Aerospace and defense

Salut
Aircraft engine development gets a boost from PLM

Widespread use of NX and Teamcenter has cut six to 10 years off the development cycle for a new engine and reduced production costs to one-tenth the previous amount.

Building aircraft engines for nearly 100 years

The history of Moscow Machine-building Production Plant (MMPP), “Salut,” began in 1912 when a French company built its workshops near the location of the present plant and began producing the first serial aircraft engines in Russia. Those first engines, referred to as “Gnome” engines, were installed on such popular aircraft as Moskva, Newpore-4, Farman-16 and Moran-Zh.

Salut engines also powered the first nonstop flight from Moscow to America via the North Pole. During the war the plant produced more than 10,000 AM-38F engines for the legendary IL-2 armored battle plane. In 1947 the plant mastered the production of the first Soviet turbojet TR-1 engine. From then on, it has continued making aircraft engines for well-known production airplanes. In 1984, new engineering procedures were introduced with the AL-31F engine. Su-27 planes with AL-31F engines hold about 30 world records.

Today Salut is the largest Russian trading company involved in the design, production and aftersales service of aircraft engines. Its roster includes: AL-31F engines (for planes of “Su” family); engine repair for Su-22 and MiG-25 aircraft; assembly and component production for engines on Be-200, Tu-334, An-74TK-200, Tu-230, An-70, An-180 and Yak-130 planes; and the electric power plant GTE-205. Currently the total number of employees is 23,000 with 14,000 working in the parent enterprise.

Transition from Soviet times demands PLM

Until 1990, the plant produced serial engines but did not possess its own significant design capabilities. However as the industry began to change and Yuri S.

Products
NX, Teamcenter

Business initiatives
New product development

Business challenges
Establish R&D and design divisions equipped with the latest CAD/CAM/CAE software
Ensure innovation
Reduce design and manufacturing times and costs

Keys to success
Solutions from Siemens PLM Software at all stages of design and production
3D digital models
Digital simulation
Use of design geometry for NC programs
Product data management

Results
Engines developed in only 2 to 4 years vs. 10 years previously
Cost of PLM investment paid for in reduced physical testing
Engine production costs one tenth as much as previously
A stable and growing economic position for the company
Eliseev became the company’s general director, emphasis was put on developing engineering expertise that would rival production, which was constantly updated and modernized. Engineering offices and several scientific centers were established. The two main ones are the aviation engineering office of prospective development and the engineering office of industrial gas-turbine units. Experience showed that this was the right decision. Today two thousand designers work in the plant engineering offices. The company independently develops aircraft engines as well as industrial gas-turbine units.

To meet the growing needs of aviation, Salut made the decision to adopt product lifecycle management (PLM) technology, introducing it during a program of extensive modifications to the AL-31 engine. Dmitry Eliseev, IT director of MMPP Salut explains why: “Earlier, in Soviet times, the government financed the military-industrial complex and it took up to 10 years to develop and launch mainstream production of each engine. In this period the plant produced up to 50 copies of each engine, many of them crushed during tests. The present cost of such an engine would amount to tens of millions of rubles. Imagine if today it took 10 years to begin series production of an engine. The engine would be out of date by the time it went into production. And how much would it finally cost? It is impossible to develop engines without modern technology such as digital modeling and simulation.”

Salut realizes that to stay competitive it must apply PLM technology broadly, extending its use to marketing, design, production, maintenance and support. The introduction of information and computer technologies began in 1996. From 1996 until 2006, the number of computer-assisted workplaces increased by more than 200 times and reached several thousand.

In 2002 MMPP Salut evaluated several competing CAD/CAM systems (CADD5, Pro/Engineer, the NX™ digital product development system from Siemens PLM Software, Catia and others. Two of the systems were selected for further evaluation: Catia and NX. Their functionality was compared across more than 100 parameters. While the CAD functions of both systems met the company’s requirements, the CAM system was much better in NX, which became the company’s choice. Another significant reason for the choice of NX was the high level of technical support provided by the Russian representative of Siemens PLM Software.

NX was adopted as the digital modeling solution for the entire enterprise. Before 2002 there were approximately 10 workplaces equipped with NX software. Today there are 100. In addition, the Teamcenter® digital lifecycle management system from Siemens PLM Software serves as the product data management (PDM) system for the aviation engineering office.
Teamcenter software is used by many designers as well as those connected directly with parts manufacturing. An electronic archive has been established in Teamcenter. It contains 2D drawings, 3D models and scanned drawings. Teamcenter is also the repository for AutoCAD drawings, Microsoft Word files, simulation test results and so on.

**NX in action**
The compressor and the turbine are the most important components of an aircraft engine and they affect many other parameters. The operational properties, reliability and performance of an engine, for example, depend directly on the production quality of these components. Although NX allows the creation of all design documents for these components, from sketches to production drawings, its more important function is the creation of solid 3D models. The most complicated parts of compressors and turbines – rotating and nozzle blades, castings of complex shapes and rotor wheels – are now developed as 3D models in NX. The high degree of precision in the digital model minimizes inaccuracies and deviations. NX permits parametric changes to the models, allowing a designer to change parameters of the product on the fly and see the result on the screen from any angle. Modeling now takes far less time, and the possibility of making errors is minimized.

Finished 3D models are passed to the technology department of CNC machining where NC programs are generated from the NX data. Modern CNC centers can process most parts with a minimum of manual control. Rotating blades – one of the most critical parts in an engine's compressor or turbine – must be tested after production to see if they meet the specifications. Salut uses high-production measuring machines that work from the NX 3D data.

The adjustable nozzle with controlled vector thrust for the AL-31FM1 engine, made by ADPOPD of MMPP Salut, offers an example of NX comprehensive use. Early in the project a full 3D model of the hinged nozzle was created in NX. The model contained about 3,000 parts, 500 of which were original. Prior to production, NX made it possible to check potential interferences in the digital assembly, to see the presence and sizes of clearances, and to determine the weight and the center of gravity of the nozzle, even as design properties and characteristics changed. In addition, the full 3D model allowed design optimization in the context of the complete assembly. The availability of 3D models of cast parts considerably decreased the time needed to produce physical samples by allowing the use of rapid prototyping technology instead of waiting for injection-molded samples. Having 3D models of parts, especially those with complicated shapes, also accelerated the development of programs for the measuring machines, which improved the quality of the parts.

All of the parts in the overall assembly of the hinged nozzle module were parameterized. Parameterization made it possible to quickly address tasks related to changes in the geometry, design optimization, replacement of materials and so on. In addition, growing demands for increased reliability, lower weight and fewer parts required the ability to quickly understand nozzle operation. Both kinematic and
Solutions/Services
NX
www.siemens.com/nx
Teamcenter
www.siemens.com/teamcenter

Customer's primary business
Moscow Machine-building Production Plant (MMPP)
Salut is the largest specialized Russian enterprise for production, technical maintenance and repair of aircraft engines and power plants.
www.salut.ru

Customers location
Moscow
Russia

“In addition to evaluating the functionality of competing high-end systems, we became acquainted with their sales and support teams. There are none in Russia whose professionalism equals that of Siemens PLM Software’s Russian office.”

I. I. Kuznetsov
Vice-director of CAD/CAM Systems
MMPP Salut

Dynamic analyses of the design were done using NX. Ultimately these design and manufacturing capacities resulted in an adjustable nozzle with a controlled vector thrust that had minimal mass and high performance.

A good return on investment
“MMPP Salut would not be able to exist without these solutions from Siemens PLM Software,” says Eliseev. “They are mandatory. In terms of the return on investment, we can point to the fact that we no longer need 50 experimental sample engines. That alone can justify the cost of the software! And you can add to that the ten years’ salary for all the designers and workers involved in the process. Today the development cycle for a new engine takes from two to four years, and usually the first sample not only passes the tests but immediately goes into experimental-industrial trials. In these ways, production is 10 times less expensive.”

Salut made a thorough evaluation of high-end CAD/CAM/CAE and PDM solutions. “The result was clear that there are two or maybe three solutions suitable for developing gas-turbine machines,” Eliseev adds. “When it is necessary to support the entire lifecycle of the product, from its design through production, only Siemens PLM Software solutions meet our requirements. I do not see any other alternatives. Only NX can handle the complicated geometry of cold blades with complicated inner structures, impellers and the large assemblies of such complicated products. In addition, the professionalism of Siemens PLM Software’s Russia office is unequaled. The office’s technical specialists really try to understand the problem and solve it, and their fast reaction is crucial.”

Ultimately these modern technologies help Salut unify the process of bringing an engine from concept through production. The use of a 3D digital model provides the opportunity to simplify collaboration and interaction among the various stages of the development cycle. It also decreases the number of processes, increasing accuracy and significantly reducing the likelihood of errors. As a result, Salut is able to significantly reduce expenditures and fill orders in the shortest possible time.