SIEMENS PLM SOFTWARE

NX LIFECYCLE SIMULATION

A DEVELOP3D SPECIAL REPORT

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THE FOUR TENETS OF SIMULATION

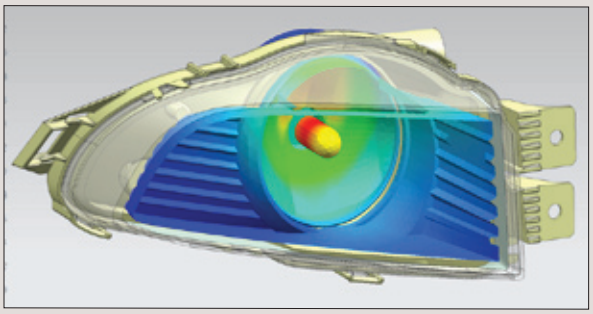
SIEMENS PLM SOFTWARE HAS A COMPREHENSIVE SUITE OF COMPUTER AIDED ENGINEERING (CAE) SOFTWARE. WE LOOK AT THE FOUR CORNERSTONES OF SIMULATION THAT FORM THE FOUNDATION FOR ITS POWERFUL NX SIMULATION OFFERING

Since the merger of Unigraphics Solutions and SDRC nearly eight years ago, the NX product has been the flagship offering from Siemens PLM Software. The union brought together expertise in geometry creation, manufacturing knowledge and know-how in CAM, deep simulation (CAE) knowledge as well as data management with Teamcenter. One area that has advanced the most is analysis and here Siemens PLM created a suite of NX Simulation software. This revolutionised analysis in NX, offering a huge raft of tools and technologies to help understand the behaviour of a wide range of products.

In developing these next generation simulation tools, Siemens PLM Software identified four cornerstones of Computer Aided Engineering (CAE) which would be built into its technology: those of integration, multi-disciplines, analysis & test correlation and openness. Let's take a closer look at exactly what each of these means.

> "NX SIMULATION REVOLUTIONISED ANALYSIS IN NX, OFFERING A HUGE RAFT OF TOOLS AND TECHNOLOGIES TO HELP UNDERSTAND THE BEHAVIOUR OF A WIDE RANGE OF PRODUCTS"

1 INTEGRATION

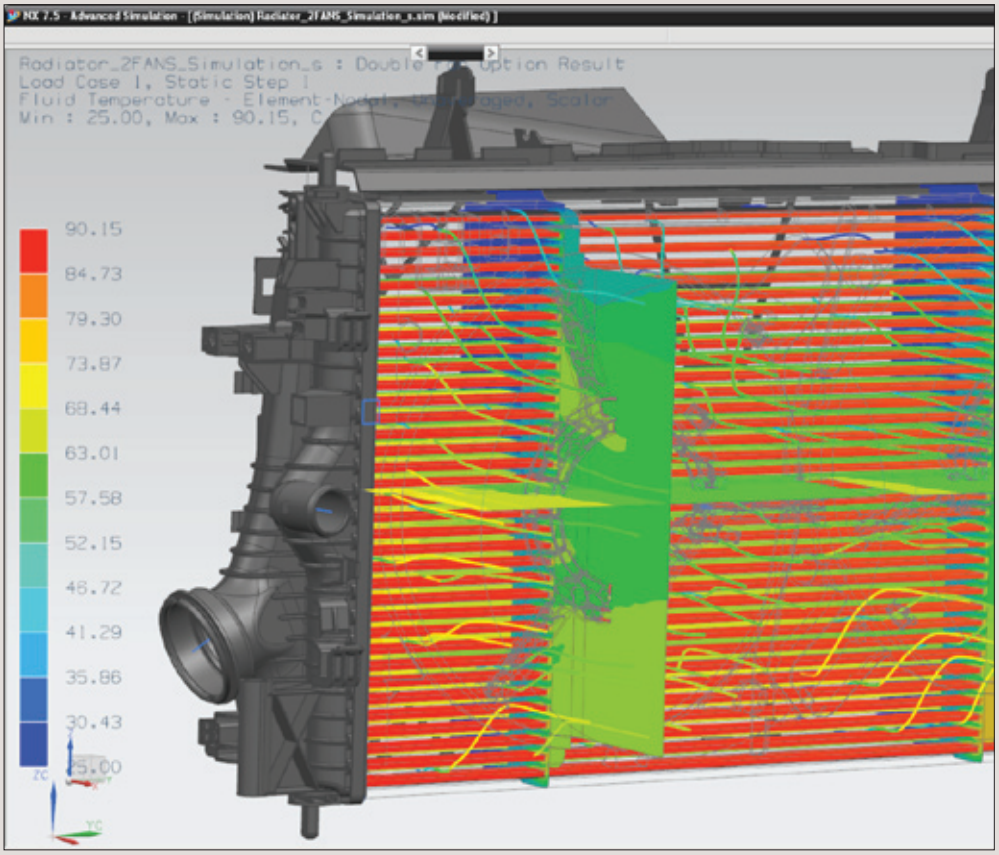


It is no longer acceptable to have experts working independently, creating geometry from scratch and conducting arcane FEA simulations on abstract geometry. If product development is to be accelerated and the goal of better, cheaper and more efficient products is to be reached, then something different is required.

NX provides a range of tools for product simulation that integrate directly into the product development platform. These range from the Stress and Vibration wizard-based tools delivered with every NX license, through to the more advanced NX Simulation tools that bring static, modal and thermal analyses directly to the NX interface.

This integrated approach means that many firms use NX as their core platform for both Design and Simulation, a prime example being the Acura division of Honda. Looking to replace a heavy magnesium gearbox casting with a thin walled aluminium structure for its Le Mans prototype, the Acura design team was able to create and update new design iterations with over 4,000 features in under 30 minutes. Once done, a single team member can evaluate its performance in under three hours and feed the results directly back into the design workflow - a process that would previously have taken ten days.

2 MULTI-DISCIPLINES



The simulation world has historically been split into several disciplines. Finite Element Analysis (FEA) deals with structural and modal performance and behaviour. Computational Fluid Dynamics (CFD) deals with both fluid flow and heat transfer. Motion Simulation deals with assemblies in motion and fatigue studies a product's performance with respect to time.

Traditionally, each of these simulation processes have been conducted in isolation, but the introduction of multiple disciplines is changing this by creating an environment in which the results and findings from each can influence the others.

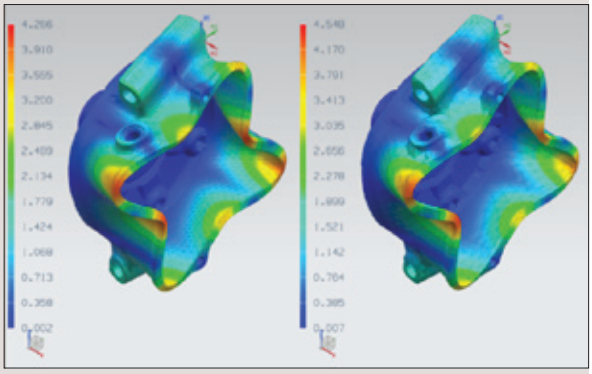
One customer already taking advantage of NX's multi-disciplinary capabilities is Keyria, a leader in turnkey solutions for building materials. The company makes huge machines that produce building materials such as bricks, concrete blocks, moulded plaster, many of which require automation in very high temperature conditions. Keyria's team uses NX Nastran, NX Thermal, and NX Flow products to assist with simulating its products. The team managed to cut the research and development cycle for a brand new 'force air' industrial oven system from one year to two months and through the use of comprehensive simulation also managed to deliver some pretty dramatic energy savings in the system.

3 ANALYSIS & TEST CORRELATION

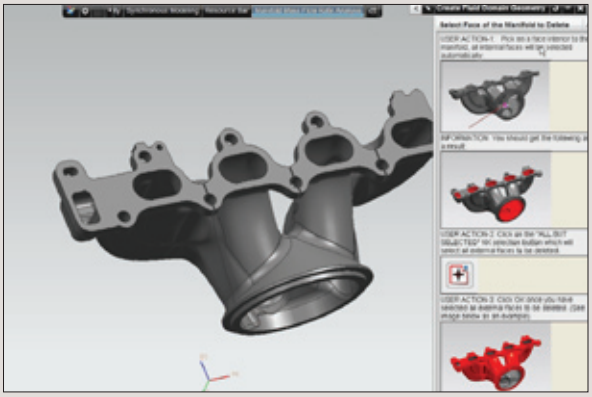
While many CAE software vendors espouse the digitalisation of test, the facts are that physical testing is a way of life and is going to remain so for the foreseeable future. With that in mind, it's important to be able to form a synergy between digital simulation and physical testing.

Can simulation be used to assist with preparing physical test rigs, to optimise them and fine-tune them to achieve the most accurate results possible? And can physical test results be used to add confidence that digital simulation work is accurate and matches physical, real-world results?

NX delivers its analysis and test correlation tools in two key modules - FE Model Correlation and FE Model Updating. FE Model Correlation supports the pre-test planning process, and offers import/export of data plus tools to compare physical and digital tests side by side. The pre-test planning is key, as the digital simulations can be used to conduct modal analyses, which can then be used to position sensors exactly where they're needed, rather than using guess work. Meanwhile, FE Model Updating allows digital simulation models to be updated to ensure that they match real life test data.



4 OPENNESS

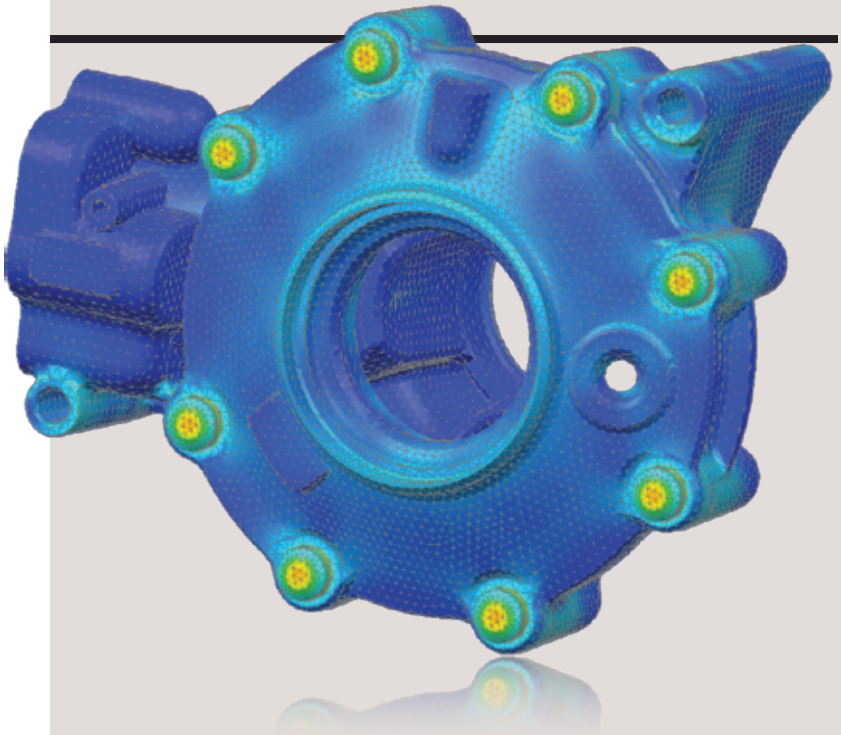


In the world of simulation openness is the key to providing an environment in which standard software solutions can be customised and automated and integrated with increasingly common in-house applications.

Siemens PLM Software has a reputation for openness, from its licensing of the Parasolid and D-Cubed engines used in many of today's leading applications, through to the establishment of processes, workflows and best practices using the JT format. Within the Simulation space, NX Open provides an environment in which organisations can use standard programming technologies (.NET, C++) as well as journalling capabilities (think: Macros) to get users up to speed as quickly as possible. To explore things a little further, the Knowledge Fusion environment was introduced into NX's predecessor some time ago and has become the foundation for automation and customisation within NX. Using this along with more recent developments, such as the Product Template Studio, allow users to capture best practices not only in terms of simulation, but in terms of many other areas of the system (modelling, manufacturing etc). Here, easy-to-use tools can be created that store and formalise expertise and knowledge and these can then be distributed to non-specialist users.

AN INTEGRATED APPROACH TO SIMULATION

SIMULATION IS APPROPRIATE TO BOTH THE EXPERT USER AND THE AVERAGE DESIGNER AND ENGINEER. WITH A SINGLE COMMON PLATFORM, SIEMENS PLM SOFTWARE'S NX NASTRAN PROVIDES THE FOUNDATION FOR OPTIMUM PERFORMANCE



For many years, CAD vendors have been espousing the benefits of bringing simulation further forward in the product development process. The argument goes that by providing the designer or engineer with simulation tools products can be tested, validated and optimised more quickly, with less recourse to physical prototyping and costly rework later on. However, the fact remains that many simulation tasks still require a more experienced specialist at the helm. As a result, many organisations that use simulation within the design process have two sets of tools.

For the designer or engineer this means a set of tools that are built directly into the geometry modelling system and allow rapid validation and results inspection. For the specialist this is typically a higher-end suite of applications that are used to perform highly complex simulation tasks. This bifurcation of simulation tools and processes causes several disconnects. First and foremost, both sets of tool will typically use different underlying solver technologies. This introduces several problems into the workflow.

Firstly, the designer can't typically pass simulation data onto the specialist for further work. Yes, results sets can be viewed and inspected, but if the specialist needs to rework or enhance the initial simulation, it needs to be redone. This introduces delays, as models need to be rebuilt, often by de-featuring or abstracting the core 3D CAD geometry, or in some cases rebuilding the model from scratch.

Secondly, it creates a barrier for organisations looking to use their specialists as mentors to the design or engineering department. The knowledge of best practices and process/ workflow used by the specialist can't easily be formalised and reused by the designer or engineer. Data formats are mismatched as well as the age-old problem of a disconnect between language/ terminology.

NX NASTRAN AS AN ENABLER

To solve many of these problems, Siemens PLM Software offers three levels of products in its CAE suite, all powered by common technology and applications including NX Nastran. The base level NX offering features wizards to solve part-based structural and modal simulations integrated into core NX. The mid-range NX Design Simulation is a natural extension to part design, offering structural, modal and thermal simulation, again integrated directly into NX. The high-end offering is CAD-independent and offers system simulation in addition to structural, modal, buckling, dynamics, and heat transfer. It also goes into the realms of non-linear analysis. All three offerings share the same underlying platforms: NX Nastran provides the solver technology, Parasolid provides the geometry handling kernel whilst Synchronous Technology turns on the geometry afterburners.

For those wanting to take a holistic approach to simulation this not only means a common platform for geometry sharing, but also that the simulation set-ups and results are equally as transferable, with data able to be passed up and down the process.

For the designer / engineer, preliminary simulation work can be carried out during the design process then passed onto the specialist / analyst for further work. Using the Product Template Studio it also means that the specialist can create 'sub applications' that encapsulate established best practices and workflows. These can then be reused by the designer / engineer to carry out common simulation tasks and first pass validations without requiring the involvement of the specialist, who can concentrate on the trickier, more involved work.

In terms of geometry transfer, this also gives rise to some additional benefits. By using a common geometry platform, product form can be manipulated, reworked and shared between anyone involved in the process. This not only leads to a greater use of simulation, but more importantly through the use of best practice and tools that are task- and knowledge-appropriate, the products that come out of the end of the development process are of greater quality and more suitable to their performance requirements.

"BY USING A COMMON GEOMETRY PLATFORM, PRODUCT FORM CAN BE MANIPULATED, REWORKED AND SHARED BETWEEN ANYONE INVOLVED IN THE PROCESS"

A CLOSER LOOK AT NX FLOW AND NX THERMAL

WHILE MANY ARE AWARE THAT SIEMENS PLM SOFTWARE PROVIDES ITS OWN VERSION OF THE NASTRAN SOLVER, THEY MAY NOT KNOW THAT THE COMPANY ALSO PARTNERS WITH MAYA TECHNOLOGIES TO COMPLEMENT THE STRUCTURAL ANALYSIS WITH HEAT AND FLUID FLOW CAPABILITIES

Coupling multiple-disciplines in a single simulation is the next stage in the evolution of simulation technologies. While discreet technologies that allow structural and heat/fluid flow simulations have been available for some time, a multi-disciplinary approach sees these combine into something much more powerful.

SIMULATION PARTNERSHIP

Addressing the shift to a multi-disciplinary approach, Siemens PLM has partnered with Maya Heat Transfer Technologies (mayahtt.com) to create a set of deeply integrated Fluid Flow and Heat Transfer add-ons (commonly collected under the umbrella term Computational Fluid Dynamics) for its NX product development system. These are offered as basic and advanced applications which, like the rest of NX's CAE solutions, can be used to create specific new-to-CFD designer wizard-based add-ons, where detailed control is offset against a guided usage scenario that encapsulates best practices.

FLOW AND THERMAL

In the base level, NX Flow and NX Thermal provide a rich set of controls and usage scenarios where users, with experience of the system and a solid understanding of the operating and performance requirements for their products, can conduct detailed simulations. Further on from that are the advanced flavours of these add-ons adding capabilities formerly only available to 'rocket scientists'.

What's interesting is that the various modules and the underlying datasets are all based on the same core technology and the data is transferable between each, both up and down the cost and complexity structure, meaning that an organisation can license the most appropriate tool for the experience, knowledge and functional requirements of its design and simulation team.

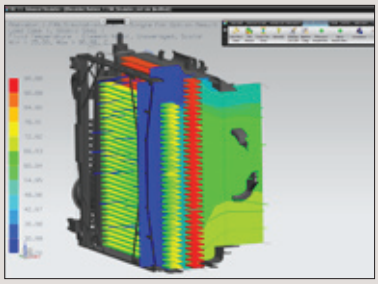
The various modules allow users to conduct all manner of Flow and Thermal simulations in isolation, but also provide the ability to couple together the two disciplines to achieve a much more holistic understanding of a product's performance.

When this capability is combined with the powerful geometry tools within NX, such as Synchronous Technology which allows rapid creation, repurposing and abstraction of 'design' geometry, the result is an environment in which simulation can be used to truly optimise design rather than simply validate it.

Alongside these tools, there are also several special purpose add-ons that take very industry-specific terminology, workflows and best practice and deliver a set of tools designed to solve very specific problems. While the Electronic Systems Cooling module is going to be applicable to a large number of users, there's some enjoyment in the knowledge that there's also a module to assist with the simulation of Space Systems (satellites as well as other 'out of atmosphere' vehicles).

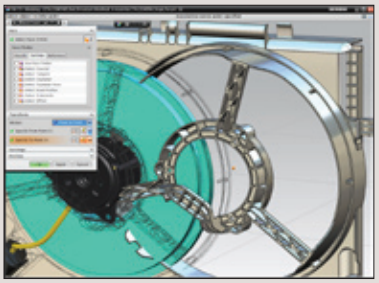
WORKFLOW: SOLVING COMPLEXITY WITH MULTIPHYSICS

1 AN ISSUE WITH HEAT EXTRACTION



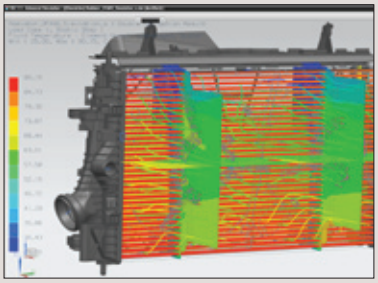
Using a combination of NX Flow and NX Thermal it is discovered that a radiator assembly isn't pulling enough heat out of the system. It is only achieving 36kW whereas 41kW is required for this engine.

2 MODELLING DESIGN CHANGE



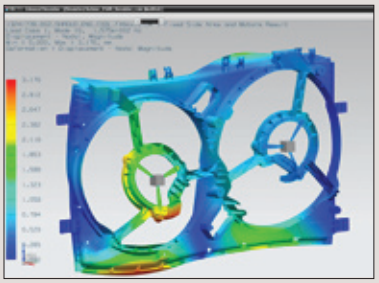
The single fan design concept is quickly modified using Synchronous Technology to take the existing design (including fan and mounting sub-assemblies) and create a two fan variant.

3 VALIDATION WITH FLOW SIMULATION



Further simulation is conducted to ensure that the new design variant achieves the performance requirement of over 41kW.

4 STRUCTURAL SIMULATION



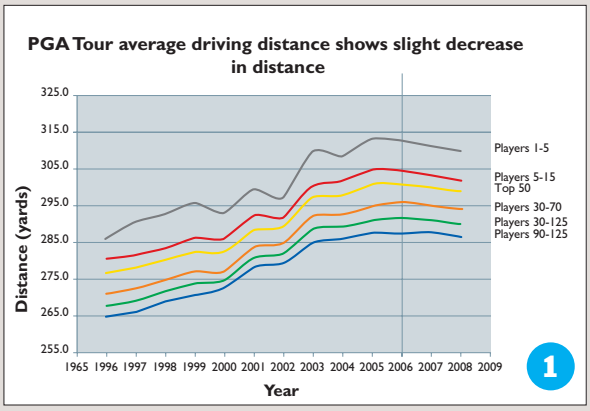
Structural and modal simulation is conducted to ensure that the mounting scheme will support the new design variant with the required performance parameters.

HEAD FIRST: THE NEED FOR SPEED

ADAMS GOLF ADOPTED ADVANCED SIMULATION TECHNOLOGY FROM SIEMENS PLM SOFTWARE TO HELP DESIGN A NEW GENERATION GOLF CLUB THAT OFFERS ULTIMATE DRIVE DISTANCE DUE TO ITS SOPHISTICATED AERODYNAMICS

For a relatively small company Adams Golf, a Texas-based golf club and equipment manufacturer, certainly caused a stir in the golfing world last year when it launched its Speedline FAST 10 driver - a club that retains a large driver head but has low aerodynamic drag force. It was also the company's first product to integrate both Siemens PLM Software's NX Flow application for CFD analysis as well as aerodynamic wind tunnel testing into the product development process. "We are a small fish in a very big pond so we are constantly competing with other larger companies to gain market share. NX Flow has definitely given us a competitive edge," says Jeff Albertsen, a design engineer at Adams Golf.

The creation of the Speedline FAST 10 started when Adams Golf began noticing a peculiar trend amongst golfers. "We've seen driving distances actually decrease over the last couple of years," claims Albertsen. "I think the trigger was driving distance on the PGA Tour. These are obviously the best players in the world so if there is a trend there, it's most likely to be a trend in the rest of the industry. We decided to test why is this happening. Why are the distances decreasing?"



1 PGA Tour statistics showing how drive distances have declined since 2006. This, according to Adams Golf, is due to a reduction in club speed due to aerodynamic forces as head size has increased

Through extensive player and aerodynamic wind tunnel testing Adams Golf discovered that large MOI (Moment of Inertia) club heads, those with displaced volumes at or near 460cc, are subject to aerodynamic forces large enough to impact club head speed. So, they identified the problem that as manufacturers strove to meet all the requirements of the ruling authorities of golf, namely the Royal and Ancient Golf Club of St Andrews (R&A) and the United States Golf Association (USGA), they converged on driver head shapes that have been a detriment to driving distance among all golfers due to poor aerodynamics.

As a result of these revelations Adams Golf set itself a design challenge of creating a 'large footprint' 460cc driver head with low drag to increase club head speed and ultimately distance. "This discovery led us to go down the path of designing large heads that were low aerodynamic drag," confirms Albertsen. "We wanted to offer a driver that would hit the ball the furthest of any other driver in the golf store."

In order to improve on the design of the original Speedline in a new driver model - Speedline FAST 10 - Adams Golf decided to use NX Flow simulation software. For the past seven years the company had already been using NX CAD and rendering software in its product development process and then just over two years ago

2

2 Big in size, low on drag: Adams Golf's Speedline FAST 10 driver

decided to implement NX Flow into this process in order to perform CFD analyses on each iteration of the design as it is being developed.

"Speedline FAST 10 driver was really the first driver we were able to go in and make design changes based on the use of the NX Flow software," says Albertsen. "We were able to make subtle modifications to the face area and the transition areas from the face to the body of the club to help keep that airflow attached and reduce drag even more. Using the NX Flow software, we were able to run simulations on several different iterations of the design and ultimately find the final design that was the lowest drag."

PROOF OF THE PUDDING

Once the Adams Golf design team was happy with the 3D model a prototype was produced which then underwent real player as well as wind tunnel testing to further validate the final design. "Every time we get a prototype in we run wind tunnel testing and we also do player testing. This is just to validate the simulation results," comments Albertsen. "To this date since we have started using NX Flow we haven't had to make any changes, the physical data has matched up pretty well with the simulation."

The key advantage for Adams Golf of using NX is that all those involved in the product development process work in an integrated environment. So, Adams Golf's engineers are able to leverage the same models that the industrial designers use for CAD and rendering in order to undertake analyses and run simulations. "We can take our 3D model, just click a button on the NX screen and we're in stress and strain analysis. Click another button and we're in a deflection analysis. Click another button and we're running flow simulations. So being able to integrate all those different analysis tools right into our 3D modelling software has benefited us greatly," explains Albersten.

Jan Larsson, EMEA marketing director at Siemens PLM Software, comments, "With Adams Golf it is a typical use of NX. The value that they get out of NX and where they really benefit from this integrated solution is being able to do a very quick analysis, get the results and then go back to the design phase, in this case change the club heads, to optimise the design based on the analysis results. So, when they look at airflow around the club heads they can make a decision very quickly whether this will be a product that works properly or not and if not they can go back and do alternative designs and look at the results very quickly and iterate the design around the analysis results."

SPEED TO MARKET

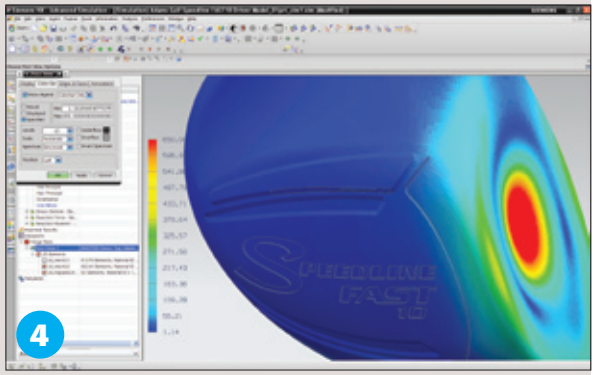
By using 3D design together with analysis tools, Adams Golf has also been able to shorten its product development cycle significantly and, in the highly-competitive golf equipment market, this means launching new products more frequently. "The typical manufacturing process for us - from conception to seeing actual prototype parts - is anywhere from 30 to 60 days," says Albertsen. "Now using the NX Flow software, we can design, test the design, validate that it's going to work and actually have a real-time working concept in probably less than 20 days. So by using the NX software, we can cut down on manufacturing lead times, we can cut down on manufacturing costs, we can cut down on testing times."

The Speedline FAST 10, with its large dimension and low aerodynamic drag force that enables increased club head speeds and greater distance for golfers, was launched in 2009 to high acclaim. Since launch the driver has not only been involved in several tour victories but has also received a number of awards including a gold award in the Golf Digest 2010 Hot List. Adams Golf was also the first golf club manufacturer to be honoured with a Progressive Manufacturing (PM100) award for its application of CFD analysis in the design process.

NX product development software is now integral to its innovation and success and as Tim Reed, Adams Golf's vice president of research and development, concludes, "The role NX ultimately plays is speed to market, providing us extraordinary flexibility and adaptability to the ever-changing environment of the golf industry."

www.adamsgolf.com

"SINCE WE HAVE STARTED USING NX FLOW WE HAVEN'T HAD TO MAKE ANY CHANGES, THE PHYSICAL DATA [FROM WIND TUNNEL TESTING] HAS MATCHED UP PRETTY WELL WITH THE SIMULATION"



3 NX Flow was used to locate critical areas in multiple head designs meaning fewer prototypes needed to be made

4 Stress plot using NX Advanced Simulation

THE VALUE OF MANAGING SIMULATION DATA

AS THE USE OF SIMULATION INCREASES, THE AMOUNT OF CAE DATA WILL GROW COMMENSURATELY. ALONGSIDE DESIGN, MANUFACTURING AND PRODUCTION INFORMATION, HOW DO YOU GAIN CONTROL OVER THIS WEALTH OF INTELLECTUAL PROPERTY?

For many design and manufacturing organisations, simulation holds the key to being able to produce higher quality, better differentiated products, and delivering them in a shorter timeframe. The ability to thoroughly test, validate and optimise a product long before getting anywhere near tooling up for production, has become an integral part of the product development process.

With this movement towards simulation-driven product development comes the inevitable problem of data management. As we test and optimise more, all the data associated with a product's development grows with each iteration, with each solution set created, with each associated design change.

Alongside this, the nature of the information is changing. In addition to the geometric and manufacturing information we also need to capture simulation data in a digital form. This critical information needs to be managed and made available for traceability, reuse and learning. It also needs to be protected as it contains much of the real intellectual property and knowledge within our organisations.

TAKING CONTROL

So how can we regain control over the rapidly expanding assets we create? Over the past few years Siemens has been enhancing integration between its simulation tools and its industry leading Product Lifecycle Management (PLM) solution, Teamcenter.

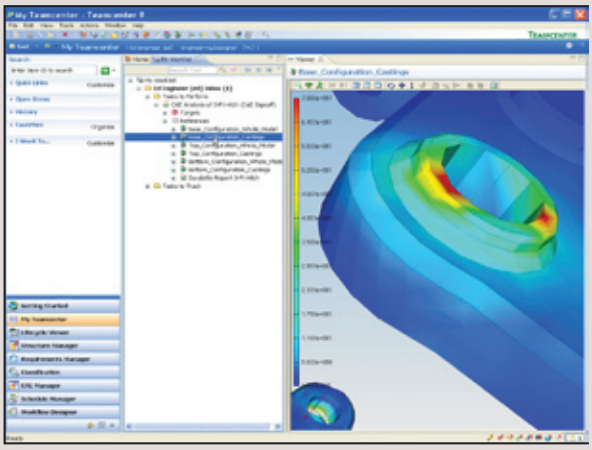
Using Teamcenter, it's not only possible to manage who has access to simulation data, but it can be used to control how, when and by whom the simulation tools can be accessed. It can be used to store CAE-specific variations of geometry that have been through an abstraction process, and simulation users can document potential design change and feed that information back into the process.

With tools such as Synchronous Technology, it's possible for simulation-focussed users to create new part variants, experiment with design change to solve any issues raised, to overcome problems found during the simulation process, rather than having to go back to the design team to request redesign. Problems can be found, dealt with, them information fed back into the system to be rationalised by those responsible. Results and documentation is made accessible to those that need it, without the need for costly post-processing systems – it's all handled in a tracked and managed environment within Teamcenter.

DATA REUSE

The real power of lifecycle management, particularly in terms of CAE, is when the next project comes around. Anyone that's involved in product development knows that issues often repeat themselves and time is often wasted duplicating the same simulation jobs with slightly different inputs and requirements. However, because Teamcenter provides this wealth of information in a controlled and managed system, it's dramatically easier to find how similar issues were solved in previous projects. Data can be reused where needed, as can workflows and processes, or more granular information can be extracted from previous projects. It is all there, searchable and available as and when required.

A recent report by research firm, AberdeenGroup, said that best-in-class companies are almost twice as likely as the industry average to manage simulation and product data relationships. The question is, are you ready to be best in class?



"BECAUSE TEAMCENTER PROVIDES A WEALTH OF INFORMATION IN A CONTROLLED AND MANAGED SYSTEM, IT'S DRAMATICALLY EASIER TO FIND HOW SIMILAR ISSUES WERE SOLVED IN PREVIOUS PROJECTS"