PCA2000 is a software which was created to carry out in an optimal way the entire conceptual design of a small single- or twin-engine aircraft project

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are determined by the decisions taken during the conceptual design.

1 Introduction

1.1 Introduction

After a short recall of the genesis of PCA2000, we will briefly describe the design process and, more specifically, the conceptual design. We will then present PCA2000 starting with the description of the various modules which are part of it, we will name the specificities of the software to finish with a quick overview of the interface.

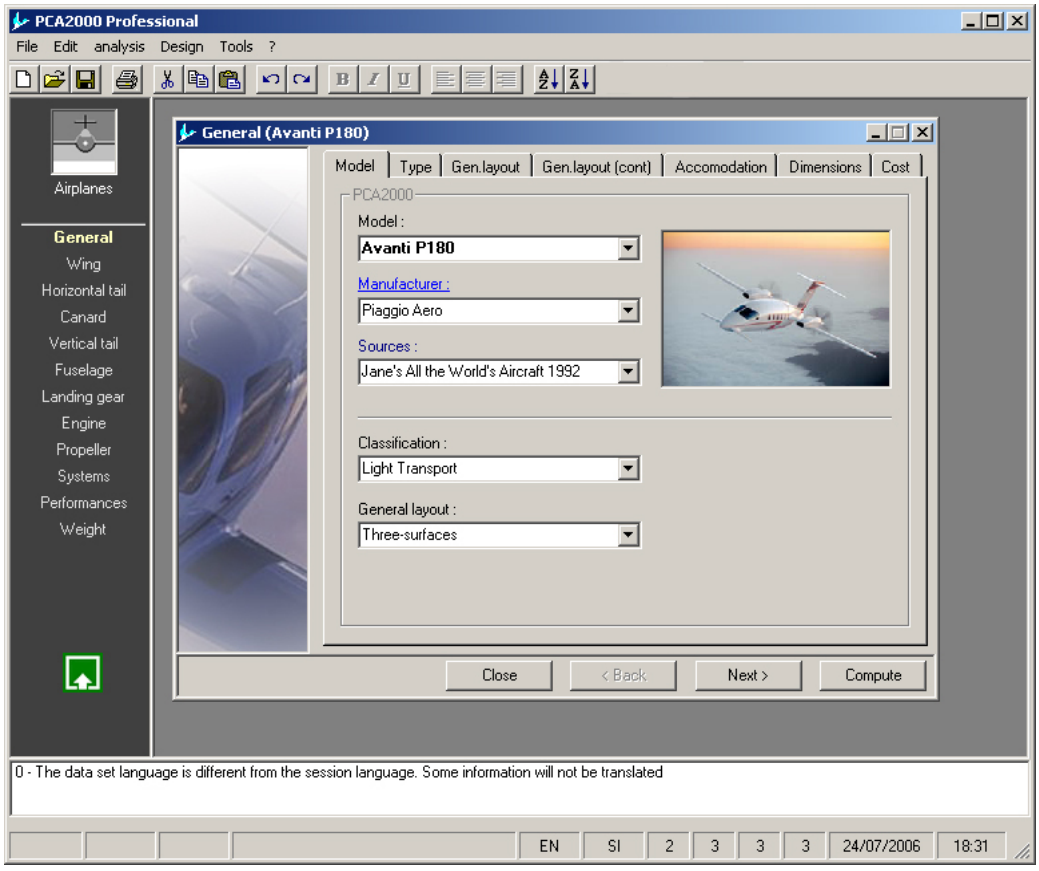

Figure 1.1 : Interface of PCA2000

1.2 Table of content

1.3 Background

PCA2000 is developed under OAD (Optimal Aircraft Design), a company established in Namur, Belgium.

Didier Breyne, the founder of OAD, is a mechanical engineer. During several years, he was manager in a design department attached to a research centre active in the field of nuclear physics. He also has several years of experience in developing software to model the behavior of the atmosphere.

The development of PCA2000 goes back a few years when the idea of designing a light aircraft emerged. As Didier Breyne built a strong experience in modeling and design, he knows that the essential phase of the design process of a product is the conceptual study.

Although there is no lack of literature on the subject, one can't find anywhere a book nor software that will make it possible to carry out in a simple, fast and precise way the conceptual analysis of one's project to design a light airplane.

That's why he took the decision to create PCA2000.

Six years were necessary to work out this new product.

Because it was tested and validated, we believe that using it will allow the designer to increase in a considerable way its chances of success to make his project concrete.

1.4 The design process

The design process of a new product is structured in 3 major phases:

1. Conceptual Design
2. Preliminary Design
3. Detail Design

During the conceptual design, the general outline of the aircraft is determined. Before getting there, all possible configurations, of course compatible with the requirements of the specifications, will have been considered (conventional configuration, 3 surfaces, nose plane, fixed or retractable landing gear, single or twin engine, built with metal, composite or wood…). During that phase, the elements are designed in a simple way. The interaction between the various components and systems is more important than the exact geometry. The conceptual design can take several weeks but that can be made much easier if adapted IT means are available. The CAD (Computer Aided Design) is not justified at this stage but it is interesting that the simplified design can be quickly updated when the geometry is modified, for example to quickly visualize the modification of the sweep angle of the wing.

Once we get to the preliminary design, the general configuration is fixed, only a few small details can still be changed. However, one should keep in mind that a modification at this stage can have quite a strong impact on the development costs of the project. This part can take several weeks to several years. At this level, the CAD becomes increasingly interesting.

The detail design starts when one begins designing parts with the aim of manufacturing them. During that stage, the conception and design of the different parts are carried to extremes, no detail can be forgotten.

1.5 The conceptual design

The conceptual design is an iterative process whose main stages are:

a) The definition of the specifications. The specifications is a document in which the objectives to reach in terms of performance, cost… as well as the constraints with which one has to comply such as the airworthiness requirements, for example are mentioned.

b) The analysis of the existing technologies to determine the ones that could be integrated in the project.

c) The first pencil strokes, the first drafts.

d) The analysis of the existing aircrafts. This analysis is essential in order to define some weight (empty weight ratio), aerodynamic (aerodynamic quality criterion) and geometric (area ratio) parameters.

e) The first estimate of the performances and the geometry, generally determined during the adaptation point of the aircraft for the cruise flight condition

f) The optimization of the performances and the geometry, for all the phases of the flight. At the end of this optimization, we reach the best configuration, which means the configuration that fulfils in an optimal way the requirements of the specifications. We have an accurate idea of :
   - The total weight,
   - The fuel weight to carry away,
   - The engine power,
   - The surface of the wings, tails and fuselage.

g) Follows a stage to control the stability, the costs, and the structure.

At the risk of repeating oneself, it is important to point out that at the end of the conceptual design, no major changes can be made anymore.

A figure can prove the importance of this conceptual process step: 90% of the development costs are determined by the decisions taken during the conceptual design.

1.6 General description of PCA2000

1.6.1 Introduction

PCA2000 is an easy, user-friendly tool, intending to proceed with the conceptual design of a project of a light single or twin engine aircraft that can meet the requirements of the FAR23.

1.6.2 Modular structure

PCA2000 is made of various modules which, all together, make it possible to go through all the stages of the conceptual design of a project and even more.

- The analysis module makes it possible to make a detailed analysis of an existing aircraft and to get to know all about its characteristics.
- The statistical analysis module makes it possible to have an immediate idea of the current state of the art. The analyzed parameters (weights, surfaces…) are posted in the form of graphs and charts. Databases of aircrafts, engines and profiles are accessible via the PCA2000 website.
- The design module makes it possible to calculate precisely the performances of the aircraft during all the phases of the flight.
- The optimization module makes it possible to determine the best configuration for the currently analyzed aircraft so that it fulfils in an optimal way the requirements of the specifications.
- The 3D module makes it possible to generate a 3D geometry in conformity with the results of the modeling and that can be used in all the CAD software.
- The digitizer module makes it possible a) to use in a quick and effective way all the information that appears on a **three-view drawing** (to measure distances, distance ratios, angles, surfaces) and b) to digitize quickly a **curve** which will have been scanned beforehand such as the speed polar of a glider for example.

1.6.3 Specificities

PCA2000 uses specific algorithms which are presented in detail in the technical note called « Detailed description of the algorithms used in the PCA2000 model ». This technical note is available on the PCA2000 website at www.pca2000.com.

1.6.4 The interface

The PCA2000 interface is structured in a simple and ergonomic way like the majority of the Windows applications. The main form is composed with the following controls:

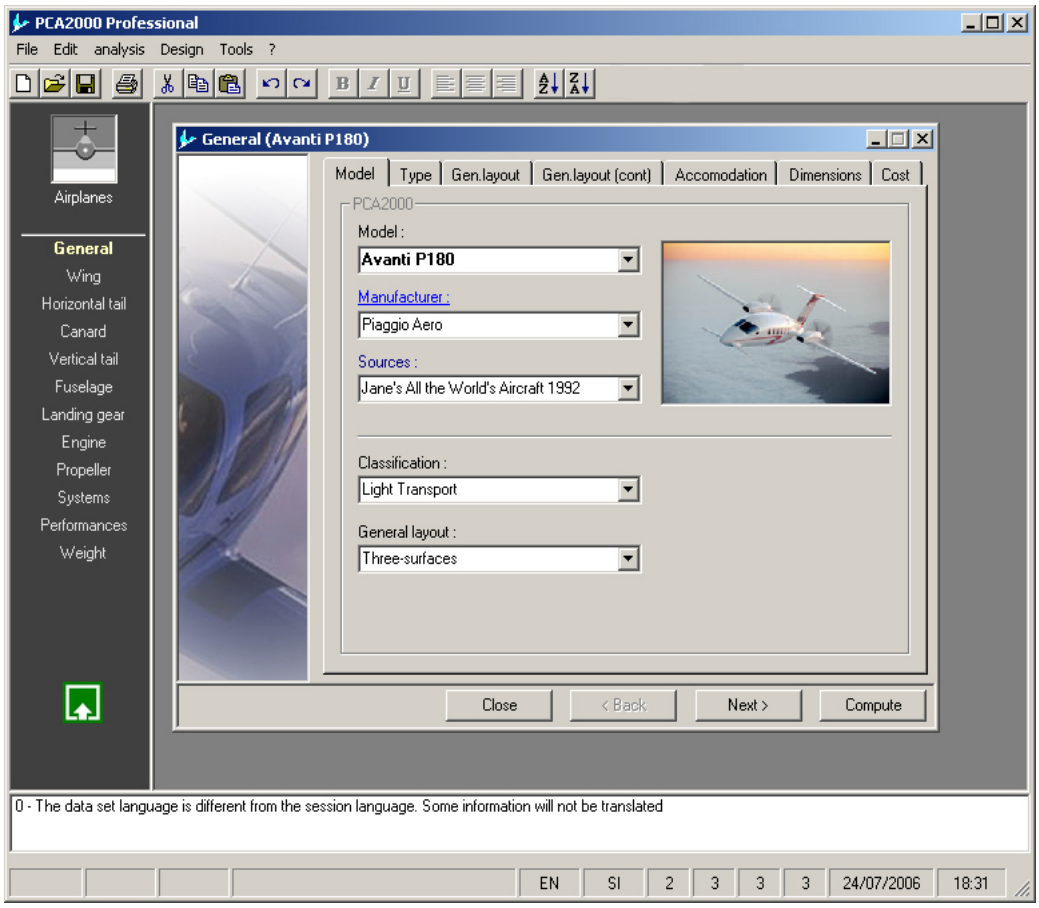

Figure 1.2: The PCA2000 interface

The **toolbar** makes it possible to access the different software modules.

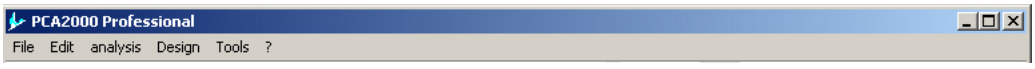

Figure 1.3 : The PCA2000 toolbar

The **upper toolbar** makes it possible to run with a simple click the most common functions (save, copy…).

Figure 1.4 : The upper toolbar

The **vertical toolbar** makes it possible to access directly the main modules of PCA2000.

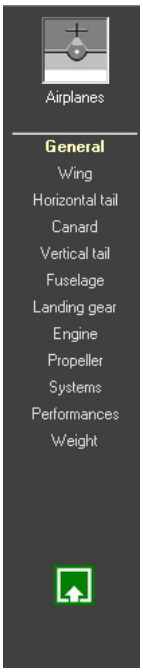

Figure 1.5 : The vertical toolbar

A special zone is dedicated to inform the user about the operations carried out by the software.

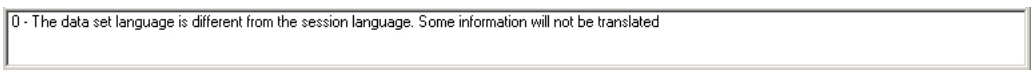

Figure 1.6 : The information display area

The **status bar** informs the user about the available options in use (language, units, analysis and design level).

Figure 1.7 : The status bar

The **main zone** holds the windows of data acquisition and visualization of the results.

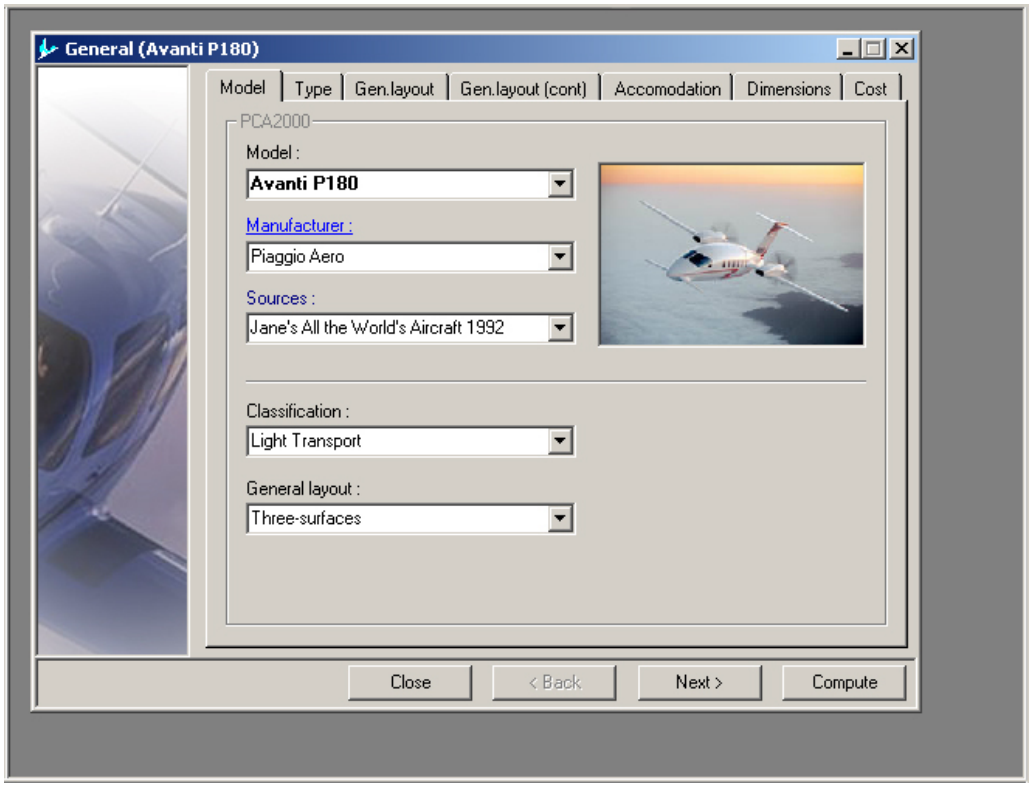

Figure 1.8 The display area