Optimus Insights

Issue 1

Cool Customer

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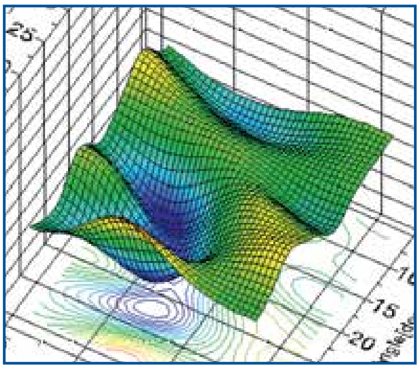

Tell us what you think, and share topic ideas

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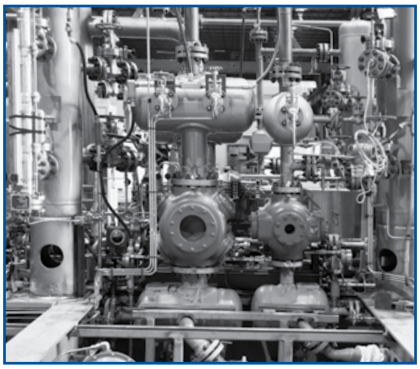

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Trane uses Optimus with ANSYS to address fatigue life of copper refrigerant lines in a new scroll compressor chiller configuration. Trane evaluates 10 design alternatives in the time previously required to analyze just one design.

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Working Wonders

Find out how Optimus enables leading manufacturers in engineering-intense industries to further increase their competitive edge. They use Optimus to design benchmark products 'right first time' – reducing time to market and development costs.

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Stay Connected

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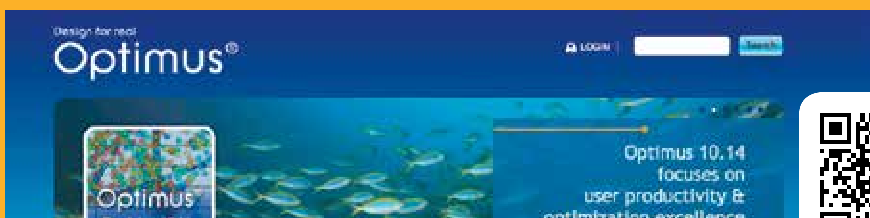


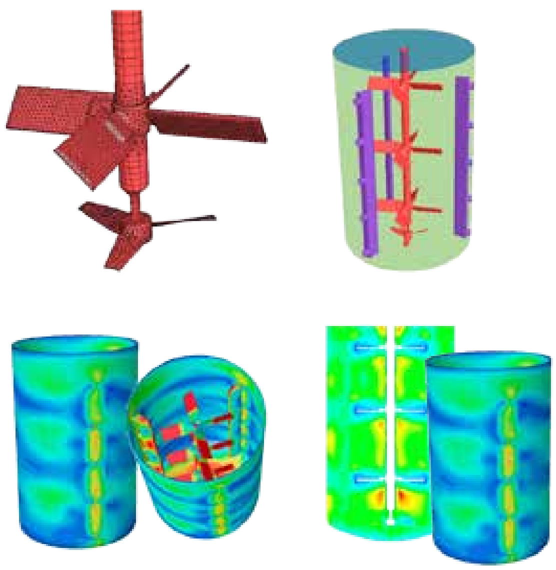
Transforming Simulation Based Engineering

Simulation based engineering is needed

Over the past decades, leading manufacturing companies have integrated simulation based engineering into their product development process. How did this change engineering practices, and did it ultimately bring the expected turnaround?

Simulation based engineering changed the development process

Companies apply simulation based engineering to front-load simulation in the development process and acquire deeper insight into product behavior. Engineering departments set up simulation models and adapt them incrementally toward the target design objectives, largely relying on their engineering expertise and experience.

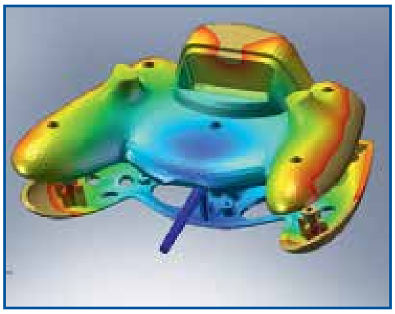


Advances in computer hardware enable simulation software to deliver more accurate results faster, and raise the complexity level these software tools can deal with. As a result, the trustworthy evaluation of the functional performance on a virtual prototype (in terms of stress, flow, noise, vibrations, durability, crash, emissions, etc.) became increasingly accessible to the engineering community.

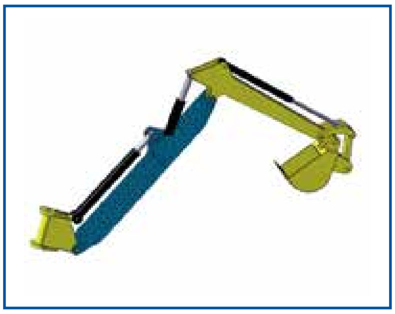
Simulation based engineering also repositioned the role of physical testing. Instead of serving solely as a troubleshooting tool, carefully planned testing is performed on a limited number of physical prototypes to validate and refine the designs and to calibrate simulation models with real-world test data.

Design engineers searched for the impeller locations that would minimize liquid precipitation in a 600,000 liter mixing tank. Optimus allowed them to reduce the critical precipitation area by 71%, and minimize maintenance downtime.

Using Optimus, Snecma (Safran Group) realized a 2% efficiency increase of its HPC rotor blade aero-mechanical design process. Keywords are process integration and multi-objective design optimization.



Virtual prototyping allows engineers to evaluate the functional behavior of a new product design, before building the first physical prototype.



A significant amount of time is spent on implementing the model changes to evaluate design variants, as well as on handling and manipulating the data for each simulation run.

Hurdles slowing down simulation based engineering

In practice, design engineers mostly perform manual design iterations in search of the target design objectives. A significant amount of time is spent on implementing the related model changes, as well as on handling and processing the data for each simulation run.

This implies that only a limited number of design iterations can be evaluated in the available development time frame – considerably reducing the window of opportunity of simulation based engineering to deliver benchmark performance.

Download White Paper

Struggling with trade-offs and constraints

In the process of engineering new products, development engineers generally face conflicting design objectives for which they need to find an acceptable trade-off. They also need to take into account the design constraints imposed by manufacturing realities and more stringent regulatory and standardization requirements.

Simulation based engineering is essentially an iterative process in which simulation models are incrementally adapted. This implies it can only be verified afterwards whether model changes really deliver improved design performance and respect all design constraints. Indeed, specific design constraints and performance objectives cannot be included upfront as an integral part of the process.

Overall, simulation based engineering does not reveal to what extent product performance improvements are feasible. These development uncertainties make it difficult to really judge the achieved design improvements and commit to a product capabilities roadmap. ▶

'Engineer by Objective' optimization strategy delivers benchmark products

The 'Engineer by Objective' approach – based on Optimus process integration and design optimization (PIDO) technologies – transforms the way simulation based engineering is applied throughout the product development process.

When detecting unsatisfactory design performance, engineers modify the virtual design by changing the relevant design parameters and re-run the related simulation(s). Temperature peaks observed in a laptop can for instance be reduced by changing the location and characteristics of the laptop's active heat sink in the virtual prototyping model.

Directing and automating virtual prototyping

Instead of trial and error, 'Engineer by Objective' starts from the functional performance targets identified as critical factors for a successful product. Following this approach, engineers identify the design parameters that have the highest impact on the most critical performance objectives. Then they automatically trace the design parameter values that define the product design which best matches the critical performance targets and takes into account all relevant design constraints.

Supporting a more transparent development process

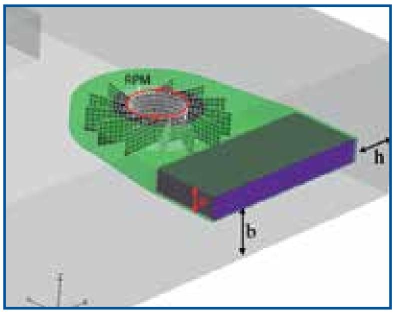
More and more products have evolved into complex systems that are a combination of an increasing number of mechanical, electronic and software components – very often to be offered in multiple variants. To deal with increasing product complexity and to define a uniform development process, the so-called V-model concept is widely used in industry. The Optimus approach enables a model-based systems engineering strategy that emphasizes the importance of objective-driven engineering.

Simulation robot eliminates repetitive manual work

Typically, design engineers sketch the workflow in the Optimus graphic process integration editor - connecting the commercial, legacy and in-house simulation tools and data models. This is also where they define the design parameter ranges as well as the design objectives and constraints. A formalized simulation workflow allows Optimus to act as a 'simulation robot' that automates and directs simulations without user intervention. Internally, Optimus takes the necessary steps to parameterize the workflow and automate the required design variable substitutions within the defined design parameter ranges.

Simulation process capturing consolidates engineering knowledge

Many benefits of Optimus deployment stem from the capability to systematically capture simulation know-how. In doing so, manufacturing companies build up an information base of best practices, and eliminate the need for design engineers to re-create simulation processes on their own each time from scratch. This structured approach enables those companies to standardize on superior development processes across the entire enterprise and consolidate the intellectual assets representing their most valuable resources.



The challenge is to find a trade-off between flow speed and flow uniformity (cooling performance) on one hand, and fan torque (power consumption) on the other hand, taking into account contraints with respect to fan position and dimensions.

In a CFD related 'Engineer by Objective' project, a leading German vehicle OEM optimized a diesel engine using Optimus, delivering 8% higher engine power.

Optimus design exploration capabilities helped supplement tablet manufacturer Asahi balance ease of swallowing and production machine durability. Tablet diameter was identified as the most influential design parameter with regard to the pressure resistance of the tablet punches.

Up-front exploration of the entire design space

Design space exploration techniques provide up-front insight into the unexplored design potential. Dedicated Design of Experiments (DOE) methods define a minimum set of well-chosen virtual experiments to sample the design space most effectively. The DOE results illustrate the relative importance of the design parameters and constraints. Response Surface Modeling (RSM) condenses complex simulations into so-called surrogate models based on a set of virtual experiments defined by a DOE method. Surrogate models are very effective in evaluating new designs without requiring a full detailed analysis, radically increasing design optimization efficiency.

Automated search for designs matching the target objectives Subsequently, an automated and coordinated search identifies the optimum design parameter values. This approach of tracing design candidates that best match performance objectives and respect design constraints, is significantly faster than any iterative process delivering an acceptable design. Advanced optimization algorithms are integrated to resolve the toughest multi-disciplinary optimization challenges. In the process, Optimus informs design engineers on the ongoing optimization progress and allows them to steer the process based on their extensive experience.

Improving return on software and hardware investments

Simulation campaigns powered by Optimus take maximum advantage of the available computing resources by distributing simulation jobs in parallel. Thanks to the integration with resource management systems, Optimus allows virtual prototyping simulations to be submitted to and balanced over the available computation resources in a heterogeneous ICT infrastructure - without any user intervention. Making more effective use of the available software and hardware infrastructure, increases the number of virtual prototyping simulations that can be completed in the available development time window. ●

Download Case Studies

Cradle Embeds Optimus Technology in SC/Tetra and scSTREAM

October 14, 2014 - Leuven, Belgium, Noesis Solutions and Software Cradle Co. Ltd., Osaka, Japan, announced today that they have selected the Optimus engine from Noesis Solutions to embed in their product, SC/Tetra and scSTREAM simulation software, to provide comprehensive design space exploration capabilities.

Under the terms of the agreement, Noesis Solutions will provide a portal between its Optimus multi-disciplinary design optimization software and Cradle's SC/Tetra and scSTREAM environments thereby allowing CFD designers simple means for exploring design space and optimizing performances. This new Cradle feature is scheduled for commercial release in the course of 2015.

Optimus 10.15 Announced in October

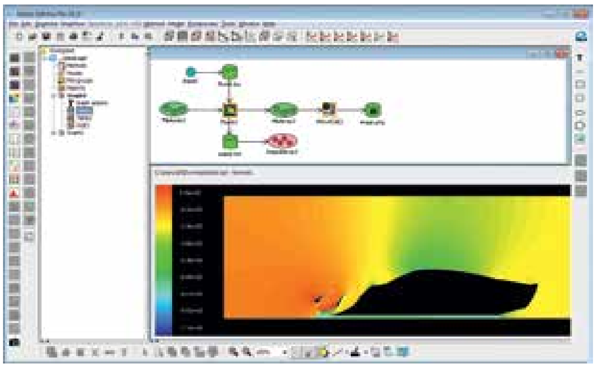
CMA-ES Global Optimizer

Noesis Solutions introduces the Covariance Matrix Adaptation Evolution Strategy (CMA-ES) algorithm. This new global evolutionary optimization algorithm is perfectly suited for high-dimensional, non-linear functions. No specialist expertise is needed, as only very limited information is required to set up the CMA-ES algorithm. The population size as well as the number of parents and offspring are automatically determined on the basis of the optimization case.

The state-of-the-art CMA-ES algorithm applies statistical distribution technology, and automatically tunes itself when converging toward the targeted design configuration optimum. As it is able to find an accurate global optimum using a relatively low number of experiments, CMA-ES is a lot faster than other global optimization methods. The maximum number of experiments can be specified upfront, and CMA-ES will target the best possible optimum while respecting the entered number of experiments. This also makes the CMA-ES algorithm extremely useful when dealing with computationally intensive simulations such as CFD and FEA.

Picture Plot

During Design of Experiments (DOE) or design optimization, Optimus automatically orchestrates simulations involving many virtual experiments. With Picture Plot, Optimus allows users to keep track of simulation sample alterations



during the design optimization sequence. For every virtual experiment that is executed, Optimus has a screenshot captured automatically. Therefore the CATIA and Virtual.Lab interfaces are already extended so that users can generate screenshots for the CAD and CAE models simply by enabling it during workflow creation. Looking at these screenshots - separately, comparison, or in a sequence – provides additional graphic insight into design configurations and corresponding performances.

VCollab Interface

VCollab software, powered by the CAX file format, provides easy and comprehensive visualization and data reduction software. Besides file compression, Optimus' optional VCollab interface enables engineering teams to take advantage of extended Picture Plot visualization capabilities. They can further inspect (and rotate, etc.) the simulation model by opening the CAX file in the VCollab software package.

Upcoming 2014 webinars

- Optimus & Flowmaster – October 28
- Optimus & Beta CAE – November 20
- Optimus & Simulation X – December 11

Webinars on Demand

Watch the recordings of past webinars.

Optimus 10.16

Adaptive DOE

Development teams doing simulation-based engineering can boost their productivity using Design of Experiments (DOE) performed early in the process – planning virtual experiments to deliver a maximum of relevant design insights at minimum simulation cost. Now they can go one step further with Optimus Adaptive DOE to actively exploit the design space knowledge being built up as the experiments run.

Incredibly easy to set up, this automated active learning process adds virtual experiments where needed most in order to better capture the design space. In addition, it delivers a Response Surface Model (RSM) that more accurately condenses even the most complex physics simulation models into an inexpensive-to-use surrogate model. Obviously such RSMs provide an excellent foundation for ultra-fast design optimization.

FMI/FMU

New is that such high-quality RSM models can also be exported as Functional Mock-up Units (FMU), condensing detailed complex physics models into an accurate and inexpensive-to-use equivalent. Using the Functional Mock-up Interface (FMI) open standard, RSM models can easily be exchanged with and integrated into any environment for model-based system development.

New Reseach Projects Starting in 2014

IDEaliSM (under the ITEA2 umbrella)

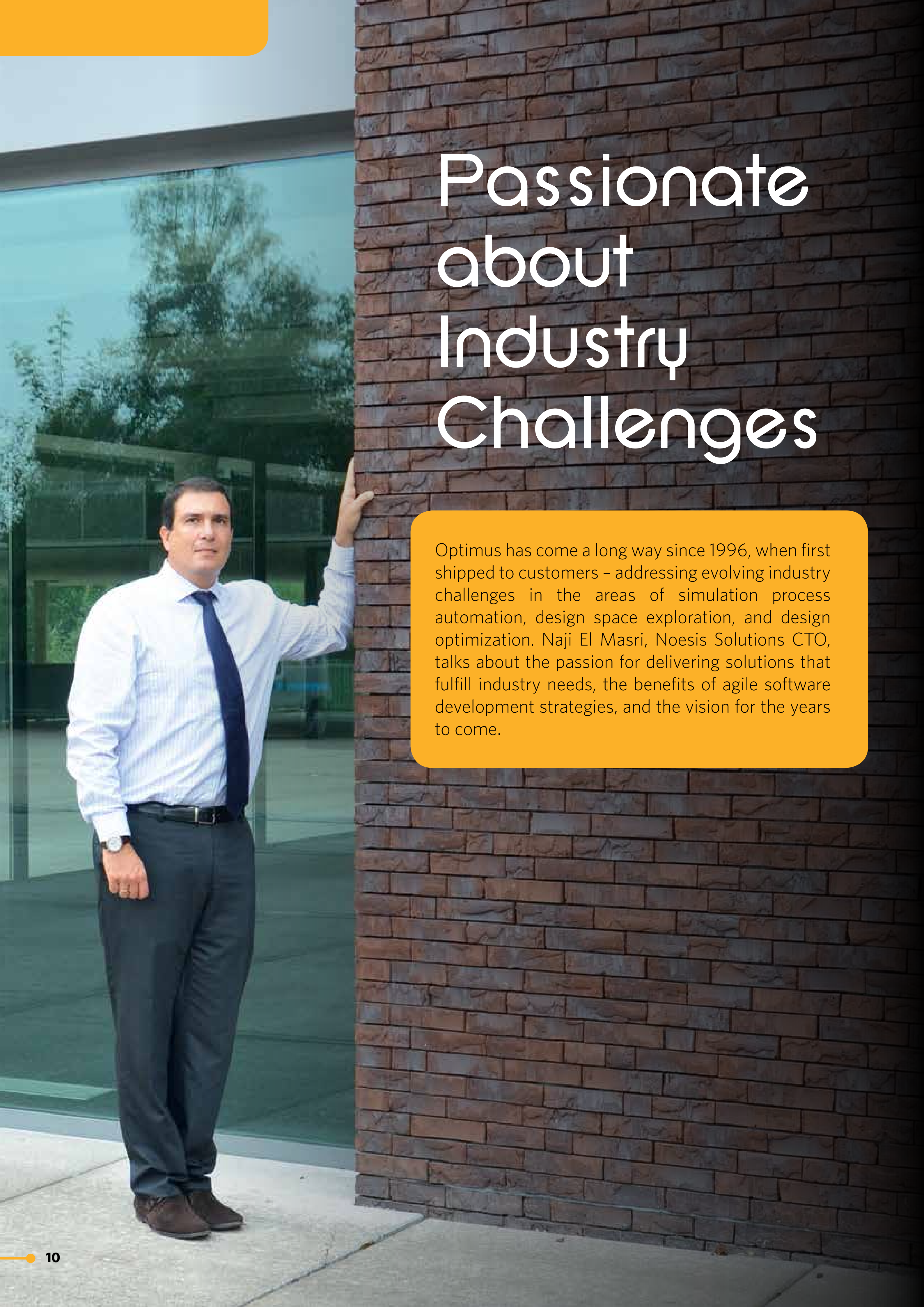
The aim of this project is delivering the ultimate MDO platform for aircraft and automotive design, with cutting edge strategies capable of solving high-dimensional continuous/discrete optimization problems, based on a solid foundation of cloud computing integration, thanks to the cooperation with KU Leuven. The paradigm shift from classical optimization approaches to new machine learning algorithms will deliver a performance and information boost to the design optimization goals.

HAROS HD

The development of key enabling techniques such as SOMBAS, Deep Learning, Cross Entropy, Adaptive DOE, Ensemble Modeling within HAROS-HD and others have found their application in other fields such as mass production of consumer goods. It was with Philips that Noesis Solutions has done research on adaptive process control to achieve the zero-defect manufacturing goal by embedding its Optimus technology within the process control strategy of one of its consumer lifestyle production lines within the MEGaFiT project.

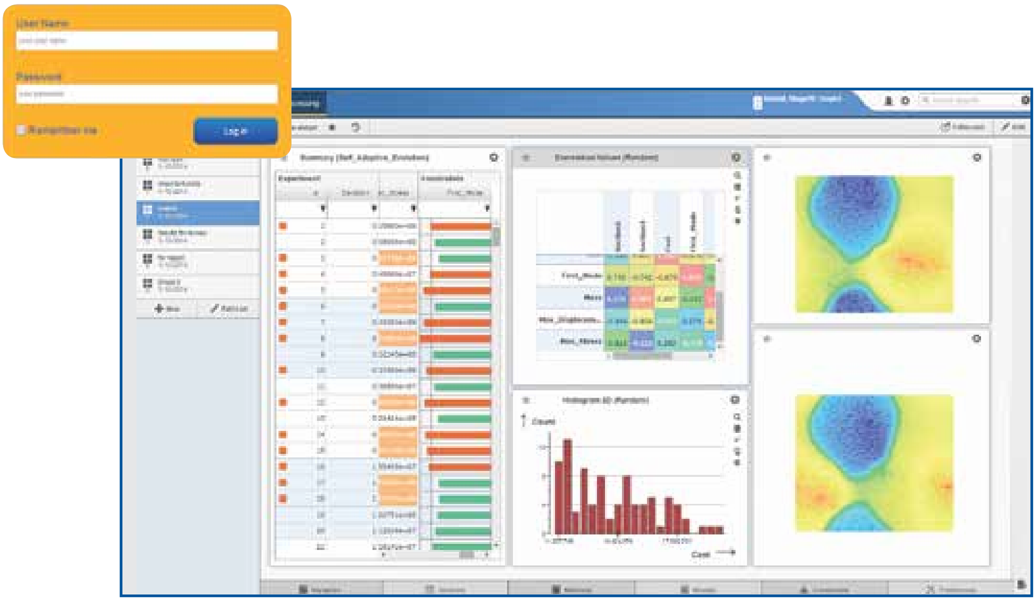
C3PO project

Noesis Solutions is ready to further unleash the power of these new technologies within the C3PO project, to support continuous optimization and redesign patterns typical of smart cities design challenges, where multiple actors, problems and models are adopted and continuously optimized in a spiral design circle. Here Noesis Solutions contributes with its optimization experience and by implementing an added-value tool that radically increases designer knowledge acquisition through the use of innovative semantic workflows.



Passionate about Industry Challenges

Optimus has come a long way since 1996, when first shipped to customers – addressing evolving industry challenges in the areas of simulation process automation, design space exploration, and design optimization. Naji El Masri, Noesis Solutions CTO, talks about the passion for delivering solutions that fulfill industry needs, the benefits of agile software development strategies, and the vision for the years to come.



You have been with Noesis Solutions for a long time and are heading its Research & Development operations since two years. How would you explain Optimus' successful evolution to become the leading PIDO software it is today?

Naji El Masri: When looking back, I clearly see a common thread of putting our customers first. I am really convinced that the intensive interaction with them and the passion of the entire Noesis Solutions team to deliver solutions that fulfill their specific industry needs have made (and still make!) the difference.

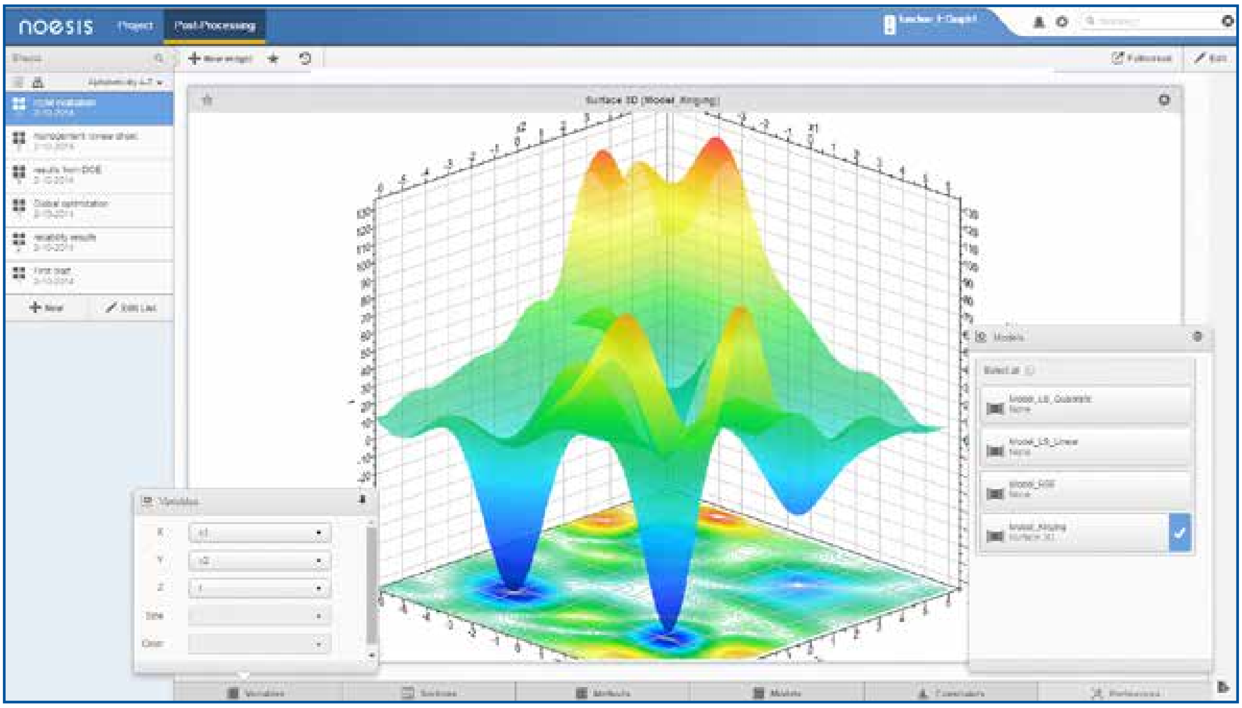
Our objective is therefor not to extend Optimus with as many features and methods as possible, but rather focus on the implementation of process integration and design optimization capabilities that successfully resolve manufacturers' product development challenges. Regular interaction with our customers enables us to correctly capture their needs and expectations, and also validate the performance of our solutions in their specific industrial context.

Let me put it this way: in close collaboration with our customers, we invest in research & innovation to develop processes and methods that robustly handle their models and data sets, and really easy to use at the same time. This makes Optimus the solution in the market that is best suited for deployment in every type of industrial environment – from a small team of specialized engineering consultants to various multi-disciplinary development teams at a large manufacturer scale. A key element in this regard is the strong focus on openness of Optimus, by maximizing its compatibility with customers' preferred engineering tools, physics simulation software & data management solutions. This philosophy gives customers a jump start, and combined with Optimus' ease of use they become more productive than with any other PIDO software on the market place.

As part of your answer, you indicated that interaction with customers is key. But how exactly do you capture their experience and feedback, and how do you integrate these insights into new product enhancements?

Naji El Masri: We support our customers in many ways, including long-term maintenance & support services. Regular interaction enables our team of experienced application engineers to understand customer needs, respond to their questions and discuss feature requests. With some of our larger customers, we even have regular meetings during which we share information about our strategy and new product functionalities, while they discuss their priorities with respect to Optimus. This information is important for us to better direct request selection, product specification, development and quality control of new Optimus revisions.

Overall it is fair to say that the Optimus product creation process is a coordinated effort. This smooth process involves a number of customers early on and focuses on incrementally delivering new capabilities – following a so-called agile development strategy. Over the past years we have delivered six new Optimus releases per year, on average. This agile development approach allowed us to deliver well-contained packages of new functionalities on a regular basis, maintaining high-quality standards with each new release. ▶



And what about the future? What important trends do you see in your customers' requirements? And which strategic choices will continue to make Optimus the preferred solution to help manufacturers achieve their development ambitions in the most effective way?

Naji El Masri: We saw manufacturing companies quickly adopt Optimus and experience the power of Optimus in their development process. Does this mean that PIDO solutions such as Optimus can be considered a commodity today? Well, not yet. Although easy to use, the design space exploitation and optimization technologies available in Optimus still require specific user knowledge and expertise. So one of our focal points will be to further facilitate the deployment and the use of Optimus. This means we will continue to develop Optimus as a so-called central solution that our customers use to easily and automatically interface with any CAD tool, physics simulation software and data management solution – to fit any combination of those tools and platforms.

In addition, we will release new technologies that make Optimus easy to use also by non-optimization experts. In fact, we are already doing this today with the new adaptive DOE method in Optimus 10.16. For any specific product development project, it proposes only those DOE methods that will deliver the most valuable engineering insight. Another example is acquiring deeper insight through interactive diagrams that highlight various feasible and infeasible design space regions. It is particularly interesting to learn which engineering aspect is responsible for making a specific region infeasible.

Equally important is our focus on data analytics to more thoroughly and efficiently deal with multi-dimensional engineering complexity. The purpose is reducing engineering teams' time and effort to gain more extended and in-depth insights into product model performance. 'Predictive models' (e.g. RSM-based surrogate models) are real efficiency boosters that also heavily reduce software license and CPU cost. With such high-performance models, the up-front design exploration of complex multi-dimensional engineering challenges goes multiple times faster, for 3D and even more for 1D.

There is a next-generation Optimus release in the works. Our readers would love to hear how this software release

The new Optimus blends engineering simulations with predictive design space explorations, which saves tremendous time and opens up remarkable development opportunities.

Naji El Masri, Noesis Solutions CTO

removes the typical hurdles faced by engineering teams in developing new products.

Naji El Masri: We see that shorter product development cycles impact the way manufacturers engineer new products. It is all about making smart decisions in early-phase conceptual work, detailed component design and model assembly validations. Ideally, they want to efficiently combine and evaluate engineering analytics toward well-founded technical decisions taken in every stage of the design/engineering process. The purpose is also to overcome the situation where existing design and exploration tools tend to over-rely on field experts and IT specialists.

With the new Optimus we want to unlock this situation across the development chain by offering all involved engineers the powerful design exploration and analytics at their fingertips. Readily capturing and automating complex simulation processes with dedicated interfaces to any commercial design and simulation software, is essential in order to seamlessly upload their datasets or securely access simulation performance characteristics. At the same time, the new Optimus guides the engineers through sophisticated statistical analysis and modern visualization, without being a statistics wizard or knowing how to code predictive scripts.

Truly unique is that Optimus smoothly guides users through very powerful answers with a software suite that is incredibly easy to use. Optimus inspires development teams with its huge potential of interacting with engineering data in a natural way. The software blends engineering simulations with predictive design space explorations, saving tremendous time and opening up remarkable development opportunities – all the way from process capture, design exploration, predictive simulation to performance visualization. In a nutshell, this is how the new Optimus retains vital engineering insights from loads of unstructured simulation information.

Turning Challenges into Differentiators with Optimus

Keeping in mind the legacy of the Optimus software as well as the vision and strategy laid out by Naji El Masri, Noesis Solutions CTO, Optimus is ready to successfully tackle today's industry challenges. Moreover, Optimus enables manufacturing engineers to make smarter moves toward products that excel in highly competitive markets. Instead of struggling with product and process challenges ahead, engineers turn these into differentiators that further increase customer satisfaction and business profit.

Pole position

At Noesis Solutions, we realize our customers have no time to waste. Optimus therefor offers users a kick start through its short learning curve. Workflows form the backbone of Optimus, enabling fast workflow setup, reuse and execution. The vendor-neutral solution allows any commercial, legacy and in-house software tools to be flexibly combined into a single workflow, using consistent and tightly integrated software interfaces. In a subsequent step, the engineers can select the design inputs & outputs and shape the most efficient design optimization strategy.

This approach slashes turnaround time from days to seconds by generating accurate surrogate models and having simulations automatically directed toward the optimum design variants. Furthermore, they are able to turbocharge the process through parallelization on experiment and workflow levels.

TE Connectivity Case Study
Robust Crimp Connection Optimization at TE

Workflows form the backbone of Optimus
First, TE Connectivity engineers drew the workflow in Optimus' graphic drag-and-drop process editor and entered limited information. Then, Optimus automatically directed Design of Experiments (DOE) and robust crimp connection optimization.

Adaptive DOE Twitter Post
Active Design Space Learning with #Optimus #Adapative #DOE

To learn or not to learn – That's the question
Optimus Adaptive DOE goes one step further. It enables engineering teams to actively exploit the design space knowledge being built up as the experiments run. Adaptive DOE proposes the best suited RSM and optimization methods, activates relevant post-processing evaluation charts, etc.

Built around the user

No need to rub shoulders with an optimization guru to get the most out of Optimus. Design engineers simply sketch the workflow in Optimus' graphic process integration editor. Fewer mouse clicks are needed because Optimus automatically proposes the best-suited DOE, RSM and optimization methods – requiring only limited, targeted information to be entered. In addition, only the most relevant post-processing charts are displayed for easier and faster evaluation.

State-of-the-art methods

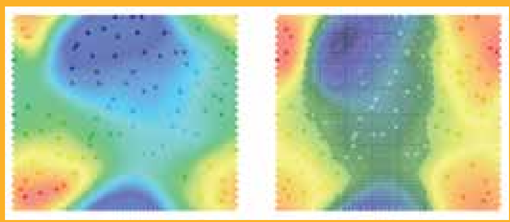
Complex design spaces call for state-of-the-art DOE, RSM & optimization technologies. Optimus bundles a range of genetic and evolutionary methods as well as advanced FOSM/FORM/SORM algorithms for reliability and robustness evaluation – and puts increased R&D focus on developing more and better methods. These methods enable engineering teams to understand the design space up-front and follow a faster route to design optimization (dimension reduction, surrogate modeling, etc.).

Optimus offers the flexibility to initially define a hybrid strategy, which consist of a global evolutionary optimization to capture the most promising region followed by local gradient-based optimization to identify the ultimate design point with minimum physics simulations.

Injector Optimization Case Study
Automating System Simulation to Optimize Fuel Injector Robustness

Identifying an injector's optimum design space region faster than ever
Global design optimization followed by evolutionary optimization, both performed directly on RSM, only required seconds to execute hundreds of experiments.

Visual Insight Press Release
New Optimus Revision Offers Faster Visual Insight into Design Dependencies



Deeper understanding through SOM Plots
By graphically comparing SOM plots, engineers instantly discover correlations that allow them to fine tune their design optimization strategy. SOM plots also enable them to detect design space regions of specific interest, essentially driving adaptive DOE with a human in the loop.

Effective decision support tools

Intuitive and flexible graphical tools make it easy reveal and understand the design space. By graphically comparing SOM plots, engineers instantly discover correlations that allow them to fine tune their design optimization strategy. Deeper insight into dependencies between design variables & simulation response offers greater opportunity for design improvement. The surface plots combine 3D post-processing matrix display data from multiple RSMs. Sobol Indices post-processing highlight model variance relationships, allowing engineers to flexibly analyze correlations, sensitivities and response surface local accuracy confidence.

Cluster Analysis takes post-processing analysis to a higher level. By grouping design points with similar characteristics in separate clusters, Optimus is able to identify valuable correlations between and within clusters. Optimus supports visualization tools for easy graphic cluster evaluation including cluster scatter and parallel coordinates charts. The latter visualizes each design alternative in a multi-dimensional space. Parallel coordinates can reveal correlations between multiple variables and identify which conditions and constraints highly correlate to a particular outcome of the design.

Highly adaptable, deployable & scalable

As a vendor-independent platform, Optimus can be flexibly adapted to any commercial, legacy and in-house software tools the customer uses. It provides an open architecture to communicate with any simulation software to set up a highly automated design optimization process.

Installations with 30+ seats at major aerospace and automotive manufacturers illustrate successful Optimus deployments on an industrial size. Platform stability is key in such major deployments as well as the flexibility to scale the solution in function of the number of users from geographically distributed engineering teams.

Users managing simulation campaigns with Optimus can take maximum advantage of the available computing resources by distributing simulation jobs in parallel. Optimus Parallel Services (OPS) is a lightweight queuing system that is easy to install and configure in a network environment without advanced IT infrastructure. It allows an Optimus client to submit simulation jobs to different nodes or workstations in the network. Alternatively, Optimus seamlessly works with third-party resource management systems. avoiding spending hours to set up a dedicated commercial batch system. In addition, Optimus also supports advanced HPC capabilities provided with specific CAE software solutions.

Optimus 2014 Conference Blog Post
Slashing Simulation Turnaround Time using Optimus

Optimus offers the unique capability to automate the design process by formalizing the underlying simulation workflow. Typically, engineers sketch this workflow in Optimus' graphic process integration editor - connecting any commercial, legacy and in-house simulation tools and data models. They can then define a Design of Experiments (DOE) method to specify a minimum set of well-chosen virtual experiments. This enables them to sample the relevant regions of the design space in the most effective way.

Easy reuse of workflows, models and methods

To protect company investments, Optimus supports the flexible reuse of existing workflows, models and methods. A workflow defined in Optimus can be reused many times for different studies without any user modification, and multiple Optimus projects can be opened simultaneously. Similarly, the possibility is offered to reuse a method as the start population for another method without copy paste.

Maximizing ROI in multiple ways

First of all, the standard Optimus version comprises a balanced set of capabilities to efficiently tackle a range of industry engineering challenges. No need to pay extra for SOM & Clustering as well as Local Parallelization. ROI also increases with Optimus' automated simulation workflow execution, which makes much more intensive use of existing CAD and simulation tool licenses in search of the optimized design. Efficiently managing the simulation workload across multiple cores is seen as another ROI booster.

Optimus & Scilab Twitter Post

Boost #Solar Energy System Efficiency with #Optimus & #Scilab

Multi-objective optimization of active solar energy systems

The referenced application note shows how Optimus and Scilab are combined to optimize the performance and cost of an active solar energy system using pumps to circulate fluid through the solar collectors.

Optimus® 2014 World Conference

Sharing 'Engineer by Objective' optimization strategies

This year the biannual Optimus World Conference took place October 14-15 in Paris. The conference offered engineering teams the opportunity to share successful optimization projects, and learn about lean ways to transform their simulation based engineering processes. Industry presenters and research delegates showed how they apply Optimus' automated 'Engineer by Objective' optimization strategies to maximize design performance and speed up development.

Charles Lindbergh's historic solo transatlantic crossing

The social event of the conference took place in Paris' former Le Bourget airport. In 1927, the airport served as the landing site for Charles Lindbergh's historic solo transatlantic crossing. Noesis Solutions invited all conference speakers and attendees to a memorable evening at the 'Musée de l'Air et de l'Espace' in Le Bourget. A guided tour took them along a number of historical aerospace engineering highlights, followed by an informal dinner in this unique setting.

Optimus 2014 World Conference microsite

http://www.optimus2014.com

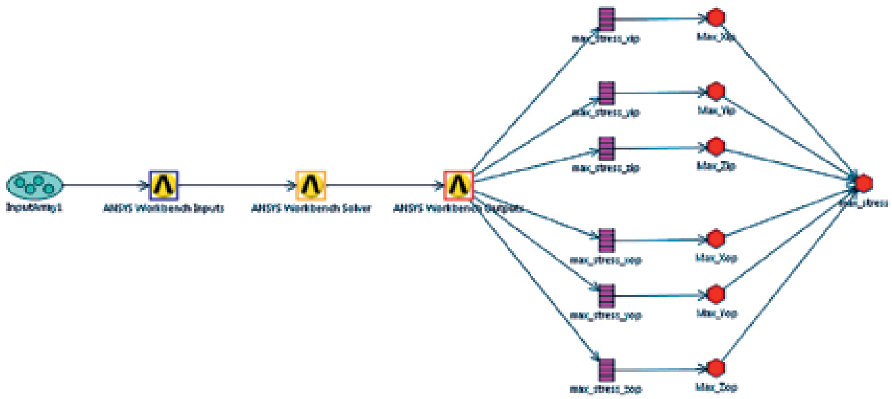
Cool Customer

Design optimization demonstrates the ability to reduce engineering time and increase fatigue life of refrigerant lines on a new generation of scroll chillers

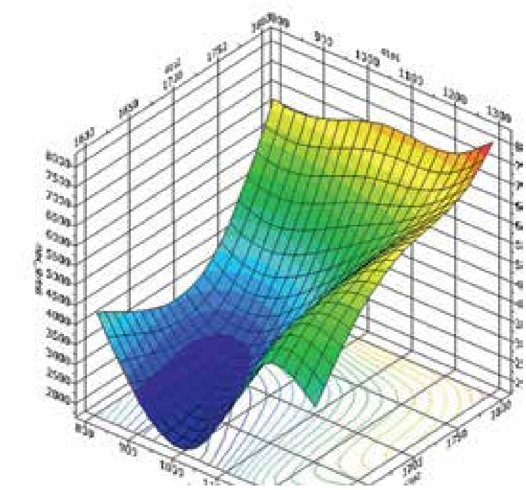
By Pavak Mehta, Acoustic Engineer, Trane, La Crosse, U.S.A.

Preventing fatigue failure of copper refrigerant lines that connect compressors to condenser coils is a critical aspect of designing a new scroll compressor chiller configuration. Traditionally, R&D teams use a combination of physical testing and conventional finite element analysis to qualify the lines, especially to identify and correct resonances that could cause a reliability problem. But this approach is too slow to address chiller designs that have more than 100 refrigerant-line configurations.

Trane has developed a new automated workflow capable of developing robust designs. The methodology combines design of experiments, response surface modeling and numerical optimization algorithms to configure refrigerant lines to minimize stress at running speed. The automated workflow uses ANSYS® software combined with Optimus® parametric optimization tools to evaluate 10 design alternatives and tune the refrigerant line geometry until operating stresses are below the endurance limit — all in the time once required to analyze just one design.



Optimus simulation workflow with ANSYS Workbench integrated



Response surface map for two design variables

Existing Manual Process

Trane is the world's leading producer of commercial and light commercial scroll air-cooled chillers that are used for air conditioning, process cooling, refrigeration, dehumidification and other applications. The company's line of chillers includes single-scroll compressor configurations under 15 tons up to tandem compressors over 60 tons. The refrigerant lines are sized to survive long periods of near-continuous operation in an environment that teems with strong vibrations generated by compressor cycling. Lines that are configured with a resonant frequency away from the operating frequency of the compressor have a substantially longer fatigue life. Each line's resonant frequencies depend on the details of its geometry, such as overall length, bends and bend radii. The geometry of each line is, in turn, constrained by the need to avoid obstructions, such as equipment and other lines.

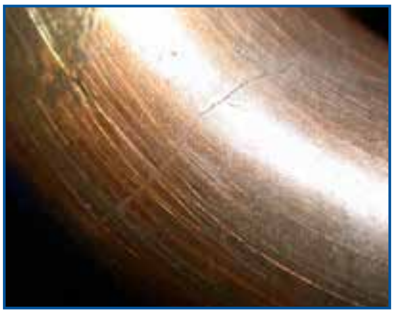
The refrigerants lines for scroll chillers are designed using a combination of finite element analysis and physical testing. Dynamic finite element analysis is performed to predict the amount of stress generated by a unit of motion. Then the compressor is run to determine the maximum motion actually experienced by the line. These tests are time consuming because they have to be run at wide range of speeds under several configurations to be certain of exciting all of the resonances in each line at its peak. The motion observed in the test is used to scale up the stress seen at unity motion to predict actual stress on the line. If the stress exceeds the fatigue limit, then the line has to be redesigned. The general approach is to reduce resonant frequency of a refrigerant line by increasing its mass and reducing stiffness. Likewise, to increase resonant frequency, the team reduces the mass and increases the line's stiffness. Each time the design is changed, a new analysis iteration is performed. This is a tedious process; traditionally, it relied heavily on the experience of the engineer.

New-Generation Chiller Increases Design Challenge

Creating a newer generation of scroll chiller that delivers higher performance while greatly increasing the number of configurations creates a major challenge. Current traditional analysis methods would greatly increase the amount of physical testing required and lengthen the product introduction schedule. Trane looked into developing an alternative approach: utilizing an optimization tool to automate a simulation workflow that evaluates potential resonance issues and iterates toward the most favorable lower-stress solution.

Trane worked with Optimus® from Noesis Solutions, a process integration and design optimization solution that ▶

Typical refrigerant lines



Example of fatigue failure

bundles a collection of design exploration and numerical optimization methods. Optimus is tightly integrated with ANSYS® Workbench, enabling the user to directly interact with Workbench design parameters and analysis results. Rather than manually defining substitution and extraction rules of design parameters and analysis results, the user simply drags and drops the Workbench icon into Optimus' graphic workflow editor. By visually formalizing the refrigerant lines simulation process in the workflow editor, Optimus establishes direct and automatic interfacing with ANSYS Workbench.

Trane engineers built a CAD model of a tandem scroll compressor and refrigerant line layout, which they imported into ANSYS Workbench. They defined and parameterized the relevant design variables of the refrigerant lines and identified feasible ranges for each variable. Then the team used the Optimus workflow engine that automatically drives the design exploration and optimization process.

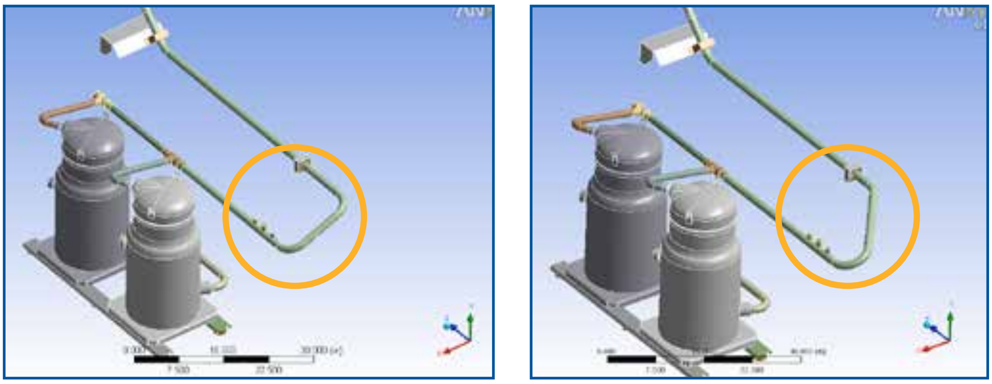
Automating the Simulation Workflow

The simulation process starts with meshing the model and setting up boundary conditions. These tandem compressors are designed so they don't exceed a certain vibratory motion. Trane engineers used structural dynamics to determine the amount of motion generated by a small unity force, then they back-calculated the amount of force required to produce the maximum possible motion in a single compressor. The two compressors each

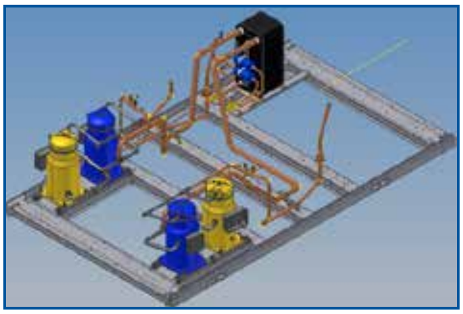
The company's line of chillers includes single-scroll compressor configurations under 15 tons up to tandem compressors over 60 tons.

can generate this force in different phases relative to each other. Trane engineers considered four load cases based on 0, 90, 180 and 270 degrees phase lag between the two compressors. For example, with 0 degree phase lag, the two compressors both exert maximum force in the same direction. Engineers used ANSYS Mechanical to conduct harmonic force response analysis and employed APDL command snippets to extract the maximum equivalent stress at each load, frequency and phase angle.

Then the engineers used Optimus to perform design of experiments (DOE) on the simulation workflow to explore the design space with minimum computational effort. A response surface fitted to the data points revealed by the DOE serves as a reliable meta-model to efficiently identify the global optimum for the refrigerant



Original design (left) and optimized design (right)



CAD geometry of compressor frame with lines

lines configuration under investigation. Performing design optimization directly on the meta-model eliminates the need to rerun additional ANSYS Workbench simulation iterations, saving substantial amounts of time. Subsequently, a local gradient-based optimization is carried out by rerunning the harmonic force response analysis in the area of the global optimum. Optimus' automated workflow execution results in an optimized set of refrigerant lines design variables, ensuring that the local operating alternating stress remains below 5,000 psi.

The increasing complexity of new-generation chiller design created challenges for Trane engineers in ensuring robust design of refrigerant lines. Trane is ready to address this challenge with an Optimus-driven optimization process including engineering simulation from ANSYS that substantially reduces stress in each line while also ensuring conformance to geometric and functional specifications. The future process has the ability to reduce line stress, which will make Trane scroll compressor refrigerant lines more robust while reducing time to market and freeing engineering effort for more proactive tasks. ●

This article is also published in ANSYS Advantage.

The Optimus-driven optimization process substantially reduces stress in each line, making future Trane scroll compressors more robust

Working Wonders

Find out how Optimus enables leading manufacturers in engineering-intense industries to further increase their competive edge. They use Optimus to develop more appealing and better-performing products in a shorter period time

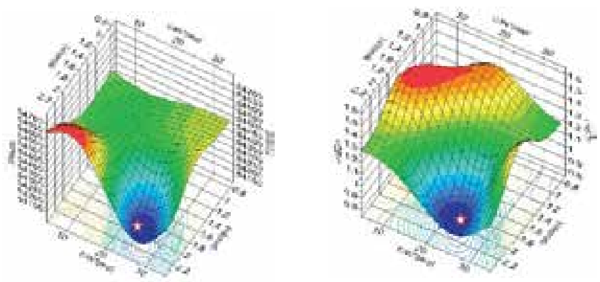
Winglets increase the lift generated at the wingtip by smoothing the airflow across the upper wing side near the tip. Winglets also reduce the lift-induced drag caused by wingtip vortices, improving the lift-to-drag ratio of the aircraft.

Fuji Heavy Industries' Winglet Optimization

Optimus realized a 1.2% reduction in aircraft takeoff weight

Wingtip devices are intended to reduce aircraft drag through partial recovery of the tip vortex energy. Fuji Heavy Industries (FHI) used Optimus to automate and couple FEM and CFD simulations to identify optimized winglet design configurations offering operational and environmental benefits. Optimus realized a 1.2% reduction in aircraft takeoff weight for a typical mission profile at 1G cruise speed. It achieved this by balancing the aerodynamic benefits and weight penalties of a passenger aircraft model integrating wing reinforcement to withstand winglet induced loads.

Optimus' design of experiments (DOE) and response surface modeling (RSM) capabilities helped FHI engineers understand the impact of winglet characteristics on aircraft performance up-front. Global design optimization enabled them to reduce the aircraft's cruise drag by 4% and its take-off weight by 676 kilograms, while respecting the shock induced separation (SIS) airflow constraint.



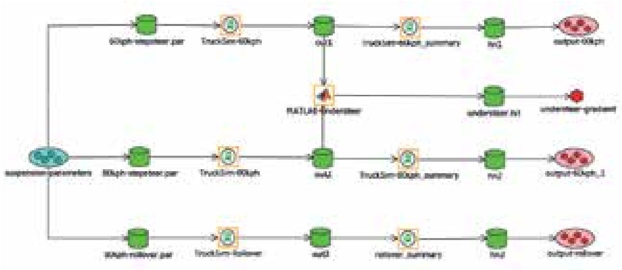
Response surface charts highlight that low aircraft drag and takeoff weight requires relatively high winglet span and cant angle

Big Wheels Rolling

Running Optimus for vehicle suspension optimization

With Optimus, development teams set up a procedure to optimize ride & handling of a tractor-semi-trailer combination, and derive the corresponding design targets for its suspension systems. Optimus software enabled development engineers to automate the evaluation of various suspension configurations in context of full vehicle performance.

This process includes designing the optimal set of virtual experiments, generating the surrogate models for each vehicle performance metric, and performing multi-objective optimization with deterministic and probabilistic constraints. Apart from significantly reducing total product development cycle time, this Optimus-driven procedure delivers a more consistent and robust design of the tractor-semi-trailer suspension systems.

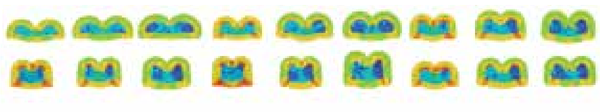


Simulation process flow sketched in Optimus, including different simulation scenarios required to generate the performance metrics associated with vehicle ride, handling, and rollover stability.

Robust Crimp Connection Optimization at TE Connectivity Japan

Development teams at TE Connectivity (TE) in Japan (formerly known as Tyco Electronics) engineer B-type barrel designs to further enhance the gastight solder-free connection between barrel and stranded wire. The electrical and mechanical connection characteristics are tested and simulated to accurately model the barrel design. TE engineers use Optimus software to coordinate and automate crimp and tensile analyses in search of optimized design variants combining highest crimp connection quality and robustness.

Optimus automatically drives the execution of ANSYS Workbench and LS-DYNA when performing design of experiments (DOE) and design optimization studies. The automated simulation process enables TE engineers to identify robust optimum barrel design variants and speed up the development cycle. In a next step, they plan to incorporate thermal and vibration analyses into the Optimus-driven barrel design process.



FEM analysis results on cross sections of a range of barrel design variants

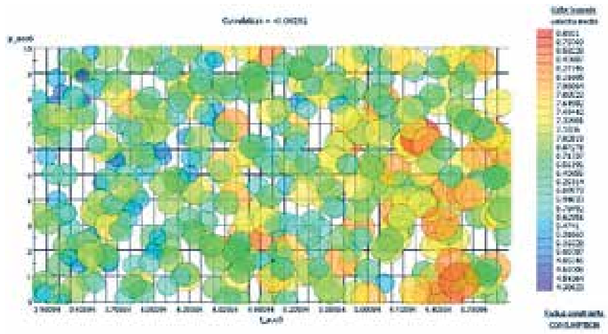
"Optimus contains all necessary functions to automatically execute Taguchi methods from start to end, considerably saving development time and cost."

Kazushige Sakamaki of Tyco Electronics Japan G.K.

Cutting Hydrogen Consumption to 3000 km for 1L Fuel

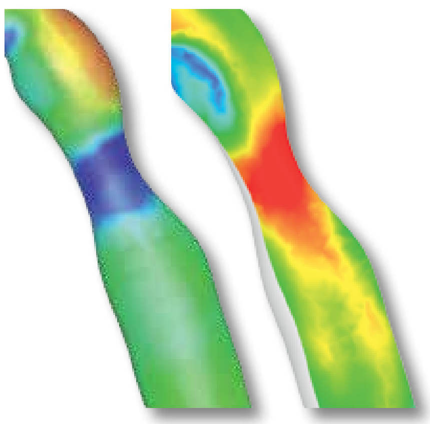
The lowest possible hydrogen consumption is what counts for the futuristic, lightweight IDRApegasus prototype vehicle developed by Politecnico di Torino, in Italy. The H2politO Team of engineering students optimized the vehicle's electronic energy management for maximum sustainability, using Optimus process integration and design optimization. Optimus enabled them to convert their manual 1D LMS Imagine.Lab AMESim simulation procedure into an automated process, directing simulations toward an optimum and robust electrical motor current profile.

Through innovative Optimus-driven system simulation, the team successfully optimized the concept vehicle's energy management to already achieve podium in the 2012 Shell Eco-marathon in Rotterdam. To account for incremental enhancements, reducing vehicle weight and improving vehicle dynamics, the team further optimized the IDRApegasus' energy consumption and race strategy. This resulted in another podium position in the 2013 race edition in the fuel cell prototype category.

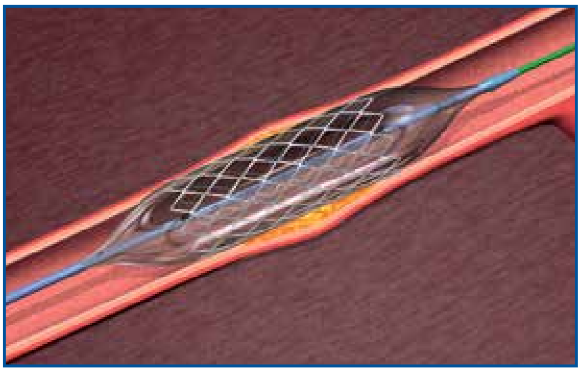


Bubble diagram showing the correlation between hydrogen consumption and electrical motor current. Optimus used the information to optimize the energy management of the teardrop-shaped IDRApegasus.

CFD Optimization Driving Patient-specific Coronary Stents



The untreated stenosis (narrowed section) of the coronary artery causes excessive blood pressure drop (left) and velocity gradient (right) in the investigated artery segment.



Using a catheter fed through blood vessels, a balloon is inflated and a commercially available stent inserted to permanently open the narrowing artery.

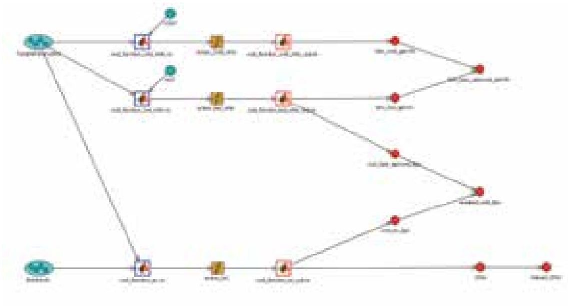
When cardiologists treat narrowed or blocked heart arteries as found in coronary heart diseases, they typically use off-the-shelf available stents. Placing such stents permanently opens the arteries at locations with build-up of cholesterol-laden plaques. Engineering simulation plays little or no role in this process. Recent research resulted in an Optimus-managed simulation process that optimizes medical intervention for improving local coronary blood circulation. In this optimization process, Optimus integrates mesh morphing (using Sculptor) and computational fluid dynamics (CFD) simulations (using ANSYS Fluent) into an automated, repeatable process.

Optimization results underline the need for patient-specific stents that optimize local blood circulation for heart disease patients undergoing medical treatment. Compared to treatment using standard coronary stents, optimized patient-specific stents were found to improve local blood circulation characteristics by over 20%.

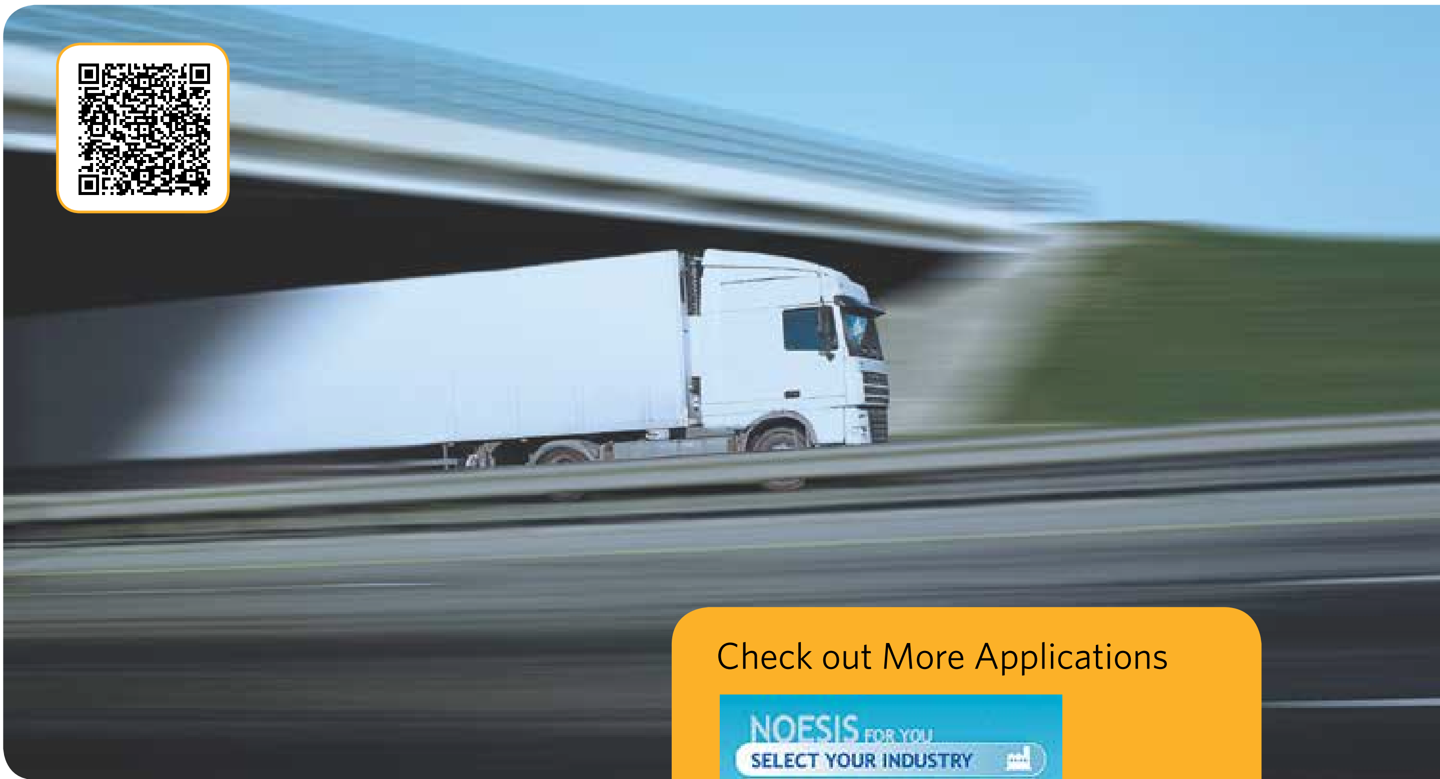
TNO optimizes truck emissions controller for Euro VI compliance

Heavy-duty truck manufacturers have little time left to develop powertrain systems that comply with Euro VI emissions legislation, to take effect end of 2013. TNO worked with Optimus design optimization and process integration software in combination with its proven SIMCAT solution for exhaust after treatment modeling. Combined with Optimus, SIMCAT simulations were successfully automated and directed toward an optimal emissions controller design.

As a result, engine and catalyst performance are influenced to minimize fuel consumption and reduce NOx emissions. Engineers at TNO also relied on Optimus to make the controller design robust to sensor and actuator inaccuracies. Thanks to the synergies between SIMCAT and Optimus, extreme driveline complexity was successfully managed in an automated fashion. This innovative approach effectively allows manufacturers to meet Euro VI emissions standards faster and at reduced cost.



TNO used Optimus to automate and direct SIMCAT simulations toward an optimal emissions controller design. This approach allows truck manufacturers to comply with powertrain type approval and truck in-service conformity.



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The Noesis Solutions website serves as your entry point to a wealth of structured information. It is a repository covering descriptions of Optimus capabilities as well as testimonials illustrating 'Optimus in action' across many industries and applications.

Also visit the website to subscribe to our email newsletters, sign up for more in-depth webinar sessions, or check out exhibits and presentations in the events section.

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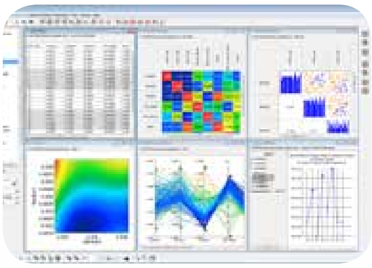
About Noesis Solutions

Noesis Solutions, a subsidiary of Cybernet Systems Co. Ltd. in Japan, is an engineering innovation partner to manufacturers in automotive, aerospace and other advanced engineering industries. Specialized in simulation process integration and numerical design optimization, its flagship product Optimus focuses on resolving customers' toughest multi-disciplinary engineering challenges. Noesis Solutions operates through a network of subsidiaries and representatives in key locations around the world. The company also takes part in key research projects sponsored by various official organizations, including the European Commission.

Visit www.noesissolutions.com for more information.



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