start just for that file.

Piano now covers a vast database of carefully calibrated planes and an even greater base of user-defined designs. It is essential that minor changes to internal methodologies that potentially affect any kind of results must leave existing designs unchanged. This parameter provides for future consistency and backward compatibility.

• Other minor changes

• It is now possible to **Flag** a plane ('*Plane -> Flags*') even before its definition is complete (i.e. before all vital parameters have been specified). This helps when you are in the middle of a generating a new plane and need to quickly check some data for another plane without losing your work.

- Piano will now use flat extrapolation (i.e. staying constant beyond extreme values in the Mach direction) for any **idle fuel flow** data matrices that do not fully cover all required flight conditions. It would previously produce a blocking message indicating insufficient data. This change was at the request of an engine manufacturer to minimise unnecessary input.

- It will also use flat extrapolation (i.e. constant beyond extreme values in the Mach direction) for any **idle thrust** data matrices that do not cover all required flight conditions. Previously, it would default to zero thrust in cases of insufficient data. It is theoretically possible that this might make a marginal difference to descents if you have been using some incompletely-defined engine models.

- The **Mass Barchart** has been annotated with additional information including MZFW, MLW, MRW, visual indications of capacity restrictions and other useful bits and pieces. **Mass reports** have been slightly reformatted and include max. payload and max. fuel figures at the end.

- A new parameter called **enroute-stall-margin** can be used to change the minimum allowable settings during Piano's searches for some 'optimum' speeds in the enroute configuration, such as during 'best climb gradient' calculations with OEI and during various flight manoeuvres.

- **3-Views** now include the fore and aft limits of the cabin section in plan views, matching the cabin floor outline in side views. You can remove them through the '*Draw Seats*' options in '*Report -> View Options -> Set Up 3-View*'.

- When you Right-Click on a parameter name inside a **palette**, you will now see a new option marked '*Remove all variables below this*'. This is convenient for creating new or temporary palettes (in conjunction with the '*Recent*' and '*Edited*' buttons in the palette chooser) by picking and trimming your parameter choices.

- The **wing-mass-method** parameter now includes an option for using the average of the existing '*revision05*' and '*tor-mod*' options. The differences between these have been explained before. Revision05 is simply an extension of the original default method in Piano. Torenbeek's (modified) method is probably better used with very large aircraft and is more sensitive to extreme spans. Averaging gives reasonable results (or a minor confidence boost) when in great doubt, but of course constitutes little more than an acknowledgment of the uncertainties involved in all 'preliminary design' weight estimates.

- The initial settings for tolerances and convergence criteria in the Optimiser dialog have been relaxed slightly to improve performance. The occasional flickering of the plot that shows changes in the objective function is reduced.

- The startup setting for '*Misc -> Update Dialogs*' has been changed to '*Only after Load Plane*'.

- When running a **Flight Manoeuvre** with the '*Airspeed*' option set to '*economy at cost index*' and the '*Stop*' option set to '*after 1 point calculation*', Piano clearly should *not* output any 'Cost' figure at the bottom, because the duration is zero: We are by definition

only looking at a spot point calculation, not a complete segment. However, a bug meant that in certain situations Piano would still print a spurious number for cost, a leftover from previous calculations. The bug has been fixed.

- A bug which under some circumstances prevented Piano from completing '*Missions Table*' studies for short ranges and with a particular style of reserves ('10% flight time') has now been fixed.

- The upper limit of **hold-time-mins** has been increased to 180 minutes. This is needed to handle the still common practice by some operators of lumping all reserves into an equivalent 'Time Over Destination' (TOD) in their comparative assessments.

Finally, for those of you still having to struggle on with ICAO's fundamentally flawed approach to 'quantifying' aviation CO_2 emissions, the previously released patch that implemented the precise definition of the ICAO CO_2 pseudo-metric in Piano will also work in version 5.3 without any changes. You can simply copy it into the patches folder for the new version. If you are not familiar with the patches mechanism, please contact me directly as always.

Regards,
Dimitri