

Pilatus Aircraft Flies into the Future

VPD Tools Help Bring New Turboprop Aircraft to Market Faster



Pilatus Aircraft Inc. is highly regarded due to the excellent performance and reliability of their products, which they owe to their turboprop engines. The flagship of the company's reputation is the Pilatus PC-6 Porter, in production for more than 40 years. The civil program has been supplemented since the mid-1990s by a single-engine business aircraft, the PC-12. In 1945, the company produced its first military training aircraft and to date has sold more than 750 Pilatus trainers to customers in more than 20 countries. In order to secure their leadership role in the trainer market of the future, Pilatus' high-tech specialists worked at full speed on a new project. The PC-21, which undertook its maiden flight in 2003, was planned to be certified in 2004 and released to the market. For the first time in the history of Pilatus, the most advanced development methods and tools were used to implement this ambitious project.

Aircraft Construction - Engineering at its Best

High technological demands, as well as the need to simultaneously reduce time-to-market and development costs, are practically incompatible with conventional development processes. At Pilatus, the PC-21 project was viewed as the trigger project to subject the product development process to a very thorough re-engineering. At the top of the priority list stood requirements such as reliable and robust design, consideration of lifecycle standpoints, the reduction of design iterations, and the more rigorous inclusion of external development partners.

Pilatus saw a solution in turning away from a paper-based sequential development process. Knowledge acquisition as early as possible and the use of an electronic master model, or digital mock-up, based on CAD data were intended to shorten the development process, parallelize task sequences (concurrent engineering), and avoid unforeseen design changes in later steps. The early recognition of functional and technological requirements and links necessitated the use of powerful design and simulation tools that meant relatively high initial investments in terms of time and money. In the long term, however, reduced costs and shorter development time were the result.

Of Pilatus' more than 140 developers and designers, more than 60 were involved with the plans for the PC-21. The development program, which began in January 1999, focused on three core objectives: superior aerodynamic performance when compared with any other turboprop trainer currently on the

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Customer:

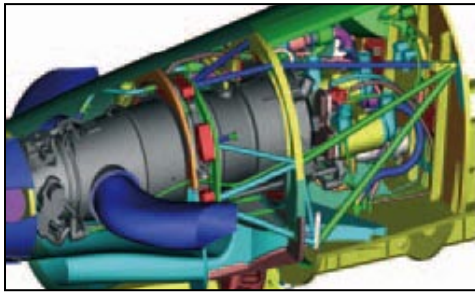
Pilatus Aircraft Inc., Switzerland
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Software:

MSC.ADAMS®, MSC.Nastran™

Summary:

Pilatus Aircraft used MSC.Software Virtual Product Development (VPD) tools to improve their development process in order to satisfy increasing customer requirements and stringent statutory regulations. For the development of the new turboprop training aircraft PC-21, Pilatus employed MSC.Nastran for analyzing components with respect to structural mechanics and dynamics, while MSC.ADAMS was used for design control kinematics. Thanks to the use of MSC.Software VPD tools and techniques, Pilatus realized time and cost savings, resulting in shorter time-to-market and the minimization of technical risk.



market; a more powerful, flexible, and cost-effective integrated training system than any other turboprop or jet trainer; and a lifecycle support cost that did not exceed current turboprop benchmarks. Designed for basic, advanced, and fighter lead-in training, the PC-21 is a single-engine, low-wing, swept monoplane with a stepped tandem cockpit optimized for aircraft handling, tactical navigation training, mission and system management, simulated air-to-ground engagement, simulated air-to-air engagement, and reconnaissance training requirements.

For the PC-21 project, Pilatus engineers used a common digital mock-up generated using Unigraphics CAD software, the components of which are managed in the Unigraphics Fast Standard Part Library. The production and manufacturing data were derived from this master model in later phases. Initially, however, the model data was predominantly used by computation engineers in order to have as comprehensive a picture as possible of the functional behavior of the still-virtual aircraft at an early stage in development.

A Model Case

In accordance with the wide range of tasks, the list of simulation solutions used by Pilatus was very

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comprehensive, which is why the eight computation engineers working on the PC-21 project could not complain of lack of work. Aerodynamics, especially in the concept and design phases, obviously had a central significance. In combination with wind tunnel tests, CFD (Computational Fluid Dynamics) simulation rapidly provided important feedback on the reliability of aerodynamic concepts and solutions. Pilatus relied on CFD++, which is still largely unknown in Europe; the package solved the tasks to their full satisfaction.

However, simulation and analysis served not just to safeguard development and design but were also part of certification conditions, which have to be fulfilled for submission to the Luftfahrtbundesamt (Swiss Federal Office of Civil Aeronautics). For this reason, Pilatus decided to follow the majority of the aerospace companies by adopting MSC.Nastran, the simulation program seen in the aerospace industry as a quasi-standard.

In combination with the pre- and postprocessor Femap (UGS), all safety-relevant components were analyzed with respect to structural mechanics and dynamics. The aeroelasticity module in MSC.Nastran served specifically to analyze the flutter response and was therefore, from the safety point of view, of particular importance for the optimization of the flight characteristics.

But the list of simulation tasks was long. MSC.ADAMS was used for the design of control kinematics. In order to increase the use of multi-body simulations in the future, Pilatus engineers will use MSC.ADAMS as part of its so-called Multiphysics Applications in which, for example, kinematic simulation is combined with structural mechanics data. Simulation is completed with LS-DYNA (Livermore Software Technology Corp.) analysis for transient problems, such as bird impacts on the cockpit shield or the function of the ejection seat.

The number of simulations and variations was immense and would not have been possible within tight development schedules without corresponding computing performance. A. Borel, a leading member of the structure analysis team at Pilatus, estimated that for his team, the number of load cycles investigated was 3,000-4,000, with

about 50 'critical' load cycles reviewed particularly carefully. The size of the computation models varied considerably and could easily comprise several hundred thousand degrees of freedom. Pilatus uses the Linux operating system for its simulation computers; due to its combination of speed, stability, and low investment costs, the system is an attractive alternative for an increasing number of companies. The installed Linux network consists of four Hewlett-Packard high-performance workstations hp x4000 double processors and an additional head node. Despite this high performance level being available, further capacity is being considered.

Engineering Flight Simulator

- Insight into Technology at an Early Stage

With the date of the PC-21's maiden flight approaching, tension increased. The pilot had to decide whether the new design actually met expectations. While pilots' wishes and inputs are taken into consideration during development, the 'jargon barrier' often makes it difficult for real communication to take place. At Pilatus, for the first time, a flight simulator was used to integrate computation and simulation data. Pilots could thus test aircraft that did not yet exist in reality and make assessments and comparisons. The data obtained could be input directly into development and prototype construction. Even if the number of prototypes was not reduced, the simulator represented an essential help with respect to the minimization of design changes - even in the early design phase.

Simulation - The Key to Success

Leonardo Manfrani, chief aerodynamics specialist at Pilatus, is firmly convinced that it was the implementation of Virtual Product Development technologies and the consistent use of simulation tools that made the PC-21 achievement possible.

The Pilatus concept proved itself even before the new aircraft reached series production. Shorter time-to-market, lower investment costs, lower lifecycle costs, and last but not least, the minimization of technical risk were the positive outcomes of this development project. With a positive attitude toward innovation and confidence in the potential of modern computer and simulation systems, Pilatus is poised for more success.

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