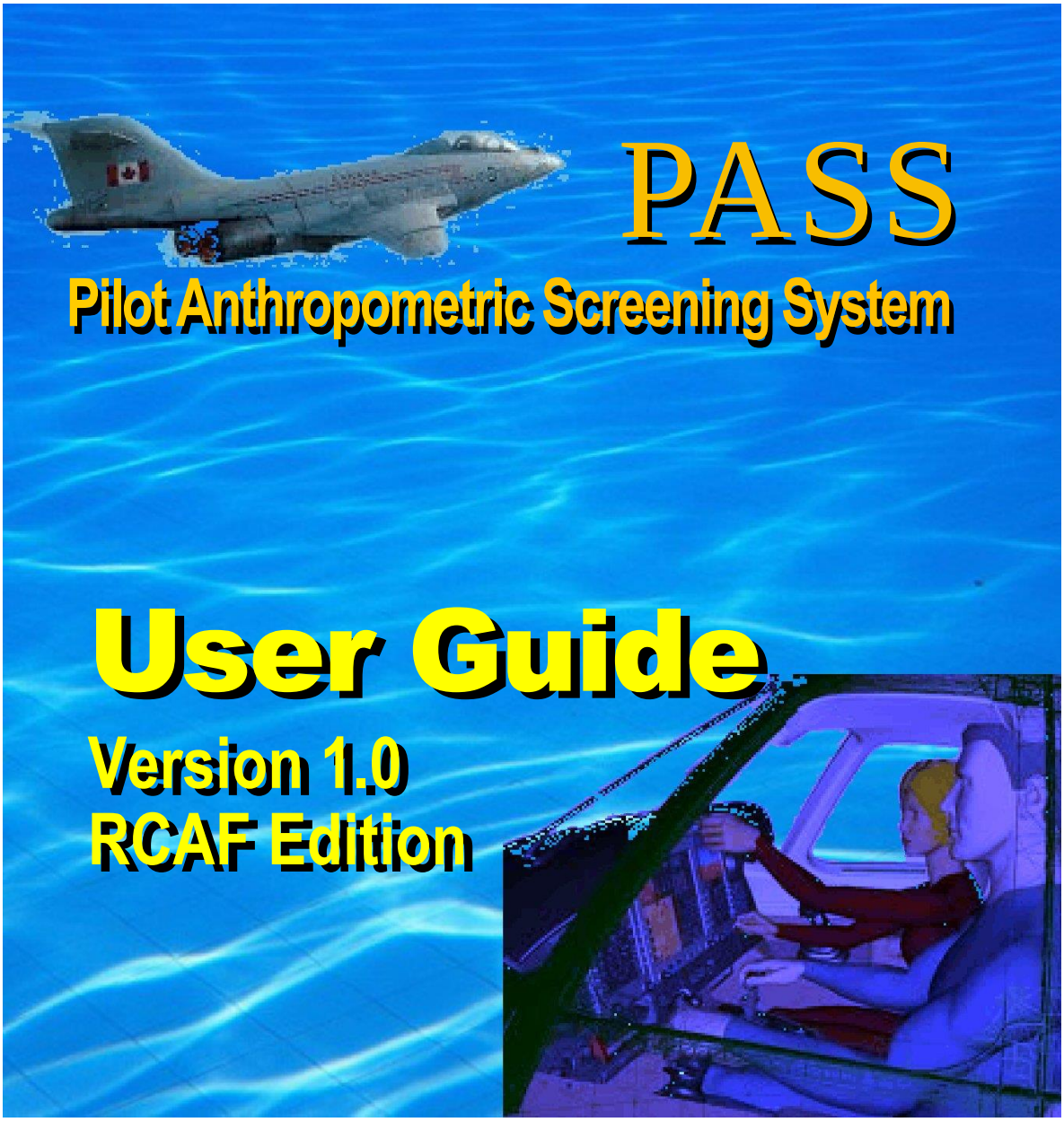

PASS

Pilot Anthropometric Screening System

User Guide

Version 1.0
RCAF Edition

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1. INTRODUCTION

PASS (Pilot Anthropometrical Screening System) is a patented technology[1] owned by Canadian Government and implemented by VisImage Systems Inc.

PASS is a method and system for determining a subject's suitability for workstations such as aircraft cockpits, based on the subject's anthropometric measurements. The subject's measurements are used as input to a workspace accommodation model that predicts an individual's ability to perform the tasks that are judged to be critical to the safe operation of said workspace.

The workspace accommodation model is derived from experimentation and testing to determine the critical anthropometric measurements which will allow a subject ti acceptably accomplish the tasks required for the workspace. Further the model is modular and adaptable such that it can improve the accuracy of its predictions with new cases, and thus learn over time.

PASS 1.0 has been implemented in such a way that it is integrated with the automatic body sizing system – BoSS-21—AutoPASS. AutoPASS makes it easy to determine a subject's suitability for workstation. PASS RCAF (Royal Canadian Air Force) Edition contains most aircraft cockpits models used in RCAF.

PASS 1.0 is the first implementation of the PASS technology. Not all the desirable features are implemented in this version, such as on-line help and password modification. Your valuable feedback and suggestions are welcome.

A Word About Passwords

Depending on the environment in which you use your PASS system, you may be more or less concerned about the security of your system and the privacy of your data.

In some environments it is very important to separate different functionality, and to restrict these tasks to different people by using passwords. In other environments these distinctions are irrelevant and you may find the password requirements intrusive.

The default password for "Unlock admin Functions" is "2468". The password for modify the air plane model files in aircraft_input folder is "VisImage"

[1] US patent No. US2010/0179918A1, Pilot Anthropometric Screening System

2. PASS INSTALLATION AND REMOVAL

This section describes the procedures to install and remove PASS software.

2.1 INSTALL DotNetFrameworks 2.0

Install DotNetFrameworks 2.0 version provided by Microsoft. DotNetFrameworks is free to download from the Microsoft website.

2.2 INSTALL MCR (MATLAB COMPONENT RUNTIME) 7.9

Matlab MCR 7.9 is a free library. You can download it from the Matlab website.

2.3 INSTALL PASS 1.0 PROGRAM

Install PASS software is easy, there's no difference between PASS installation and any other standard windows application.

a. Double click the setup.exe in the folder PASS Setup.

b. Select the installation folder and click Next button.

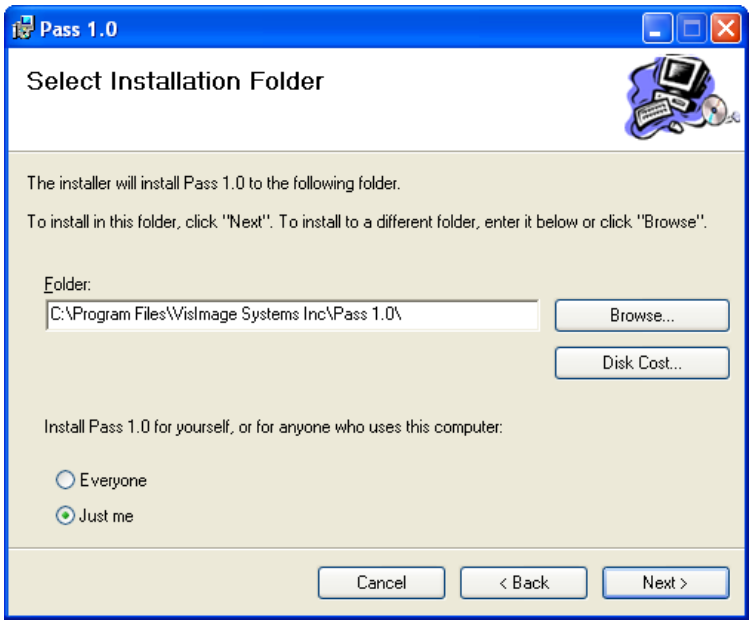


Figure 1: PASS Installation Folder Selection

c. Click button [Close] when Installation is done.

2.4 REMOVE PASS PROGRAM

Go to <Control Panel>, double click <Add or Remove Programs> icon and Select PASS1.0 to remove.

3. PASS OPERATIONS

3.1 LAUNCH PASS

Upon the execution of PASS program, two main PASS operation windows appear on computer screen: a “Pass” window and a “Bivarplot” window as shown in figure 1 below.

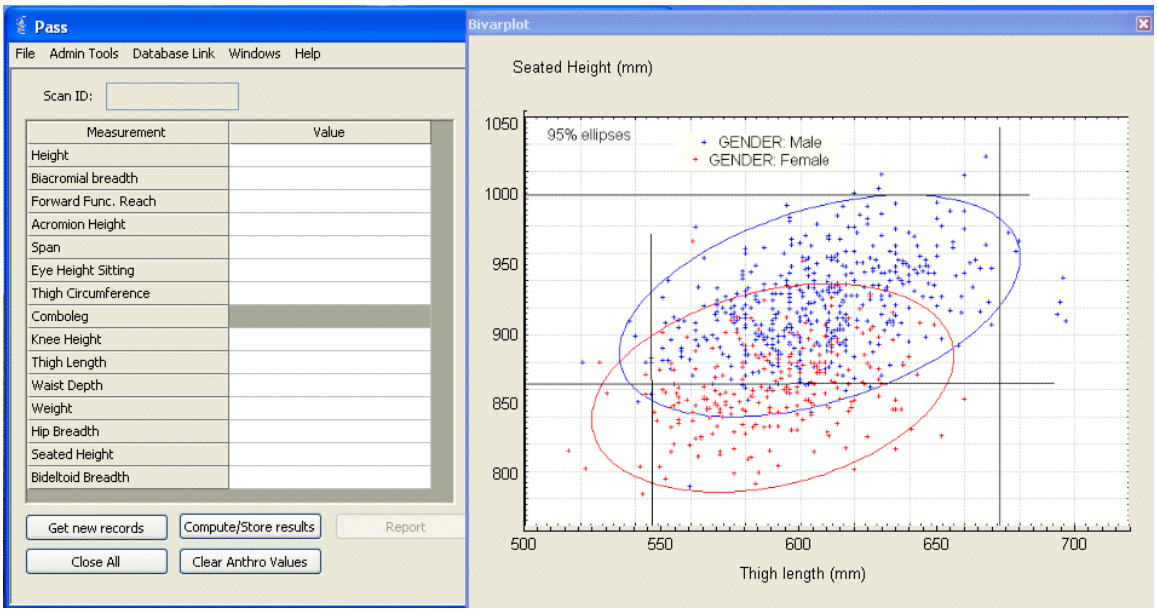


Figure 2: PASS Main GUI and Bivarplot Window

The “Pass” window displays a set of anthropometric measurement for a given pilot. The “Bivarplot” window displays a distribution of seated-height and thigh-length according to the anthropometric survey from Canadian Forces in 1997.

To predict if a pilot is suitable to an aircraft, a set of anthropometrical measurements from this individual need to be input to PASS as displayed. When the required anthropometrical measurements are presented to PASS, press Compute/Store results button will invoke the Aircraft Summary window as shown in Figure 9.

3.2 INPUT ANTHROPOMETRIC MEASUREMENTS TO PASS

There are four methods for PASS to input the anthropometrical measurements of a pilot and each of them will be described in detail in this section.

3.2.1 Load a Measurement Record from a MS Excel File

There are several ways to load record to PASS program. You can load from the excel file, you can load from PASS Database or you can load from the BoSS Combo Database.

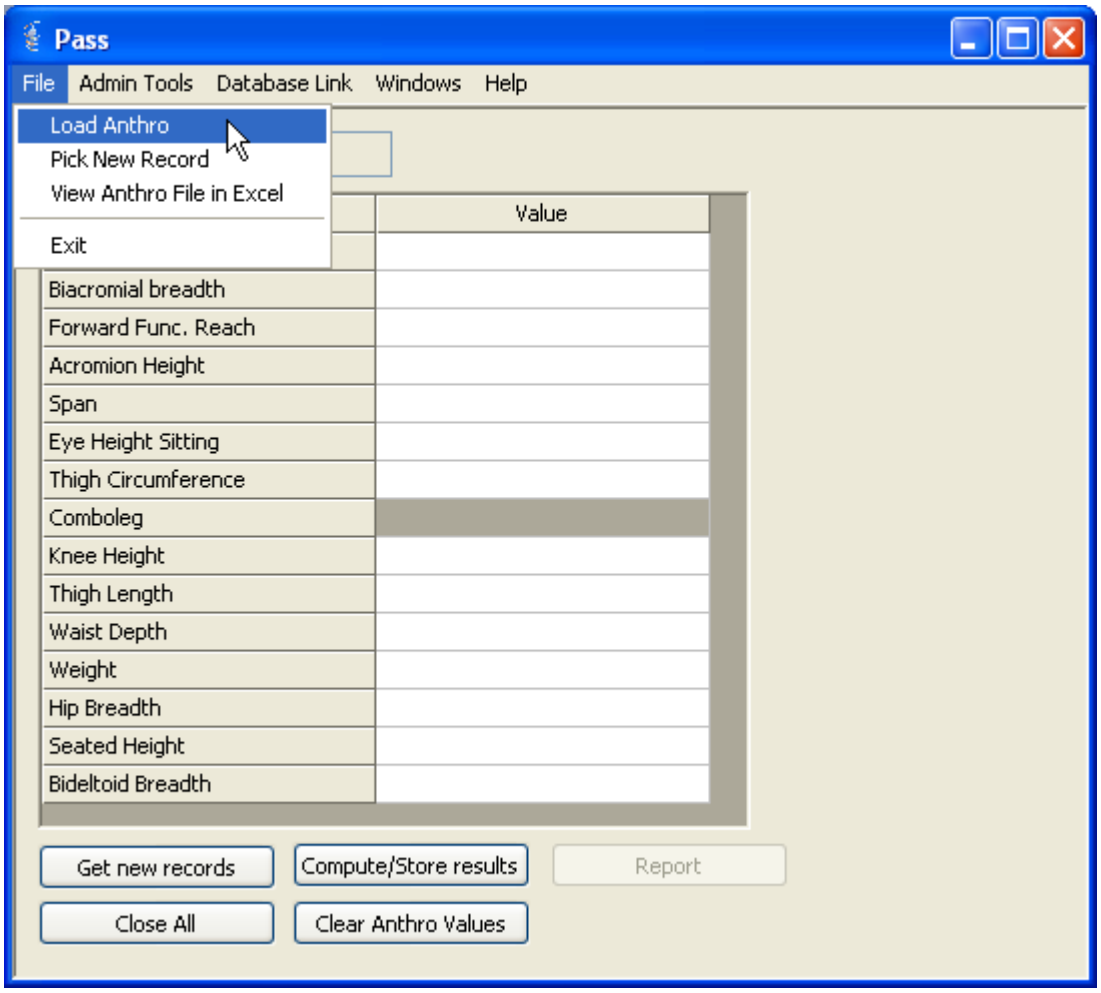


Figure 3: Load a Record from MS Excel Files

Select the file that contains the anthropometric data to open.

This function will display a list of record IDs, corresponding to a set of anthropometric measures of a pilot.

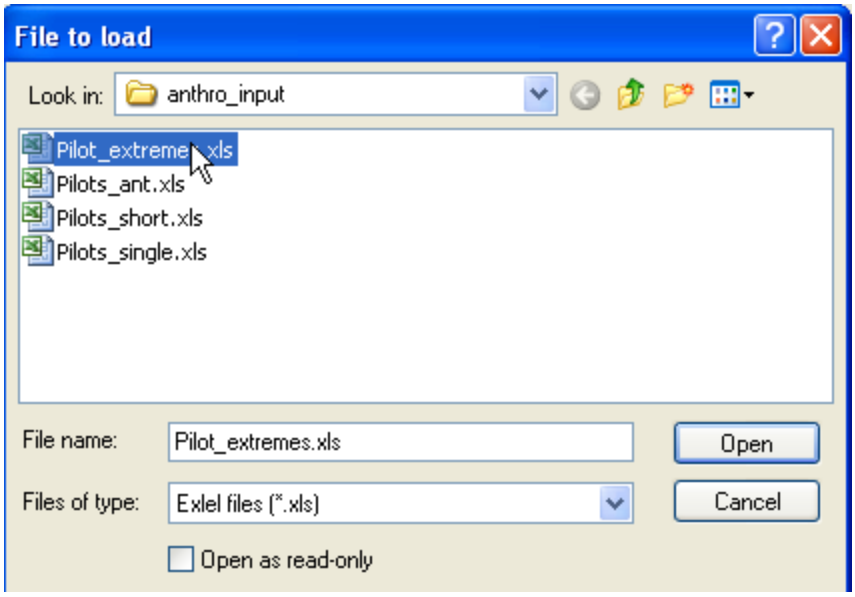


Figure 4: Select a MS excel file

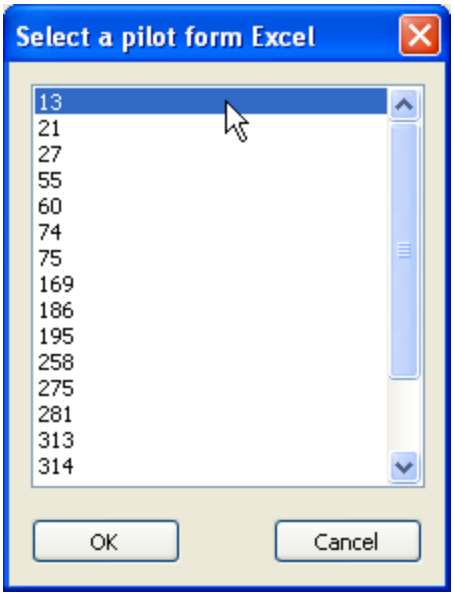


Figure 5: Pilot Measurement IDs

Select one ID and click OK to load. The record ID and measurement values will show on the Pass window.

3.2.2 Load a Measurement Record from a Pass Database File

A measurement record can be loaded from the PASS Database. Go to menu [Database Link]→ [Retrieve Anthro record]

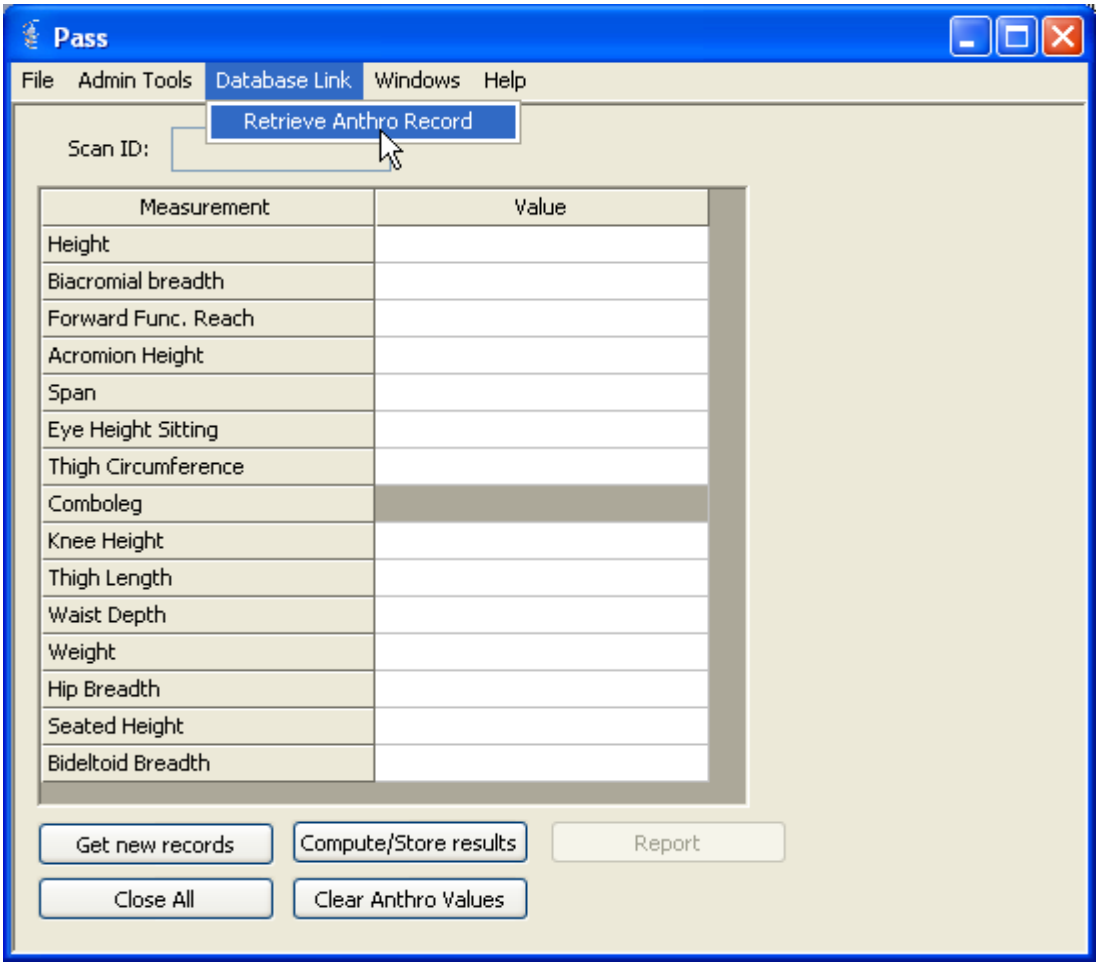


Figure 6: Load a Record from a PASS Database File

Select one an ID and click Process button to input the anthropometric measurement into PASS.

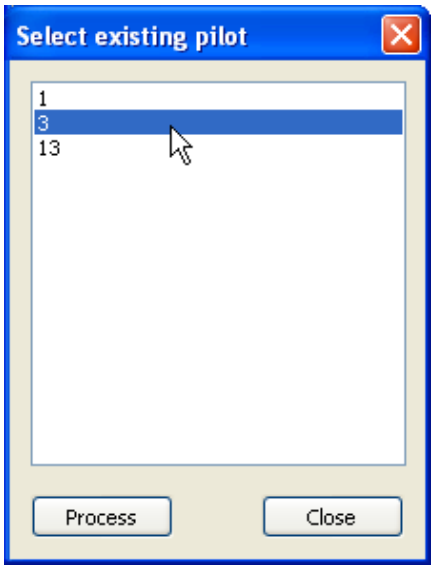


Figure 8: Pilot IDs in PASS Database

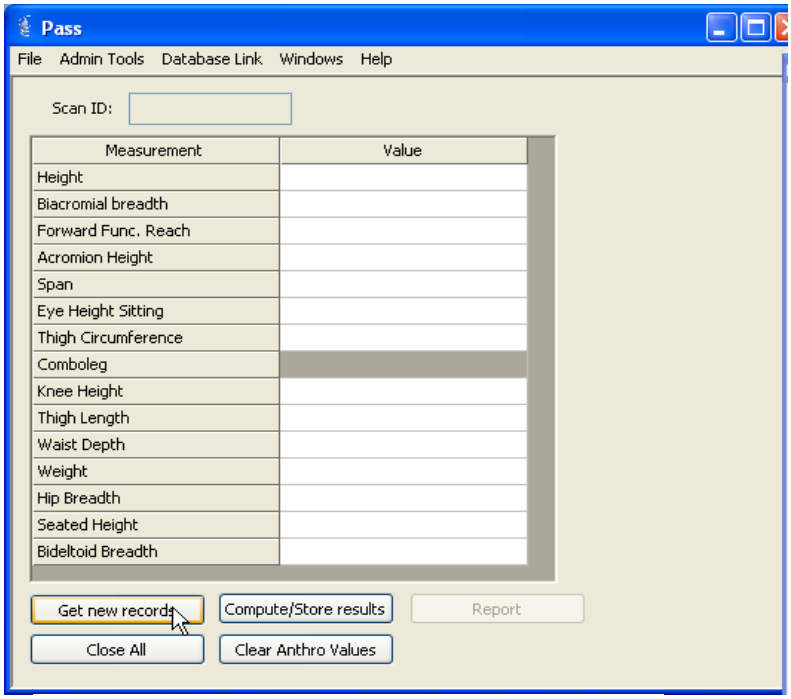


Figure 7 : Load a Record from BoSS Database File

3.2.3 Load a Measurement Record from BoSS Database File

Pass can retrieve BoSS records directly. When PASS reads the list of Ids in BoSS Database, it will automatically remove the ids that already exist in the PASS database from the list. To retrieve the record from the BoSS Combo database you need click the [Get new records] button in the main user interface. Then like the other 2 functions, just select a ID from the list to load.

3.2.4 Input Measurements Manually

Anthropometric measurement for an individual can be entered into PASS using on-screen interface and keyboard directly.

3.3 COMPUTE AND ANALYZE THE RESULT.

Once the anthropometrical measurements are loaded, PASS can compute and check if this pilot can operate certain aircraft. The result will be displayed and save.

To make the computation on the current record, click the button [Compute/Store results]. PASS will pop up aircraft summary window and bivarplot window.

3.3.1 Aircraft Summary Window

The Aircraft summary window, as shown in Figure 9, displays the summary of the result on checking if a pilot can operator certain aircraft, as shown in the figure below. The color background surrounding an aircraft name indicates the result.

Red represents Fail for that aircraft, Green represents pass and Yellow represents Borderline.

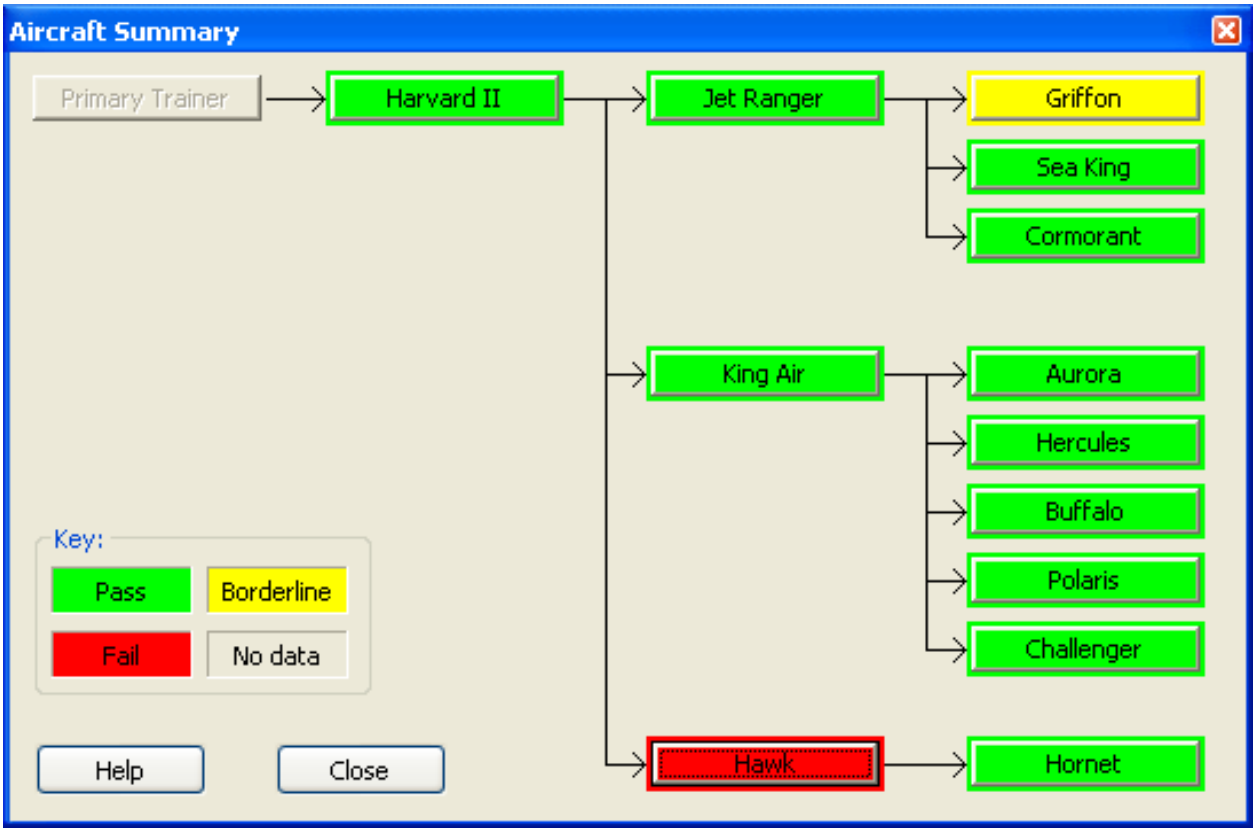


Figure 9: Aircraft Summary Window

The aircraft summary window shows which aircraft could be operated by this subject from the anthropometric point of view. The green means <Pass>, Yellow means <Borderline>, Red means <Fail> and Grey means <No Data>. <No Data> happens only if the specific aircraft module has not been trained.

A seat position summary window is available by click on the button for each aircraft. In PASS, aircraft seats are divided into 4 different types. They are:

a. Up/down adjustable seat

b. Forward/backward adjustable seat

c. Up/down + Forward/backward adjustable seat

d. Non-adjustable seat

Each seat type and the corresponding position summary is described in the following s To look into specific aircraft seat position summary, click the button with the correspondent aircraft name.

a. Up/Down Adjustable Seat

If the seat can only be moved up and down, Seat position summary window (figure 10) will only display up and down position as shown below.

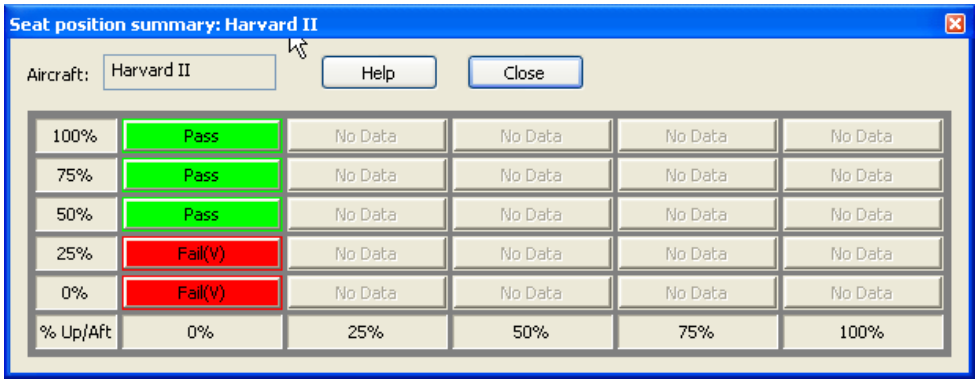
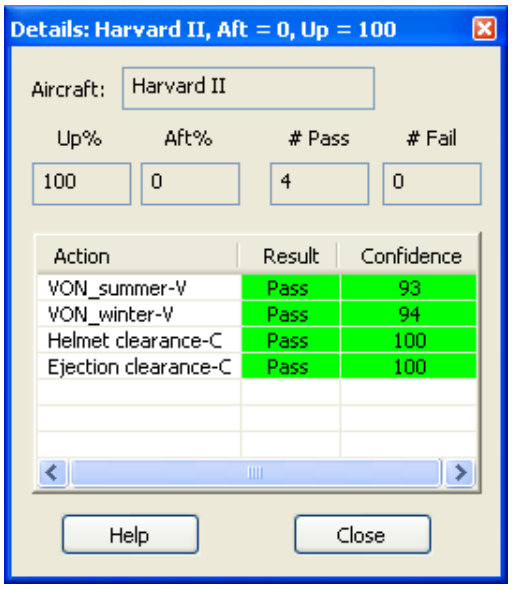


Figure 10: Up/Down Adjustable Seat Position



Further details for each seat position can be retrieved and displayed by click a colored button in the seat position summary window as shown in figure 11.

Figure 11: Details on a Seat Position

b. Forward/Backward Adjustable Seat

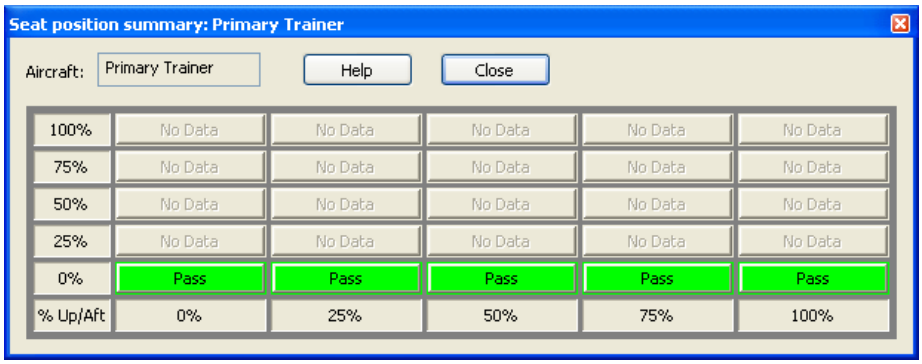


Figure 12: Forward/Backward Adjustable Seat Position

c. Up/Down + Forward/Backward Adjustable Seat

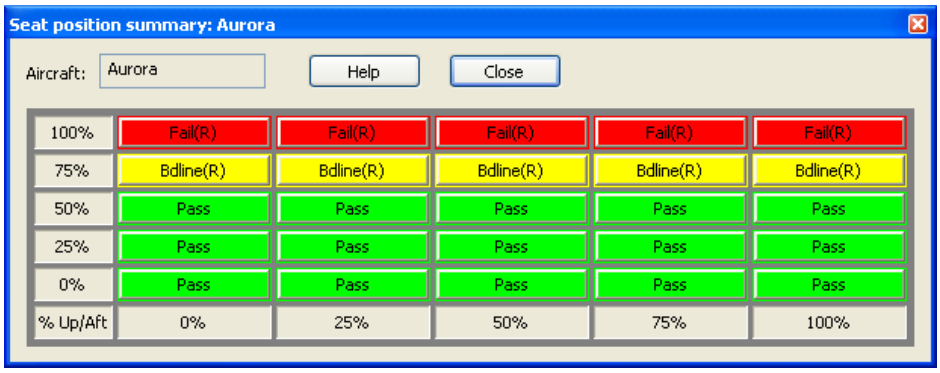


Figure 13: Up/Down + Forward/Backward Adjustable Seat Position

d. Non-Adjustable Seat

For non-adjustable seat, PASS will display confidence result for the actions directly.

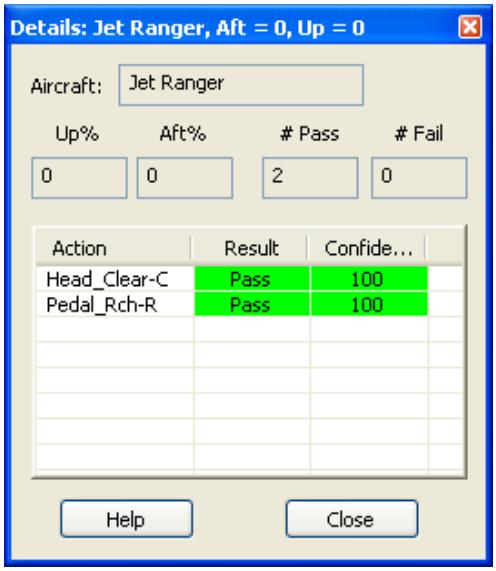


Figure 14: Non-Adjustable Seat Position

3.3.2 Bivarplot Window

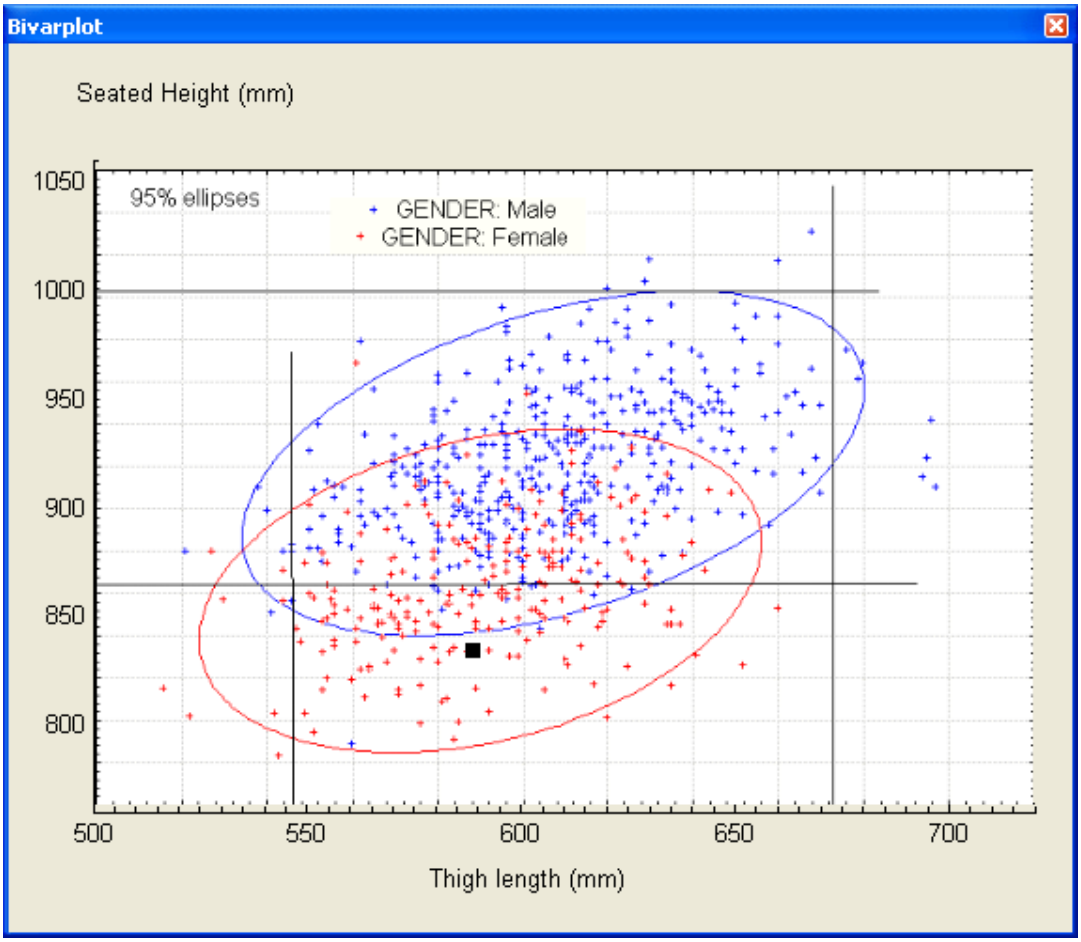


Figure 15: Bivarplot Window With The Current Record

Bivarplot window shows the Seated Height and Thigh length coordinates distribution.The small rectangle black square shows current record point. The red-color crosses represent the Female distribution and the blue-color crosses represent the male distribution.

3.4 STARTING PASS INSIDE BOSS COMBO

PASS application can be invoked within BoSS XXI[2] upon the completion of automatically measurement on a pilot. In such a case, the anthropometrical measurements obtained by BoSS will be automatically input into PASS and the Aircraft Summary report will be generated in the PASS report folder. (the default folder is Program Files/VisImage Systems Inc/PASS 1.0/reports.

[2] For the instruction to start PASS within BoSS XXI, please refer to ***BoSS Combo v2.0 UserGuide***

4. ADVANCED PASS OPERATIONS

4.1 CLEAR ANTHRO VALUES BUTTON

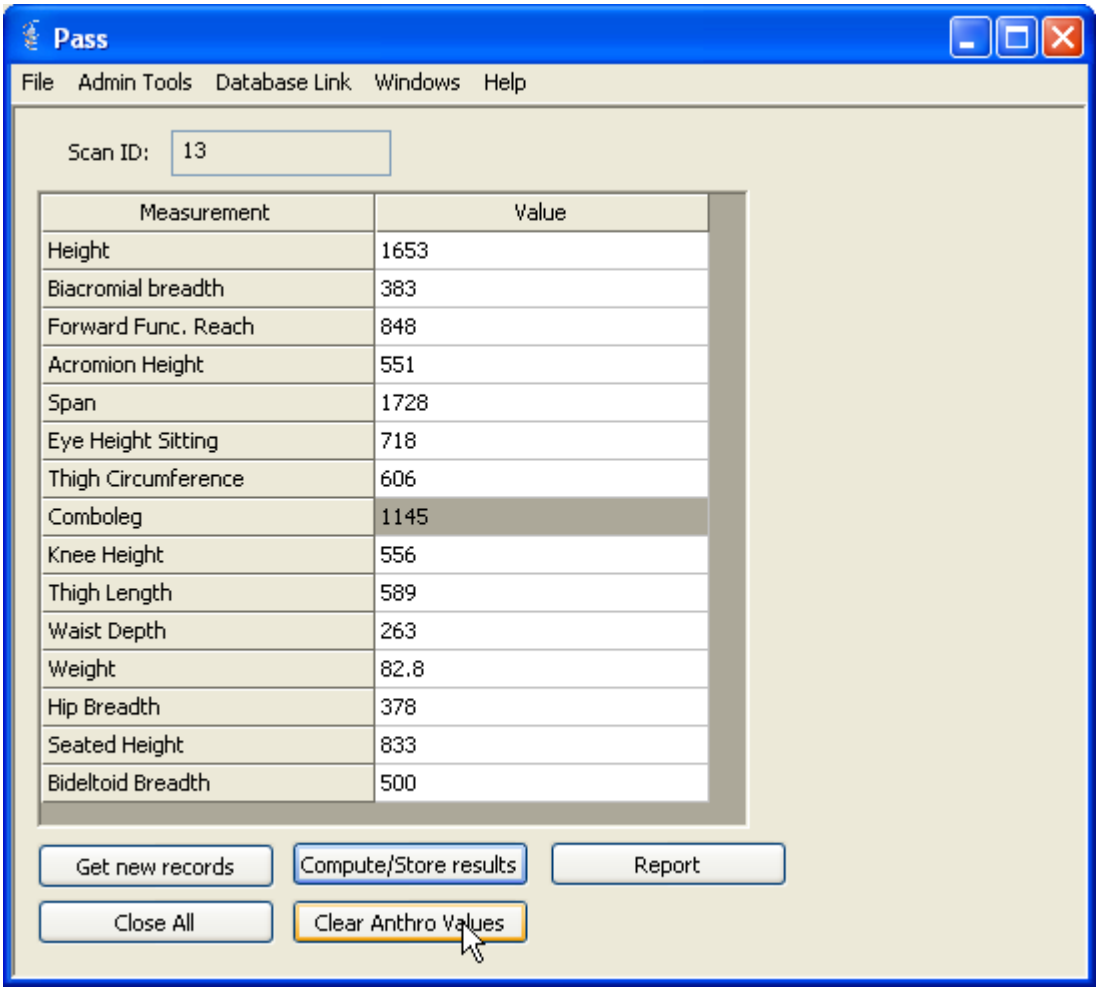


Figure 16: Clear Antho Value Button

Click this button to clear all the anthro measurements values in the Pass window.

4.2 COMPUTE/STORE RESULTS BUTTON

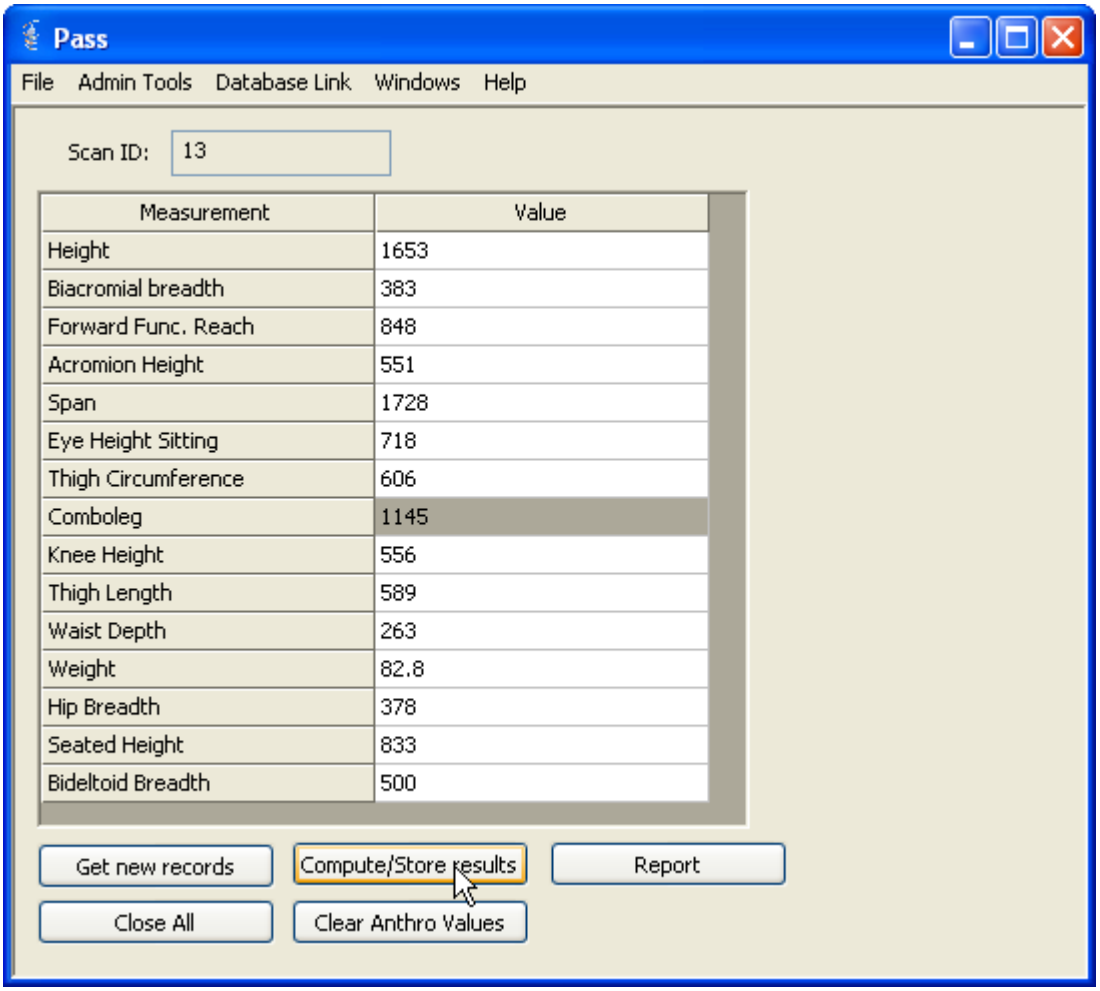


Figure 17: Compute/Store Results Button

Compute/Store results button calculates the current record in the PASS and store it in the PASS Database. It's very necessary to use this button to compute and save each time after you manually modified measurement values in the main window.

4.3 REPORT BUTTON

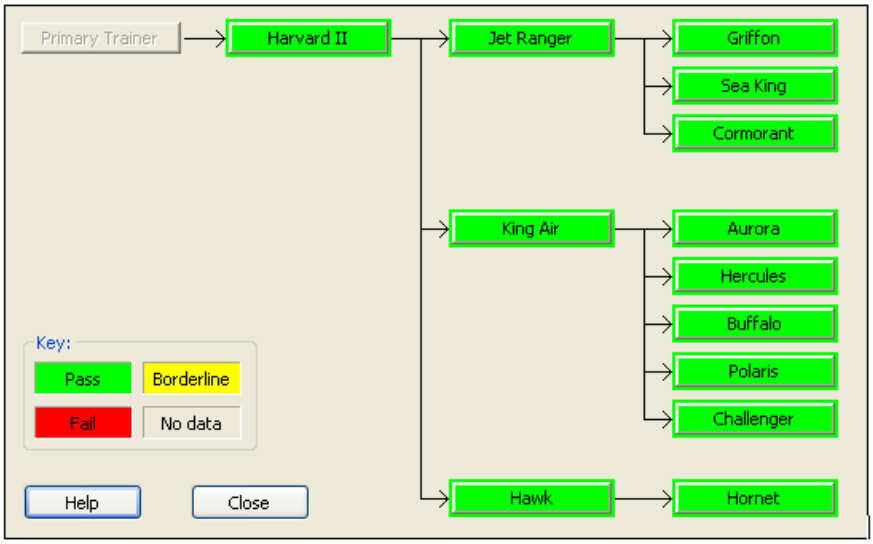
Report button generates the PASS report for the current record. The report file is in the MS word format and it's compatible with Microsoft Word 2000 and Microsoft Word 2003. The report file will overwrite/replace the old one when generating the new one if old one exists.

During this process, you will see the aircraft summary window (Figure 9) pops up or updates if it's already opened.

The aircraft summary window disappears after the report is saved and a message pops up shows "Report is saved in C:\Program files\VisImage Systems Inc\Pass 1.0\reports\Pilot_Report_1.doc!" Then you can go to this folder and open the report. Report is saved as MS word document. It's compatible with MS Word 2000 and MS Word 2003 format.

The report contains aircraft summary window (a snapshot of bivarplot window), table of measurements and bivarplot chart (a snapshot of the bivarplot window).

Name: Sample 1
Service #: A00-000-001
Date: 23/04/2009 9:53:28 AM



Anthropometry

Anthro ID	1
Stature	1879
Biacrominal Breadth	472
Acrominal Ht Sitting	623
Eye Ht Sitting	855
Comboleg Length	1268
Knee Ht Sitting	624
Buttock-knee lth	644
Waist Depth	-10
Weight(kgs)	90
Hip Breadth	369
Sitting Height	990
Bideltoid Breadth	556

Results: Weight within ejection seat limits

Aircraft	Vision	Clearance	Reach	Overall
Aurora	√	√	√	Pass
Buffalo	√	√	√	Pass
Challenger	√	√	√	Pass
Cormorant	√	√	√	Pass
Griffon	√	√	√	Pass
Harvard_II	√	√	√	Pass
Hawk	√	√	√	Pass
Hercules	√	√	√	Pass
Hornet	√	√	√	Pass
Jet_Ranger	√	√	√	Pass
King_Air	√	√	√	Pass
Polaris	√	√	√	Pass
Sea_King	√	√	√	Pass

Figure 18: A PASS Report for a Pilot

The VCR (Vision, Clearance and Reach) result is for the best seat position for correspondent aircraft. And also the Green or Red highlighted background for the weight decision. The background weight color is green if within the weight range, or red if out of the weight range.

4.4 AUTO REPORT PRINTING

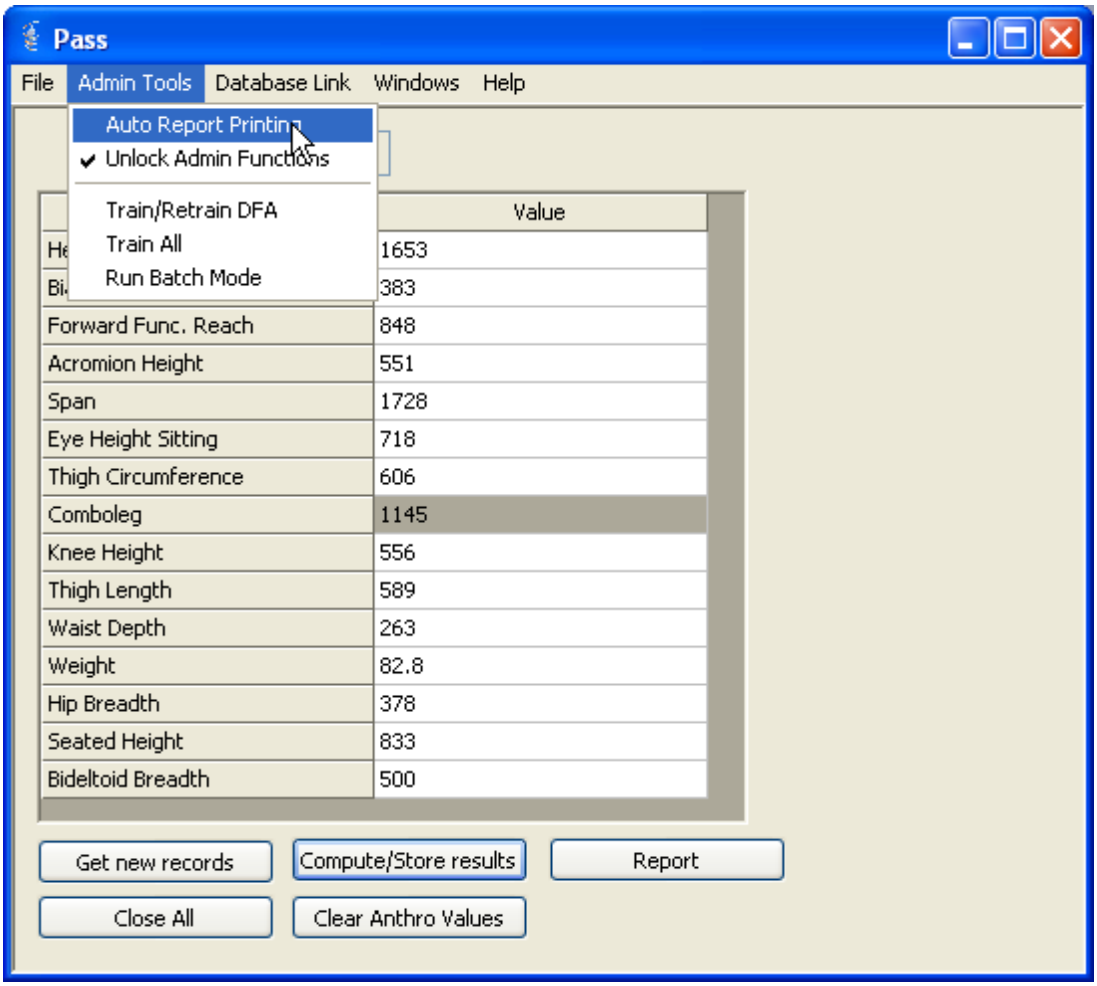


Figure 19: Auto Report Printing Selection

Check this option to have report printed right after you finish processing the record.

4.5 ADMIN FUNCTIONS FOR PASS ADVANCED USER/DESIGNER

The admin functions are protected by Password to prevent unsafe or unexpected changes. Admin functions generate the train data which is used for the DFA functions to predict results. These functions include Train/Retrain DFA, Train All and Run Batch Mode.

4.5.1 Unlock the Functions Protection

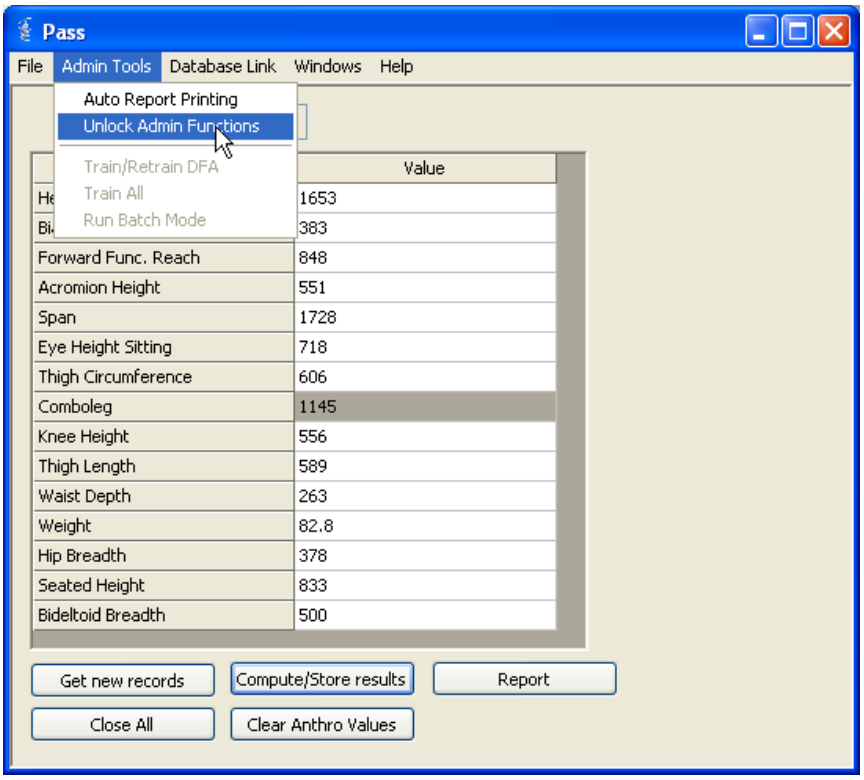


Figure 20: Unlock Admin Functions

Click Admin Tools→Unlock Admin Functions.

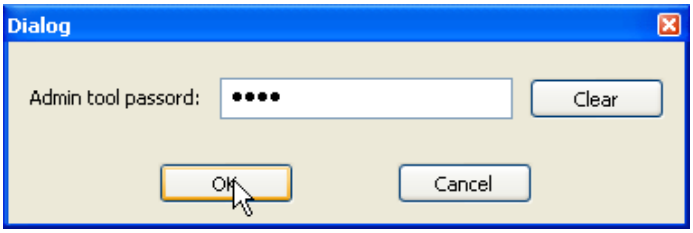


Figure 21: Password for Unlock Admin Functions

Input password 2468 and click OK to unlock the admin functions. If the Admin functions are unlocked, the admin functions menu will be enabled.

4.5.2 Train aircrafts

PASS Admin functions include training aircrafts. Training aircrafts backup the current DFA binary result, take the excel aircraft module file as the input, generate the new binary DFA train data, save it to hard drive and use it as the current DFA result. There are 2 methods to train the DFA data. One of them is Training all the aircrafts at one time, the other is only training specific aircrafts.

4.5.2.1 Train Specific Aircrafts (Train/Retrain DFA)

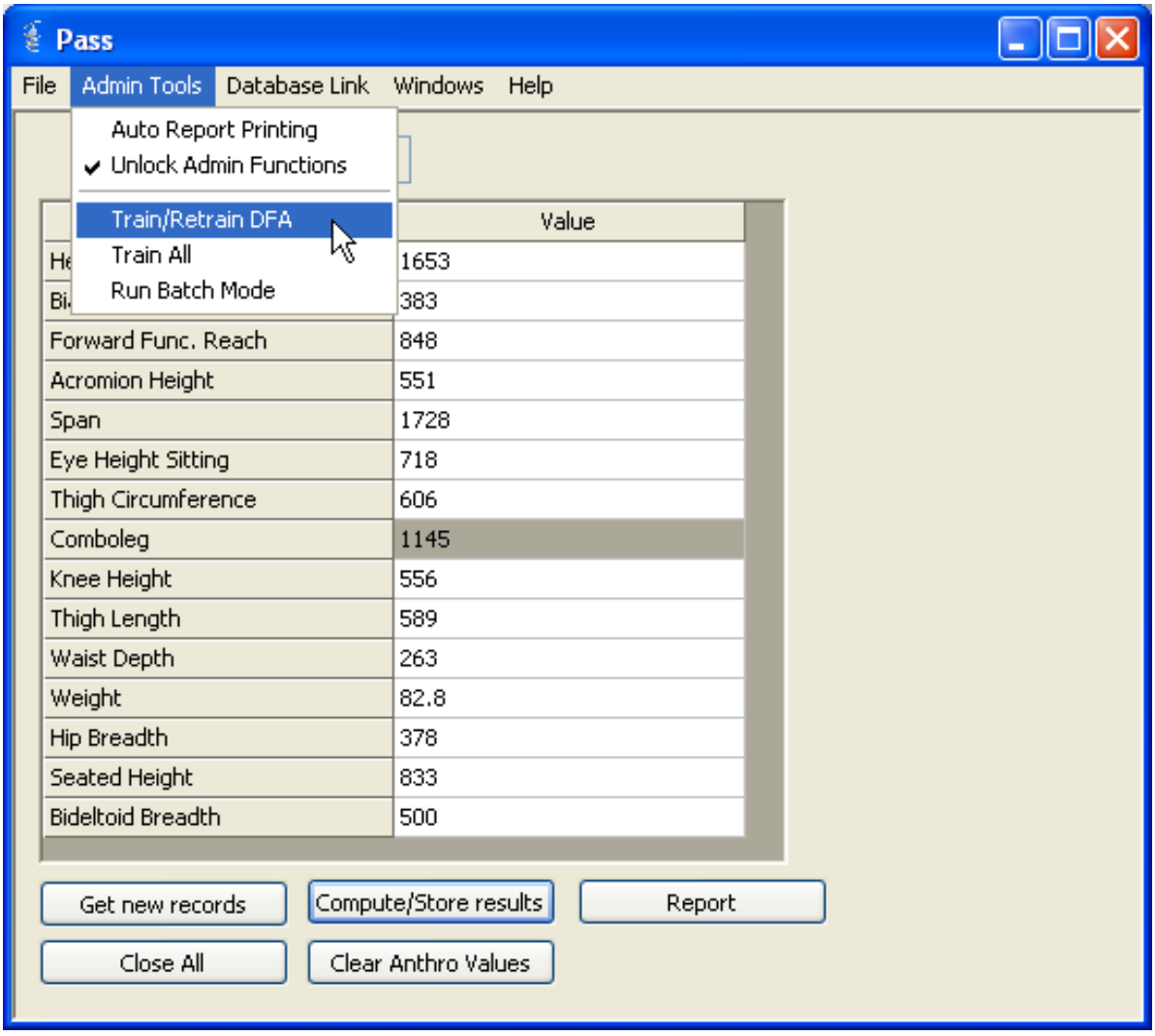


Figure 22: Train Aircraft Using DFA

Click Admin Tools→Train/Retrain DFA menu item. You will see Window [Select aircraft file(s)] pops up.

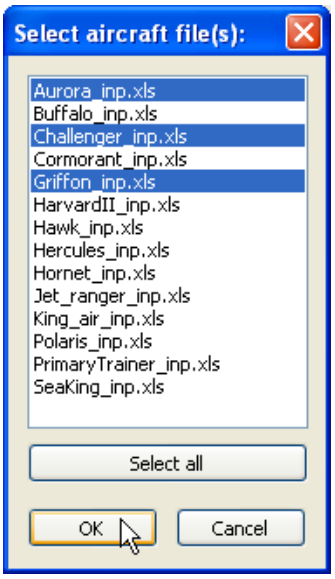


Figure 23: Select Aircraft

Select aircrafts you want to train. To multi-select, you can click the aircraft excel file by holding the Crtl key. Press OK to start training.

If you trained only some of the aircrafts (Not All aircrafts), PASS will update these involved aircrafts info in the DFA binary file and all the other aircrafts will remain the same as before.

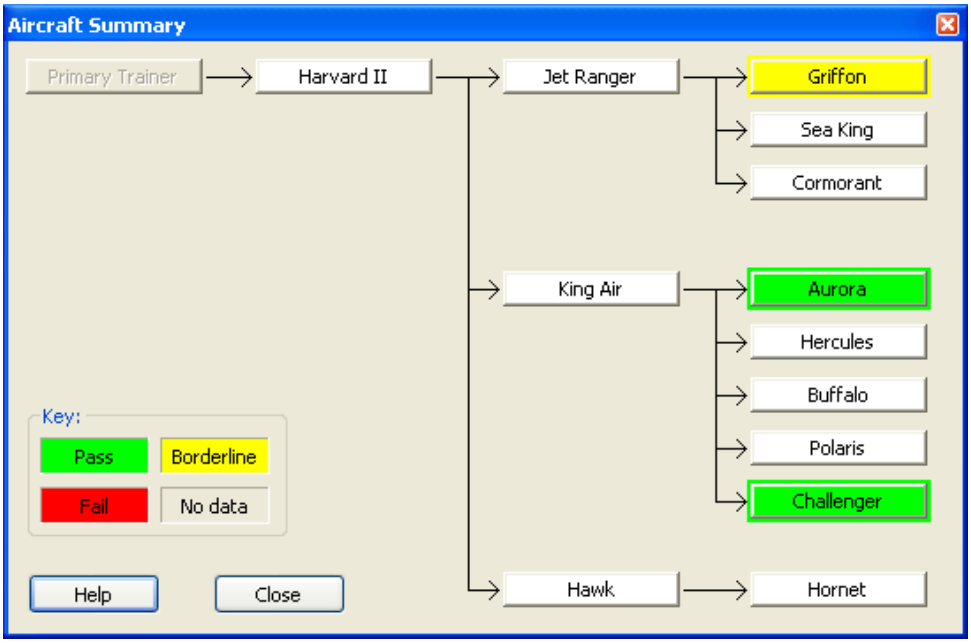


Figure 24: Only the Latest Training Aircrafts are Highlighted

To make the retrained aircrafts have some special with the others, PASS only displays colors for the latest trained aircrafts and also PASS only output these latest trained aircrafts to the batch file. In this case we trained aircraft “Griffon”, “Aurora” and “Challenger”, so only these 3 aircrafts have color identified by the aircraft summary window.

4.5.2.2 Train All Aircrafts (Train All)

This function allows you train all the aircraft in one time. PASS will use all the aircraft excel files in the installation folder\aircraft input.

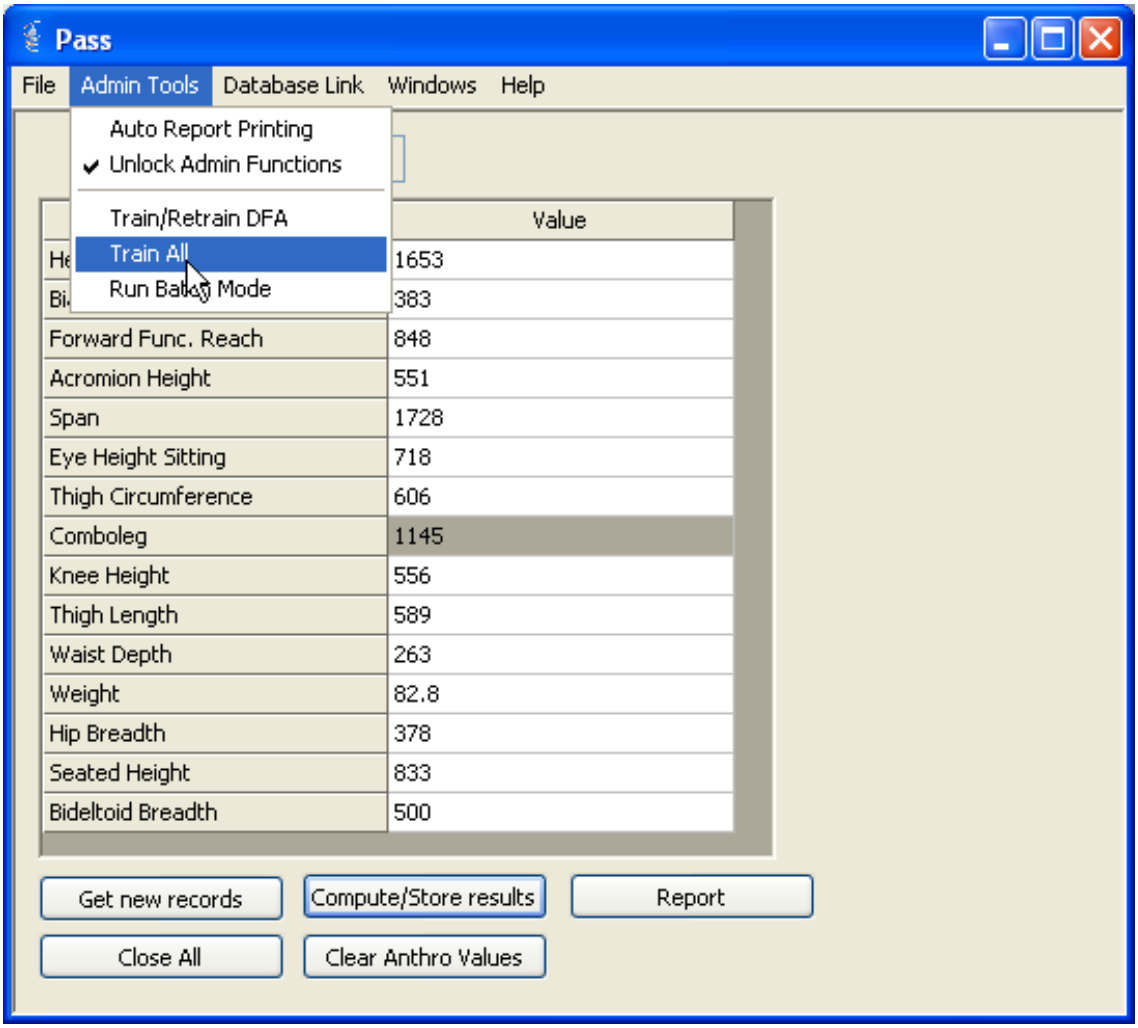


Figure 25: Training All Aircrafts Selection

The progress bar shows the current status of the training process.

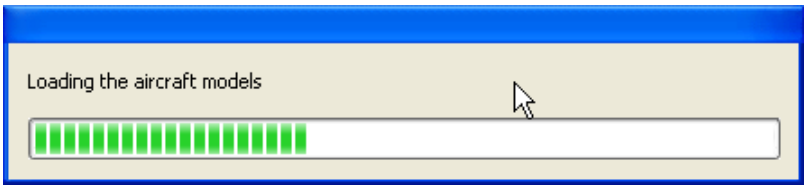


Figure 26: The Progress Bar in the Training Process

4.6 RUN BATCH MODE

This function allows you to calculate and save all the records in an Excel pilot file to a result file. The result file includes all the PASS prediction result (Overall Pass/fail, factors, best seat position, anthropometric data and etc.)

Click Admin Tools→Run Batch Mode

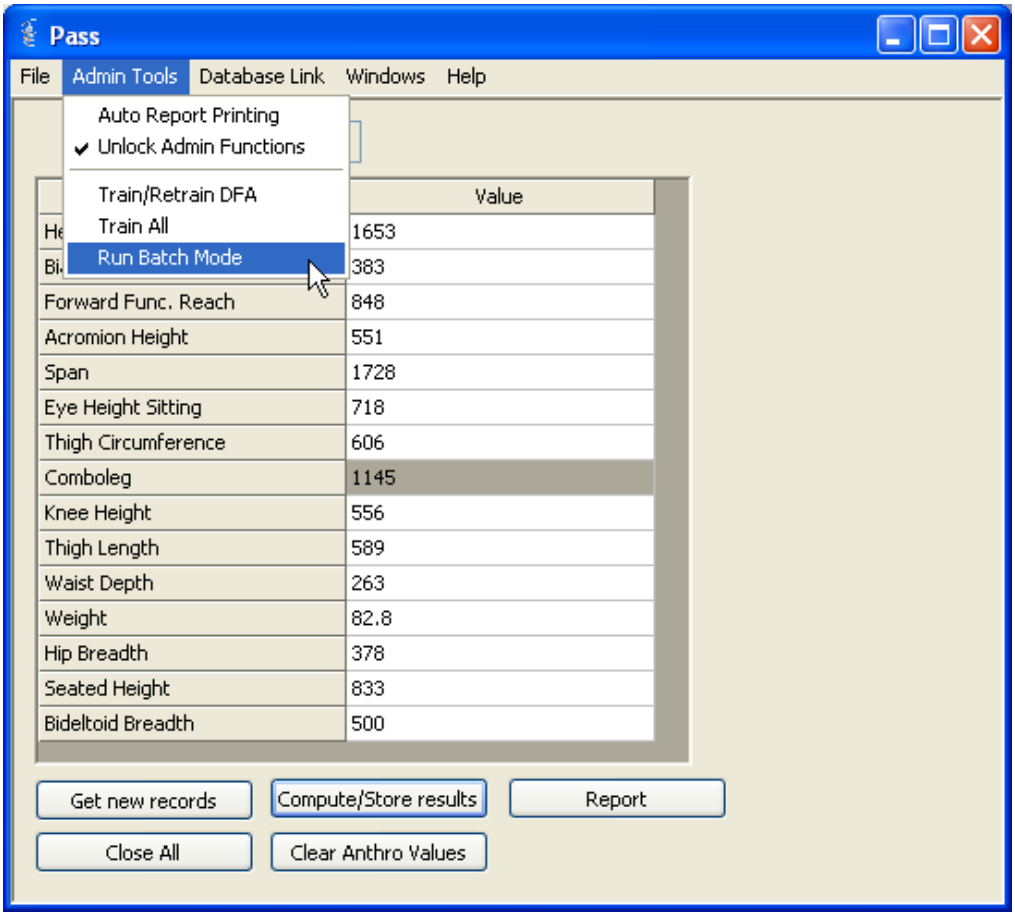


Figure 27: Run Batch Mode to Compute All The Pilot In An MS Excel File

Select an Excel pilot file and designate the output file name.

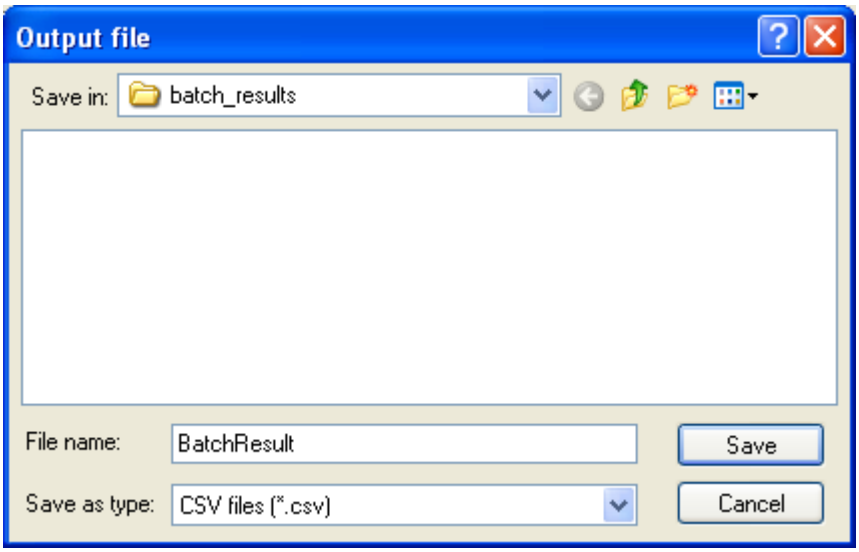


Figure 28: Selection Window For The Output

There are only 3 aircrafts in this batch result file, because we only trained these 3 aircrafts previously.

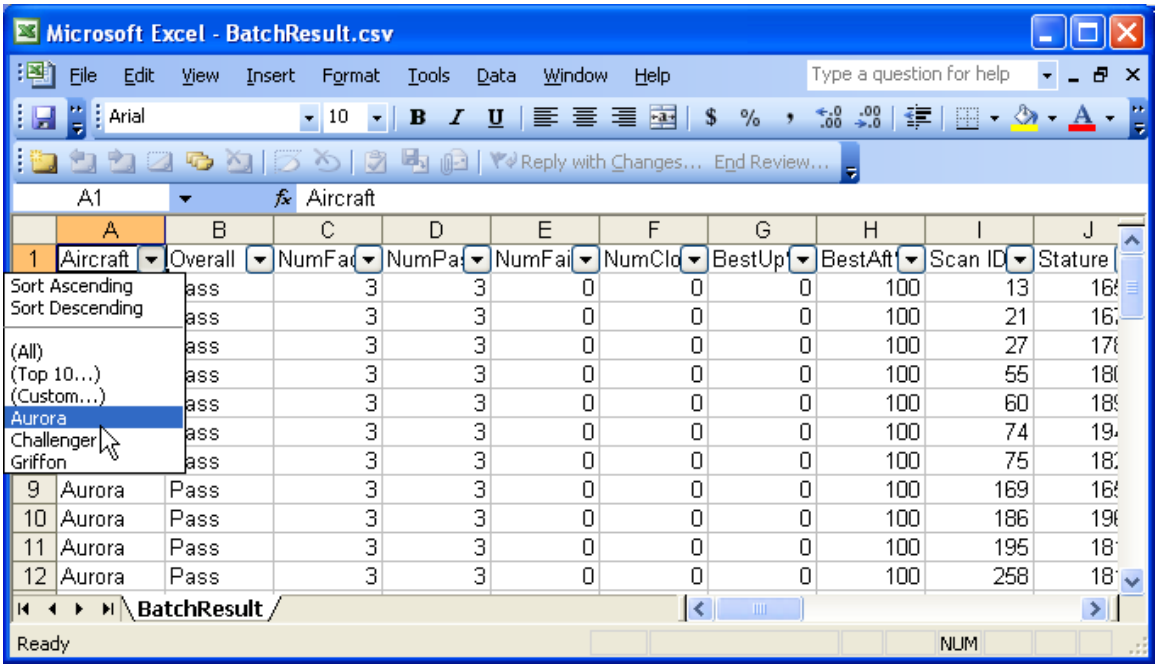


Figure 29: Batch Calculation Result

5. ADD/MODIFY AIRCRAFT SCREENING CRITERIA IN PASS

This chapter introduces how to edit aircraft (cockpit) model files. These operations are very serious and may affect PASS prediction results.

Upon installation of the software suite, (accomplished easily by running the install program), several sample files are included that can be used for this tutorial, or as templates for adding additional aircraft. These files are installed in a sub-directory named tutorial of the root installation directory chosen at the time of installation.

The files used in this exercise (found in the tutorial folder) are:

1. New_air_template.xls – Sample template for adding new aircraft using DFA only.
2. New_air_template2.xls – Sample template for new aircraft using DFA and individual factor thresholds.
3. New_air_template3.xls – Sample template for new aircraft using DFA and linear regression (inequality) constraints.
4. New_air_template4.xls – Sample template for new aircraft using DFA, factor thresholds and linear regression (inequality) constraints.

These files may be used to train the PASS tool (for testing purposes only), appearing as the 'Primary Trainer' aircraft. Note that the tutorial files do not contain real training data for that aircraft, but are supplied for documentation and training purposes only.

Detailed Guide / Specifications for Adding / Modifying Aircraft Model Files for PASS

For each aircraft there is one multi-tabbed MS Excel Worksheet that contains all of the DFA training data, anthropometric factors, critical actions (reaches, vision, clearances), and seat position dependency.

This file may also contain optional threshold constraints (maximum and minimum anthropometric dimensions), and/or optional linear regression inequality constraints.

These files are stored as Excel spreadsheets located in the aircraft_input sub-directory of the root installation directory. These input files are implemented in the program's prediction database through a training command found on the Administrator menu of the data_entry graphical interface.

To ensure successful program operation, precise construction of these aircraft model files is needed.

The simplest way to add or modify aircraft model is to modify the provided templates, or adapt another aircraft's training file similar to the new one with respect to factors, limits, etc.

To begin the tutorial, please open the file "new_air_template.xls" using MS Excel. This file contains sample data used in this guide (the sample can be installed as the 'Primary Trainer'). When the Excel file is opened, you should see a screen similar to Figure 30 (shown split horizontally).

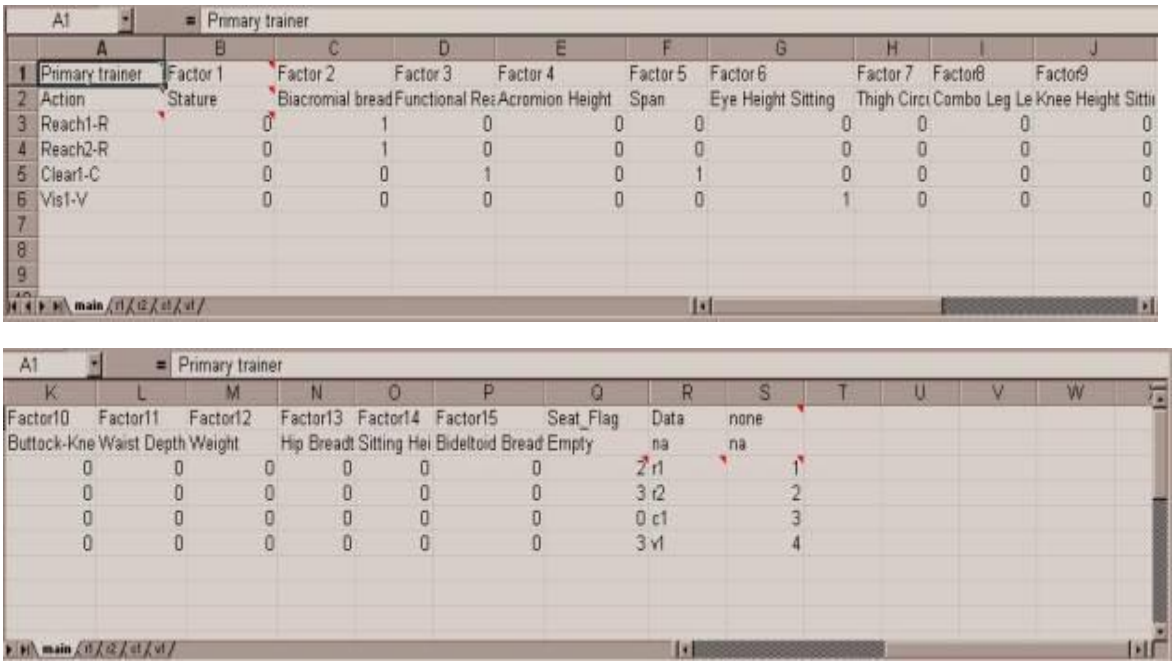


Figure 30: Multi-Tabbed MS Excel Worksheet

Note the small diagonal red lines in the upper right corner of some cells. These cells contain embedded comments summarizing characteristics of those (and related) cells. The comments can be viewed by pointing to the cell with the cursor, as shown in Figure 31. They may also be displayed by right clicking and selecting the *Show Comment* command.

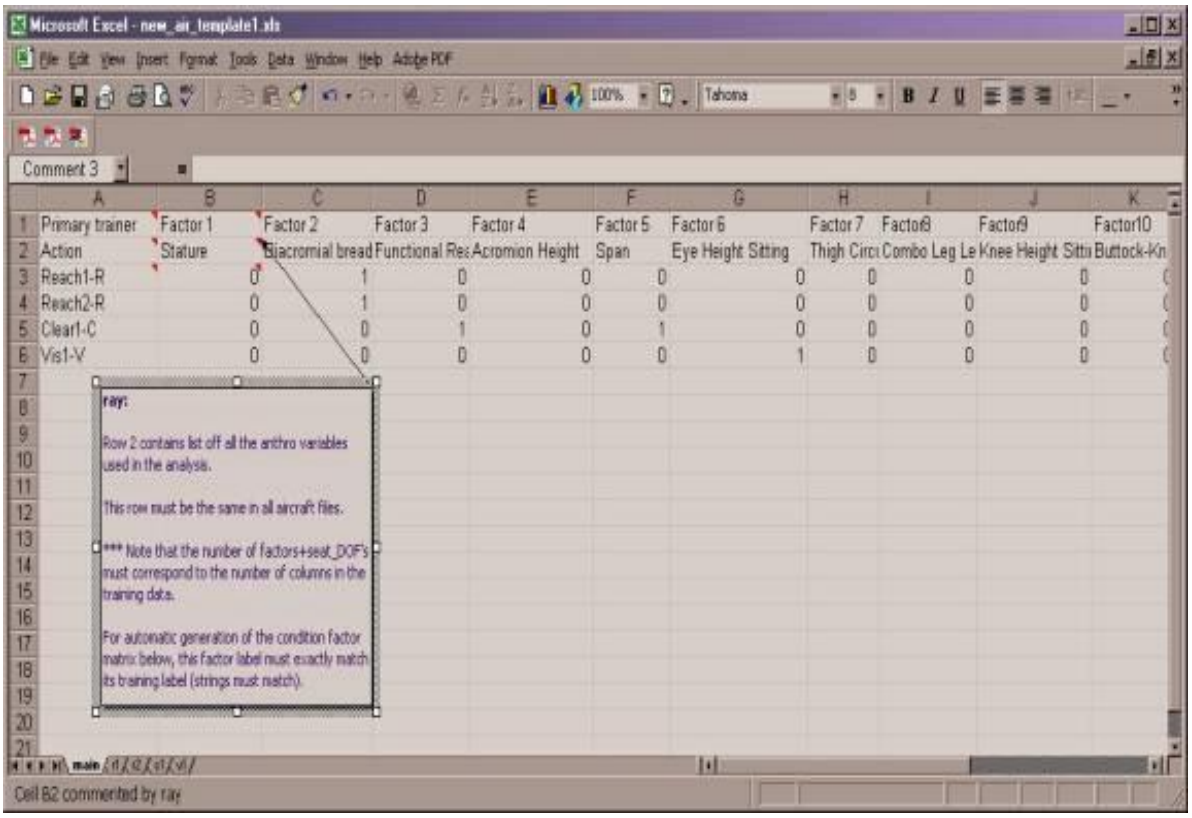


Figure 31: Detailed Information Is Shown As Comment in Excel File

Note, as shown in Figure 31, that the Excel file has multiple worksheet tabs.

There are four possible cases to consider in setting up the training files

5.1 CASE 1: WHEN NO INDIVIDUAL FACTOR THRESHOLDS OR INEQUALITY CONSTRAINTS ARE USED

5.1.1 Setting up the Main Tab

The first tab 'main' contains a summary of all the factors (anthro variables), actions (reaches, etc.) and their relationships (or dependencies).

The main tab also defines the display labels for all of the items, and contains links to the training data tab labels (each other tab contains training data for individual Actions, one per tab).

Finally, this page also may contain a link to the special constraints (if present), allowing absolute minimum and maximum thresholds for anthropometric measurements, and/or linear programming inequality constraints.

Below is a detailed summary of the required cells in the main worksheet tab; these should be modified as needed for new aircraft:

Cell A1 (e.g. "Primary Trainer") – Contains a string with the name of the aircraft. It must precisely match one of the names shown in the Aircraft Summary (see Figure 1).

Cell A2 (e.g. "Actions") – Descriptive heading only, should have no effect on analysis. Can be changed, must be a string (not number). Recommend leaving to default vale.

Cells A3 (e.g. "Reach1-R") – This column defines the display title of each relevant critical reach, clearance or vision action for the given aircraft.

The length of the list is variable, depending on the aircraft. These alphanumeric titles are displayed in the graphics summary of the predict program, and are also contained in the report from the batch mode of the program.

The actions can be classified using DFA, thresholds, and/or linear programming inequalities. Note that the last character can indicate if the action is related to reach '-R', vision '-V', or clearance '-C'. (e.g. 'R' in this case for Reach). These are used in the seat position display to show the source of predicted failing actions.

Cells B2 ... P2 (e.g. "Stature", etc.) – This row defines the display titles of the anthropometric factors (human dimensional measurements) that are used to predict the success/failure of the listed actions. The display titles may be changed/modified as needed; however, adding additional anthropometric functions requires source code modification. Unlike the action labels, that are unique for each aircraft, these anthropometric variables must be identical for all aircraft.

The actual assignment or dependency of each action to each anthropometric factor takes place in three ways:

1. By providing matched training data on a worksheet tab linked to a particular row or action.
2. By providing a flag indicating the factors that each action (or row) is dependent upon (see below).
3. By providing a flag indicating which seat movements are also modeled for each action, such as (up/down, fwd/aft, both, or none) (also see below).

The column order of these factors is on the main tab, and their related relative position in the training data must be consistent. Thus, columns in the training data must appear in a fixed order from left to right, as described later in this document.

Renaming anthropometric variables is possible, though care must be used to ensure that the names are consistent internally for each excel aircraft input file (making sure that the training data column titles are exact matches to those on the main tab). For renaming anthropometric variables, it is recommended to use a third party Excel search and replace tool, such as one provided by www.replsoft.com. It can search and replace in batch mode, renaming variables across multiple workbook files and worksheet tabs.

It is also important to ensure that the anthropometric names and labels are consistent across the various aircraft. In general, if renaming anthropometric factors titles is needed, it is recommended to contact Array for assistance.

Note that due to dependencies with specific fields in the sample database, and certain error checking routines, at this time the reordering of anthropometric variables is not supported. This feature is planned for future versions of the program.

Cell S1 (e.g., 'none') – Used to specify an optional special constraints tabbed sheet that contains individual Factor thresholds (minimum/maximums) and/or linear programming inequalities. This cell must contain either the string 'none', or a string containing the label of the worksheet tab containing the thresholds and/or inequalities.

For more information on using and specifying thresholds, please see Case 2 below.

Cells R3 (to end of actions list) – (e.g., 'r1') – Link of each specified action (in column A) with its training data (on named worksheet tab). Each cell contains a string with the exact name of the tab (or worksheet) that contains the training data for the action contained on that row.

If the action (row) is only dependant on thresholds (min/max) and/or inequalities, enter the string 'none' (no quotes) in the corresponding cell in column R.

Cells B3 (to end of actions list) -- (e.g., 0) – These numeric cells define the condition matrix that consists of integer flags that link the actions and anthropometric measurements, thresholds, inequalities and their relationship/dependence. In other words, it specifies which measurements each critical action (row of reach, vision or clearance action) depends upon.

The matrix consists of integer flags as follows:

1 = Indicates that the specified Anthro/Action is classified using DFA (trained)

0 = Indicates that the specified Anthro/Action are not related.

-2 = Indicates that the specified Anthro/Action is classified using thresholds (specified min-max limits for related anthropometric measurements.

-3 = Indicates that the specified Anthro/Action is classified using a linear programming inequality.

For the 0's and 1's with respect to training data, the spreadsheet contains functions that automatically generate these flags, provided that the column headings and labels for the Anthro names are identical on both the main worksheet tab and the related training data tab.

Currently, it is required to manually specify anthro/action combinations that depend upon special factors such as min/max thresholds and/or inequalities. Thus, at this time, the –2 and –3 flags must be entered manually. Note also that for the –3 flags (inequalities), only the first anthro term in the inequality need be specified on the main tab, as all provided terms on the special conditions tab (specified in cell S1 on the main tab) will be applied.

Cells Q3 (to end of Actions list) (e.g., 0) – This numeric column contains integer flags that indicate the seat position dependency or model for each action (or row).

The cells consist of an integer flag, specified as follows:

0 = Indicates that the specified action (row) is dependant (and training data supports) on both fwd/aft and up/down seat positions.

2 = Indicates that the specified action is dependant on fwd/aft seat position only.

3 = Indicates that the specified action is dependant on up/down seat position only.

5 = Indicates that the specified action is not dependant on any seat position.

Note that this column is now automatically generated by spreadsheet functions, provided that consistent labelling is used in the column headings on all of the tabs containing training data. This means that each column heading (Row A) on each training data tab must contain either an exact anthro label matching the main tab, or the label '%up', '%aft', or the name of the critical action.

Cells S3 (to end of actions list) – This column contains a numeric value (in sequence), it is presently unused, but provides a unique index (or key) reserved for future use.

5.1.2 Setting up the Additional Tabs Containing Training Data

The remaining worksheet tabs, linked to the main tab by the labels in Column R on the main tab, contain the DFA training data.

Figure 32 contains an example of training data for one action from the sample file:

New_air_template.xls file, sheet r1:

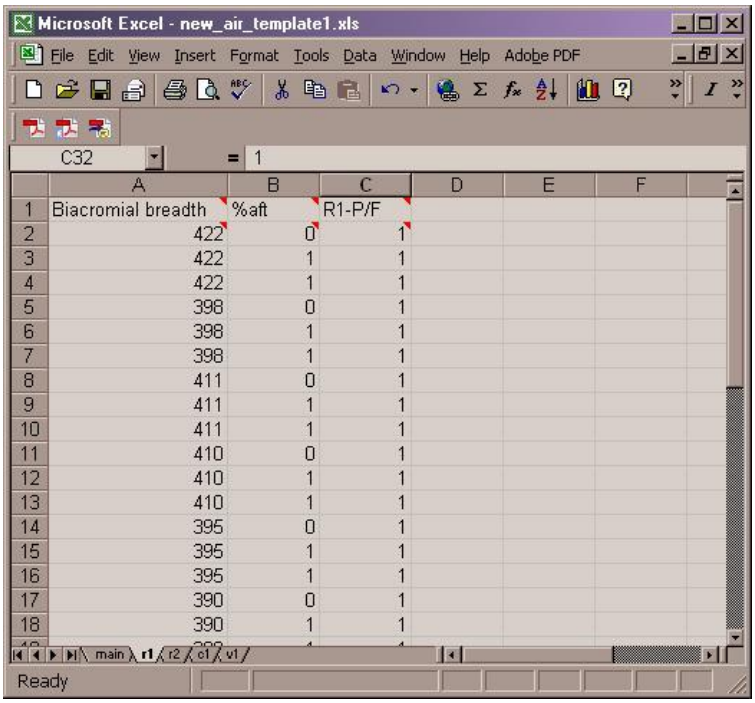


Figure 32: Additional Tabs Containing Training Data

The following format restrictions exist for specifying the training data on each tab:

1. Duplicate rows are not allowed, these will cause a run-time error (as they create singular matrices).

2. The first row contains column titles that must be present and each must contain a string. (e.g. '% aft') They must match exactly to either the anthropometric variable names in the main tab (across Row 2), or seat positions must match the labels '%up' or '%aft'. The string matching is used to automatically populate the condition factor matrix on the main tab.

3. The column order for the actual training data must be specified from left to right as follows:

    a. Dependant factor training data (discrete values), one per column (Columns A) (up to the number of factors for that action)). These must be in same order (column-wise left to right) as the coefficient flags appear on the main tab.

    b. If there is a seat up/down dependence (which will show on the seat flag on the main tab), it must appear in the next column.

    c. If there is a seat fwd/aft dependence (which will show on the seat flag on the main tab), it must appear in the next column.

    d. **It is important to note that the seat up column must come before the seat aft column**.

4. For seat position, an unsigned decimal value (as opposed to % value) must be used, 0=0%, 1=100%, 0.5=50% (or neutral), etc.

5. All columns must have the same number of rows.

6. All training data values must be numeric only (integer or real).

7. The last column must indicate the classification, and must contain either an integer 1 (specifying a pass), or 2 (specifying a fail). Strings are not allowed, nor are any values other than 1 or 2.

8. **IMPORTANT**: The last row entry for each column must contain all zeros, (0), except for the entry in the final column (the PASS/FAIL column), final row. This cell (here shown as C32 for example), must contain a 0 or 1, which is a flag indicating how to set the priori variance for the DFA. A zero (0) indicates that equal priori weighting should be used (50/50, or .5 for each). A one (1) indicates that the priori estimated variances should be computed from the training set, based on the number of classifications (pass/fail) in the training set.

All of the remaining tabs in the Excel file are configured similarly, based on the relevant factors/actions/seat positions.

5.2 CASE 2: WHEN ADDITIONAL ANTHROPOMETRIC THRESHOLD VALUES ARE USED

For additional classification flexibility, the PASS tool allows individual thresholds (min and max values) to be set for each anthropometric value for a certain critical action.

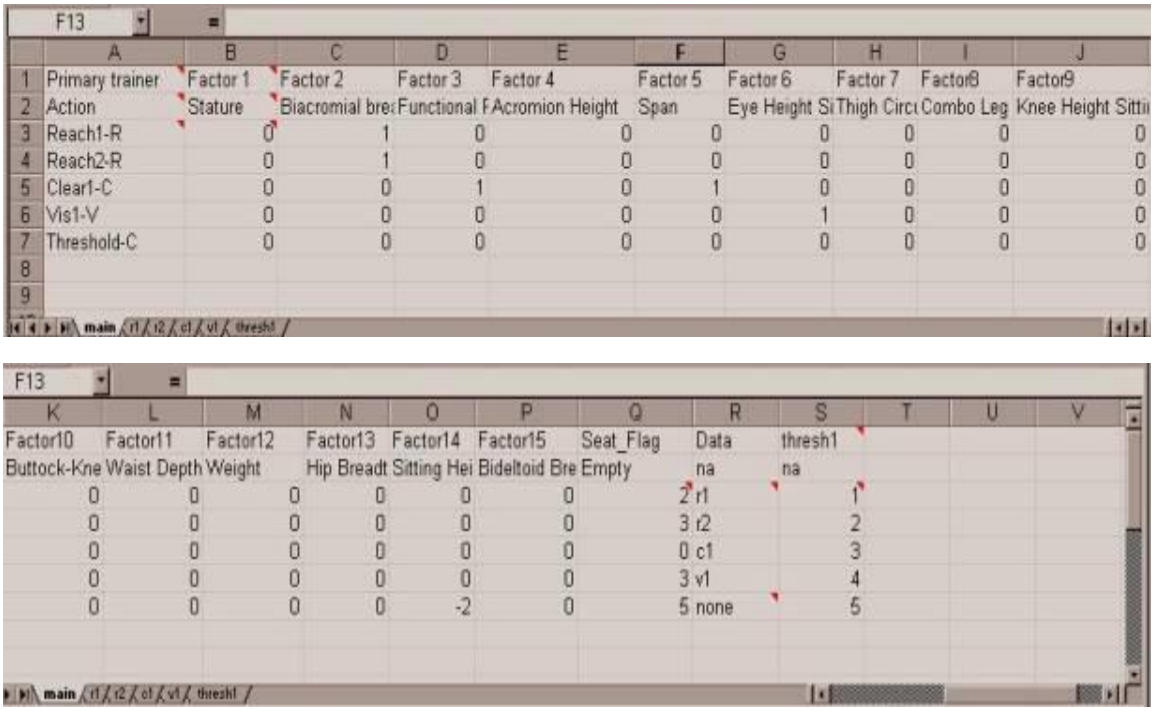
These thresholds enable absolute deterministic classification, as opposed to the stochastic classification offered by DFA.

To illustrate the use of this functionality, please open the file 'new_air_template2.xls' using Excel.

The previous format and syntax requirements of Case #1 must be applied, and in addition:

Notice for the fifth action (row) item, cell A7, 'Threshold-C', there is no DFA, but it instead is classified by using the following threshold constraint:

Sitting Height (for clearance purposes) must be between 0-1000 mm



	A	B	C	D	E	F	G	H	I	J
1	Primary trainer	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor8	Factor9
2	Action	Stature	Biacromial bre	Functional F	Acromion Height	Span	Eye Height Si	Thigh Circ	Combo Leg	Knee Height Sitti
3	Reach1-R	0	1	0	0	0	0	0	0	0
4	Reach2-R	0	1	0	0	0	0	0	0	0
5	Clear1-C	0	0	1	0	1	0	0	0	0
6	Vis1-V	0	0	0	0	0	1	0	0	0
7	Threshold-C	0	0	0	0	0	0	0	0	0
8										
9										

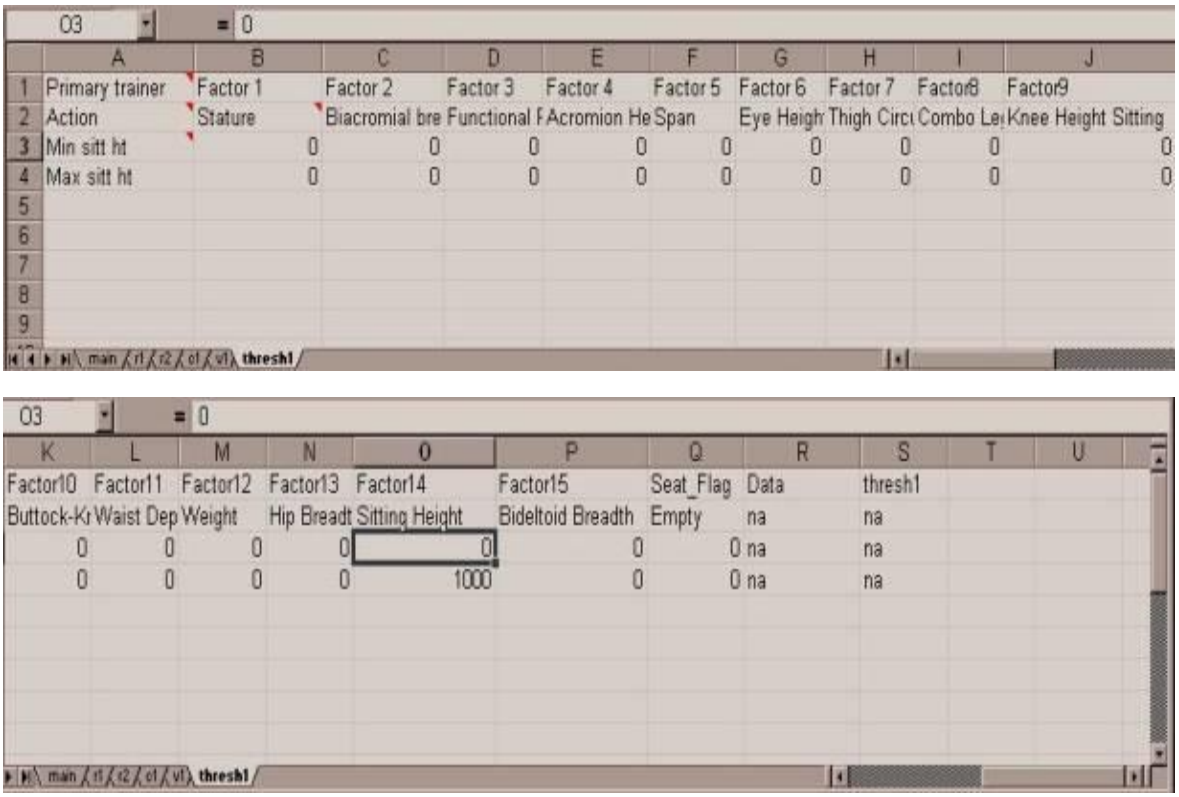
	K	L	M	N	O	P	Q	R	S	T	U	V
1	Factor10	Factor11	Factor12	Factor13	Factor14	Factor15	Seat_Flag	Data	thresh1			
2	Buttock-Kne	Waist Depth	Weight	Hip Breadt	Sitting Hei	Bideltoid Bre	Empty	na	na			
3	0	0	0	0	0	0	2	r1	1			
4	0	0	0	0	0	0	3	r2	2			
5	0	0	0	0	0	0	0	c1	3			
6	0	0	0	0	0	0	3	v1	4			
7	0	0	0	0	-2	0	5	none	5			

Figure 33: Adding Thresholds to Anthropometric Factors

In Figure 33 notice that cell O7 contains a – 2 value (flag). This indicates that these Factor/Action combinations are to be classified based using thresholds.

It is also important to note that Cell S1 now contains the label name for the Excel worksheet tab detailing the thresholds.

Figure 34 shows the format for specifying the actual thresholds on the worksheet tab named in Cell S1 on the main tab.



	A	B	C	D	E	F	G	H	I	J
1	Primary trainer	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor8	Factor9
2	Action	Stature	Biacromial bre	Functional F	Acromion He	Span	Eye Heigh	Thigh Circ	Combo Le	Knee Height Sitting
3	Min sitt ht	0	0	0	0	0	0	0	0	0
4	Max sitt ht	0	0	0	0	0	0	0	0	0
5										
6										
7										
8										
9										

K	L	M	N	O	P	Q	R	S	T	U
Factor10	Factor11	Factor12	Factor13	Factor14	Factor15	Seat_Flag	Data	thresh1		
Buttock-Kr	Waist Dep	Weight	Hip Breadt	Sitting Height	Bideltoid Breadth	Empty	na	na		
0	0	0	0	0	0	0	na	na		
0	0	0	0	1000	0	0	na	na		

Figure 34: Specifying Threshold Values for Individual Factors/Action Items

The following formatting/file structure restrictions apply to setting up this worksheet tab:

1. Each action that is flagged on the main tab with thresholds must appear in row order, with each action requiring two rows; the first row specifying the minimum threshold, the second the maximum. Both minimum and maximum values must be specified for each flagged action. Note that an arbitrarily large or small number might need to be entered to satisfy this condition.

2. The column titles, number of columns and order of factors (column order) must be the same as specified in the main tab.

3. The order of the Actions in the threshold file must be given in the up/down (row-wise) order of appearance of the indicator flags (-2) on the main sheet, main tab.

4. The minimum values must appear before the maximums, and naturally must be smaller numerically.

5.3 CASE 3: WHEN ADDITIONAL LINEAR PROGRAMMING INEQUALITIES ARE USED

For even more classification flexibility, the PASS tool now also allows the use of linear inequality constraints to classify a certain Factor and Action combination. This is most commonly used in linear programming derived solutions.

The previous format and syntax requirements of Case #1 must be applied, and in addition:

These inequalities allow deterministic classification with functions that contain multiple anthropometric variables.

To illustrate the use of this functionality, please open the file 'new_air_template3.xls' using Excel.

This file is similar to the one examined in Case #1, but with the addition of the following linear inequality constraint restrictions:

Notice for the fifth action (row) titled 'LinearP-C', there is no DFA or thresholds, but it instead is to be classified by using the following linear programming inequality:

0.24 * Knee Height Sitting + 1.00 * Buttock-Knee Length < 795

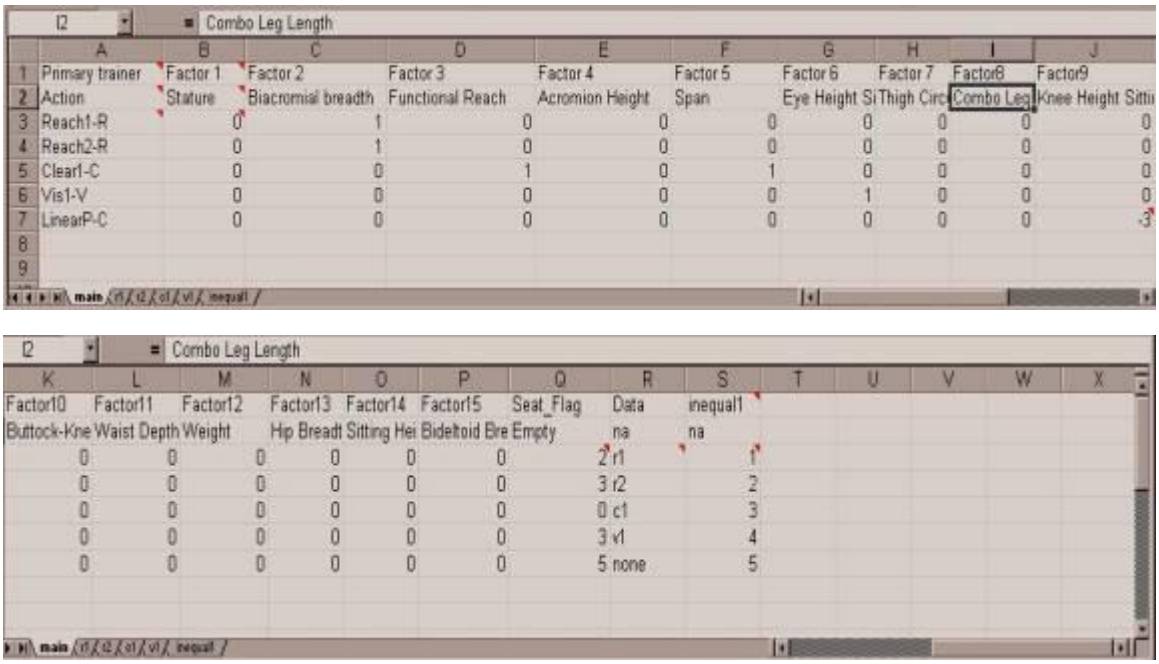
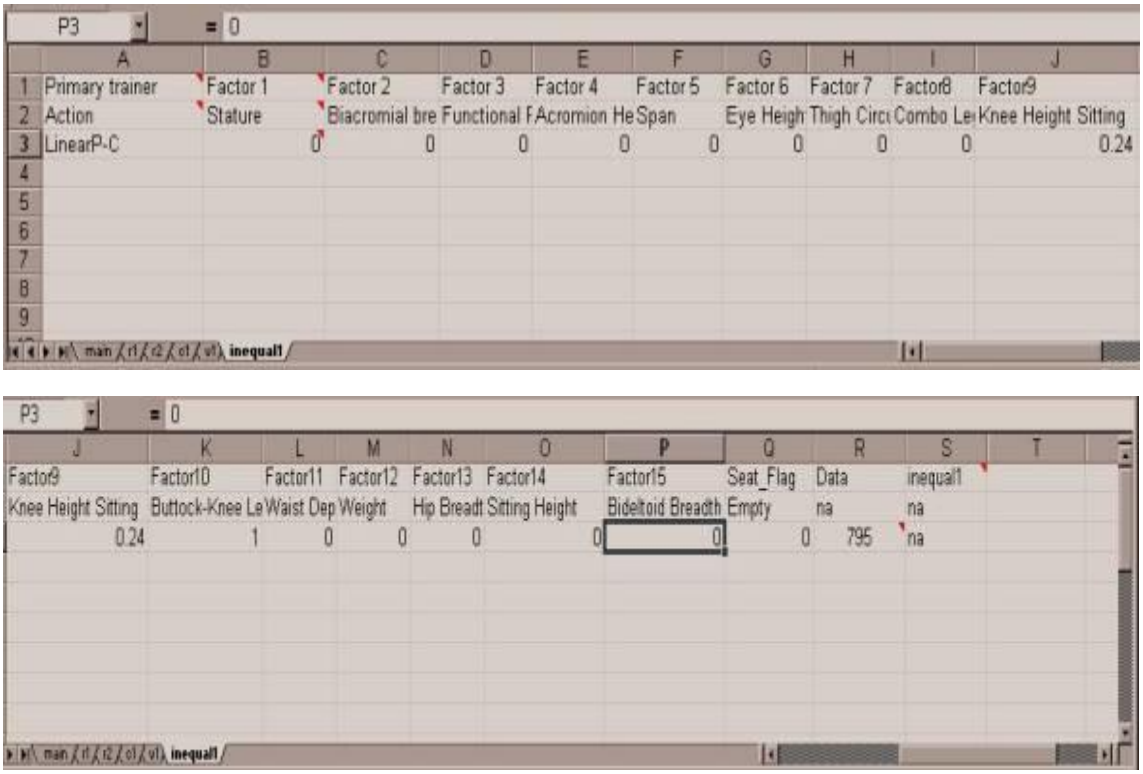


Figure 35: Adding Linear Programming Inequality Constraints (Main Tab)

In Figure 35, notice that cell J7 contain a –3 value (flag). This indicates that this Factor/Action combination is to be classified based using an inequality constraint.

It is also important to note that Cell S1 now contains the label name for the Excel worksheet tab detailing the inequality (e.g. 'inequal1'). This worksheet tab must be set up as shown in Figure 36.



	A	B	C	D	E	F	G	H	I	J
1	Primary trainer	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor8	Factor9
2	Action	Stature	Biacromial bre	Functional F	Acromion He	Span	Eye Heigh	Thigh Circ	Combo Le	Knee Height Sitting
3	LinearP-C	0	0	0	0	0	0	0	0	0.24

	J	K	L	M	N	O	P	Q	R	S	T
	Factor9	Factor10	Factor11	Factor12	Factor13	Factor14	Factor15	Seat_Flag	Data	inequal1	
	Knee Height Sitting	Buttock-Knee Le	Waist Dep	Weight	Hip Breadt	Sitting Height	Bideltoid Breadth	Empty	na	na	
	0.24	1	0	0	0	0	0	0	795	na	

Figure 36: Specifying Inequality and Threshold Constraints for Individual Factor/Actions

The following formatting/file structure restrictions apply to setting up this worksheet tab:

1. The column titles, number of columns and order of factors (column order) must be the same as that specified in the main tab.

2. Cells B3-P3 in row 3 must contain the linear inequality coefficients for each anthropometric value. They must be real signed numerical values, as they will be multiplied by the corresponding anthropometric value and summed.

3. The constant value of the inequality must be specified in cell R3. It is a signed value, **with positive indicating that the inequality is to be less than the constant value to pass (<).** For a greater than constraint, simply negate the constant (>). Equality constraints are not presently supported.

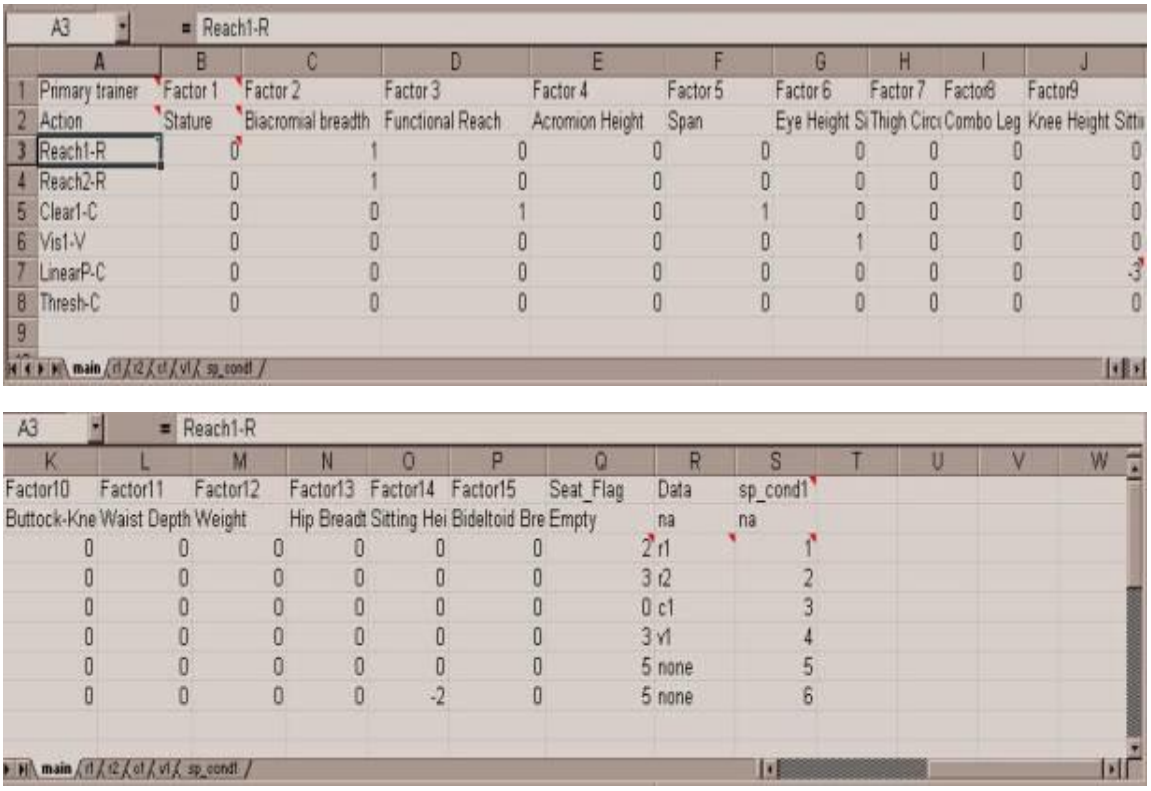
5.4 CASE 4: USING BOTH ANTHROPOMETRIC THRESHOLDS AND LINEAR PROGRAMMING INEQUALITIES

For maximum classification flexibility, the program also allows the combined use of both anthropometric value thresholds and linear inequality constraints to classify a certain factor/action combination.

The previous format and syntax requirements of Case #1 must be applied, in addition to the additional requirements given in this section.

To illustrate the use of this functionality, please open the file 'new_air_template4.xls' using Excel. This file shows the format and syntax for combining Cases #2 and #3.

This file is similar to the one examined in Case #3, but with the addition of the following, as shown in Figure 37.



	A	B	C	D	E	F	G	H	I	J
1	Primary trainer	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor8	Factor9
2	Action	Stature	Biacromial breadth	Functional Reach	Acromion Height	Span	Eye Height Si	Thigh Circu	Combo Leg	Knee Height Sitti
3	Reach1-R	0	1	0	0	0	0	0	0	0
4	Reach2-R	0	1	0	0	0	0	0	0	0
5	Clear1-C	0	0	1	0	1	0	0	0	0
6	Vis1-V	0	0	0	0	0	1	0	0	0
7	LinearP-C	0	0	0	0	0	0	0	0	-3
8	Thresh-C	0	0	0	0	0	0	0	0	0

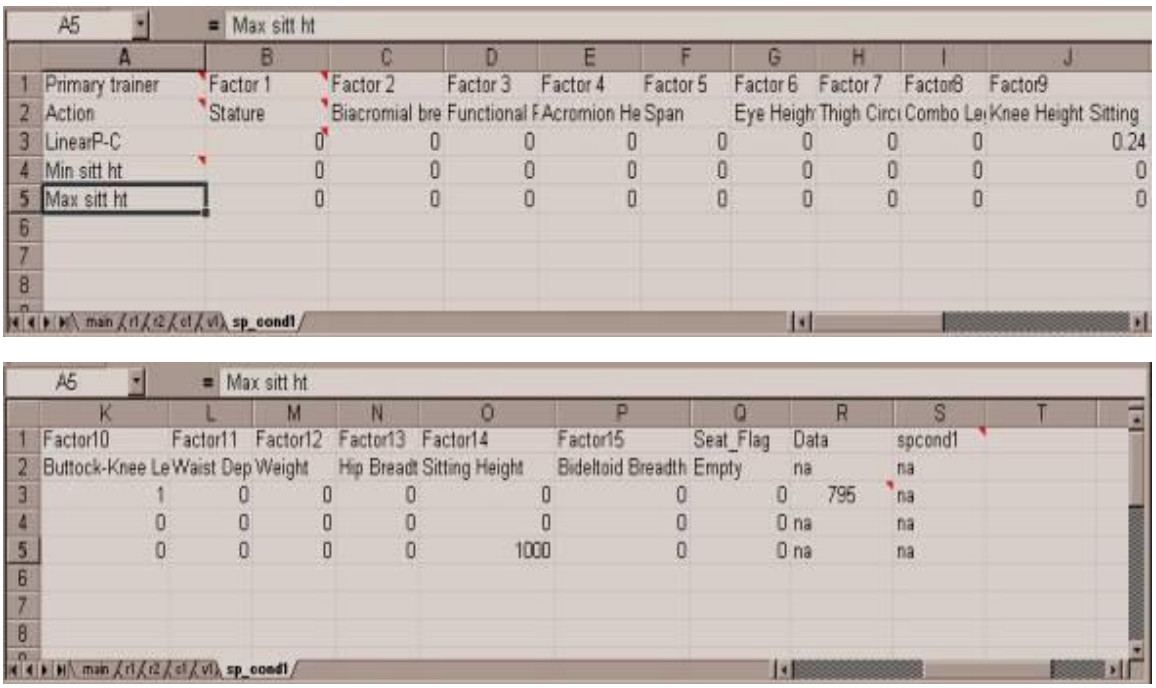
	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	Factor10	Factor11	Factor12	Factor13	Factor14	Factor15	Seat_Flag	Data	sp_cond1				
2	Buttock-Kne	Waist Depth	Weight	Hip Breadt	Sitting Hei	Bideltoid Bre	Empty	na	na				
3	0	0	0	0	0	0	2	r1	1				
4	0	0	0	0	0	0	3	r2	2				
5	0	0	0	0	0	0	0	c1	3				
6	0	0	0	0	0	0	3	v1	4				
7	0	0	0	0	0	0	5	none	5				
8	0	0	0	0	-2	0	5	none	6				

Figure 37: Adding Threshold and Linear Programming Inequality Constraints

The fifth critical action (Row 7 in the template) implements the inequality constraint, as in Case #3, while the sixth action (Row 8 in the template) implements the threshold constraint.

It is recommended to group the thresholds and inequality constraints, and to implement them as shown. With respect to row order, it is recommended, from top to bottom to list all DFA related functions (row by row), followed by all inequality constrained actions, finally the threshold functions.

It is also important to note that Cell S1 now contains the label name for the Excel worksheet tab that details both the inequality constraints and the thresholds (e.g. 'sp_cond1'). The correct format and syntax for the combined factors worksheet tab is shown in Figure 38.



A5 = Max sitt ht

	A	B	C	D	E	F	G	H	I	J
1	Primary trainer	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor8	Factor9
2	Action	Stature	Biacromial bre	Functional F	Acromion He	Span	Eye Heigh	Thigh Circ	Combo Le	Knee Height Sitting
3	LinearP-C	0	0	0	0	0	0	0	0	0.24
4	Min sitt ht	0	0	0	0	0	0	0	0	0
5	Max sitt ht	0	0	0	0	0	0	0	0	0
6										
7										
8										

main / r1 / r2 / c1 / v1 \ sp_cond1 /

A5 = Max sitt ht

	K	L	M	N	O	P	Q	R	S	T
1	Factor10	Factor11	Factor12	Factor13	Factor14	Factor15	Seat_Flag	Data	spcond1	
2	Buttock-Knee Le	Waist Dep	Weight	Hip Breadt	Sitting Height	Bideltoid Breadth	Empty	na	na	
3	1	0	0	0	0	0	0	795	na	
4	0	0	0	0	0	0	0	na	na	
5	0	0	0	0	1000	0	0	na	na	
6										
7										
8										

main / r1 / r2 / c1 / v1 \ sp_cond1 /

Figure 38: Specifying Inequality Constraints for Individual Factor/Action Item

The following format restrictions apply to setting up this combined special factors worksheet:

1. The column titles, number of columns and order of factors (column order) must be the same as that specified in the main tab.

2. Rows #1 and #2 should be as shown, corresponding to those on the main tab.

3. Cells B3-P3 in row 3 must contain the inequality function coefficients for each anthropometric value. They must be real signed numerical values, as they will be multiplied by the corresponding anthropometric value and summed.

4. The constant value of the inequality must be specified in cell R3. It is a signed value, with positive indicating that the inequality is to be less than the constant value to pass (<). For a greater than constraint, simply negate the constant (>). Equality constraints are not presently supported.

5. Following each inequality constraint row, there are two rows for each anthropometric threshold related constraint. **It is important that the threshold constraints appear last (in top to bottom row order) on the special conditions tab worksheet.**

6. The order of the actions in the threshold file must be given in the up/down (row-wise) order of appearance of the indicator flags (-2) on the main tab.

7. The minimum values must appear before the maximums, and must be smaller numerically.

5.5 TROUBLESHOOTING: COMMON ERRORS

Errors in the training data and/or aircraft template will result in either program exceptions, or invalid predictions/classifications. The former are much easier to detect.

Here is a list of potential common errors:

1. Auto-generated flag settings inconsistent with Training Data.
2. Anthropometric names on main tab worksheet don't exactly match those in training data worksheet. Cut and paste is recommended to match names.
3. Missing values or flags on main tab.
4. Name of first worksheet is not set to 'main'.
5. Names of training worksheets are not set correctly.
6. Incorrect data format type (string instead of number, etc.).
7. Number of flagged dependant variables doesn't match training data.
8. Duplicated rows in training data.
9. Incorrect spelling of aircraft name, extra whitespace.
10. Tab names don't match specified labels in Column R.
11. Name of threshold/inequality tab incorrectly specified or located in wrong cell.
12. Incorrect order of columns in training data – they must follow the ordering requirement given previously.
13. Incorrect specification of pass/fail in training data, they must be numeric only: 1=pass, 2=fail.
14. Real values entered for integer columns such as flags.
15. Numeric values entered in string required columns such as tab names.
16. Hidden or extra data/whitespace is present on the spreadsheet.
17. Sign of inequality constant is incorrect (+ is less than <).
18. Extra rows or columns appear in the worksheets. These must be deleted.

5.6 SUMMARY/CONCLUSION

In summary, for every aircraft, the following information must be supplied in the Excel file, in the manner and format previously indicated:

1. Aircraft Name (Must exactly match one name on the figure)
2. List of Critical Actions (Each critical reach, vision, clearance, etc.) (One per row)
3. List of Anthropometric Factors (Variables) (One per column as shown)
4. Auto-generated indications of dependant seat positions (Columns Q)
5. Auto-generated condition matrix of indexes indicating the dependencies of the above items 2-4
6. Training data (one action per tab)
7. Flag indicating how to compute priori variance for DFA (Last value on each training data tab)
8. Links to tab worksheets with training data for each action (Column R)
9. Link to tab worksheet with threshold values/inequality constraints if needed (Cell S1)
10. Separate tab sheet with threshold values and inequalities as shown above

ACRONYMS AND ABBREVIATIONS

Table 1 shows the acronyms and abbreviations used in this document.

Acronyms and Abbreviations	Explanation
Array	Array Systems Computing Inc.
DFA	Discriminate Function Analysis
DND	Department of National Defence
DRDC	Defence Research and Development Canada
GUI	Graphical User Interface
ODBC	Open Database Connectivity
RCAF	Royal Canadian Air Force
PASS	Pilot Anthropometric Screening Software

Table 1 - Acronyms and Abbreviations

CUSTOMER SUPPORT

If you have questions concerning the operation of PASS, you may contact VisImage Systems Inc. customer support. E-mail your questions to: support@vis.ca, or send them by fax to 905-946-1060. A customer service representative will reach you within 24 hours.

If you want to speak to us directly, please call 1-905-946-0000. Within the U.S. and Canada, a toll-free number is also available: 1-866-VIS-IMAGE (1-866-847-4624).

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