Digital mock-up and product lifecycle management

MechTech talks to Igal Filipovski (right), MD of CNC Design Consultants (CDC), a local value-added reseller (VAR) of Dassault Systèmes’ CATIA, DELMIA and ENOVIA solutions.

French aircraft manufacturer, Dassault Aviation, was founded in 1929 by Marcel Dassault and is still owned by the Dassault family. It is, today, a multinational company with a presence in 83 countries (2012) employing around 12,000 people. Over 8,000 aircraft have been delivered since 1945, with its Falcon business jets representing 71% of turnover.

Dassault Aviation was one of the first companies in the world to offer employees a full week of paid leave (1935); it was the first French company to be certified to ISO 9001/2000 (in the year 2000) and – through the development of CATIA (computer-aided, three-dimensional interactive application), an in-house development that began in 1977 to assist the Mirage fighter jet development programme – a world pioneer of 3D CAD/CAM/CAE software. “And from its inception, CATIA was underpinned by PLM principles,” says Filipovski.

In 1981, Dassault Systèmes (DS) was founded as an independent software solutions and services development company. The company was responsible for developing CATIA and a 25-year partnership was struck with IBM to market the software on its UNIX-based AIX operating system. According to Filipovski, “CDC started in 1995 to provide consultancy services to IBM and began to support DS in 1997. But in 2010, Dassault Systèmes bought the marketing rights for its software products back from IBM, so now CDC is a dedicated local representative of DS software products.

“CATIA was developed in 3D from day one,” he continues, adding that “2D has long been susceptible to interpretation errors and CATIA was quick to realise the power of designing directly in 3D.”

The main different between CATIA and other early design software solutions, including SolidWorks, which is also a DS product, “is that CATIA was developed as a process-centric solution. Most 3D modelling software developments have been design-centric. The process tended to end once the ‘pretty’ 3D model could be displayed on a screen,” Filipovski suggests.

From the start of CATIA’s development as an internal tool for designing the Mirage, a single platform was envisaged that could take the digital mock-up idea all the way through the maintenance and disposal requirements. “Today’s DS solutions cover all of the bases of a process much more thoroughly than any competitor. It is even able to integrate social networking information into its development database, so client and customer opinions can be accumulated and easily accessed by product developers,” he reveals.

Describing the PLM concept, Filipovski says that, because of the complex requirements of aircraft design, CATIA emerged with very sophisticated CAD/CAM capabilities. “CATIA had to have enough functionality to cover all aspects of the Mirage design, including mechanical, electrical, wire harnesses, piping, tubing and advanced ergonomics, and this functionality is taken through to maintainability.”

As early as the 1990s, Dassault was talking about digital mock-up (DMU) processes. And while digital prototyping is a commonly used term today, DS’ DMU vision has always been focused on manufacturing. “In principle, the DMU allows you to test and evaluate a digital model long before you begin to spend money on manufacturing.”

DMU is mostly about clash detection and fitting simulation, to see if a component can be physically removed and replaced, for example or to “check that an engine doesn’t have to be removed every time you need to replace a belt”. But CATIA is also able to test ergonomics using animated manikins. “When you design a cockpit, a virtual pilot is put into the seat for posture, visibility and reachability analysis, for example,” Filipovski tells MechTech.

“The Boeing 787 Dreamliner, was fully designed using CATIA and the first plane was manufactured without having printed a single drawing,” he
says. DMU was used for stress and clash testing on the hybrid digital model and then the entire plane was ‘digitally manufactured’. “This process not only ensures that every component and sub-system is fully specified, but also allows the assembly process to be fully tested and optimised,” he explains.

This approach avoids having to make physical prototypes, which used to be made from wood in the aircraft industry, and eliminates the risk of expensive modifications during first manufacture. One of the electronics racks on the Airbus A350, for example, although designed to fit the available space, would have been impossible to manoeuvre into place. By identifying assembly problems like these with DMU processes, programme delays, modification costs and all knock-on compromises and post design adjustments are avoided.

Also part of the PLM concept are virtual maintenance and testing capabilities built into the interoperable DS suite. “Dassault Systèmes is very strong in the power and energy fields, where maintenance simulation becomes vital. A plant designed for easy maintenance is not only a safer plant, but by thoroughly analysing and optimising maintenance procedures and routines, shut-down times can be minimised, potentially saving millions of dollars in the plants lifetime,” estimates Filipovski, adding the converse: a plant that is difficult to maintain is “very expensive to modify after it has been built”.

From a personnel point of view, he says that “every maintenance task can be 100% simulated, timed and costed in the virtual domain. It is even possible to start delivering maintenance training courses before the plant has been built. If a pump needs to be replaced, for example, account is taken of how many people need to be involved, which tools are required and how the facility can be accessed. It is important to know that there is sufficient space to remove the failed unit and that the access pathway is sufficient to bring in the replacement. Reachability is analysed for every bolt needing to be removed – and the effort required by the maintenance personnel will also be determined. DS’ DMU approach can even determine the amount of physical stress that will be applied to a workers back,” he informs.

The full DS suite for DMU includes: CATIA for digital product definition, DELMIA for digital manufacturing and ENOVIA, the internal and external collaboration and communication add-on. “Essentially, these are different workbenches with different menus, but each programme component uses an identical user interface and enables data to be seamlessly passed around. Together with the data management repository, which is now called 3DEXPERIENCE, all aspects of PLM are catered for, from conceptual design to product disposal.

“3DM information is at the core of the process, but this information needs to be shared. When developing a new car, for example, the workflow is essentially split into two. The DMU workflow processes cover the management of the entire process while in digital format. The fully optimised digital mock-up is then used to generate electrical and mechanical bills of materials (BOMs), which can cover the mechanical and electrical requirements of the car itself and the assembly plant necessary to build it. These BOMs are typically the end point of the development stage.

“From the BOMs, the company needs to start ordering parts and preparing for the manufacturing stage of the project lifecycle. The digital information from the BOMs and the DMU process is then shared with the company’s ERP (enterprise resource management) system, so that financial issues and data can be well controlled and managed – and SAP or Sage or any proprietary ERP system can be coupled to DS’ development software,” says Filipovski.

Why is the shift to PLM important? “Finding and holding onto accurate and useful information is not an easy task. It is estimated that 30% of all inefficiency in an engineering office is because of unnecessary searches or information validations. By implementing a good PLM philosophy, along with the software required to implement it, efficiencies can immediately be improved.

“Also, it is essential in today’s environment for a development company to protect its intellectual property, and this goes well beyond protecting patents. Product development is dependent on the know-how and skills of the company’s engineers. This is often simply lost when a key staff member leaves the company. ‘Experience information’ is also intellectual property. It is very valuable because it tells one what to avoid in the future, which procedures to adopt for best efficiency and how best to optimise work flows,” Filipovski responds, adding that DS renamed its PLM platform to 3DEXPERIENCE to better reflect this.

“PLM is not only about storage, though, it is also about having easy access to one’s own intellectual property.” The control of development and manufacturing processes is key. “The majority of companies involved in development at this level are ISO 9001 certified and have therefore embedded workflow processes into their daily routines. Best practice processes have been incorporated into DS solutions for various different product development environments – such as aerospace and defence, automotive, and ship and yacht design – and digital signatures allow these processes to be easily configured to suit the specific work flows chosen by individual companies,” he explains.

“At CDC, we do not see ourselves as PLM software resellers. We like to go into a company to do a business value assessment (BVA). We spend about three days interviewing different company stakeholders to get a clear sense of the company’s internal processes, bottlenecks, strengths and weaknesses. Then we look at the company’s mission, goals and drivers to root out any mismatches between the philosophies and the realities.

“Only once this information has been determined can we begin to make recommendations about a PLM software solution. But in almost all cases, DS’ customisable and configurable solutions can be accurately matched to a company’s internal process requirements to improve efficiency, quality and global competitiveness,” Filipovski concludes.