

# DEVELOP 3D

(TECHNOLOGY FOR THE PRODUCT LIFECYCLE)

Siemens PLM Software  
NX for Product Engineering supplement

## The final frontier

Advanced instrumentation  
for space missions

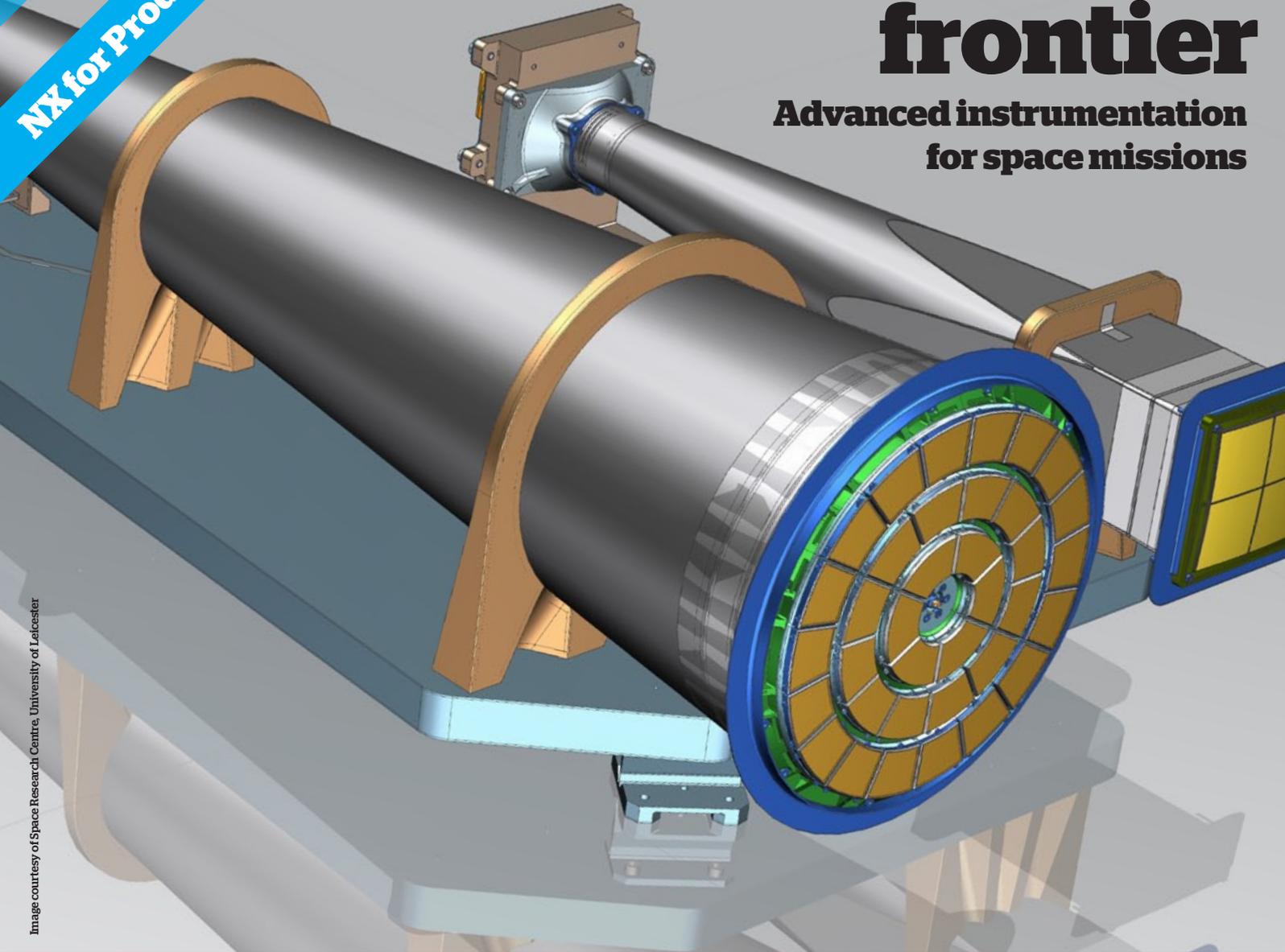
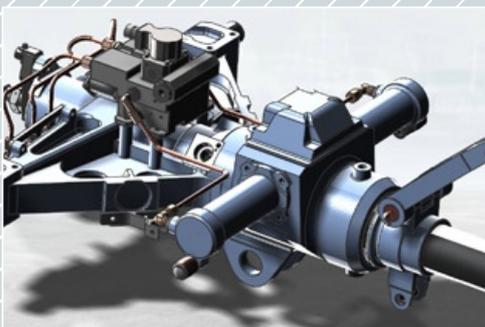


Image courtesy of Space Research Centre, University of Leicester

### PLUS

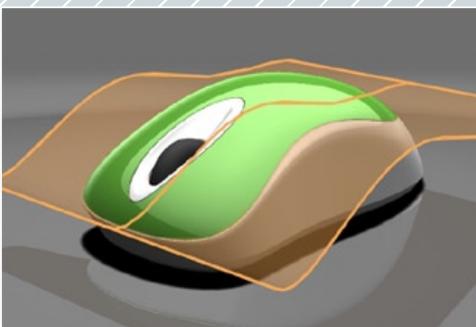
#### Product development

Overcoming the challenges



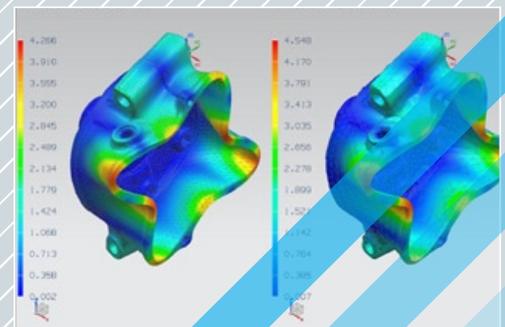
#### Freeform modelling

Bringing order to creative freedom



#### Simulation first

Simulation-driven design



# Key challenges for product engineering

**From complexity and sustainability to quality and performance, the challenges in product engineering are very different from those faced by our forebears. We take a look at the big six and how Siemens PLM Software's NX can help overcome them.**

## Complexity

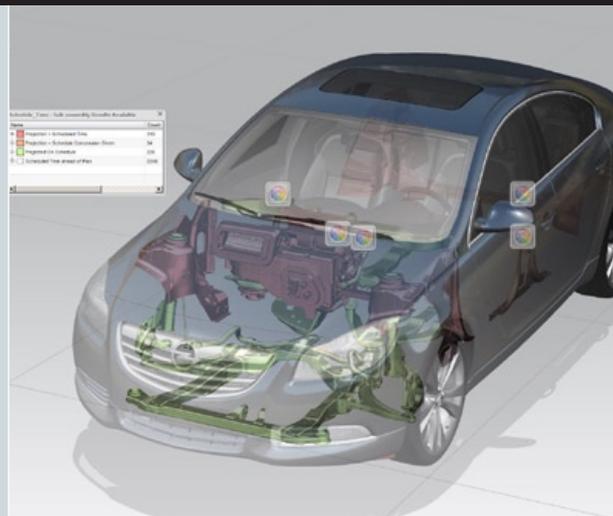
Modern products are incredibly complex. From the smart phone in your pocket to heavy duty industrial equipment, they often fulfil multiple roles and can be customised to cater for discerning customers. Designs not only comprise mechanical form and function, but electronics, electrical control systems and connectivity.

NX supports all design elements in a modern product – tools to generate concepts and variants more quickly, the integration of

electronics data and into the realms of mechatronics and systems design.

With the integration of Teamcenter, it's also possible to manage customer or functional requirements, options and variants and pull that information into the design environment.

To put this all in context, turn to page 7 to find out how the Space Research Centre at the University of Leicester is using NX and Teamcenter to assist in the development of complex instrumentation for space missions.



High Definition 3D (HD3D) technology in NX can help users dive into the wealth of information held within complex product models

## Sustainability

The responsibility for reducing the environmental impact of products rests in the hands of the design and engineering profession. This includes the development of cleaner, greener power sources, the reinvention of transportation and more localised and smaller scale improvements on a per product basis.

With consumers also demanding greener products sustainability will be a key focus for the design industry for years to come.

But how can sustainable design be accomplished

when profitability is still the number one driving factor? Techniques such as whole systems design, light-weighting, materials selection and design for disassembly can all contribute and NX has a broad set of tools to support them. From the ability to rethink existing processes and products at a root level, to the ability to find, test and refine designs based on new materials and into the world of product compliance, the combination of NX and Teamcenter gives the design and engineering team everything they need.



Visual reporting can provide visual feedback on material choice, weighting and compliance. This can give vital feedback to help improve the sustainability of a design

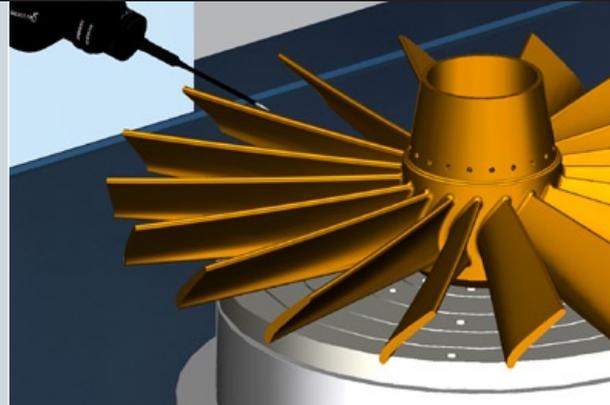
## Quality

Quality is hard to quantify. Does it relate to the perceived quality of a product – will the user love it and cherish it? Do the materials used give a product an air of quality and therefore command a higher price premium? Does it come down to lower reject rates on the production line?

Many of these things can be designed into a product during its development, but are often hard to evaluate

with basic 3D geometry displayed on a monitor.

NX supports photorealistic rendering to enable stakeholders to gain a better insight into how a product will look and feel. And once prototypes are required, data can be created for use in various processes, from NC controlled milling machine tools to 3D printing machines that build parts from raw materials.



NX CMM Programming can help provide quality assurance on manufactured products

## Aesthetics

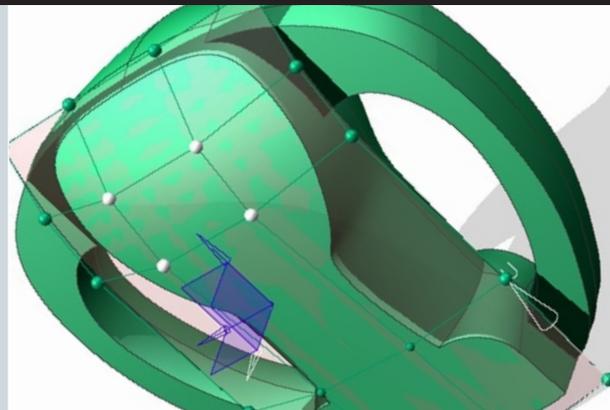
Consumers no longer tolerate bad looking products – whether that's a member of the public shopping on the high street for a new TV or a contractor investing in construction equipment.

Traditional "function-first" products from the likes of JCB now differentiate themselves by incorporating the types of design aesthetics typically reserved for the automotive industry. And this is an

industry wide movement.

By integrating advanced, but easy to use surface modelling tools, alongside the core engineering design feature set of NX, users have the ability to develop exterior style to the quality required, then move the product forward into detailed design and engineering.

We explore this further on page 6 with a look at NX's freeform design tools.



NX offers a range of advanced surfacing tools to help design forms that are aesthetically pleasing

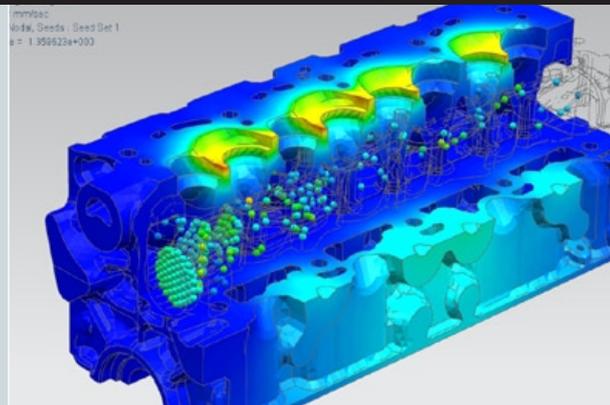
## Performance

We all want our products to perform better – whether it's motor vehicle or a kitchen top coffee pot, we want it to function well throughout its entire life. This places a burden on the designer or engineer to explore the operating limits of a product iteration before it even gets to the prototyping stage.

Using a range of simulation technologies, NX allows designers and engineers to

explore a product's operating conditions, to find areas where mechanical strength can be optimised, where heat dissipation can be improved and form can be adjusted.

NX also offers a range of new tools to assist with capturing an organisation's knowledge and expertise in easy to reuse and deploy templates for simulation. This is explained in more depth on page 4 and 5.



NX CAE can be used to assess the operating limits of a product before it gets to the prototyping stage

## Cost

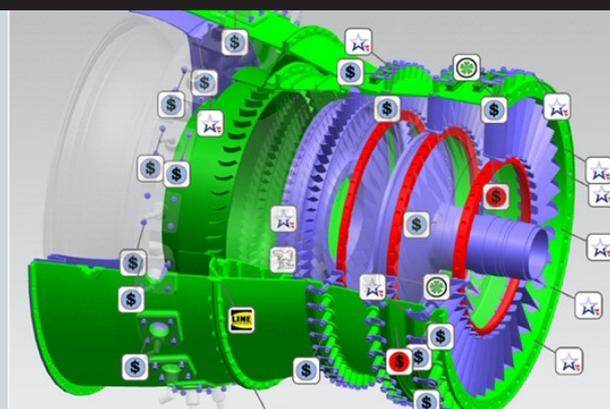
In the current economic climate there has rarely been more pressure to reduce costs in product development.

Rapidly increasing materials costs, the need to increase profitability and the drive to reduce overheads through outsourcing, must all be considered by the design and engineering professional.

The full feature set of NX allows an organisation

to reduce material use through optimised design. It also allows new materials options to be explored and geographically dispersed development teams to be managed.

With access to the full suite of manufacturing tools in NX the software can then help users reduce costs further by taking products into a more efficient manufacturing process.



Visual reporting can be used to identify which components are over budget or contributing the most cost.

# Deriving value from knowledge capture

**Knowledge capture in CAD has always promised great things, but unless the knowledge is easily reused, the return on investment is minimal. We explore the Product Template Studio within NX that aims to truly deliver on that vision.**

**W**ith the introduction of digital design tools came the mantra 'create once and reuse many times'. Pretty soon after this, we started to hear the term 'knowledge capture'.

Knowledge capture differs from data reuse in the sense that it's about much more than just reusing geometry and copy/pasting lines, circles and arcs. It is about capturing the thought processes and inputs that went into making that geometry, and re-using that knowledge to create new designs. Specialist knowledge held by a designer or engineer can be transformed into a digital asset that can be harnessed by other users.

Historically, knowledge capture or knowledge-based engineering (KBE) systems have been highly specialised, often more of a consultancy gig than a user focussed tool. They are often expensive and time consuming to program from scratch. If it takes six months of consultancy to automate a process that might only take the designer

or engineer a week to complete, you have to ask yourself is it really worth it?

In highly complex applications, such as conceptual engineering on turbine engines, knowledge-based engineering systems have proven beneficial but, for mainstream applications, the pain and cost of setting up such systems often didn't make sense. But does that mean that the benefits of knowledge-based engineering can't be applied to the masses? Of course not.

The Siemens PLM Software team has been building tools into NX that allow us all to do just that. So let's explore how they work, the benefits they offer and what some of Siemens PLM Software's customers are doing with it.

## A different approach

NX and its Unigraphics predecessor have included knowledge capture and reuse tools for many years, in the form of Knowledge Fusion (KF). This was a traditional style tool which required the use of a visual programming language to define each instance of capture and

reuse. It was powerful, but complex and very time consuming to program.

With NX 4, Siemens PLM Software introduced a new set of tools for capturing design and engineering knowledge that were equally as powerful, but dramatically easier to use. This culminated in the release of the Product Template Studio (PTS) in NX 6.

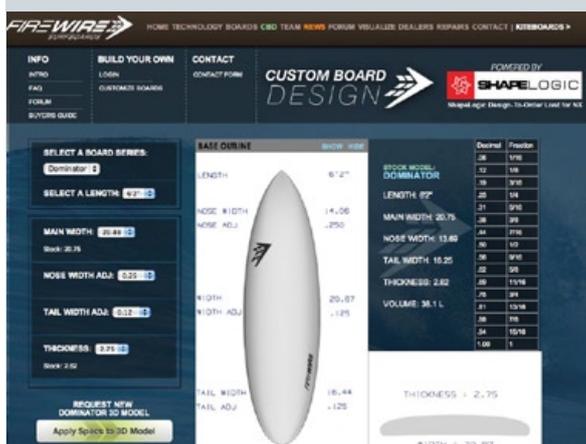
Product Template Studio represents a breakthrough in capturing commonly repeated and reused processes, workflows and tasks and making them available for reuse. It combines parametric modelling tools, logic and equation-based parameterisation (using Expressions) and an environment that allows anyone to create templates graphically: no programming required.

## Getting started

The starting point for knowledge capture in PTS is the geometry. The user needs to ensure that it can be parameterised and works correctly.

A native NX model is the ideal, as this contains all of the parameters and

## Firewire Surfboards pushes knowledge direct to the customer



One of the biggest challenges for Western Australia's Firewire Surfboards is how to serve hardcore surfers who want custom boards to suit their individual styles and local wave conditions.

"It's important for any premium, high-performance surfboard brand to offer custom boards if they want to be recognised as an industry leader," says Firewire Surfboards CEO Mark Price.

The firm's web-based Custom Board Design (CBD) system enables registered customers to select models from Firewire Surfboards' standard surfboards, then alter the design with their own dimensions. CBD users can

tweak the board's length, wide point, nose and tail width, and thickness to tailor the board to their preferences.

The Product Template Studio (PTS) in NX was ideal for prototyping the custom surfboard design-to-order system. Using drag-and-drop tools, Firewire's development partner, ShapeLogic, devised a simple user interface to drive the parametric surfboard models. This interface served as a template for creating Firewire Surfboards' web-based interface. The use of PTS also facilitated testing of multiple parameter combinations to ensure the robustness of the models.

[www.firewiresurfboards.com](http://www.firewiresurfboards.com)

expressions required to drive its form and function. For older legacy data, however, or even non-native data, Sync Tech pays some dividends. It can be used to quickly re-parameterise the geometry so a template can be built off a new version of the original geometry.

Alongside a sound geometry model, additional tasks can also be incorporated into the template. Essentially, anything that's used within the NX environment to define a product's form and function. An obvious example is the increasingly common use of CAE (Computer Aided Engineering) or simulation. Not only can simulation studies be incorporated into a template to validate the geometry that's created, but it can also be used to feedback into other areas, such as including part checks against customer requirements or performance limits.

#### Adding a user interface

One of the key innovations in PTS is that the resultant templates are driven from a graphic user interface, which is often indistinguishable from those used in vanilla NX. The user interface provides direct access to the parameterised model and associated processes.

The range of input values presented in the dialogs are set so those reusing the template across the organisation can't work outside the defined boundaries and limits.

If the organisation is using Teamcenter, it is also possible to link a Product Template to design requirements,

calculation worksheets, dialog images, tabular engineering data, help documentation, and other relevant knowledge resources stored in the Product Data Management (PDM) system. Changes made to this knowledge, which can be centralised within Teamcenter and maintained by non-CAD users, can quickly be reflected in the Product Template, ensuring that anyone who uses it will be leveraging a design based on the most up-to-date information possible.

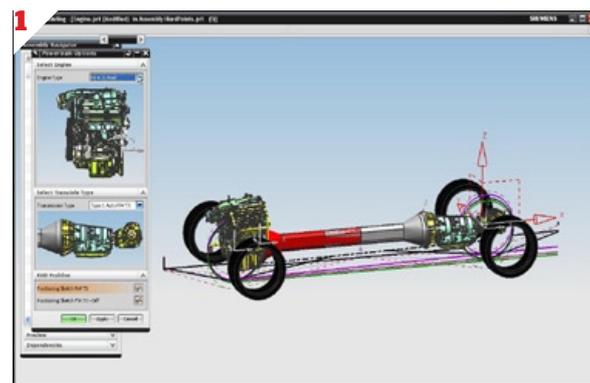
#### Deployment of templates

Once the template has been defined and everything is in place, it can then be deployed. Luckily, Siemens has done a lot of work to centralise the mechanisms for data reuse within NX. Consolidated into the Reuse Library, this goes beyond the typical standard features, parts and sub-assembly libraries and is the central place to locate reusable data. Anyone within the organisation can then drag the appropriate template into their work space and make use of that mission critical knowledge.

#### The benefits of knowledge

We're all aware of the knowledge gap that the design and engineering profession is currently facing. There are fewer entrants into the industry while an ageing workforce is retiring, taking with it a lot of knowledge and expertise within an organisation.

Alongside this, we spend much of our time repeating work that if not done by



1 Powertrain design with knowledge captured using the Product Template Studio in NX 8.0.

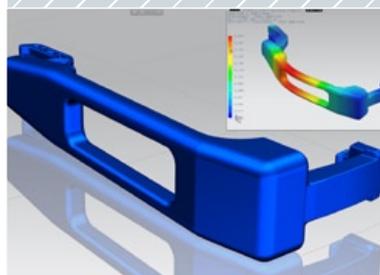
ourselves, certainly has been carried out elsewhere within our organisation. Design and engineering is often a case of adapting existing products, parts or concepts to a new set of requirements. It makes no sense to do everything again from scratch.

Digital design tools like NX can help, but the problem is that even if knowledge is captured in digital form, those that need it often don't know where to start looking.

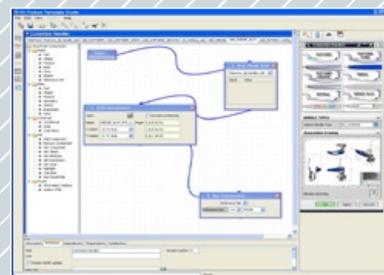
This is where NX's Product Template Studio and the Reuse Library can pay massive dividends. Knowledge and expertise can be captured and formalised in an easy to use and very powerful manner. But, just as importantly, those templates can be accessed by those that need them, when they need them. When you combine these two factors, it's clear that the value of capturing your organisation's knowledge can be truly realised.

## Workflow Setting up a Product Template within NX 8.0

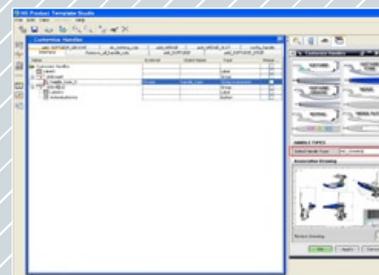
1 The starting point is a fully developed, parametric part model with any associated CAE studies and other processes.



2 Intelligence is then added. This connects the different variables, inputs and parameters as well as providing the ability to 'nest' multiple templates within a single deliverable.



3 A dialog is created matching native NX user interface standards. Only those inputs and options that the user can experiment with are shown, ensuring best practice.



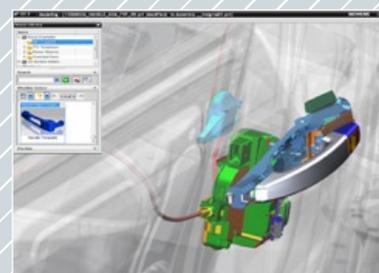
4 The user interface elements are then connected to the appropriate model elements.



5 Lookups pulling Requirements or other managed resources from Teamcenter allow enterprise-level best practices and standards to be integrated into a Product Template.



6 Once placed in the Reuse Library, the template becomes available to anyone that needs it, allowing them to reuse that data at will and gain full benefit from it.



# Integrated form design

**NX has always had a reputation for supporting those that require the ultimate in form development. We explore how its surface modelling tools, when used as part of an integrated design and manufacturing process, can benefit firms of all types.**

**T**he requirement for high-quality aesthetic design is no longer the preserve of the automotive industry or manufacturers of exclusive designer products. Today, more than ever before, design is in the mind of every consumer and everything from industrial machinery to the objects we previously considered to be purely functional, needs to look good as well as perform to specification.

This has caused a shift in what designers and engineers are demanding from their CAD tools. Whereas prismatic

shapes used to be sufficient in a product development system, now everyone needs to be able to create and edit high quality surface models.

While modern CAD tools have developed advanced surface creation and editing functionality, they are often disconnected from the software that is used to take a product further into production.

Siemens NX software has always provided a rich set of surface manipulation tools. These have recently been boosted by the introduction of Synchronous Technology. Fine edits

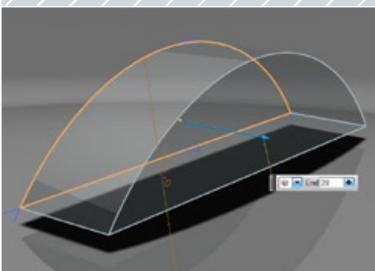
made to surface geometry can now be quickly propagated throughout the whole model.

The result is an integrated toolset that's easy to use, contains deep and rich functionality from intelligent geometry creation, as well as the industry standard analysis and validation tools that are expected.

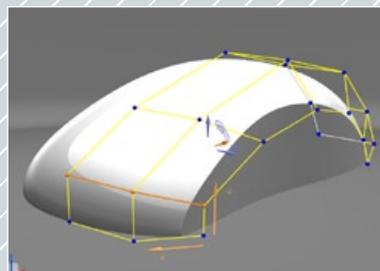
But the real benefit of using this integrated system is that advanced surface creation and editing tools now allow the user to take the same data through into design, engineering and production readiness.

## Workflow Using freeform modelling to develop a mouse

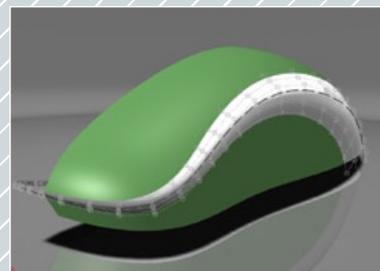
**1** Freeform design conceptualisation can begin from simple geometry, employing familiar concepts such as sketch and extrude to quickly arrive at an initial form.



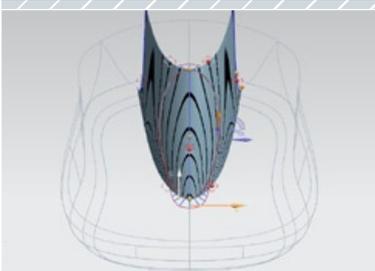
**2** To give it more desirable aesthetics the integrated high quality surfacing (styling) capabilities can be used within the NX Synchronous Modelling toolset.



**3** A full suite of high quality (Class-A) blending tools are available for defining complex transitions. All tools work the same across surface or solid model geometry.



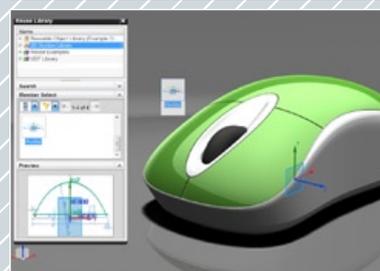
**4** Zebra stripe reflection analysis can be used in combination with surface to surface intersection analysis while shaping the thumb wheel scoop.



**5** The full capabilities of NX can be used including support for engineering surfacing, component breakout and detailing, and template based parametric design tools.

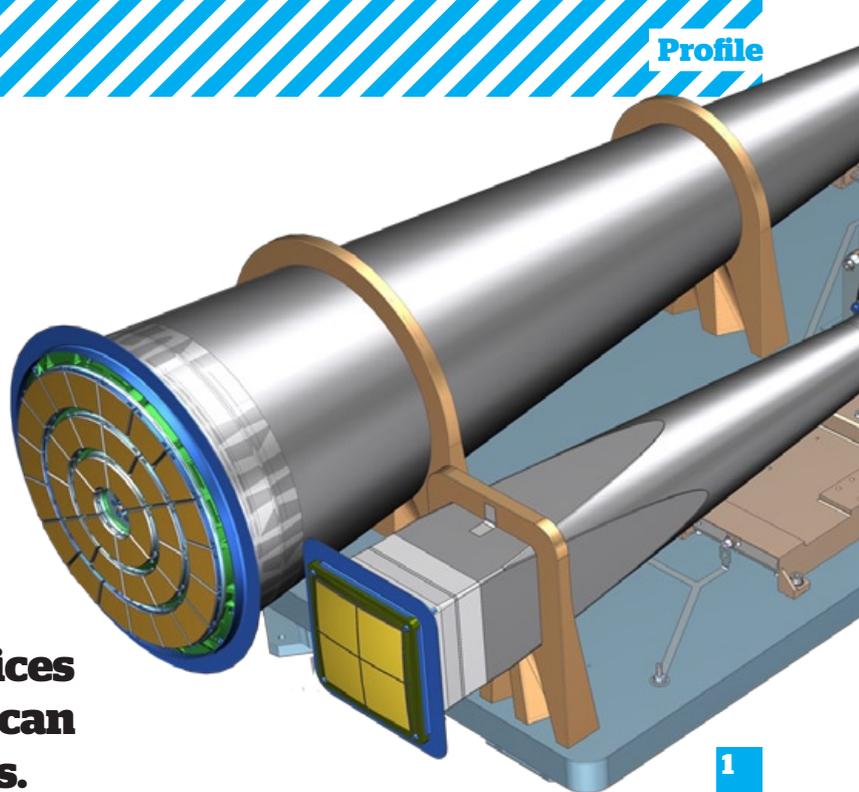


**6** All design data from styled to mechanical can be reused from the NX Reuse Library making it possible to capture and reuse elements of a product's "design language".



# The final frontier

**The Space Research Centre relies on NX to ensure the devices it develops for space missions can survive in harsh environments.**



1

**S**ending spacecraft into orbit to explore the unknown is inherently exciting. The Space Research Centre (SRC), part of the University of Leicester Department of Physics and Astronomy, has a long history of involvement in major international space missions. Stretching back more than five decades, its activities are diverse with its core engineering pursuit being the development of instrumentation for space missions.

Considering that it costs in excess of £20,000 per kilogram to launch hardware into space, product assurance and reliability are paramount at SRC. In conjunction with its in-house facilities, including test laboratories, environmental test chambers, clean rooms, electronics design and manufacturing facilities, it uses Siemens NX for mechanical design, analysis and manufacturing.

"NX and Teamcenter are very much core to our research as it really has allowed us to be a lot more efficient in how we deliver quality to schedule and budget," says Piyal Samara-Ratna, mechanical engineer and CAD administrator for the SRC.

The SRC has been using Siemens PLM's software solutions for around 15 years and over the past four years it has slowly moved completely over to a fully integrated NX and Teamcenter solution – a transition managed by Siemens' software reseller, TEAM Engineering.

## Out of this world

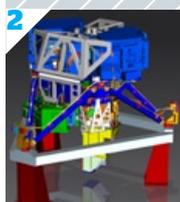
One of SRC's ongoing projects that has benefited from Siemens software is its work on the MIRI (Mid InfraRed Instrument) for the James Webb Space Telescope (JWST), the next-generation mission to replace the Hubble Space Telescope. Led by NASA, the project represents an international collaboration of around 17 countries and

**1** CAD model of the Mercury Imaging X-ray Spectrometer Instrument (MIXS). In collaboration with Magna Parva.

**2** CAD model of the Mid Infrared Instrument (MIRI) for the James Webb Space Telescope.

**3** The University of Leicester Space Research team in the clean room with their hardware contribution to the MIRI.

At the University of Leicester, JWST activities are funded by the UK Space Agency (UKSA), BepiColombo activities by UKSA and the European Space Agency.



has a rather hefty goal of studying the birth and evolution of galaxies.

"Siemens products have been used extensively in this programme for design, analysis and manufacturing and have been essential tools in ensuring that the flight instrument passed its structural testing with flying colours," explains Jon Sykes, University of Leicester lead mechanical engineer for the instrument.

The SRC is also involved in the development of the Mercury Imaging X-ray Spectrometer Instrument (MIXS), one of the key instruments onboard the BepiColombo spacecraft that is being developed by the European Space Agency. Due to launch in 2014, it will reach its final destination of Mercury in 2020. MIXS will be used to help determine the composition of the planet's surface by measuring fluorescent X-rays.

Unlike MIRI, the SRC are actually leading the MIXS project and are responsible for managing the overall consortium, which consists of a number of international partners and teams. MIXS represents a leap forward in scientific capabilities and, because of the challenges involved, an iterative design, analysis and test campaign has been undertaken, with increased functionality introduced at each stage.

"We are designing a product of optimum efficiency with strictly

controlled margins of safety," comments Samara-Ratna. "If our instruments fail in space then there is nothing that can be done to fix them. Therefore we undertake an extensive analytical and test programme to ensure reliability. We find that the NX Nastran solver is an industry standard tool and this promotes the sharing of models and data with our project partners."

The group has recently finished the structural thermal model, which combines the flight structure with partial electronics and optics. The next stages will be launch load simulating vibration and environmental testing. "This is an expensive process and we rely on our analysis data to give confidence that the design will work. To move efficiently through these design phases quickly we need a multi-functional tool like NX," comments Samara-Ratna.

## Technology transfer

Although the core of what the SRC does is space science and related instrumentation it is also heavily involved in technology transfer. "Our work is applicable to a board range of industrial sectors," stresses Samara-Ratna. "Currently research is being carried out into medical detectors that use technology spin-offs from space instrumentation to detect tumours."

"We are also making increased use of new manufacturing technologies like additive manufacturing and for this we make extensive use of NX's wave-linking and synchronous modelling tools to allow us to take advantage of the geometries feasible with this technology," he adds.

Now that the SRC has fully transitioned to NX and is using Teamcenter for CAD management, the next phase is to incorporate document and project management. "We want to use the full breadth of what Teamcenter is capable of doing," concludes Samara-Ratna.

# Simulation at the core of design

**Under pressure to shorten time-to-market, manufacturers are seeking to take advantage of simulation earlier in the design process, writes Jan Larsson at Siemens PLM Software.**

**W**ith traditional product development workflows, analysis and physical prototyping are used to confirm the intended functional performance of a design. But, if design problems are found at this late stage, development schedules can slip, costs can skyrocket and products can often fall short of market and business requirements, increasing the risk of customer dissatisfaction and/or recalls.

In many instances, the design team and the simulation analysis team are working almost entirely independently. Even when bringing simulation into the process earlier, teams are using disparate, specialised tools that are disconnected from each other. This creates redundant data and workflows, and ultimately impedes the speed of simulation.

According to a report by the AutoSim Consortium, of the total time needed by engineers to perform a full simulation for a system or subsystem, 80 per cent is devoted to generating the model.

To speed things up, every step in the simulation process must be aligned. The goal is to get to a point where simulation is in sync with design and, in some cases, leading design so analysis results can be fed back into every design decision. Simulation models (such as finite element models) with detail matching the accuracy desired at a particular design stage must be available.

In a simulation-driven design process, engineers have access to powerful geometry editing tools, like direct modelling and dimension-driven design. The most recent advance comes in the form of synchronous technology, a unique capability that combines the speed and flexibility of direct modelling with the precise control of dimension-driven design. These powerful tools allow engineers and analysts to easily edit and obtain the idealised geometry they need without having to wait for designers to perform these tasks. This enables them to respond rapidly to design changes or suggest changes to

the design based on simulation results.

Because models and data can be shared easily, this level of integration can provide confidence for a manufacturer's decision makers. Through a centralised hub, it's possible to deliver tools which allow designers to run basic simulations, and analysts to make any necessary tweaks to a model's geometry. This helps garner greater synchronicity and trust between the designers and the analysts, and gives both teams the ability to make alterations without having to go through a complex and time-consuming back and forth process.

By turning to a simulation-driven approach and introducing it right at the concept stage, product developers can reuse existing models and design geometry instead of rebuilding them from scratch. This allows them to explore alternatives, spot flaws and optimise product performance before the physical prototype or detailed design is created. The process allows important decisions to be made on functionality, geometry and materials early in the cycle based on simulation results.

This high level of coordination between designers and analysts can be achieved through the implementation of a complete suite of integrated process automation tools, such as Siemens PLM Software's NX software. By using NX - which integrates high-end analyst modelling tools with world-class geometry capabilities - and combining it with data management software, such as Siemens PLM Software's Teamcenter,



**1** Jan Larsson, marketing director, NX, EMEA Marketing at Siemens PLM Software.

**2** NX enables you to compare physical test data with CAE analysis results and to optimise your models to ensure results will accurately predict physical tests.



users are able to develop and share analysis models faster than with traditional CAE workflows.

## Changing the culture

The simulation-driven design process represents a significant cultural change for many companies. In addition to new technology, these requirements will also call for dramatic changes in processes and attitudes. It may mean re-organising the way groups work together and it is likely to mean changing old habits.

People that used to hold data for as long as they could to get as much context from other groups and to minimise their chances of revision, for example, have to be encouraged to release preliminary information early to support a more rapid process. Each group working on the design has to learn the needs of the other groups.

This kind of concurrent and collaborative engineering - where 3D models, data and results are shared so everybody is able to see the geometric model in real time - creates workflows that help facilitate design reviews and enables multiple departments to review and approve or reject the design. As an added benefit, by properly synchronising and centrally managing processes, companies can more easily adhere to all regulations around tracking and traceability.

## Innovation

Simulation guides critical trade-off decisions to balance competing product objectives such as reliability, cost and weight requirements. But it also plays a major role in product and process innovation. New ideas have to be tested, qualified and refined before they can be put into practice.

Usually hundreds of concept alternatives are evaluated before detailed design is begun. In the past this required physical testing, so very few design alternatives or radical ideas were tested and products evolved slowly.

Advances in technology and processing power, combined with the coherence of a centralised design and analysis hub mean that there is much greater scope for experimentation. This is crucial to innovative product design. If the simulation and feedback process is fast enough, even radical but unfeasible ideas can reveal useful information and increase insight into a design. This is especially true early in the design process when you want to eliminate potential 'losers' and focus subsequent efforts on a smaller set of potential 'winners'.

The message is clear - by putting simulation at the heart of the design process, engineers are better able to understand, predict and improve product performance digitally. More design concepts can be explored, which in turn reduces direct costs associated with expensive physical prototypes and enables faster, more informed decisions.

