esi talk

The Virtual Prototyping Magazine

Transforming Mobility

How Electric Vehicles are Disrupting the Transportation Industry

special report

Plus: Customer Successes, Product News and Upcoming ESI Forums

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Editorial

Peiran Ding, Ph.D.
Electric Vehicles Center of Competence (COC) Manager
ESI Group

Dear Reader,

As we all know, our society seeks to address energy and environmental challenges and to achieve sustainable development. To reach these objectives there is an imperative to develop new transportation powered by new energies. At the same time, we are experiencing the digital revolution and learning to benefit from artificial intelligence and the Internet of Things. In that context the automotive industry is amongst the most challenged. But this industry is being offered tremendous opportunities for innovation while new forces from electric vehicle startups, such as Waymo (formerly Google) and Baidu, are consistently challenging traditional OEMs.

Volkswagen announces that electric cars will be their hallmark, stating: "By 2025, we plan to sell 1 million electric cars per year, and by then we also want to be the global market leader in electro-mobility.*" In the fast-growing market in China, in the first 3 months of 2018 the output of internal combustion engine (ICE) cars decreased by 1.4% relative to last year, while the production and sales of new energy vehicles increased by more than 150%. China's Geely Automobile Group officially started work with Daimler recently. CEO Mr. Shufu Li announced, "We have released 'Blue Geely Action'. By 2020, more than 90% of Geely automobiles will be new energy vehicles.**"

Is the industry prepared for the innovation necessary to achieve these ambitious and fast evolving objectives? If we just look at technology, we see that new energy vehicles come with new challenges: energy management and balance, high frequency noise control as the accustomed noise of the internal combustion engine disappears, new materials that allow light weight construction, multi-material assembly for novel and efficient fabrication, battery management and safety, thermal comfort in the context of energy management, and more. The very layout of vehicles changes as the body structure must be adapted and optimized to assure battery safety in the event of crash and to protect occupants who are no longer anchored in the positions so familiar today.

ESI is the right partner for these innovators. The company brings more than 40 years of experience in the business of enabling automotive simulation and provides the solutions needed to shape the future of Electric Vehicles. These are not invented alone but in a spirit of collaborative endeavor.

Along with a Special Report dedicated to EVs, this 51st issue of ESI*talk* is in large part about recognizing the successes of companies with whom ESI work. Customers in many industries have entrusted us with their most disruptive challenges and we are proud to share their successes (pages 9-14). Users all over the world have been gathering at ESI Forums in the USA, Europe and Asia to share their experiences, anxieties and ambitions (pages 18-19). Take note of upcoming events (page 21) where you can meet ESI teams and see how the new generation of Virtual Prototyping solutions can transform your development cycle. Last but not least, you'll discover how the Hybrid Twin™ can change the story in the Electric Vehicles journey.

Enjoy reading!

Peiran Ding

Transforming Mobility
How Electric Vehicles are Disrupting the Transportation Industry

Used by leading OEMs worldwide, ESI Virtual Performance Solution was designed to meet the past and emerging challenges of the automotive industry

Electric Vehicles (EV) are here. Driven by entrepreneurs in a technologically ready and connected world in which carbon emissions have been declared public enemy #1, transportation has begun a violent and fundamental shift from the combustion engine and into the next era; one in which the very function of vehicles is being reinvented

Nations are setting ambitious targets and making commitments that would have been unthinkable only ten years ago. China, Japan, India, Norway, and a considerable part of the European Union have announced their intention to phase out combustion engine vehicles in a matter of years. In this context, automotive OEMs have set aggressive timelines to electrify their entire fleets. Spurred on by Elon Musk's passionate efforts to achieve what was recently deemed impossible, scores of new EV startups are pushing forward the technologies that will make reliance on fossil fuel a thing of the past; not only for cars and trucks, but also planes and hyperloops!

Fully electric and increasingly autonomous cars and trucks have moved quickly from the pages of science fiction novels to our roads, placing established OEMs in a challenging position. Suddenly the fundamentals of the automobile are being redefined. Fuel tank, engine, gearbox, transmission and exhaust line are being replaced by control units, battery packs and electric motors. We are witnessing a transformation in vehicle design and manufacturing, and a disruption in the way vehicles are distributed, used and powered. Even matters as basic as vehicle noise need to be fundamentally revisited as Electric and Hybrid Vehicles present many new challenges to automotive designers who previously focused on the engine as a dominant noise source for both interior and exterior noise emissions.
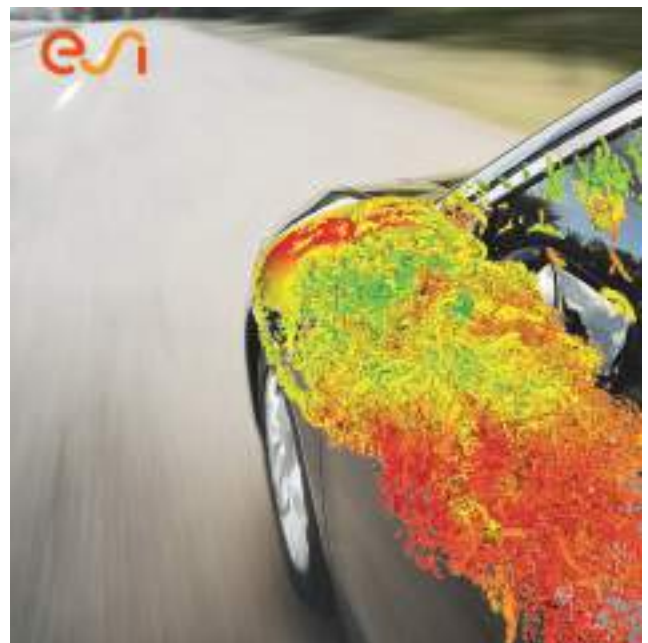
ESI VA One can accurately predict the overall acoustic performance of an electric vehicle to address the challenges of ensuring passenger comfort and pedestrian safety

In this context, today's automotive OEMs are hard pressed to take a sharp turn while at the same time ensuring a continuity in their fleets' recognized identity and staying on track with their established vehicle development schedules. They are developing new and lighter cars that deliver increased range and interiors that are safe and comfortable for the modern and connected traveler. Of course, they must address the new noise balance and mass distributions, and be equipped with the sensors, hardware and software that enable assisted and autonomous driving!

While today's OEM's struggle with their transformation, newcomers in the industry face their own challenges. Typically endowed with tight funding and limited

ESI Pro-SiVIC™ allows OEMs to virtually test the operational performance of various perception systems (sensors) onboard a vehicle, thereby supporting the development of functions such as Advanced Driver Assistance Systems (ADAS) and Autonomous Driving
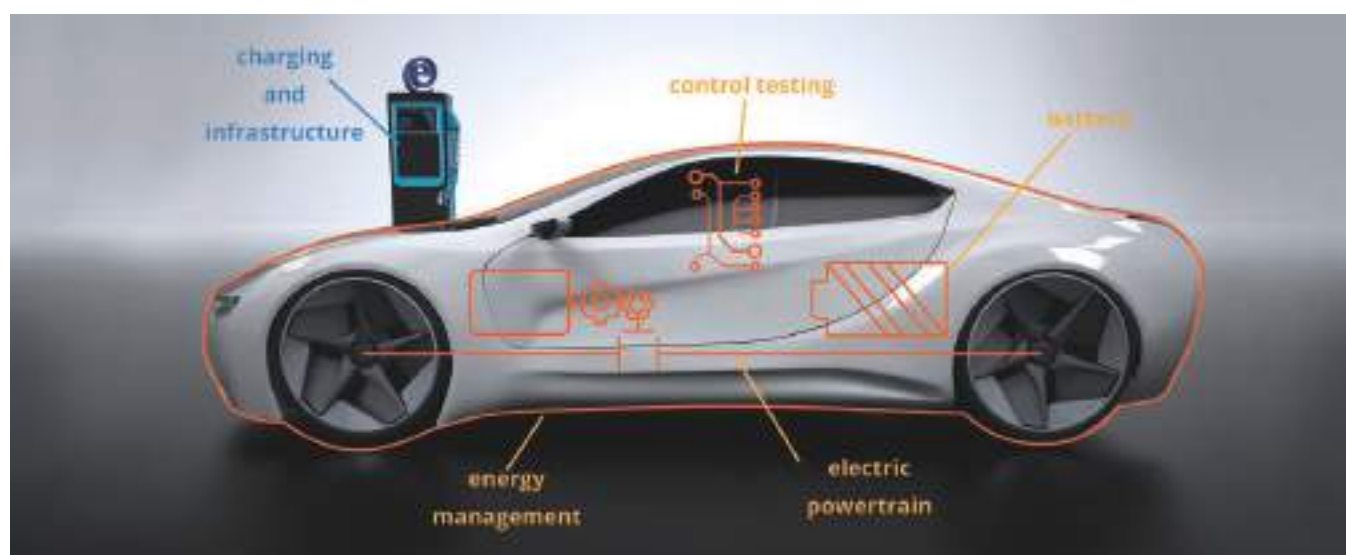
Applications of electric vehicle development and testing with ESI's system simulation solution SimulationX

experience, EV startups strive to understand and meet regulations that established OEMs have dealt with over decades. Challenged with the imperative to catch up with all that expertise and market innovative vehicles that deliver the experience and safety that consumers expect, they need to find the right partner to help them grasp a short window of opportunity with confidence.

As illustrated in this article, ESI has anticipated this need through the acquisition and development of specific solutions, highly relevant for next generation vehicles. Importantly, we have launched a specific initiative that takes a holistic view of electric vehicle engineering.

Speaking of an end to end solution provided by ESI that is highly pertinent to the development of next generation vehicles, Caroline Borot, Industry Solutions, Marketing & Business Development Manager at ESI, comments:

"The efficiency of climate and heating control systems can significantly impact the range of an electric-drive vehicle. Ventilated, heated or "Climate" seats have the potential to improve the thermal comfort of occupants while reducing the thermal loads. The use of interior and virtual seat prototyping combined with digital human models can predict the thermal comfort of a driver or passenger seated in a heated or cooled seat. It allows engineers to address not only the thermo and energy management but also the comfort and the ergonomics of the interior space." *

Development of such Virtual Prototyping solutions has been achieved by ESI in partnership with the leading OEMs of the industry, as well as tier-1 and tier-2 suppliers, over the past 40 years. From a humble start, we see Virtual Prototyping enabling vehicle program

managers to achieve their objectives in engineering and manufacturing and to prepare for future maintenance and support, all before any physical prototype is built. More than just offering tools, ESI works with industrial manufacturers to make sure they are breaking development silos, leveraging cutting edge technologies, and delivering on the expectations of the Industry 4.0 revolution.

> *"ESI Virtual Performance Solution saves us time and money. We are able to validate the performance of our innovative composite vehicle virtually before even manufacturing the first real prototype."*
>
> **Gaël Lavaud**
> CEO
> Gazelle Tech

What's next?

Computer-Aided Engineering (CAE) has historically focused on solving problems encountered in the design and use of products. We have moved to a new paradigm in which we build virtual prototypes that allow us to not only anticipate and correct design problems before they occur but also to build a virtual twin of the "as manufactured" product. This now opens the door to

Water management is becoming even more essential to the development of new car models, for instance in preventing water related issues for electric and autonomous vehicles.

building a complete and continuously updated virtual representation of the product – a Hybrid Twin™ – which can co-exist throughout the lifecycle of the actual product – from creation (manufacture), through operational life and, ultimately to decommissioning and disposal. This can provide essential insights into both the design of the product and its overall quality but most importantly provides a platform for smart operation, maintenance and support.

ESI delivers Virtual Prototyping as the foundation for the Hybrid Twin™, synchronized through the Internet of Things (IoT) and Big Data to receive real-life product feedback to maximize the longevity of a product through intelligent predictive maintenance. Considering, for example, what will be needed to manage and support a fleet of green vehicles in a smart city, it is evident that the Hybrid Twin™ will deliver significant value to the automotive industry as it transitions into a new era.

*Further reading: ESI paper on "Development of a human thermal model to predict seat occupant thermal comfort" https://www.esi-group.com/resources/technical-paper/development-human-thermal-model-predict-seat-occupant-thermal-comfort

read more about how ESI's engineering solutions help address Electric Vehicle challenges
www.esi-group.com/EV

3 Questions for...

Herve Motte
R&D Innovation Manager
ARRK

Why are composite materials important for the Electric Vehicle market?

Overall weight reduction is key to optimizing the energy consumption of electric vehicles and to increased autonomy. A number of projects have led to reduction in structure, body and trim mass, but few have targeted powertrain mass.

At ARRK, we have worked on reducing powertrain weight. We looked at optimizing the weight of the typical two-stage electric transmission by substituting the aluminum housing material with materials of lower density. When doing so we had to consider all requirements to be satisfied. Carbon fiber reinforced thermoplastic materials provide a good combination of mechanical properties and fast manufacturing processes, but attaining the stiffness needed to reach the durability and acoustics expectations for the gearbox, especially at temperatures above 100°C, is challenging for this group of materials.

What are the challenges related to Electric Vehicle powertrain?

The functional complexity of electrical gearboxes is lower than conventional gearboxes because the number of gear ratios is much lower today. Conventional vehicles have up to seven gear ratios and electrical vehicles only one or two.

What is most challenging for an electrical gearbox is the acoustics. Where you used to have a combustion engine that would drown the operational noise of the gearbox, you now have an electrical

engine that is silent. This makes the gearbox acoustics dominant, especially at low speed. The sound of a transmission itself, usually a whining sound, is annoying for the occupant, and must therefore be managed.

Acoustic performance is also related to the production of thermal energy, or energy loss. Imperfect acoustic behavior generates thermal energy. In an ideal gearbox, there would be no deformation of the housing caused by the transmitted loads. But in real life, there is displacement of bearings of the shafts that leads to a change in position of the gears running on that shaft. The challenge is to achieve the same or better stiffness values with the new housing material as for the original aluminum gearbox. Axis deviation and axis inclination error of the intermediate and output shafts have to be on the same level or below the values for the aluminum housing.

Gearbox assembly

How was ARRK able to rise to this challenge?

In our gearbox project, we replaced the aluminum housing material of an electric transmission with fiber reinforced thermoplastic material. Our aim was to replace the housing material only – reusing all interior parts.

In the design we developed, an organo sheet (carbon fibers fabrics with multi orientation, and polyamide thermoplastic matrix) is over-molded by a short fiber reinforced thermoplastic material (PPA

with short glass fibers). Aluminum inserts, as bearing seats, ensure transmission of the bearing loads into the organo sheet and reduce the deviation of the gear mesh. Additional injection molding ribs and unidirectional tapes ensure the stiffness requirements.

ARRK P+Z (German entity) and ARRK Shapers (French entity) worked together to show the ability of the ARRK product development group to develop the parts, to build the tools, to set up the production process and to produce in a small series production size. ARRK P+Z was responsible for the engineering and ARRK Shapers set up the production process and built the tools and the prototype.

The engineering approach used was simulation driven. Different types of simulations like finite element method, molding simulation, stamping simulation and optimization were used – ESI provided
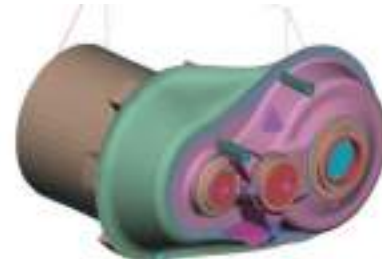
simulation support with ESI's composites manufacturing solution. Ultimately, the gearbox using the new material weighed 4kg, compared to 5.8kg with aluminum, so we achieved almost 30% mass saving. We demonstrated the capability of ARRK to design and prototype composites gearboxes, that outperform a standard aluminum gearbox.

for more information
www.arrkeurope.com

Moving Towards a Hybrid Twin™ Paradigm for the Battery Management System

The Battery Performance Challenge

Most Electric Vehicles (EVs) have an onboard Battery Management System (BMS) that maintains safe and consistent operation of the battery pack. By evaluating the State of Charge (SoC) and the State of Health (SoH), the BMS deploys strategies such as cell balancing to reduce degradation and optimize the performance of the battery system. Typically, the BMS uses data-driven models to estimate the SoC and SoH. However, these models become inaccurate as batteries degrade or undergo important changes in their environment and operation, including changes in ambient temperature and charge cycles.

In contrast to data-driven models, physics-based models are accurate but far too time-consuming to be of practical use in real-time applications. The challenge is to develop BMS models that are both fast and accurate.

Introducing the Hybrid Twin™

Numerical techniques based on Model Order Reduction (MOR) have opened new possibilities for efficient simulations. These techniques involve calculating – offline – the parametric solution of a parametric model. That solution is then deployed online to perform fast predictions at any point in the parameter space, allowing for optimization, uncertainty propagation, and simulation-based control – all in real-time. However, when such techniques are integrated into data-driven application systems, unexpected difficulties can arise. These are related to significant deviations between the predicted and observed responses thanks to the unpredictability of system behavior.

One solution is to construct a data-driven model "on-the-fly" to fill the gap between prediction and measurement. When this is achieved, system control can be efficiently attained. This is the rationale behind ESI's Hybrid Twin™, which has two main contributions. First, the system obeys the time evolution that physics imposes. Second, a correction model is constructed on the fly, making use of any appropriate machine learning. For efficiency purposes, big data is replaced with smart data, which

Reduced thermal model on a hand-held device. From the collected data, the model detects that the system is ill-functioning, as the real parameters are different from the nominal (optimal) ones.

essentially requires addressing three key questions, using multi-scale modeling of data and information theories: what data is needed, where, and when.

The potential gains of the Hybrid Twin™ are tremendous. Suddenly, simulation that is both physics and data-based, is possible in real-time, delivering an accurate and predictive model that can be used to anticipate failure or performance loss, to maximize product operation by reducing downtime, and to manage maintenance and repair costs.

The Battery Hybrid Twin™

The physics-based battery model consists of a system of non-linear, tightly coupled parametric partial differential equations describing reaction-diffusion-thermal transport. The multi-physics interactions described by such a model occur over a wide range of length scales, making real-time evaluations difficult. Here the Hybrid Twin™ becomes an appealing approach as it makes use of the physics-based models, whose parameters can be updated online from the collected and assimilated data, such as local temperature.

The marriage of physics and data-based models is well adapted to tracking SoH and accommodating degradation throughout the battery's operation. Furthermore, we can see that such models can be adapted to provide a real-time charging recommendation by evaluating the health of the battery, temperature conditions, and previous charge history. In summary, the battery Hybrid Twin™ provides a basis for real-time, accurate monitoring, prediction, and control of the battery system.

for more information
www.esi-group.com/HybridTwin

Gazelle Tech Reduces Energy Consumption by Half with Virtual Prototyping

Challenge

With the car market expected to double in the next 20 years, and fossil fuels becoming scarcer, disruptive and innovative green, light cars must be developed. Developing these types of vehicles, which can be produced close to the ultimate customer, presents an interesting opportunity to reduce the total CO_2 footprint. With cutting-edge technology, that is exactly to what Gazelle Tech aspires; to decrease our carbon footprint yet still offer mobility to all.

Benefits

Gazelle Tech is developing a new production method for an innovative, low carbon impact vehicle, with the objective of offering sustainable transportation to all. In that context they are using ESI Virtual Performance Solution to:

• Reduce time to market by eliminating physical prototypes

• Ensure a safe, lightweight vehicle design

• Realize the necessary design adjustments for an overall optimal design

Story

Gazelle Tech, a French startup company created in 2014, is the first peri-urban composite vehicle manufacturer of its kind. Their vehicle is currently under development and the industrial version is expected to be released in 2018. It features a composite chassis and body technology that makes it one-third the weight of its competition and reduces energy consumption by half. The model will be offered in both gas and electric versions for a B2B market in France, as well as emerging countries in Africa and Asia.

Gazelle Tech offers disruptive innovations, both in their car concept technology and its production model. The chassis, composed of 10 pieces (vs. 300 on a standard vehicle), can be assembled without the need of special tools within an hour in micro-factories supplied in containers. Additionally, modular production units can be installed quickly and close to the customer. For example, if the customer is in South Africa, the vehicle will be produced in South Africa; reducing energy consumption linked to the transportation of vehicles.

A Gazelle at the end of a frontal crash using ESI Virtual Performance Solution

Based on their new design and car concept, Gazelle Tech created a virtual prototype of their car in order to test safety and comfort virtually and to anticipate any issue before building the first real prototype. For several months, using ESI Virtual Performance Solution (VPS), they subjected the composite vehicle to rigorous crash and structural rigidity simulations and carried out vibration analysis to refine passenger comfort levels until an optimum design was achieved. In their next phase, Gazelle Tech plans to focus on the optimization of the manufacturing processes of the car's composite parts.

All vehicle manufacturers must present a prototype before commercialization so that the competent authorities can carry out tests. Gazelle Tech has finalized their first prototype and plan the production of the first Gazelles in 2018.
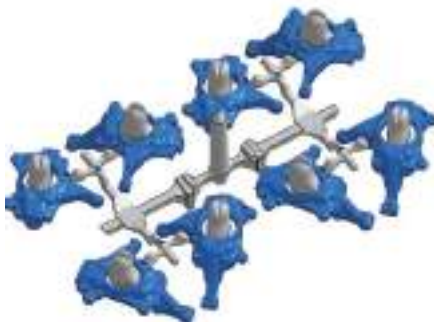
for more information
www.gazelle-tech.com
www.esi-group.com/VPS

Renault Improves Yield and Produces Over 520 More Parts per Hour

6-cavity die vs. Simulation Driven 8-cavity die

Challenge

Renault needed to define design rules for the filling and feeding systems for casting processes on different product lines in order to enhance competitiveness and achieve high quality production.

Benefits

Using ESI QuikCAST, part of ESI's casting solution, Renault was able to enhance competitiveness, reduce development time and cost and improve product quality. Most importantly they increased their know-how of filling and feeding systems for casting and established new production design methodology.

Story

Fonderie de Bretagne (FDB) joined the Renault Group in 2009 and is now a wholly owned subsidiary. The company produces rough and machined parts in spheroidal graphite cast iron and other materials.

Renault has made a considerable investment in installing a new molding line at FDB. In the scope of commissioning the new line, Renault decided to standardize their production methodologies and to use simulation early in the development cycle. This meant devising a standard for creating molding layout and feeding design that could be replicated across a wide range of casting products. For the pilot project, they chose an existing 6-cavity mold layout of a cast iron knuckle; one already in production but experiencing some noticeable shrinkage porosity problems.

They started from scratch as they would with any new product. First, using the ESI QuikCAST simulation software, they performed a single casting simulation with no filling or feeding system, simply observing the solidification in the sand mold, with a starting temperature close to the pouring temperature. The natural thermal gradients of the casting were used to identify the solidification path and pinpoint the last solidifying regions in the casting.

> "After using ESI QuikCAST, not only were we able to increase our bottom line by saving on metal and creating more castings than before, but we also implemented a completely new system for casting that we now use routinely across various product lines within the company."
>
> **Laurent Soulat**
> Casting Specialist
> Renault Process Engineering

Next, they created various practical feeding designs and performed a complete simulation of each proposed design to identify the one leading to the best solidification pattern and without signs of shrinkage porosity in the casting. Having identified a suitable feeder, a similar exercise was repeated with multiple gating options in order to identify the optimal in-gate position and size; one offering the best filling behavior and solidification pattern.

The final, and arguably most important, step was to expand this optimized single-cavity design into a multiple-cavity mold. Renault improved the knuckle mold from a 6-cavity 97kg to an 8-cavity 82kg cluster. The new design solved the shrinkage problem which had plagued earlier production, and provided a remarkable yield improvement; saving 37% in metal for every part produced. Furthermore the new design produced two additional parts per mold, delivering over 520 additional parts per hour. The cost savings with the new design was substantial, to say the least.

Ultimately, thanks to the use of ESI QuikCAST, Renault resumed production of the Spheroidal Graphite Iron "Renault Traffic Front Knuckle", and illustrated the standardized methodology built during the commissioning of its new molding line at Fonderie de Bretagne. Renault now uses this methodology successfully across different product families within the company.

Shrinkage porosity map on four of the eight cavities of the new molding layout (symmetry considered during simulation with ESI QuikCAST)

CRRC Zhuzhou Locomotive Optimizes Designs with their Customer in Real Time

Driver reach analysis with ESI IC.IDO

Challenge

CRRC ZELC received an order to develop a high quality, low-floor electric locomotive, along with the rolling stock, in the shortest timeframe possible. The validation and optimization of the product required an ergonomic product design and assembly process. To do this, CRRC ZELC needed a solution to conduct human factors analyses and ensure the quality and progress of the product development.

Benefits

With ESI IC.IDO, CRRC ZELC improved the efficiency of the product development and subsequent assembly. The engineering team could conduct accurately the ergonomic analysis for each region's users all across the country. Moreover, their client was able to review the design with a 1:1 3D virtual prototype and communicate modifications in real-time. Deploying ESI's solution, the company saw a huge saving in development time and costs.

Story

The rapid transformation of information technology and product intelligence poses a major challenge for all industries. The railway industry finds that it too must focus on being as efficient and environmentally friendly as possible. To that end, they make use of the latest technologies to manage the lifecycle of their products and meet the personalized needs of their customers.

CRRC Zhuzhou Locomotive CO., LTD. (CRRC ZELC) is the key subsidiary of CRRC Corporation, China's largest research and manufacturing company of electric locomotives. They are the leading enterprise in Hunan's rail transport industry, which is valued at roughly 129 billion Euro and coined 'Home of China's Electric Locomotives'. CRRC ZELC needed a new solution to improve their product development and help them meet strict deadlines given by their clients.

> "ESI IC.IDO is a comprehensive approach to help us solve the time and quality issues during product development. With its powerful and user-friendly functions, our design team could complete the project with much higher efficiency. Most importantly, this immersive engineering tool brought us a very creative and innovative way of designing a product and we have gradually integrated it into our daily work."
>
> **Nan Gao**
> Senior Product Manager
> CRRC ZELC

Overall, CRRC ZELC needed to improve their ability to evaluate different options to assure efficient assembly processes and to have a platform for matching interior and exterior colors. As is typical for low-floor electric locomotives, the customer expected a significantly customized product and set unique customer-specific requirements.

Before implementing ESI's Virtual Reality solution, IC.IDO, CRRC ZELC used physical prototypes for validation of the ergonomics of their locomotives' design and manufacturing process. They relied on visual observation, manual analysis, and time-consuming modifications. This led to numerous redesigns and updating of physical prototypes, which greatly increased costs and impacted quality. Looking for an alternative to physical prototyping, CRRC ZELC evaluated different products. After several rounds of comparisons they concluded that IC.IDO's immersive experience, coupled with its friendly user interface and powerful functions, perfectly matched their requirement; from product design integration to assembly process planning.

CRRC ZELC acquired three Virtual Reality Powerwall systems and their design team used the IC.IDO desktop version to load the Computer-Aided Design (CAD) model for ergonomic, assembly, and visual analysis. Leveraging the real-time collaboration feature, they used the Powerwall system for remote project reviews and product presentations. This way, customer suggestions could be generated and recorded in real-time. Most importantly, with the immersive 1:1 3D experience, the costly physical prototype wasn't necessary for product review. This new virtual technique significantly improved the quality and efficiency of product design and CRRC ZELC delivered a high quality product, on time, and enhanced their already positive reputation.

for more information
www.crrcgc.cc/zjen
www.es-group.com/IC.IDO

Fast and Safe – University Students Test their Race Car

Challenge

When a group of students at the Czech Technical University in Prague (ČVUT) began working on a "Formula Student Vehicle" project, they immediately opted for Carbon Fiber Reinforced Polymer (CFRP) to build the crash absorber needed to assure they could "go fast and be safe" on the track. However, they had to abide by a strict timespan for design and manufacturing and stay within a tight budget. There was no room for error.

Crash box of the M-B SLR

Benefits

The students were able to avoid physical crash tests of their CFRP race car thanks to ESI Virtual Performance Solution (VPS), using only virtual coupon tests of the CFRP material to validate the material model. This enabled them to move swiftly to the design optimization of the crash absorber structure.

The capability of VPS to complete multiple simulations on a single core model allowed the team to thoroughly examine various geometries of the absorber at any given time. The End-to-End solution supported the project goals, which were met entirely within the allotted time and budget.

Story

In the automotive industry, especially motor sports, crash absorbers made of Carbon Fiber Reinforced Polymer (CFRP) are widely used because they have the best energy dissipation capacity to weight ratio amongst engineering materials. The team at ČVUT knew this well, but they also knew the challenge of designing and manufacturing these structures efficiently.

ČVUT is one of the largest technical universities in Europe, comprised of eight faculties, including Civil Engineering, Mechanical Engineering, Nuclear Science, Physical Engineering, and Information Technology. As part of its education and training program for final year students, the Faculty of Mechanical Engineering encourages students to participate in the

international competition for "Formula Student Vehicle". The main challenge is to work with complex design structures and advanced materials. From the start, it was clear to the project consultant, Michal Vašíček, that Virtual Prototyping would be necessary to meet their time and financial constraints.

The team adopted ESI Virtual Performance Solution (VPS) as their main tool throughout the project. They started by building simple models to characterize their chosen CFRP material and progressed to macro models of components, to validate their simulation results against lab tests, before tackling the design and optimization of the complete structure. Components were designed in a Computer Aided Design

"Using ESI Virtual Performance Solution to investigate the performance of a composite crash absorber completely virtually enabled us to complete the structure's design efficiently. Within a couple of days, the students learned how to use the software effectively and were capable of carrying out complex chained analyses."

Michal Vašíček
Project Consultant
Czech Technical University in Prague
(ČVUT)

(CAD) system and then imported into VPS to incorporate the physics of materials and crash conditions in the model.

The material characterization was comprehensive using a wide range of virtual coupon tests (tension, compression, in-plane shear, double cantilever beam, and end notched flexure). Having obtained a full set of mechanical and fracture properties of their materials, the students then built a simple, dynamic tube crushing experiment for validation.

With confidence in their results and simulation methodology, the students began examining various geometries of the complete crash absorber and worked on finding an optimal layup of the laminate, balancing weight reduction and performance targets.

VPS enabled the students to evaluate the design of the CFRP crash box through extensive analysis of its behavior in stiffness, strength and crashworthiness. Being able to carry out these simulations, while using one single core model for all performance load cases, made their task significantly easier. The students completed their goals in minimal time and stayed within their budget. More importantly, they were confident that they could indeed "go fast and be safe" on race day, not to mention being able to add a bullet point to their resumes: "success in using ESI Virtual Performance Solution for a prototype car design".

for more information
www.cvut.cz/en
www.cartech.cvut.cz
www.esi-group.com/VPS

JSC "Zelenodolsk Design Bureau" Accelerates Approval

JSC ZDB use ESI IC.IDO with their Powerwall to bring their customers onboard proposed

Marine compartment layouts without costly mock-up construction

Challenge

When Zelenodolsk Design Bureau designed compartments for marine vessels, approval was a lengthy process. How long depended on the complexity of compartments and the number of departments contributing to design. Full size models of packed compartments were constructed in dedicated mock-up sections, which required a considerable investment in time and money.

Benefits

ESI IC.IDO supported Zelenodolsk Design Bureau in improving the quality of their end product and project documentation. Time spent on corrections made in the final stage of the design process has been reduced, profitability has improved, and end customer value is enhanced.

Story

JSC "Zelenodolsk Design Bureau" (ZDB), founded in 1949, is part of the United Shipbuilding Corporation in Russia. Today, they specialize in developing projects for ships, boats and other marine vessels, for the Russian and overseas markets and they provide services in the areas of design, construction support, development of modernization projects, design assistance & consultation, and experiments & trials.

One of the challenges they encounter is to get approval for their design of vessel compartments – a process which often involves the costly and time consuming activity of building physical replicas. As these projects require input from various groups and departments within the organization, from electrical engineering to ventilation, approval is often a lengthy process. This inspired the company to search for a collective decision making software solution. One condition for choosing a VR solution was that Zelenodolsk Design Bureau could continue to rely on their CAD (Computer-Aided Design) models (developed in Aveva Marine, a CAD software focused on the marine industry) without significant adaptation. Ultimately, their goal was to ensure that their compartment designs fulfilled the construction requirements of complex marine construction projects.

> "We have considered various alternative systems and approaches to optimize the compartment acceptance process, including VR systems with game engines which provided very high level graphics and visualization quality. However, they appeared to be unsuitable for the engineering and construction tasks to be performed. We have chosen ESI IC.IDO, which allows us to make effective decisions not only in the construction domain, but also with ergonomic studies."
>
> **S.I. Reshetov**
> Deputy Director General
> Strategic Development
> JSC "Zelenodolsk Design Bureau"

Noticing ESI IC.IDO at various marine industry exhibitions, the Zelenodolsk Design Bureau considered this application for their own needs. After detailed evaluation they promptly came to the conclusion that IC.IDO would fulfill their requirements for virtual reality prototypes that could be used to reduce their reliance on construction of physical mock-ups in their design review processes.

By implementing IC.IDO virtual reality software, all teams involved in the decision-making process are now able to iterate on the design at the same time. They have also improved the quality of their end product, as well as the related marine project plans and construction documents.

"Implementation of the solution allows us to quickly and effectively decide on the complex construction tasks which require a collective approach. Lead time for approval has shortened significantly," says S.I. Reshetov, Deputy Director General – Strategic Development.

Today, Zelenodolsk Design Bureau has successfully integrated IC.IDO into the customer approval process for vessel compartments initially designed in Aveva Marine.

for more information
www.zpkb.com
www.esi-group.com/IC.IDO

Hwaseung R&A Improves Product Reliability

Interpreting vehicle door seal installation and door with ESI Visual-Environment

Challenge

Hwaseung R&A needed a solution to correct a trunk seal which deformed after assembly on the vehicle's body. As a solution, they considered projection of the geometry of the seals onto complex three-dimensional surfaces of the car's body structure, along trunk edge lines. This was a challenging exercise so they needed some assistance.
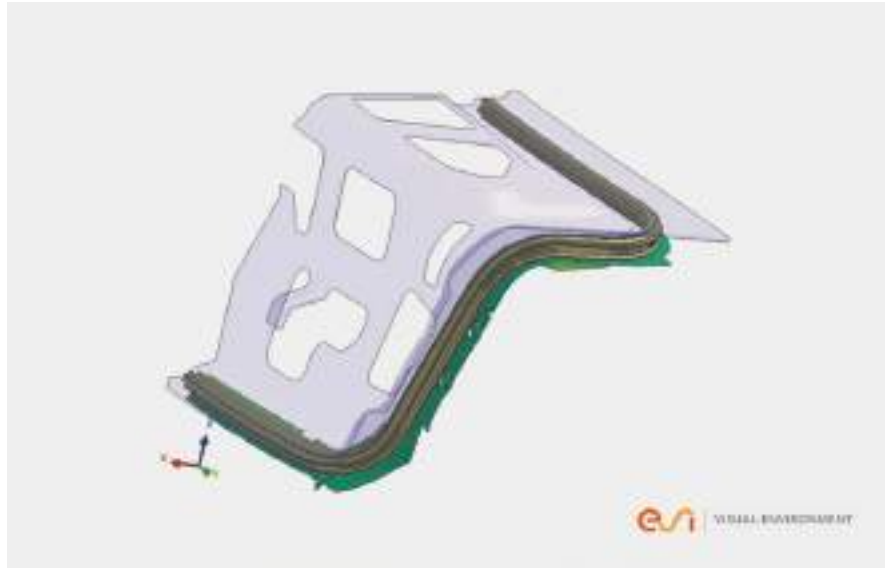
Benefits

Using ESI Visual-Environment, Hwaseung R&A engineers discovered they could virtually simulate assembly of the trunk seal and evaluate its performance without real prototypes. The software allowed them to generate their input data completely automatically using only design parameters and geometric information.

Story

Hwaseung R&A needed a permanent fix for their trunk seals, which became deformed or distorted at the corners after assembly. The trunk seal's function is to absorb trunk vibrations and to close the gap between the vehicle body and trunk assembly. When the seal has an irregular shape, the consequent non-uniform pressure distribution on trunk panels causes issues such as increased noise, water leakage and even failure of trunk panels.

Engineers began seeking a solution using simulation software that offered a fully automatic model creation process. Their search led them directly to ESI Visual-Environment. With this tool they could build an automated process to reduce model creation time and facilitate performance evaluation and parametric studies within a short product development cycle. The process they developed uses only Computer-Aided Design (CAD) geometry, design parameters and sectional Finite Element (FE) mesh and creates ready-to-run 3D models automatically. Hwaseung R&A

experimented with different positioning methodologies for thread and ribbed shapes as well as various types of sectional shapes.

Not only was Hwaseung R&A able to correct the defect and reduce their development time and costs but they were so successful with process automation in Visual-Environment that it has been implemented as a standard in their design process for trunk and body seals. They are also using the solution to assist with initial conditioning for trunk and door closing simulation.

About Hwaseung R&A Co.,LTD.

Hwaseung R&A Co., LTD. established in 1978 has maintained the core position of automobile parts in Hwaseung Group. Automobile high pressure hose, low pressure hose and weather strip, etc. which are produced by Hwaseung R&A Co., LTD. have firmly kept the number 1 of domestic market share in automobile parts. Also, as it has offered its products to worldwide well-known automobile makers as well as domestic automobile manufacturers such as Hyundai, KIA, GM Daewoo, it has grown up as the 7th world biggest corporation in the automobile parts. Also, it entered into shipbuilding equipment business in order to enhance new competitiveness through management diversification.

While Hwaseung R&A Co., LTD. sets up manufacturing branches and offices all over the world in order to strength its overseas advancement, it is also about to join Global Top 1 in automobile parts industry with continuous efforts to secure the R&D technical capability, and spreads out the corporate vision.

for more information
www.hsrna.co.kr/hsrnaen
www.esi-group.com/visual-environment

Facilitating the Integration of Sensors within their Operating Environment

Driven by the race towards wireless 5G and the Internet of Things (IoT), the total number of connected devices is expected to reach 50 billion by 2020, requiring more than 200 billion sensors. Assessing the performance of these sensors – within fully realistic operating conditions – is considered a key challenge for electromagnetic experts, one that ESI addresses with its latest release of CEM One and its easier integration of sensors on-board fully equipped models.

applications focusing on radar signature and stealth are consolidated through extended output for easy target recognition and hot spots localization.

- Smart Factory – biggest potential CEM One beneficiary, with sensors at the heart of industrial IoT solutions. ESI's solution enables machine-to-machine communication, providing real-time data, or strategic installation in large sized plants for efficient monitoring.

Sponsored by the Single Interministerial Fund (FUI) – the French financial funding program that supports cluster-based R&D – and with the support of the Rhône-Alpes region and major competitiveness clusters for Aeronautics, the 3-year SIMUCEDO project aims at developing an industrial solution for the Virtual BCI Testing of airborne electronics, as defined by RTCA DO 160 regulations.

With advanced BCI probe models, hundreds of bundled cables and wires –

ESI CEM One 2018, ESI's solution for Computational Electromagnetics, enables the Virtual Electromagnetic (EM) Testing of fully equipped large industrial models over a wide frequency spectrum, from radio to millimeter waves. Supporting engineers and EM experts in their daily challenge of designing EMC safe products, subsystems and systems, CEM One offers unique coupling capabilities, allowing multi-scale electromagnetic phenomena assessment within fully realistic scenarios. However, the biggest attribute of this latest release is its focus on sensor integration for better performance evaluation.

With the focus on sensor integration, CEM One 2018 significantly benefits the industries ESI addresses, such as:

- Ground transportation – with the advent of cooperative, connected and automated mobility on a global scale through Intelligent Transport Systems (ITS), the ability to handle sensors integration in CEM One is a huge advantage

- Aeronautic & Defense – the increase in number of sensors makes integration challenging. With CEM One 2018,

ESI participates in the SIMUCEDO Project for Virtual BCI Testing of Airborne Electronics

With all-electric aircraft (AEA) initiatives on the rise, the pressure is mounting for airborne electronic suppliers to deliver faster EMC compliance checking, and in particular Bulk Current Injection (BCI) testing. Additionally, with the constant increase of electrical and electronic

devices – coupled with tighter safety margins – operating conditions become more and more difficult to manage. Even if the final EMC compliance check phase were to remain experimental, virtual testing is still the obvious choice to shorten the design phase.

twisted, shielded or over-shielded – can be managed using ESI CEM One. Since electronic devices are characterized through experimental measurements combined with "black-box" modeling, the long, tedious modeling work of terminal equipment is no longer necessary and faster virtual testing is enabled.

Coordinated by AVNIR Engineering, the SIMUCEDO project calls on industrial partners (THALES Group and ADENEO), software providers (ESI Group & ALTAIR), and R&D centers and academic institutions (ESYNOV technological platform, AMPERE & G2ELab).
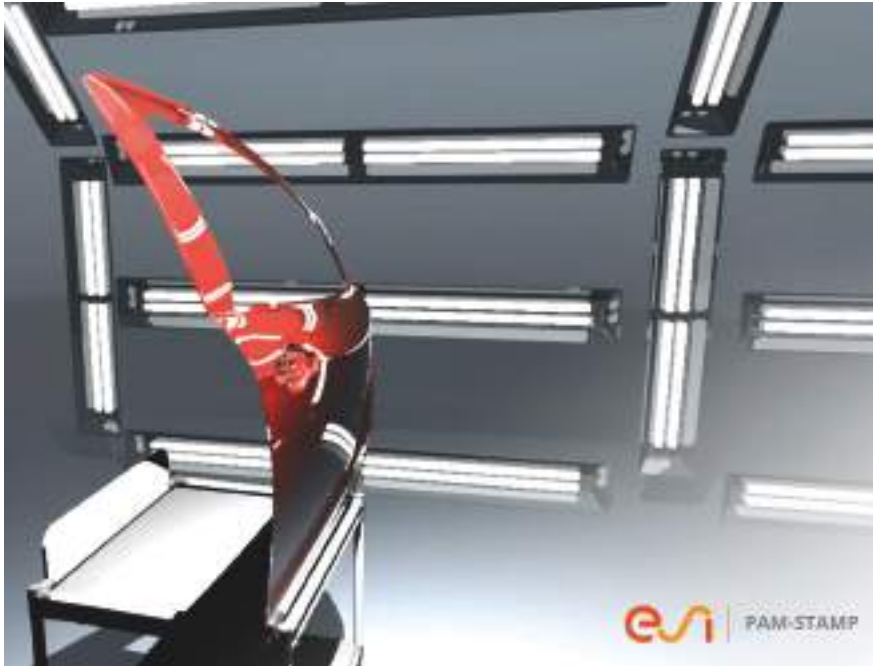

for more information
www.esi-group.com/CEM-ONE

Minimizing the Cost and Time of Manufacturing Try-outs

ESI PAM-STAMP brings speed, accuracy and performance to sheet metal forming.

Component quality assessment in ESI PAM-STAMP 2018's Virtual Light Room, based on simulation results

The number one consumer criteria for purchasing a new car is perceived quality. Quality criteria includes distinct sculpture, crisp feature lines, minimized gaps between panels, and no visible surface distortions. Engineering focuses on optimizing the perceived quality within a given cost constraint. To reach this difficult goal today, companies spend up to 30% of the total cost of manufacturing a part in the try-out phase due to repeated tooling adjustments needed to get individual parts and assemblies right.

Better prediction of manufacturing processes and the resulting quality is key to significantly reducing this cost. This requires the best possible model accuracy and high performance in order to process models in the required time frame. Further it is necessary to model not only the stamping process of each single part but also the entire assembly process.

The new version of ESI PAM-STAMP empowers companies to significantly reduce try-out cost and get perceived quality right, in the required time.

Accurate Material Models

Today, advanced materials make up a majority of a vehicle's structure. Because they are evolving continuously, it is challenging to find the best possible predictive model for the observed behavior using readily accessible test data. To assist in the process, PAM-STAMP V2018 includes a new material data manager for which users are only required to enter measured tensile data. PAM-STAMP will then displays, with clear graphs, which material model is best suited for this data – thereby enabling comparison of the accuracy of all models "on the spot". Naturally, the software automatically provides the required material model parameters.

Speed & Performance

The latest version of PAM-STAMP scales very well – up to 128 cores. In combination with its triple speed capability, it provides

that most common simulations, even with highest quality settings and including subsequent operations, run in one hour or less. Even the largest panels, with most accurate meshes containing millions of elements, can be analyzed within one working day.

Deformable tools

Generally, tools are considered rigid in the simulation of a manufacturing process. But when considering large or advanced, high strength steel parts, high pressing forces are required and elastic deformations of tooling and press system are no longer negligible. ESI has developed an effective method to address this reality, coupling real-time stamping analysis with the tool deformation simulation. The methodology offers ultimate accuracy for springback prediction and cosmetic defects analysis.

Assembly & Virtual Light Room

To fully minimize risks during try-out, it is not sufficient to analyze only individual parts. The assembly of components should be investigated, as this process most likely will also introduce additional distortions. Thermal joining effects caused by spot welding, intermediate distortion analysis, hemming/roll hemming (with or without gluing of the components), and final dimensional control can all be easily setup and analyzed and the resulting cosmetic quality of the assembled panel can be investigated in a virtual light room.

Today, the latest version of ESI PAM-STAMP provides the best possible approach to match reality with virtual engineering and thus enables significant reduction in try-out costs.

for more information
www.esi-group.com/PAM-STAMP

Intuitive and Reliable System Simulation Software

Designed for various industries – from automotive, energy, and mining to industrial machinery, railways, aerospace and aeronautics.

ESI's SimulationX model of an electric vehicle including Worldwide Harmonized Light Vehicle Test Procedure (WLTP) driving cycle, cooling system for the battery and the electric machine, as well as the cabin heating and a driver model

Historically known as a proven solution with a focus on simulating physical systems, the latest version of ESI's SimulationX[1] 3.9, is making big strides towards providing a single modeling and simulation platform for complete technical systems. Customizable to each industry specific need, the new version of SimulationX[1] is comprehensive and integrates the features necessary to support engineers in their day to day work.

OEMs, suppliers, engineering companies, as well as research and educational facilities use SimulationX for in depth analysis of a system's dynamic behavior and real-time testing before building the first prototype. The solution supports accurate decision-making not only at the concept phase of new a product but throughout the product development cycle and beyond.

ESI's solution benefits from a unique ability to communicate with other Computer-Aided Engineering (CAE) solutions, such as Finite Element Method (FEM) simulation software, Model-Based Systems Engineering, optimization tools, and real-time-platforms. By implementing the Modelica®[2] Synchronous language elements, ESI's software is able to efficiently simulate synchronous circuits as used in almost all digital controls.

New features of SimulationX allow engineers to navigate easily within large and complex model structures and to conveniently set the model parameters. Along with improved calculation methods and results visualization, all the main work steps have become faster: modeling, calculation, and analysis. A newly developed Simulation Task Manager

"Linking the digital models of a belt conveyor's mechanical and electrical components in SimulationX produces a digital twin, which allows for design optimization and virtual commissioning of the belt conveyor. Parameters for converters and motors, as well as complex controllers, can be tested and chosen in advance to validate the technical performance and to minimize time and tests on site for a faster and safer commissioning process – something from which we benefit as much as our customers."

Dr.-Ing. Torsten Hellmuth

Product Manager Bulk Material Handling
Siemens AG, Process Industries and Drives Division

enables flexible and powerful variant studies including parallel tasks with different simulation methods. Especially for analyzing energy system, new diagrams such as carpet plots simplify interpreting the simulation results.

Featured in this latest release, a new library for the mining industry combines ready to use component models for belt conveyor systems with a novel approach for automated model setup.

As a simulation solution for conventional drive trains that has been used in the automotive industry for more than two decades, SimulationX has reached another level of detail for vibration damper modeling. Alongside the successful model elements parameterized through characteristic curves, SimulationX 3.9, introduces new elements that describe dual-mass flywheels and engine mounts, parameterized through design data which can include frequency-

ESI's SimulationX solution for belt conveyor systems in the mining industry

dependent damping behavior in transient simulations. This new release also enables engineers to solve recurring challenges around e-mobility, using new model elements in the electro-mechanical and "Vehicle Drives" (Energy and Controls) libraries, and to address the challenges of integrating e-mobility into sustainable and efficient energy grids.

for more information
www.esi-group.com/SimulationX

[1] SimulationX is a registered trademark of ESI ITI GmbH
[2] Modelica® is a registered trademark of the Modelica Association

A Look Back at ESI Forums Around the World in 2017: Thank you to our Customers and Partners

ESI held multiple international forums in North America, Europe, Japan and India between September and November 2017. These events provided opportunities to witness how Smart Virtual Prototyping is enabling the industrial transformation that is behind the Connected Cities, Smart Factories, and Industry 4.0 movements. Attendees learned about the latest innovations in ESI's software solutions and networked with fellow users, worldwide industry experts, academics, and partners.

ESI Forum in North America (September)

The ESI Forum in North America kicked off the international meeting season in Birmingham, Michigan, USA. More than 200 customers from a diverse range of industries gathered to exchange ideas on new trends in simulation and manufacturing and how to address the challenge of delivering more innovative and smarter products at a lower cost, faster, and with increased reliability.

ESI Virtual Performance Solution Conference 2017 (September)

Users of ESI Virtual Performance Solution (VPS) from Eastern Europe met for this two-day event in the Czech Republic. This annual event, on which the VPS community has come to rely, covered topics including VPS software innovation, Visual-Environment news, Crash and Safety, and NVH & Interior acoustics. On the agenda were also eight user presentations and a bonus demonstration of the new model of the Pilsen Formula Student Vehicle.

ESI's 5th OpenFOAM User Conference (October)

OpenFOAM users gathered for three days in Wiesbaden. The Conference kicked off with keynotes from Professor Philip Roe from the University of Michigan and ESI's Executive VP of Engineering Services, Mike Salari who spoke about "Strategy in the Age of Exponential Technology". The first two days offered sessions on optimization, thermal & heat transfer, and meshing & process control. Day three was aimed at experienced users of OpenFOAM wishing to learn more technical details, new functionalities, meshing best practices, and the geometry handling features available with the latest release.

ESI Forum in Germany (November)

ESI welcomed customers from Germany and abroad for this three-day event, held in Weimar. Attendees heard about the benefits of pre-certification, by virtually manufacturing, assembling and testing across multiple domains of required performance, physically realistic components and complete products. For the first time since the acquisition of ITI in 2016, the ESI Forum in Germany welcomed the creators and users of the multi-physics system simulation software SimulationX. Keynote speakers included Dr. Ralph Sundermeier, Volkswagen AG, who spoke on the Digital Transformation From the Automobile to Mobility and Dr. Vincent Chaillou, ESI Group who addressed Smart Virtual Prototyping and the concept of Hybrid Twin™.

ESI Forum in Japan (November)

ESI Forum (also known as PUCA) returned for its 27th edition. Held in Tokyo, the Forum provided participants with the opportunity to meet simulation experts

and discover how ESI is undergoing its own transformation to amplify its Smart Virtual Prototyping solutions and support the accelerating digital transformation at the heart of the Smart Factory. Offered with simultaneous interpretation of presentations in English and Japanese, the sessions focused on several challenging industry topics in Virtual Performance: from crash & safety to seat comfort and NVH and Dynamics. Topics in Virtual Manufacturing addressed composites, sheet metal forming, and welding and assembly. A special session for the community in Japan who use Scilab, the open source software for numerical

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"We discovered a new ESI which goes much deeper in our concerns for the next generation solution."

Anonymous
ESI Forum in North America

"Impressive event with great user range and high level depth of knowledge of presenters as well as exhibitors."

Felix Bauz, Volkswagen AG
ESI Forum in Germany 2017

support the goal of Indian industries to get ready for the Industry of the Future. ESI offered sessions for System Modeling tools, such as SimulationX and Scilab and special breakout sessions with ESI experts in Casting, Sheet Metal, Welding, Virtual Performance, Vibro-Acoustics, Virtual Reality and CFD.

computation sustained by the company Scilab Enterprises – acquired by ESI earlier in 2017 – added to the diversity of the event.

ESI Forum in India (November)

This ESI Forum took place in Pune, India and brought together ESI customers from an array of industries. Adopting the theme of "Virtualization – a Key Driver for the Industry of the Future", presentations focused on exciting new developments and innovation.

The Forum included dedicated sessions for the Automotive, Aerospace, Energy and Heavy Machinery Industries and explored how new technologies will

"From my point of view a mandatory event for users."
Jürgen Markgraf, Miele
ESI Forum in Germany 2017

"The ESI Forum in Germany 2017 was a well-organized conference which presented many relevant specialist topics and allowed me to establish contact with a lot of colleagues from within and outside my area of expertise."
Chistian Hunyar, Toho Tenax
ESI Forum in Germany 2017

more information on 2018 ESI Forums Worldwide
www.esi-group.com/forums

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ESI Showcased Smart Virtual Prototyping at CES 2018

Engineering Solutions for a Smart and Connected World

At the heart of the Smart Cities marketplace at CES 2018 help in Las Vegas in January ESI's booth featured live and immersive demonstrations showcasing how virtual reality (VR) and real-time physics-based computing can be used to fully experience a product, process, or venue remotely.

At CES Smart Cities, ESI illustrated the technological leaps accomplished in recent years using three main demos that give visitors a glimpse of tomorrow's smart and connected world.

Channeling the Smart Factory Experience

ESI also demonstrated the Smart Factory, in close collaboration with AP&T, a world leader in sheet metal forming, to offer visitors an immersive tour of a metal stamping press in action. The demonstration placed them in the heart of AP&T infrastructure and enabled them to visit virtually the various machines installed. This exploration of the AP&T production tool offered visitors the

Virtual Reality Makes its Opera Debut

Finally, ESI's booth offered a fully immersive virtual visit of the Opera House in Rennes, France. These 3D sessions exploited the latest version of ESI IC.IDO, and demonstrated how cutting-edge technology for VR, developed initially for engineers working on industrial projects, has unlimited applications, including for the arts.

Driving Autonomous Cars in an Immersive Smart City

The Twin Virtual Driver demonstrator allowed pairs of guests, equipped with VR head-mounted displays (HMD), to drive autonomous cars in a smart city; immersing themselves in the new world of greener and safer mobility. The participating drivers were able to interact simultaneously in the simulated environment while driving separate vehicles, in either fully autonomous mode or in conventional manual mode. Featured here was ESI Pro-SiVIC, ESI's platform dedicated to simulation of Advanced Driver Assistance Systems (ADAS) in real time, and thereby to the pre-certification of autonomous vehicles.

opportunity to observe and understand the complex engineering processes at a manufacturing plant. Exploiting ESI's latest technology for Immersive Virtual Engineering (IVE), the demo used an HTC Vive display headset system.

Users were able to visualize simulation data in an immersive 3D environment and interact with the Virtual Twin of the part in the press. The real time interaction was enabled using model reduction technology, and allowed users to visualize the influence of certain parameters on the quality of the stamped part.

"The immersive experience developed by ESI Group for the Opéra de Rennes may allow us to create an educational game to introduce the opera virtually to a broad audience, and especially to school children. It could also become a working tool, enabling technicians to try sets virtually or enabling show producers to appreciate the layout of the stage or theater."

Rozenn Chambard
COO
The Opéra de Rennes

for more information
www.esi-group.com/CES2019

ESI Shows Support for Aeronautics and Space Centers with its New French Office

ESI has opened its 8th French office in Colomiers, near Toulouse; adding to those in the Paris region, Bordeaux, Aix, Rennes, Lyon and Nantes. In doing so, the Group is continuing to amplify its business in the South West of France, making strategic investments, and demonstrating its growing presence in the aeronautics industry and its commitment to accelerating industrial digital transformation.

A strategic hub for France and Europe, the Toulouse region houses the headquarters of major OEMs and suppliers in the aeronautics and space sectors, including Airbus, ATR, Thales Alenia Space, Latécoère, Stelia Aerospace, in addition to companies like Safran, Daher and Ratier Figeac (Figeac Aero). The region also hosts various engineering and services companies – accounting for 40% of the French aerospace workforce, including main aeronautics and space R&D centers, and a strong research and education network.

With this new location, ESI is strengthening its links with the South Western ecosystem, promoting the value of Smart Virtual Prototyping for the industry, and demonstrating its cutting-edge solutions including Virtual Reality, Data Analytics, Connected Objects and more. The team in Toulouse will provide support to local customers and amplify the Group's relations with aeronautics and space OEMs, building on the numerous ongoing Research & Technology projects, specifically in the field of simulation of manufacturing processes.

> **for more information**
> **www.esi-group.com/Toulouse**

Meet ESI at the Following Events

May 13-18, 2018	**ESI Solidification Course 2018**	Intensive course for metallurgists and foundry engineers (27th Edition)	Les Diablerets, Switzerland
May 15-17, 2018	**MRW2018**	8th Microwave and Radar Week	Poznan, Poland
June 5-7, 2018	**Autonomous Vehicle Technology World Expo**	Intelligent Vehicles & Vehicle Concepts, Autonomous Driving, Sensors and Communication Systems	Stuttgart, Germany
June 14-15, 2018	**ESI Forum in China 2018**	Event by and for ESI customers, introducing the Hybrid Twin™, Product Performance Lifecycle™, and ESI's solutions for the Industry of the Future	Beijing, China
June 20-22, 2018	**26th 3D and Virtual Reality Expo**	Japan's largest exhibition of cutting-edge 3D technology and super high definition image technology, don't miss ESI Virtual Reality demo	Tokyo, Japan
July 11-13, 2018	**Automotive Engineering Exposition 2018 Nagoya**	One of the biggest Automotive Engineering events in Japan showcasing innovations and new technologies	Nagoya, Japan
August 27-29, 2018	**Internoise**	47th International Congress and Exposition on Noise Control Engineering	Chicago, IL, USA

> view all ESI events:
> **www.esi-group.com/events**

Awards Recognize ESI's Growth and Commitment to Corporate Social Responsibility (CSR)

Receiving the Technology Fast 50 prize in the "Midcaps – Paris Region" category is a fitting reward for the growth ESI Group has exhibited since 2013 (+29%). It reflects the success of the Group's Smart Virtual Prototyping approach, recently strengthened by a series of technology acquisitions. ESI's solutions meet the key challenges of the Industry of the Future by enabling industrial firms to virtually test their future products and control their operational performance.

Also in the news, for the second year in a row, ESI was awarded the first prize in the Gaïa Campaign for Midcaps with annual revenues under €150m. ESI maintains its rank in the index, which singles out the 70 top-rated companies in the Corporate Social Responsibility (CSR) domain.

"This affirmation of our CSR credentials for the second consecutive year is testimony both to our dedicated strategy in this matter and the commitment of our employees who deploy the strategy in line with our values. The technologies of the future that are currently revolutionizing industrial manufacturing, have to be underpinned by greater corporate responsibility. Companies will need to factor the CSR criteria right across their entire value-creation strategy."

Vincent Chaillou
President Edition Operations & COO
ESI Group

for more information
www.esi-group.com/fast50award
www.esi-group.com/gaia-award

Full Year 2017 Sales

A year of transformation & a return to growth

- Back to growth in Q4 2017 showing the way to sales recovery for 2018

- New Group's organization in line with the Hybrid Twin™ disruptive value proposition

- Continued investments related to the five-year plan "Objective 2020"

- Strong impact on 2017 results due to our major business transformation plan

"Our fourth quarter of 2017 marked a return to growth in Licenses at constant exchange rates. However, the strong investments in the Group's transformation, aimed at securing the success of the "Objective 2020" five-year plan, will substantially impact the 2017 EBIT. On the other hand, the reported rebound in Licenses bodes well for better sales momentum in 2018, supported by the benefits of the strategic investments and management reorganizations made over the last two years. Our new value proposition, based on the Hybrid Twin™, aims at supporting our customers on predicting their products' performance and piloting once in operation. This approach has required an in-depth adaptation of our marketing strategy as well as a new alignment of our sales and support teams. Meanwhile, the excellent performance of our Virtual Prototyping core business should continue to boost ESI's competitiveness in 2018 as the manufacturing industry experiences an unprecedented and accelerated change driven by the demands of the 'Smart Factory' and of the 'Outcome Economy'."

Alain de Rouvray
Chairman & CEO
ESI Group

for more information
www.esi-group.com/company/investors/news/full-year-2017-sales

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