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Additive Manufacturing: Revolutionizing How Products Are Made

special report



Vesta Engenharia Compensates Severe
Springback Behavior with ESI PAM-STAMP



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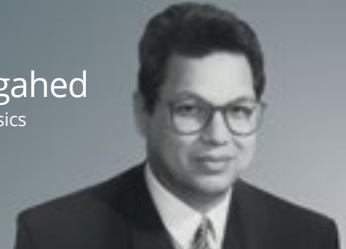
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Editorial

Dr Mustafa Megahed

Manager of CFD & Multiphysics
Center of Excellence,
ESI Group



Additive Manufacturing, more commonly known as 3D Printing, has been enjoying constant exposure in the media over the past 3 years. In February 2015, Rolls Royce¹ made the headlines with its first flight test of the largest-ever 3D printed component, developed for Airbus. In June, General Electric² announced the first 3D printed jet engine nozzle at its Alabama plant. These events cause us to ask: Is 3D printing in the process of changing the shape of the manufacturing industry?

Additive Manufacturing (AM) is widely used for the manufacture of consumer products and plastic prototypes for engineers and designers. But when it comes to using Additive Manufacturing (AM) to mass-produce a critical metal-alloy part, it is another story... While the unique processes and technologies of Additive Manufacturing open up new doors for innovation and offer a range of logistical, financial and technical advantages, 3D printing techniques are still in their infancy and face limitations and challenges.

It is in the context of the high level interest and evident challenges that we chose to explore the topic in our special report entitled "**Additive Manufacturing: revolutionizing how products are made**" on pages 4-7. There we address its numerous advantages, limitations, and explain how ESI's expertise can benefit AM players. You will learn about ESI's multi-scale, multiphysics solutions, developed specifically to characterize the physics associated with AM processes.

Additive Manufacturing is expanding, and ESI is well positioned to support companies as they seek to integrate and better understand the innovative manufacturing options it offers.

¹ Sarah Anderson Goehrke (February 19, 2015), 3Dprint.com. Rolls-Royce to Get Largest-Ever 3D Printed Component Off the Ground, Flight-Testing Engine Later This Year. Available on: www.3dprint.com/45820/rolls-royce-largest-3d-printed

² Ike Pigott (June 18, 2015), Alabama Newscenter. GE Aviation readies first 3-D printed jet engine nozzle at Alabama plant. Available on: www.alabamane.wscenter.com/2015/06/18/ge-aviation-readies-first-3-d-printed-jet-engine-nozzle-at-alabama-plant

Additive Manufacturing

Revolutionizing How Products Are Made

The global Additive Manufacturing (AM) market reached 4.1 billion USD in 2014 with an impressive 30% year on year growth¹. Market analysts expect double-digit growth in the coming years also, as industrial sectors including aerospace, automotive and medical all seek to use and benefit from the advantages of AM technologies. Nevertheless, Additive Manufacturing — commonly referred to as 3D printing — does come with challenges! Adopters of AM are struggling to achieve the production volumes and quality required to compete effectively with conventional manufacturing processes. On its part, ESI recognizes the huge potential of Additive Manufacturing and, in the framework of several large collaborative projects, has developed a suite of tools addressing design challenges and process optimization. Our objective: to enable designers and manufacturers to benefit fully from the potential that AM offers in many applications.

Metal Additive Manufacturing – an overview

Additive Manufacturing enables digital 3D design data to be physically created by building up layers of deposited material. Metal feed stock is fused to form layers using different heat sources, including lasers, electron beams and arc discharges, to build solid objects.

Metal AM technologies include powder bed, blown powder and wire feed processes. Powder bed systems melt a deposited metal powder using a laser, or an electron beam. In blown powder technologies, a metal powder is blown coaxially with a heat source, which melts the particles so that they adhere to a base metal to form a metallurgical bond when cooled. Wire feed systems allow for the highest deposition rates and are usually used for very large components. Here we focus on powder bed and blown powder technologies, but the underlying considerations are universal.

What advantages does AM bring to manufacturers?

Additive Manufacturing offers unrivalled design freedom and customization, as manufacturers can produce parts of virtually any shape.

Objects with new levels of geometric complexity can be created, delivering the opportunity to achieve functional designs that are impossible, impractical or very costly using conventional manufacturing methods.

Used in the production of metal parts, AM offers manufacturers the ability to create novel, lightweight designs, potentially with fewer number of parts. Tooling can be reduced and there is the potential to move to one step production, even of very complex parts.

And what are the associated challenges?

Application of AM technology is hampered by slow build rates, high production costs, and the need for post-build treatments to address dimensional inaccuracies, residual stresses, metallurgical properties and the quality of surface finish. Management of feed stock quality, recycling and energy consumption are some of many other challenges.

“The lack of standardization, design rules, repeatability, production speed, and quality control significantly hinder the expansion of 3D printing. Computer simulations can be a great asset in overcoming these challenges.”

Dr Mustafa Megahed,

Manager of the CFD & Multiphysics Center of Excellence,
ESI Group

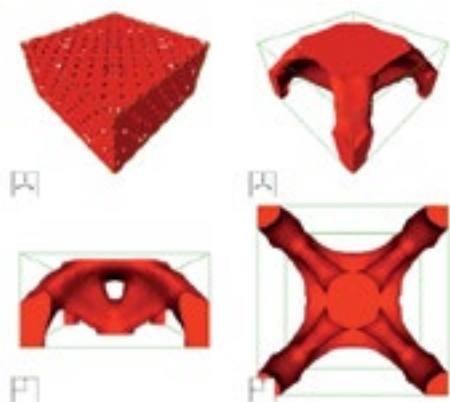
Advanced Topology Optimization Tools

As discussed, AM enables the manufacture of parts with large level of geometrical complexity. To realize the full benefit of that important attribute, ESI Group has developed advanced topology optimization tools that take into account both functional and manufacturing constraints.

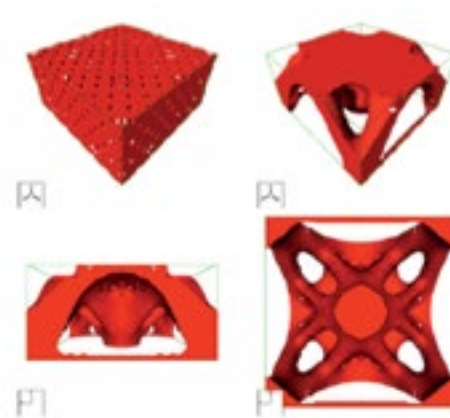
Let's take the example of a designer who wants to create a product with minimum weight, while sustaining certain functional loads. ESI's tool will create an optimal design that fulfills both functional and other requirements while additionally addressing manufacturing constraints such as minimum wall thickness.

ESI's solution is based on tracking surfaces – not material densities – and thereby enables users to define manufacturing constraints and cost functions, in addition to the functional constraints for the final product. Understanding such constraints is vital to obtain producible structures using the AM process.

Also, ESI has successfully demonstrated the ability to transfer the optimized topology back to CAD for geometry processing.



This example shows a topologically optimized component. The difference between the design here and the one below is driven by wall thickness constraints (maximum thickness 0.6 units). The results provide smooth surfaces, directly prepared for CAD return, fulfilling load constraints and cost function within the manufacturing wall thickness limitation.



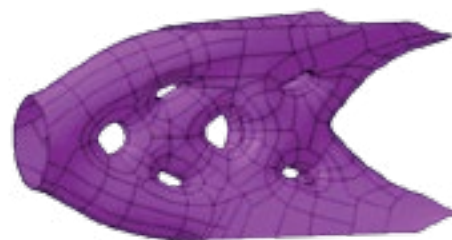
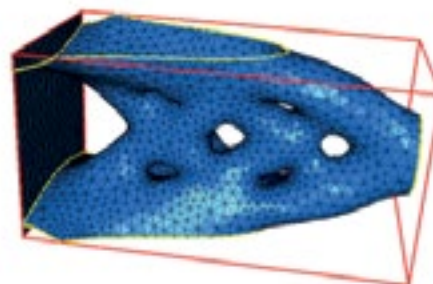
Assuming a change was made in the machine or the AM process, limiting the maximum thickness to 0.4 units, the optimization tool would take this change into account by creating a similar geometry, with each leg replaced by 2 ribs. Return to CAD would be again directly possible for further validation and certification of the design.

Additive Manufacturing Process Modeling

All AM technologies involve the use of a heat source to interact with a feed stock of material particles.

The heat source only interacts with the powder particles for a few microseconds, but the total build time can last several days. Powder particles are in the order of a few microns, whereas the total deposition track can be hundreds or even thousands of meter long. Such multi-scale problems can be a challenge to simulate! Addressing that challenge, ESI has developed a multi-scale, multiphysics solution to characterize the physics associated with AM technologies.

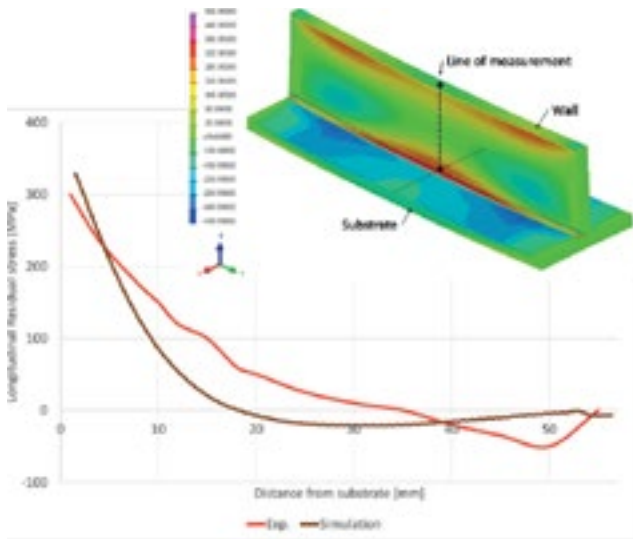
Mustafa Megahed, comments: *"In particular, when simulating AM processes, you are dealing with particles in the order of 10 microns in diameter, a work piece several centimeters long, and a laser path that could be as long as a kilometer. If you were to simulate that all at once at the same level of detail, it would take more computing power than current high performance computing can handle."*



Up: Topologically optimized beam. Down: CAD return of topologically optimized geometry.

Another major challenge of all Additive Manufacturing processes is to produce parts to specification in spite of porosity and residual stresses accumulated throughout the build process.

Quick models, which calculate the thermal history of the work piece, are key to produce accurate thermo-mechanical predictions. However, ESI has taken the next steps by validating state of the art thermo-mechanical models that are sensitive to the deposition strategy.



Residual stress predictions compared with neutron diffraction results (ESA, ESI, Irepa Laser, AMAZE - FP7 project).

Powder Bed / Direct Metal Laser Melting (DMLM)

The DMLM process involves layer-by-layer shaping and consolidation of a powder feed stock to arbitrary configurations.

To improve Additive Manufacturing production rates, the laser power is increased to enable faster scanning. Thicker powder layers are also preferred to increase deposition and, at the same time, reduce the number of deposition layers. Laser beams with a large diameter are also used to melt wider tracks. However, these control parameters interact in a very complex manner. For example, increasing the laser power may lead to a significant evaporation of the molten metal, while increasing the scan speed reduces the interaction time between laser and powder particles, which may in turn lead to reduced melting and lack of fusion.

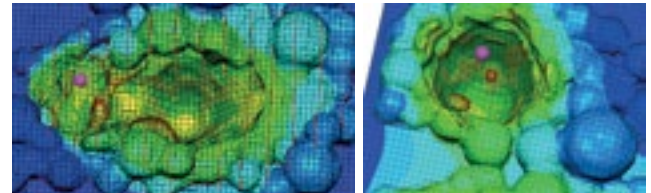
Furthermore, energy densities required for DMLM lead to a significant accumulation of residual stresses and distortions during the build process. Unfortunately, today these complex interactions are not mapped or understood in detail and therefore require cumbersome trial and error research to ensure high quality production.

Addressing these complexities directly, ESI has developed high fidelity models that account for powder feed stock coating and heat interaction with the powder particles. These models enable manufacturers to identify optimal process parameters to achieve high material density.

ESI also delivers simulation results related to the thermal cycles applied to the material, and the corresponding evolution of residual stresses during the build process.

Within the framework of the European project AMAZE, ESI studied the characteristics of a titanium alloy, as processed by a commercial machine that modulates the laser with specific exposure times.

The images below show the impact of different process parameters on material densities and the underlying simulation provides explanation for the gaseous enclosures observed in experimental specimens.



Powder Bed Fusion melt pool analysis
 Left: Example for process parameters leading to high material density.
 Right: Example for process parameters leading to gas enclosures in melt pool and high porosity (AMAZE - FP7 project).

In addition, ESI has collaborated with 3D Systems, originators of 3D printing and leaders in 3D design and digital fabrication, to extend knowledge about coating processes and how they affect the powder bed distribution prior to processing.

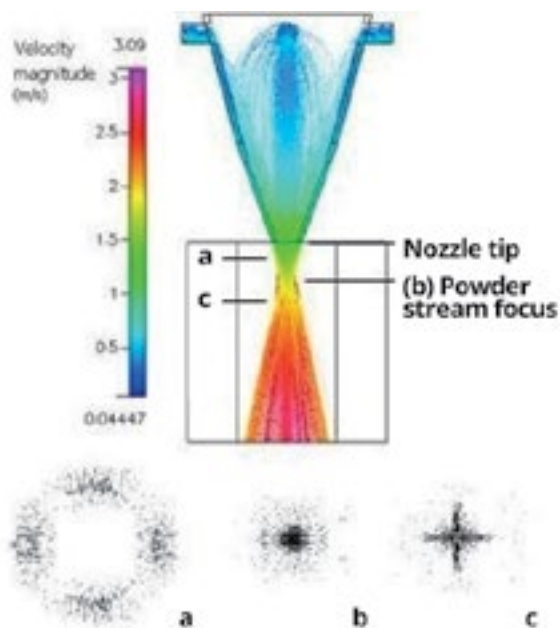
This joint research is aimed at defining processes that deliver fully dense metal parts that can be used for the most demanding applications and perform at levels equal to or greater than traditionally manufactured parts. The collaboration with 3D Systems leverages the company’s line of ProX Direct Metal Printers (DMP) and has demonstrated how tandem innovations in software and hardware are needed to take Metal Additive Manufacturing to the next level. Taking a very practical example, 3D Systems’ DMP line offers a unique compacting roller system that provides greater precision for coating each layer. Combined with ESI’s simulation solutions, that capability has the potential to provide a level of control and accuracy in metal AM that has not been achievable before.

Such advances will, in turn, enable the emergence of new applications and accelerate adoption of these technologies.

Blown Powder / Laser Direct Metal Deposition (LDMD)²

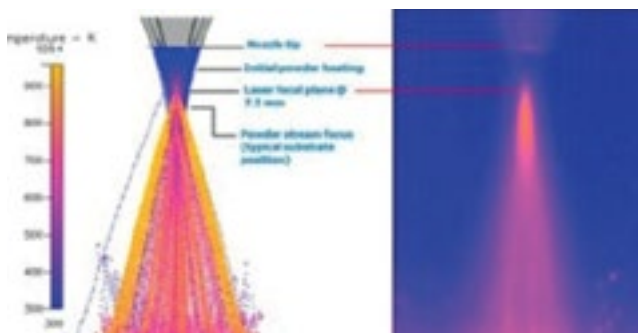
LDMD printers have a nozzle with two functions: to deliver powder particles and to direct the heat source melting the particles so that they adhere to the substrate. The nozzle-to-substrate distance needs to be optimized

to control the particle deposition pattern, and the laser's speed must be optimized to control the melt pool dimensions and material properties.



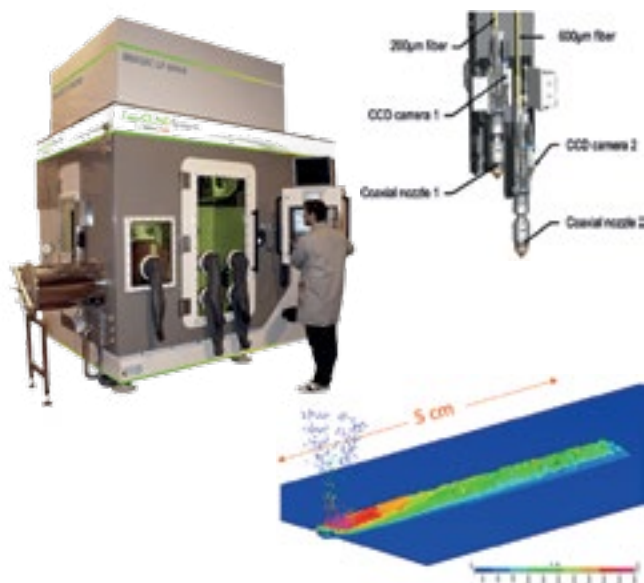
Powder Stream simulation and deposition patterns based on nozzle substrate distance ("a" close, "b" focused, "c" far). Courtesy of ESI and University of Manchester.

Within the framework of the European project INLADE, ESI developed and validated models, in collaboration with the University of Manchester, to describe how powder particles absorb and scatter the laser energy.



Comparison of thermal distribution and powder in-flight. Simulation has good correlation to reality. Courtesy of ESI and University of Manchester.

"The micro scale models of the LDMD simulation deal with the powder trajectory and the thermal cycle of the melt pool," explains Megahed. "The micro scale simulation is used to optimize the nozzle and process parameters to influence the melt pool shape, avoiding porosities or built defects. The thermal cycle is obtained as a by-product and is utilized in macro-models to determine the corresponding residual stresses," Megahed continues.



Laser Direct Metal Deposition Machine – Courtesy of IREPA LASER – and Ti-Al6-V4 bead shape for certain powder feed rate, nozzle translation velocity and laser power.

Conclusion

Many challenges must be addressed before the great potential of Additive Manufacturing can be fully exploited by manufacturers. The range of benefits is huge: "Companies benefit from the flexibility that Additive Manufacturing brings to their manufacturing line," comments Dominique Lefebvre, Product Management Director at ESI Group. "Indeed, a factory can switch or relocate its production overnight as 3D printers allow for the manufacture of infinite types of parts and require minimal tooling. The benefit is not only for the initial production but also for repair of parts."

ESI's software is improving the design processes and process control technologies behind AM. It's not a case of *if* AM will achieve the total production volume targets that the machine tool industry demands, but *when*. Lefebvre adds: "To ensure a robust process and parts that meet the manufacturer's specifications, Virtual Manufacturing simulation is needed. While AM is in many aspects more complex, numerical simulation can deliver the right answers, just as it does for many other manufacturing processes."

Article produced in collaboration with



¹ 2015 Wohlers report. Available on: www.engineering.com/3DPrinting/3DPrintingArticles/ArticleID/9908/The-2015-Wohlers-Report-Is-Out.aspx

² Shawn Wasserman (May 28, 2015). In collaboration with www.engineering.com. Metal Additive Manufacturing Optimized Via Simulation Solution. Available on: www.engineering.com/DesignSoftware/DesignSoftwareArticles/ArticleID/10176/Metal-Additive-Manufacturing-Optimized-Via-Simulation-Solution.aspx

3 Questions for...



Dr. Alonso Peralta

Principal Investigator, Honeywell

In charge of the DARPA Open Manufacturing Program

Could you give us some insights into the research projects you are working on in relation to Additive Manufacturing?

I work on several Additive Manufacturing (AM) programs; the majority of them dealing with technology development. The biggest current program is related to the DARPA Open Manufacturing (OM) initiative. Its goal is to develop Integrated Computational Materials Engineering (ICME) tools and methodologies supporting the application and acceptance of AM technologies in the aerospace market. The end goal for ICME is the certification or qualification of components by regulatory agencies. This drives us to work on AM process modeling (including melting and solidification), material property models (predicting properties such as yield and ultimate strength), and experimental techniques (for example, recording the thermal response of the melt pool). We also need to quantify uncertainty as we apply the ICME tools.

Why have you chosen to collaborate with ESI on the DARPA Open Manufacturing program?

ESI brings expertise in manufacturing process modeling. For many years now, ESI has offered a suite of manufacturing process simulation tools. In fact, the company was already working on modeling Additive Manufacturing processes before we joined forces for the DARPA OM program. Modeling AM processes requires a broad range of simulation capabilities, addressing heat

transfer, fluid flow, phase changes, residual stress modeling, and more. ESI had already made essential developments before we started working together and now applies these to AM.

How do you simulate AM processes?

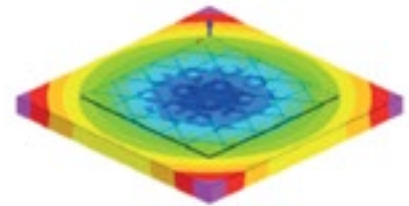
Three important models are at the heart of AM processes simulation:

- First, the powder spreading model that is used to gain insight into why powders can be difficult to spread on a fresh build plate and also to acquire an understanding of the powder packing density upon recoating. Such insights could not have been gained easily without Additive Manufacturing simulation tools. We believe these tools help us understand the powder particle size distributions needed for enhanced spreadability of the powder and to achieve better packing density in the powder bed. We are also looking forward to understanding the build thickness needed to prevent recoater arm crashes and to minimize vibration caused by interaction of the rough surface of the new build with the powder during the spreading process.

- Second, the micro model for melting and solidification, used to identify the conditions under which the three different types of porosity found in metal Additive Manufacturing can occur. It is also used to confirm the occurrence of gas porosity, which would be very difficult to confirm experimentally. We are currently analyzing a large amount of modeling data that matches experimental observations but doesn't always

confirm our expectations. The models are now explaining many of the observations we obtained and are on the verge of guiding process window identification.

- Finally, the macro model to predict the residual stresses of the 'as built' component. This is very useful as we have been able to show that residual stress and deformation are a function of the build conditions and also of the build pattern. For example, we have learned that the residual stresses are not equi-biaxial, which may prove to be important when building slender structures as excessive deformation from layer to layer could lead to unacceptable departure from the intended geometry.



As-built distortion simulation using ESI software.

About Honeywell

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Vesta Engenharia Compensates Severe Springback Behavior with ESI PAM-STAMP

Vesta successfully creates parts within the required tolerances on the very first try



Vehicle bumper.

Vesta Engenharia was founded in 2011. It is part of the Aethra Group; one of the largest manufacturers of high quality automotive components in the world.

Recently, during the manufacturing of a stamped vehicle bumper, Vesta Engenharia's engineers experienced the largest springback they faced to date. The effect was associated with use of a dual phase steel material: a high-strength steel with both a ferrite and a martensitic microstructure.

To quickly meet the challenge – as well as to avoid costly trial and error iterations and unnecessary scrap on the shop floor - Vesta Engenharia's team studied ways to stabilize the part and improve feasibility. As they routinely used PAM-STAMP (ESI's sheet metal forming simulation solution) for springback compensation, they had the experience needed to move quickly.

Using ESI PAM-STAMP, the engineers confirmed that a +/-10mm maximum deviation compared to the nominal part should be expected. Such a high value was a shock, but considering the possible impact of the characteristics of the dual phase material and their good experience with PAM-STAMP, the engineers decided to accept the results and to compensate for the large deviation. Accepting the prescribed +/-13mm die compensation was a brave step as had the springback simulation results been wrong, the

revised tool would have completely gone to waste.

After modifying the tool, Vesta immediately achieved results that were consistent with the PAM-STAMP prediction. The springback effect was managed and the part was kept within the tolerance, allowing Vesta Engenharia to avoid any further, costly, time-consuming tool modifications on the shop floor.

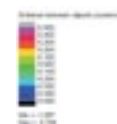
"Successful springback compensation is the result of a stable and robust process, knowledge of the product demand and a good understanding of the software results."

Bernardo Perillo,
Ricardo Micheletti Viana,
Wellington Caetano Soares,
Mechanical Engineers,
Vesta Engenharia

Getting it right the first time eliminated hours of rework and raw material scrap associated with trial and error, as every design correction loop takes approximately 110 hours.



Initial distance between part geometry and springback.



Final distance between part geometry and springback, after tool compensation.

About Vesta Engenharia

Vesta Engenharia is an independent company which aims to provide high quality services in many fields of engineering such as automotive, aerospace, mining and metallurgy, electronic and automation, naval as well as engineering for renewable energy and steel.



for more information
www.esi-group.com/pam-stamp
www.aethra.com.br/br/vesta/

MAN and the University of Applied Sciences Upper Austria Design a Truck Assembly Line using IC.IDO

Improving their manufacturing process from the early stages of product development, before the manufacturing facility is built



In today's rapidly globalizing market environment, leveraging innovative virtual product engineering technologies has become a necessary precondition to sustain and improve competitiveness, growth and quality standards for commercial vehicle OEMs and their suppliers. Virtual Reality is a key enabler in making this possible!

Back in 2010, MAN strived to create a more efficient design for a truck assembly line. In an initiative to improve its assembly processes and to better anticipate the assembly/disassembly sequences, they decided to implement Virtual Reality into their planning process.

MAN approached the University of Applied Sciences Upper Austria, Campus Steyr, to collaborate on the project. Having a Virtual Reality CAVE on-site, the University had already gained some expertise in the area. However, the solution they used at the time wasn't able to handle a sufficient quantity of data to render a smooth, real-scale, real-time and immersive experience of the product. Dr. Franz Obermair, Professor at the University, reviewed with his team different VR top players on the market. After careful review they selected IC.IDO, ESI's Virtual Reality solution, noting its usability, capacity to reproduce realistic physics, and real-time collision detection — attributes essential for MAN to achieve their objectives of this project.

Implementing ESI IC.IDO was very simple and the solution was quickly accepted by the operators, management, and subcontractors alike. MAN soon

"With rapid data preparation in virtual reality workshops, powerful assembly functionalities and user friendliness, ESI's IC.IDO proved to be the right choice for this collaboration. IC.IDO's usability, physical calculation and real-time detection of parts colliding during the assembly process matched MAN's needs. Not to mention, what previously took us two weeks could now be completed in just one day."

Dipl.-Ing. (FH) Franz Obermair,
Professor,
University of Applied Sciences,
Upper Austria

realized that IC.IDO was more than just a virtual assembly planning tool. It was a collaboration and communication platform where different stakeholders could share their knowledge and expertise.

Once all the new users had become familiar with Virtual Reality, two main benefits of using IC.IDO became immediately apparent. First, the designers, operators and subcontractors were able to exchange views about the 3D prototype even before the manufacturing facility was built. Second, it helped the factory builder anticipate the needs of

MAN so as to operate with the highest possible level of efficiency.

MAN and the University of Applied Sciences Upper Austria were thus able to reduce the time to launch and also the cost by bringing line testing operations down from two weeks to one single day. Today, by being able to correct errors in the design phase rather than on the actual assembly line, they achieve and even higher return on investment.

Dr. Obermair's future goal is to make assembly operations even more realistic by application of new tools and techniques, such as Mixed Reality and force feedback. Instead of just seeing the environment in 3D, real "tracked" assembly parts and tools can be used in a virtual environment in which real components are combined with virtual ones; achieving an even higher level of reality before any physical build of a plant.

Right now, Dr. Obermair believes that IC.IDO is the most user-friendly solution available and appreciates its ability to simulate large scale assembly/disassembly sequence optimization processes. With Mixed Reality and force feedback as part of the future, only time will tell what other benefits MAN can reap by continuing to invest in IC.IDO.

About MAN Truck & Bus Österreich AG

MAN Truck & Bus Österreich AG (MTBÖ), based in Austria, manufactures light and medium truck series as well as cabs and components. It also covers the areas of After Sales, Academy and Research and Development for all series and components in MAN's interlinked development network.



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MVC and PPE Get it Right at the First Try with ESI's Composites Simulation Solution

Manufacturing a large composite part in as little as five weeks



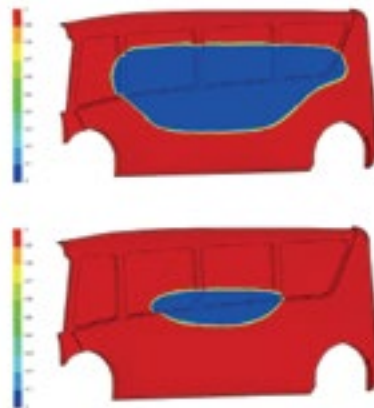
MVC Soluções em Plásticos (MVC), a Brazilian company specializing in composite materials and processes, were challenged when they needed to produce a 13-foot long side panel for a bus in lightweight composite material. Not only was manufacturing such a large component challenging, but the part had to meet demanding requirements for quality of appearance and structural robustness.

In order to avoid multiple costly tooling, it was important that MVC manufacture this part in a single run. Furthermore the injection time should not exceed a few minutes; a condition necessary to prevent dry spots and to maintain an efficient production cycle time.

Achieving this manufacturing challenge called for the expertise of Pôle de Plasturgie de l'Est (PPE), a French technical center specialized in the development of manufacturing processes for composite parts. By relying on PPE for their experience with Liquid Composites Molding (LCM) and using PAM-RTM – ESI's solution for simulating Resin Transfer Molding processes – MVC was able to get the high-quality part they needed on the very first try.

The combination of the right numerical simulation solution and the right partner enabled MVC to minimize the risk of production defects or delays. It helped MVC ensure that they would deliver the right part on time and to the satisfaction of their client. From start to finish, they

were able to bring their part to life in as little as five weeks.



Resin flow pattern during injection.

In addition to their expertise in Liquid Composites Molding processes, including Light Resin Transfer Molding (LRTM), PPE also contributed know-how in the measurement of reinforcement permeability, a key process parameter. Indeed, PPE had developed a fully integrated permeability bench, EASYPERM, able to make permeability measurements through a central injection and to automatically process measurements to create a material file in PAM-RTM format.

The part for the bus was nearly 13 feet long and 6.5 feet tall. PAM-RTM was used right from the start to define the best injection strategy, including the location of injection gates and vents and the

injection pressure. PAM-RTM also enabled MVC and PPE to optimize the mold design. With the input from simulation, a peripheral injection strategy with an inner injection channel was identified as the most appropriate.

Ultimately, MVC and PPE were able to develop a high quality part with an injection time in the range of 15 minutes. They succeeded in achieving all of the goals they had set for this project.

This was possible because PAM-RTM gave them the ability to test their initial mold design, to determine the best injections strategy, and then to optimize the product quality before any prototype was built. Both partners played a pivotal role in the successful outcome; meeting all specifications on the first try.

"In this project, the RTM simulation helped us secure and optimize the process. Today, we are using ESI's PAM-RTM not only to assess process parameters, including injection time and pressure in mold, but also to fine-tune mold design."

Jérôme RAYNAL,

Sales and Export Director,
Pôle de Plasturgie de l'Est (PPE)

About MVC

MVC develops products with complete and customized solutions for the automotive, transportation, agribusiness, wind power and construction markets.

About PPE

PPE is a technical center specialized in Liquid Composites Molding technologies, pioneer in process simulation and permeability measurements.



for more information
www.esi-group.com/composites
www.mvcplasticos.com.br | www.ppe-composites.fr/

TACHI-S Adopts ESI's Virtual Seat Solution to Evaluate Seat Performance

How the seat maker's testing department responds to the increasing sophistication of seat safety, shortens development time, and reduces costs associated with testing



From left to right: Mr. Inoue, Manager of CAE section, Testing department; Mr. Takagi, Testing department General Manager; Mr. Uchino, Engineer in the CAE section, Testing department; Mr. Okano, Manager of CAE section, Testing department.

The seat is a key component of a car's interior. "The first thing that catches your eye as you open a car door is the seat, which is why its design is very important," explains Mr Uchino, Engineer in the CAE section, Testing department at Japanese firm TACHI-S. "Another reason the seat is so important, is that it's one of the only components with which the driver is in constant contact. This is what makes it worth doing this job. I want to produce the best car seat with a high degree of credibility."

Seats are designed and produced to satisfy a wide range of requirements: comfort, touch, maneuverability, ergonomics, safety, durability, and reduction of vibration — a most critical factor for long journeys.

Since its establishment in 1954, Tachi-S, an independent Japanese car seat maker working for major automotive OEMs, has been recognized for the reliability of its car seats and its inspired designs. To respond to worldwide customers' needs

and demands, Tachi-S has started in the last few years to establish new production plants around the world, including in Asia, North, Central and South America, and Europe.

The multiplicity of seat models, seat variants and evolving safety requirements for various markets generate increased complexity for seat manufacturers.

For the TACHI-S Testing Department challenges are numerous, starting with the huge variety of car seats required to have equipment adapted to the car style and category and to deliver the expected options.

For example, Mr. Takagi, Testing Department General Manager, explained to us the typical requirements for a sports car seat: "Seat design plays a key role in buying

intention. A sports car is expected to deliver improved driving performance and at the same time, be stylish. Therefore, low center of gravity, low vehicle height and weight savings are essential. For these reasons, seats have to be thin and light. On the other hand, stiffness is required to hold the driver in place when, for example, a winding road may impose a high turning gravity on the driver. Based on these factors, seats for sports cars are usually stiff and firm."

Automotive seat manufacturers face continuous challenges as the number of seat variants multiply with local market specifications. Seat safety is addressed in the New Car Assessment Program (NCAP),

"At TACHI-S, we have successfully reached greater design targets, fulfilled safety requirements, and improved overall quality in trial phases by adding Virtual Seat Solution into our seat development process. Because there are more than 300 mechanical elements in one seat, using virtual seat prototyping at the early stage has greatly shortened the development time."

Mr. Inoue,
 Manager of CAE Evaluation Section,
 Test Engineering Department,
 TACHI-S

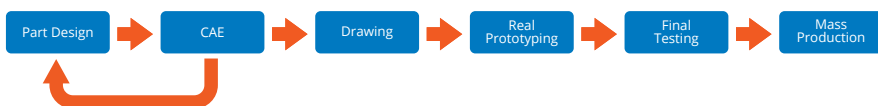
Before using virtual prototyping

Long development time and considerably high testing costs were needed in the trial phase.



After using virtual prototyping

Development time and testing costs are reduced by the use of virtual prototyping.



Reducing the number of prototypes and cost.

which originated in the United States in 1979, and in corresponding programs in Japan (JNCAP) and Europe (Euro NCAP). In recent years, a new set of tests has been introduced in NCAP to assess the performance of seats in relation to whiplash and the risk of associated neck injuries in low severity rear impacts.

Using Virtual Prototyping has helped TACHI-S achieve enhanced design targets, and to successfully fulfill safety requirements.

Since 2010, TACHI-S Testing Department has used ESI's multi-domain simulation software, Virtual Performance Solution, for crash simulation and for testing in other performance domains. Recently, TACHI-S started using ESI's Virtual Seat Solution to help them achieve NCAP whiplash seat certification and efficiently deliver the required safety levels to TACHI-S customers. The solution has greatly helped TACHI-S refine its processes across multiple domains.

"Seat crash performance must be evaluated with the occupant seated in a realistic position. Being able to predict the exact sitting posture of the dummy with ESI's Virtual Seat Solution has improved the accuracy of our crash and safety prediction. It is a big step towards decreasing the number of real prototypes we have to build and test."

Mr. Okano,

Manager of CAE section,
Testing department,
TACHI-S

A practical use case: reducing whiplash injury thanks to seat design

The JNCAP protocol includes both a static and a dynamic evaluation for neck injuries. The starting point consists in seating an H-Point dummy equipped with a Head Restraint Measuring Device (HRMD). This device is used to locate the H-Point, and adjust the backrest to match the design position of the head restraint with respect to the head.

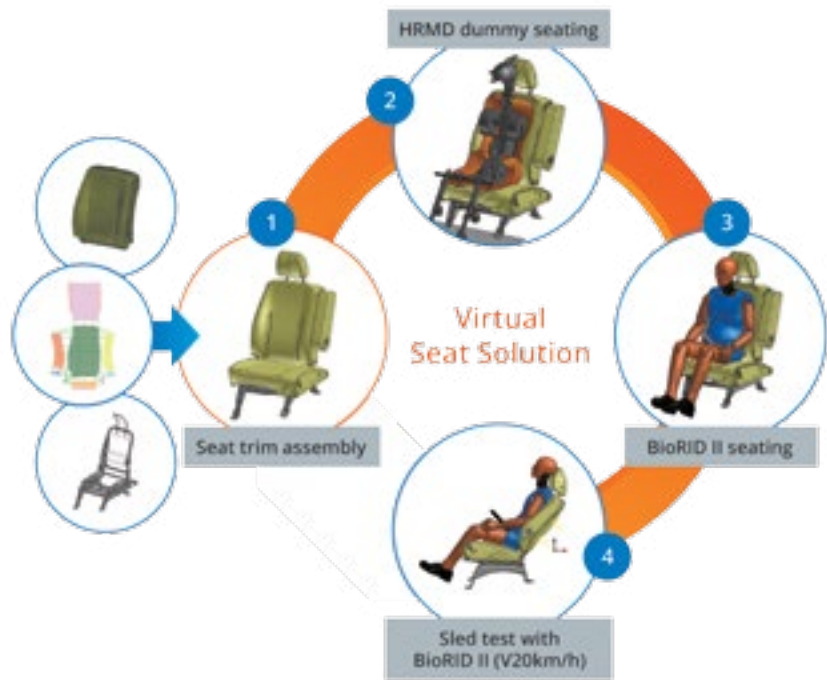


Illustration of the process followed by Tachi-S teams, from predicting seat model assembly to evaluating the seat's static and dynamic performances.

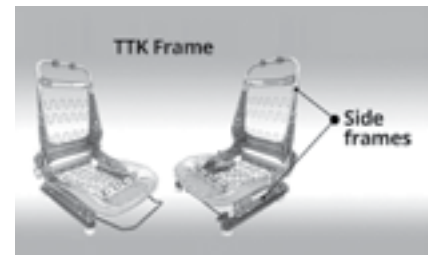
These preliminary static measurements, performed with the HRMD, ensure the correct initial position for the BioRID II crash dummy, as the position has a significant influence on the dynamic sled test result and the overall score.

TACHI-S decided to review its process and perform virtual whiplash performance tests, according to the JNCAP protocol. This enabled them to evaluate neck injury value before completing the actual JNCAP assessment.

TTK (Tachi-S Teian Kokkaku): a new generation of seat frames.

Having mastered the complexity of seat safety requirements with the help of ESI's Virtual Prototyping solutions, Tachi-S started offering in 2012 a new improved standard car seat: the "TTK frame". This safe, lightweight, and compact seat provides exceptional versatility to car makers around the world.

Providing the basic framework, the TTK frame includes function and performance that satisfy the requirements for various seat configurations. Manufacturers are



able to make a variety of car seats by changing as little as one component of the overall seat structure to achieve their design objectives and thereby reduce manufacturing time and cost.

ESI would like to thank the Tachi-S team for their contribution to this article.

About TACHI-S

TACHI-S, established in 1954, offer car seats which provide reliability and inspiration, as well as seat components, to domestic and foreign car makers alike, including: NISSAN MOTOR CO. LTD., HONDA MOTOR CO. LTD., TOYOTA MOTOR CORPORATION, HINO Motors LTD.



for more information
www.esi-group.com/virtualseat
www.tachi-s.co.jp/en

Renault Runs a Crash Optimization Study with a Car Model of 20 Million Elements

Demonstrating the capability of ESI Virtual Performance Solution to deliver the next generation of Virtual Prototypes

With increasing vehicle complexity and the need for faster innovation, car manufacturers call for predictive virtual prototypes that enable faster design iterations and optimization studies.

Renault and ESI, after several years of fruitful collaboration, participated in a research project aimed at driving the evolution of current numerical methods towards the next generation of Virtual Prototypes. Using much more detailed and refined models (up to 20 million elements) and encapsulating enhanced physics, it is becoming essential to achieve faster turnaround time by benefiting from high performance, massively parallel computers (up to 1000 cores). To explore this evolution, Renault and ESI used Virtual Performance Solution (VPS), ESI's solution dedicated to performance prediction in multiple domains, including crash.



Renault's research teams studied a frontal crash of a Dacia Lodgy, a vehicle already on the market. The objectives were to determine the benefit of increasing the model's discretization and to test optimization methods on large scale models, while increasing the number of optimization parameters.

For the first time, Renault was selected by the Partnership for Advanced Computing in Europe (PRACE), a pan-European Research Infrastructure promoting several projects of exceptional scientific excellence each year. Consequently, Renault, ESI, the Ecole Centrale of Lyon and the Ecole des Mines in Saint-Etienne were awarded 42 million calculation

hours on the CURIE supercomputer of the Très Grand Centre de Calcul (TGCC) – the largest computing center in Europe, located in the Paris region. This was the largest allocation ever awarded by PRACE to an industrial consortium and provided the project teams with opportunity to conduct the largest vehicle optimization study ever launched.

The first and essential achievement was the implementation of a stable computation model that could be readily updated with improved modeling of different vehicle elements, including body, plastic trim (bumpers), suspension systems, and engine. The refined model (with an element size of 2mm instead of 5mm) captured some very important physical phenomena which could not be addressed by previously existing models. For the optimization study, which addressed mass and costs reduction constraints, Renault added an important industrial requirement, namely maximum reuse of components from previous vehicles. Several hundred simulations were performed and it proved to be possible to achieve significant mass reduction while reusing about 80% of the parts.



Parts included in the optimization study.

The project was completed successfully and demonstrated the possibility and the value of such refined models for automotive engineering. Renault is now convinced that this scale of numerical models will soon become standard. ESI has proven that Virtual Performance Solution is able to handle large scale models and is ready to deliver more accurate results for optimization studies in a practical timeframe.

"This project was a success essentially due to the close collaboration between Renault and ESI. It brought to light the outputs and benefits linked to large size models for crashes. We were able to handle the challenges tied to the model's creation and its use within an intensive context, such as optimization."

Marc Pariente,
Numerical Simulation Trade Specialist,
Renault SAS

This unique partnership was recognized by the prestigious HPCwire Best Use In Automotive Industry "Readers' & Editor's Choice" award, distributed during the Super Computing 2014 event.

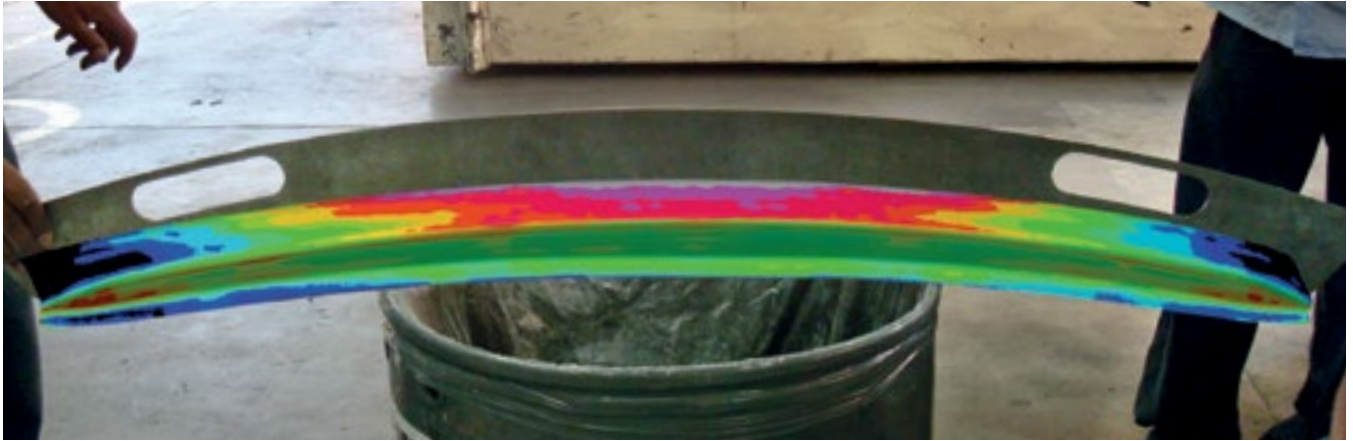
About Renault

The Renault group, founded in 1898, is an international multi-brand group, selling more than 2.7 million vehicles in 125 countries in 2013, with 36 manufacturing sites, and employing more than 117,000 people.

 for more information
www.hpcwire.com/2014-hpcwire-readers-choice-awards/5/
www.esi-group.com/VPS | www.group.renault.com/en

ESI releases PAM-STAMP 2015

Enabling Die Engineering and Sheet Metal Forming from Concept to Production



From simulation to reality: thanks to PAM-STAMP, customer Aethra manages to compensate significant springback effects.

Developed in close collaboration with industrial and academic partners over the past 25 years, PAM-STAMP precisely predicts the outcome of complete sheet metal forming processes. For manufacturers in the automotive, aerospace and heavy industries, this means saved time and cost throughout the entire product development cycle. For tooling suppliers, PAM-STAMP uniquely enables production die engineering by providing high quality, predictive simulation to support styling of outer panels and also the development of new lightweight structural parts.

“Car manufacturers aim to shorten their development cycles, sometimes to under a year. As a result, it is essential to forming operation and tool design engineers to be assured of very high surface quality early in the tool development cycle,” explains Harald Porzner, Director of Virtual Manufacturing Product Management at ESI Group. *“Demand for accurate and defect free outer panels - especially with exciting stylings - has increased dramatically. Meeting that demand is even more challenging when using advanced material forming processes for structural parts. Reliable results in both cases depend on defining the tool geometry with great accuracy.”*

With these challenges in mind, ESI recently released PAM-STAMP 2015, the latest version of its sheet metal forming simulation and die face design solution that accounts for all aspects of the stamping process and enables full feasibility assessment early in the process:

- Enhanced topology checking and geometry clean up and repair to enable most efficient geometry based die face design
- Brand new technology, Die Starter, to generate the die surfaces needed to create a part and automatically generate the die tools
- Management of splits, wrinkles, springback and cosmetic defects to improve the component's visual appearance and to ensure formability of the shape
- Accurate simulation of local bending and changing material properties for more precise results
- Time-savings of up to 90% as compared to traditional model set-up thanks to a novel algorithm that delivers results three times faster than in the past

- Advanced checking of the final part shape on the control table.

PAM-STAMP works seamlessly with ESI's platform Visual-Environment and also Dassault Systèmes' CATIA V5 to provide a very complete and efficient solution for sheet metal forming engineering. Furthermore, the results can be easily transported to ESI Virtual Performance Solution so that product performance models properly reflect the “as manufactured” components.

“ESI's new and enhanced PAM-STAMP excels in speed, capability, accuracy and efficiency, from design/styling to try-out,” concludes Porzner.

“Vesta uses PAM-STAMP constantly for several stamped parts and processes. Our main objective today is to prevent and solve aesthetical defects and to develop springback compensation strategies for various parts throughout the entire manufacturing cycle.”

Arlem Picinin Campos,

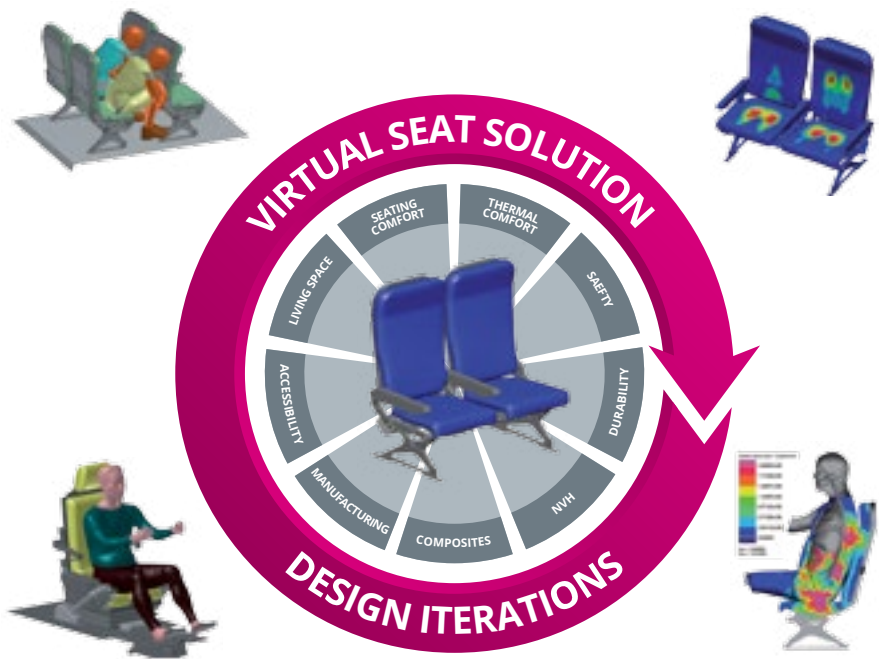
Manager of Simulations and Machining,
Vesta Engenharia (Brazil)



for more information
www.esi-group.com/pam-stamp

ESI Contributes to the Project “Passenger Seats of the Future” Led by Zodiac Seats France

Virtual Seat Solution delivers predictive capabilities from design to pre-certification



ESI Virtual Seat Solution is a unique software solution dedicated to seat prototyping.

In the highly competitive business of civil aviation, seats are a key element in an airline’s strategy to optimize payload and maximize revenue. Seats embody an airline’s differentiation within its addressed market and are the flagship component in the cabin; a means to entice and retain customers. Having the right seat represents a true competitive advantage. Illustrating the growing importance of aircraft seats, French airline Air France is currently working on cabin upgrade of its long-haul fleet and will replace almost 10,000 economy class seats aboard 44 Boeing 777 aircraft by July 2016.

Aside from meeting passengers’ growing expectations in terms of comfort, future aircraft seats will have to answer to challenges linked to weight reduction and related fuel economy. Naturally, this must be achieved without impinging

on passenger safety and in compliance with evolving safety regulations. Future aircraft seats will need to be lighter, more comfortable, and also allow new in-flight activities.

Seats must also be adapted to the changing morphology of passengers, as our population ages and increases in size and weight. Seat designers and manufacturers must now cater to all types of passengers, whatever their age, weight or disability.

To accelerate research and achieve innovative solutions that balance passenger comfort, seat weight and morphological variations, Zodiac Seats France is leading a consortium of French

industrial, academic and institutional partners in the project “Passenger Seats of the Future.” Among the project members are the laboratory LAMIH, UMR 8201 CNRS from the University of Valenciennes and Hainaut-Cambrésis, and the laboratory LBMC, UMR-T 9406 from IFSTTAR and the University Claude Bernard Lyon 1. On the industrial front, Taxisense, a French company specialized in hi-tech sensors, and ESI have joined with several subsidiaries from the Zodiac Group: Zodiac Aerotechnics, Zodiac Aerosafety Systems and Zodiac Actuation systems.

ESI brings to this project a wealth of experience in Virtual Prototyping and seat comfort prediction – addressing, for all populations, static seating comfort, thermal comfort, and vibration absorption during different phases of a flight.

This experience is embodied in ESI’s software Virtual Seat Solution; dedicated to the virtual design, manufacturing and prediction of seat performance and accounting for material physics, manufacturing processes and the behavior of human bodies of all morphologies. Thanks to its unique precision, Virtual Seat Solution enables the creation of virtual seat prototypes and the evaluation of seat performance right from the early phases of design. Virtual Seat Solution empowers seat specialists to quickly explore different innovative designs at an affordable cost, and ultimately to pre-certify these designs before a physical prototype is even produced.


 for more information
www.esi-group.com/virtualeat
www.zodiac aerospace.com/fr/zodiac-seats-france

ESI-Xplorer Enables Engineers to Manage Increasingly Complex Systems Early in the Product Development Lifecycle

This new systems modeling solution is integrated in the ESI Visual-Environment platform



Example of 0D-1D systems modeling in Visual-Environment illustrating how ESI-Xplorer can assist the design and development of architecture, systems, parts and controls for automotive powertrains.

ESI's area of expertise, Virtual Prototyping, offers manufacturers a disruptive approach to test and pre-certify their products while cutting cost and lead-time. Since acquiring CyDesign Labs Inc. in October 2013, ESI has worked on the integration of systems modeling into its Virtual Prototyping platform. ESI is now happy to announce that it has integrated the new ESI-Xplorer into its multi-domain collaborative simulation platform, Visual-Environment.

ESI-Xplorer is designed to address the needs of system engineers for systems design and analysis from the early stage of the product development process. ESI-Xplorer provides a complete model-based design platform, accounting for the physics involved, and enables engineers to accurately verify and validate system architectures. Integration of the product inside ESI Visual-Environment extends the scope of system modeling to system verification and validation, including virtual manufacturing, assembling and testing.

Thanks to ESI-Xplorer, system architects and system modeling engineers can now

"Managing the complexity inherent to advanced systems modeling requires mastering the architecture of the model, the multi-domain dynamic behavior, and the link between model, simulation and system engineering. This is why system simulation software is becoming a necessity."

Dr. Emmanuel Arnoux,

Expert in Systems Simulation,
ADAS & Autonomous Driving Department,
Renault

perform complex systems modeling, across multiple domains. Furthermore, through Visual-Environment, ESI's collaborative and open engineering platform, co-simulation between systems modeling (0D-1D) and product validation (3D) is now supported.

Visual-Environment enables the characterization of systems across multiple domains of physics – from crash test and passenger safety to mechanical, electrical, electronic, hydraulic, thermal control or electric power. Mathematically sound and user-friendly, ESI-Xplorer hides the complexity of the underlying physics while maintaining numerical rigor by using the open, non-proprietary, Modelica® language to define simulation models.

Furthermore, with the integration of ESI-Xplorer in Visual-Environment platform, users benefit from advanced functionalities enabling the storage and organization of mechanical models, control models and data across organizations. VisualDSS decision support system enables project workflow automation, lean work management, and simulation content management.



for more information

www.esi-group.com/visual-environment

www.esi-group.com/software-services/system-modeling/esi-xplorer

ESI's new European HPC Center Benefits from the Latest Datacenter Infrastructures by Legrand

The Great technical achievement behind this new Point of Delivery (PoD)



ESI's Point of Delivery for Cloud Computing, based in Teratec Campus.

ESI recently opened a new datacenter on the Teratec Campus, an ideal location to launch collaborative High-Performance Computing (HPC) projects as it is in the vicinity of Europe's biggest HPC center: the CEA's "Très Grand Centre de Calcul". The new datacenter will effectively act as ESI's PoD (Point of Delivery), serving all ESI offices across Europe as a platform for ESI's new software development and engineering services alike.

ESI teamed up with Legrand, the global specialist in electrical and digital building infrastructures to meet the technical challenges surrounding this project. ESI worked with Legrand Datacenter Solutions, a branch specialized in delivering adequate answers to the numerous challenges inherent to supercomputing: from energy efficiency to cooling, security, and scalability. ESI also teamed up with Minkels, a company belonging to the Legrand Group and specializing in datacenter hardware, including housing, UPS (Uninterruptible Power Supply), cooling, monitoring and power distribution solutions, together with their partner Cap Ingelec, who cumulated 20 years of experience in data centers.

"In the era of virtualization and cloud computing, a massive increase in the volume of data is expected: the annual growth in data is expected to rise from 50% in 2010 to reach 4400% in 2020. This rapid growth

will have a major impact on how we design our server rooms, with scalability becoming vital," says Pascal Perrin, Datacenter Business Development Manager at Legrand.

"ESI successfully completed the implantation of its new datacenter, in collaboration with Legrand. Aside of guaranteeing Uninterrupted Power Supply to support our software and services operations, this intelligent infrastructure is set to adapt to ESI's evolving needs and computational loads. It delivers a scalable, adaptable infrastructure, ready to anticipate the next big technological challenges, including Big Data evolutions and the Internet of Things."

Vincent Chaillou,
COO,
ESI Group

Other devices installed by Legrand include air filters, protecting equipment from dust that tends to cause overheating of hardware; reducing life. The datacenter also benefits from Legrand's energy saving technologies, reducing the ecological footprint of ESI's activities, as

part of the company's commitment to the environment and future generations.

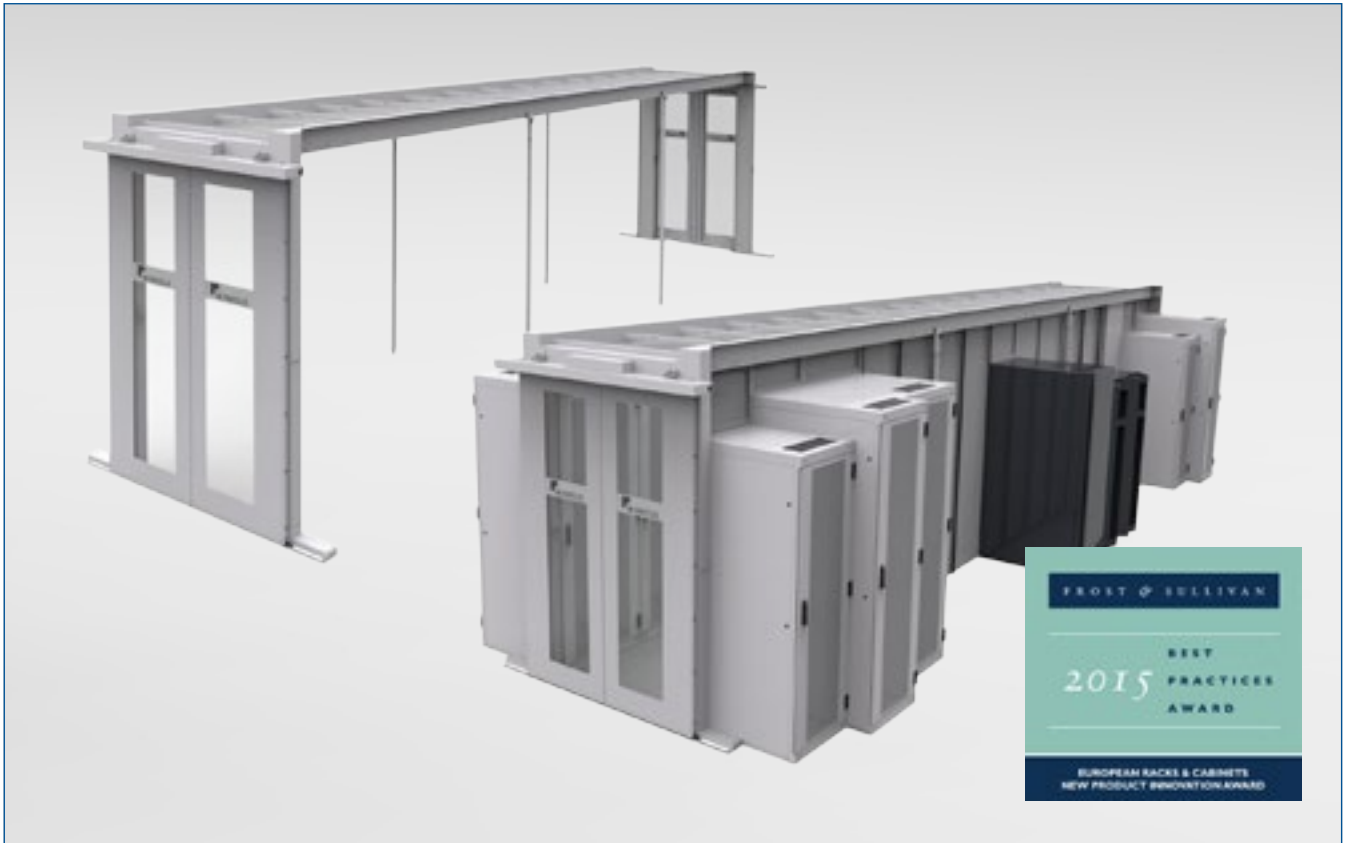
"ESI's new datacenter features Minkels's Cold Corridor®. This technology segregates the cold and hot airflows using advanced air conditioning systems. The housing solution uses specific foam joints to make sure it's airtight. Cold air is pulsed into the external alleys to cool down the supercomputers, and comes out hot into the central alley. The level of cold air absorption obtained is optimum, so that temperature variations are kept to a minimum: temperature inside the rack must remain between 22°C and 28°C. All in all, our technology delivers the best possible environment to run effective operations while protecting hardware and ensure its durability," explains Marc Daoud, Account Manager at Minkels.

"ESI is now equipped with a Cloud Computing PoD to run state of the art calculations, as required to leverage our developments and engineering studies in the field of Virtual Prototyping. This new PoD actively contributes to the achievement of ESI's vision: to grant our customers access to HPC and Cloud Computing, and to democratize the use of such technologies. We propose a new model to our industrial customers — empowering them to deliver disruptive innovation," concludes Vincent Chaillou.

About Legrand

Legrand has been supplying integrated solutions for lighting, energy, networks, and access management in buildings for years. Present in more than 80 countries with a workforce of over 36,000, the Group's mission is to design, develop, and market electrical and digital systems that are both simple and innovative.


 for more information
www.legrand.com | www.minkels.com
www.capingelec.com | www.teratec.eu



Minkels Free Standing Cold Corridor

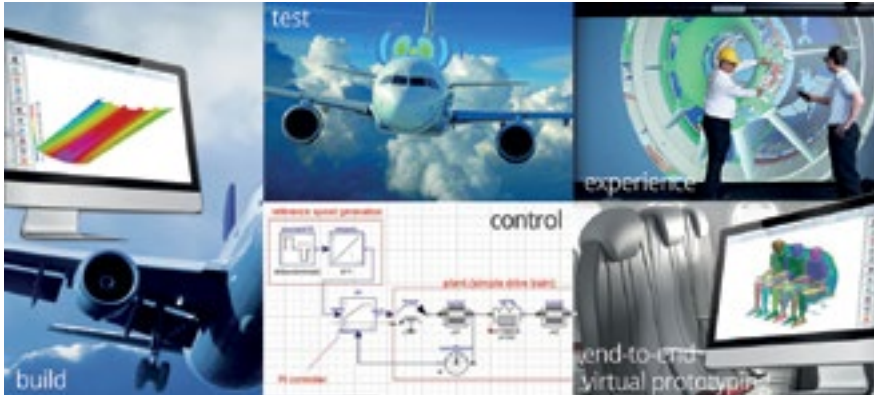
The ultimate flexible solution for a phased implementation with various racks

- Allows the design and integration of the enclosed aisle without the need of cabinets.
- Gives freedom and flexibility to populate the white space as required.
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- Different types and sizes of racks can be adapted to the design.
- Ideal for retrofit situations.

www.minkels.com/freestandingcoldcorridor

ESI Showcases its Solutions for the Aerospace Sector at the International Paris Air Show

Enabling aeronautic manufacturers and suppliers to accurately model parts, systems and components from the early design stages



Making the most of today's digital capabilities including HPC and Cloud Computing, ESI's Virtual Prototyping software empowers aircraft manufacturers and their suppliers to achieve disruptive innovations at a faster pace and managed cost.

Last June, ESI exhibited at the 51st International Paris Air Show in Le Bourget, in collaboration with other members of the competitiveness cluster Pôle Astech and the Paris Chamber of Commerce (CCI Ile de France).

The Air Show provided an opportunity for ESI experts to demonstrate the application of its software solutions for Virtual Prototyping of parts, components, and complete aircraft and aerospace systems. ESI's mission is to enable companies to follow a path through virtual manufacturing and virtual performance testing in representative environments, along the way benefiting from the facility to experience the fabrication and use of the product in immersive virtual reality.

First in line, ESI's solutions for virtual manufacturing encompass casting, sheet metal forming, welding & assembly processes, as well as the various processes involved in the manufacturing of composite parts. These solutions enable aerospace companies to evaluate new materials and manufacturing

processes quickly and thereby accelerate innovation.

Performance testing of future products can be achieved well before any physical prototype is available, by building and testing realistic virtual prototypes; enabling manufacturers to detect design errors very early on in the product development process and avoid costly, late program design changes. Among the solutions ESI demonstrated, VA One is the all-in-one simulation software used by NASA, the AIRBUS Group and many other enterprises to test the vibro-acoustic performance of products, parts or components across the full frequency range.

Also featured at the Paris Air Show, ESI CEM One addresses Electromagnetic Compatibility and Interference issues (EMC/EMI) related to the onboard electronics and complex cable networks found in aircraft and aerospace systems. With its large model-handling capacity, high operating frequencies, and sophisticated scenarios, CEM One helps aerospace manufacturers take electromagnetic modeling one step further in their quest for innovation.

Introduced through a recent acquisition, ESI Pro-SiVIC™ addresses the environment within which an aircraft operates. Sample aeronautic applications include the simulation of lighting systems essential to safety when taxiing. Such aircraft lighting systems must guarantee faultless visibility for pilots under all operational conditions. ESI Pro-SiVIC™ provides the ability to create and conduct full, immersive virtual 3D dynamic tests that recreate operational conditions both on the ground and in the air.

ESI's solution dedicated to seats, Virtual Seat Solution enables end-to-end Virtual Prototyping, addressing manufacturing and testing of a seat, and enables pre-certification. ESI customer Explaneat recently shared the story of their success with this solution: developing and certifying the lightest aircraft seat in the history of civil aviation. The significant weight reduction they achieved translates into an estimated 3 to 5 percent fuel saving – or \$300,000 to \$500,000 per aircraft per year.

Virtual Reality is increasingly used by manufacturers from all industry sectors. ESI's leading Virtual Reality solution IC.IDO uniquely provides real-scale and real time simulation of gravity, contact, kinematics and flexibility. These attributes are invaluable in fully immersive, collaborative engineering and design reviews and make IC.IDO a very effective platform for virtual maintenance training and assembly validation. Throughout the show live demonstrations of IC.IDO were delivered at three different booths: those of ESI, AEROCAMPUS Aquitaine (Europe's leading aircraft maintenance training center) and Daher (a global aircraft manufacturer and equipment supplier).



for more information
www.esi-group.com/industries/aerospace-defense

ESI Group Acquires PRESTO Software

A unique opportunity to address the very dynamic electronics cooling device market

AMOEBEA Technologies, a private US company, has developed PRESTO, a top quality innovative product customized for the electronics market. The acquisition of this product enables ESI Group to expand its targeted and domain specific positioning in the Computational Fluid Dynamics (CFD) market and, more specifically, in the dynamic electronics cooling market. AMOEBEA's initial client portfolio includes prestigious clients Apple, Amazon (Lab123), and Qualcomm, who are early adopters of PRESTO and have helped establish the reputation of the product in the marketplace. For services, Google, MagicLeap, and VSN Mobile are among the initial clients.

Alain de Rouvray, ESI Group's Chairman and CEO states:

"PRESTO software from AMOEBEA offers the next generation of capabilities for cooling simulation and design optimization, major concerns for the electronics industry. When integrated into ESI's end-to-end Virtual Prototyping solutions, PRESTO will represent a major potential for disruptive innovation,

addressing the needs of a large category of users presently hindered by the silo approach of the software tools available on the market.

Interacting within ESI's multi-domain modeling solutions, ESI's new PRESTO solution will fully include cooling within the global design requirements of electronic devices. It will allow simultaneous optimization for performance and fabrication on a single 'core model' in a holistic approach, thus achieving considerable benefits on product development cost and time.

The exceptional quality of PRESTO's customers and early industry adopters bodes exceptionally well for the technical and commercial success of this exciting acquisition and business venture.

Furthermore, we are very proud to welcome AMOEBEA's two founding partners: Dr. Sanjay Mathur and Dr. Prabhu Sathyamurthy. These

world class Computational Fluid Dynamics experts, renowned in the electronics cooling domain, share with us an enthusiasm for engineering excellence and the earnest pursuit of computational innovation for industrial benefit. Their arrival fully reflects ESI's commitment to continuously enhance our internal human resources as we strive to bring top class innovation and competitive advantage to our customers worldwide".

About AMOEBEA Technologies Inc.

Amoeba Technologies Inc. headquartered in Austin, TX, USA, was started in April 2007 with the goal to deliver the next generation CFD technology and to establish a new business model. A platform has been developed to address three critical needs of the commercial CFD world - easy access, flexible licensing, and built-in technology for sensitivity analysis.



for more information
www.amoebatech.com/presto



view our events calendar
<http://www.esi-group.com/company/events>

Save the Date!

Feb 9 - 23 2016	VA Webinar Series	Three sessions to address BEM solvers, damping models, and to create a VA model for a loudspeaker.	Online
Mar 8 - 10 2016	JEC World 2016	The largest international gathering of composites professionals.	Paris, France
Mar 14 - 17 2016	DAGA 2016	42nd annual conference on acoustics.	Aachen, Germany
Mar 22 - 23 2016	Vibro-Acoustics Marine SIG 2016	Latest developments in VA for the Marine Industry.	Southampton, United Kingdom
April 4 - 7 2016	GPU Technology Conference	The world's largest and most important GPU developer conference.	Silicon Valley, CA, USA
April 16 - 19 2016	Castexpo 2016	Connecting suppliers, metalcasters and casting buyers.	Minneapolis, MN, USA
Apr 17 - 20 2016	World Conference in Investment Casting	International Investment Casting Conference & Tradeshow.	Paris, France
May 17 - 20 2016	CIFE 2016	14 th China International Foundry Expo.	Beijing, China
May 29 - Jun 3 2016	Solidification Course 2016	Intensive course for metallurgists and foundry engineers (25 th Edition).	Villars, Switzerland
Jul 4 - 7 2016	Numiform 2016	The 12 th International Conference on Numerical Methods in Industrial Forming Processes.	Troyes, France

25th Edition of ESI's Solidification Course, dedicated to One of the Oldest and Most Important Industrial Manufacturing Processes



2015 Solidification Course instructors and participants.

Every spring since 1992, ESI has held its Solidification Course in Switzerland. 2016 will be no exception. Taking place May 29 to June 3, 2016, the week long course will celebrate its 25th anniversary, with the customary support of ESI's Swiss subsidiary, Calcom ESI, and the Swiss Federal Institute of Technology of Lausanne (EPFL), and with the participation of renowned lecturers from Swiss, French, Austrian and US universities.

Solidification is one of the oldest processes for producing useful implements and it remains one of the most important commercial processes for many materials.

Over the past 24 years, 830 participants from 38 different countries have benefited from the course, which is open to the whole industrial community. Metallurgists, foundry engineers, scientists and researchers gather to share and enhance their knowledge in the field of solidification.

Many reasons explain the success and longevity of this solidification course. Foremost is the quality of the seven

lecturers¹, every one of them having been internationally recognized for their research in the field of material processing and solidification. Four have received the prestigious Bruce Chalmers award from the Minerals, Metals & Materials Society (USA), in recognition of their outstanding contributions. Dr. William J. Boettinger was the first recipient from this team, in 2001, followed by Professor Michel Rappaz in 2002, Professor Jon Dantzig in 2005, and Professor Christoph Beckermann in 2010.

Thanks to its intimate setting and format (participation is capped at 40 people), the Solidification Course offers an optimal learning environment and facilitates interactions between participants and their instructors.

"I have gained a better understanding of which parameters are critical to improve quality in casting."

"I will now be able to develop and/or improve solidification models in my code."

"I have a better understanding of the phenomena occurring during solidification such as porosity."

"I have a much better overview of the field and how the different subjects relate."

"The course detailed the most important aspects of solidification with the appropriate scientific background."

- Comments from attendees of the 2015 edition.

Join us for the 2016 Solidification Course:
 May 29 – June 03, 2016 - In Villars, Switzerland
www.esi-group.com/company/events/2016/solidification-course-2016

¹ Solidification course professors: Prof. Christoph Beckermann from University of Iowa, USA, Dr William J. Boettinger, NIST Fellow Emeritus from National Institute of Standards and Technology (NIST), USA, Prof. Hervé Combeau from Université de Lorraine, Institut Jean Lamour, Nancy, France, Prof. Jon Dantzig, Professor Emeritus from University of Illinois, Urbana, USA, Prof. Matthew John M. Krane from Purdue University, USA, Prof. Andreas Ludwig from Montanuniversität Leoben, Austria and Prof. Michel Rappaz, Professor Emeritus from Ecole polytechnique fédérale de Lausanne (EPFL), Switzerland.

ESI Group Rewarded for the Quality of its Non-Financial Fundamentals

Ranked as one of the top medium-sized businesses by the Gaïa-index

ESI was recently ranked third in the Gaïa-index for companies with less than €150 million in revenue. This ranking rewards the Group's efforts towards developing and structuring its Corporate Social Responsibility (CSR) strategy.

The Gaïa-index, a selection from 230 French medium-sized businesses (ETI - Entreprises de Taille Intermédiaire), rewards the quality of non-financial reporting as assessed by Ethifinance, an independent agency. The performance of ESI Group was based on no less than 123 criteria, grouped into 4 categories: Governance, Social, Environmental, and External Stakeholders.

Alain de Rouvray, ESI Group's Chairman and CEO, comments: "We are most honored that ESI Group is recognized as one of the most advanced listed medium-sized businesses in terms of CSR. This success truly demonstrates that our commitment to social responsibility, matches ESI Group's values and greatly improves the Group's

responsibility profile. We are convinced that our focus on innovation and respect of people and the environment creates value and ensures long-lasting professional satisfaction."



ESI's company values, which support the company's CSR strategy.

2015 First Half Results

Strong performance in License sales and general improvement in profitability

Revenues for the 1st half of 2015 amounted to €48.4 million, a healthy 13.6% growth in actual terms (+6.0% at constant exchange rates).

Gross margin was 66.7% of actual sales, a 1 percentage point improvement thanks to the shift in the product mix toward Licenses.

Alain de Rouvray, ESI Group's Chairman and CEO, comments:

"The solid performance in the first half-year shows the widening adoption of ESI Group's Virtual Prototyping solutions and reflects the

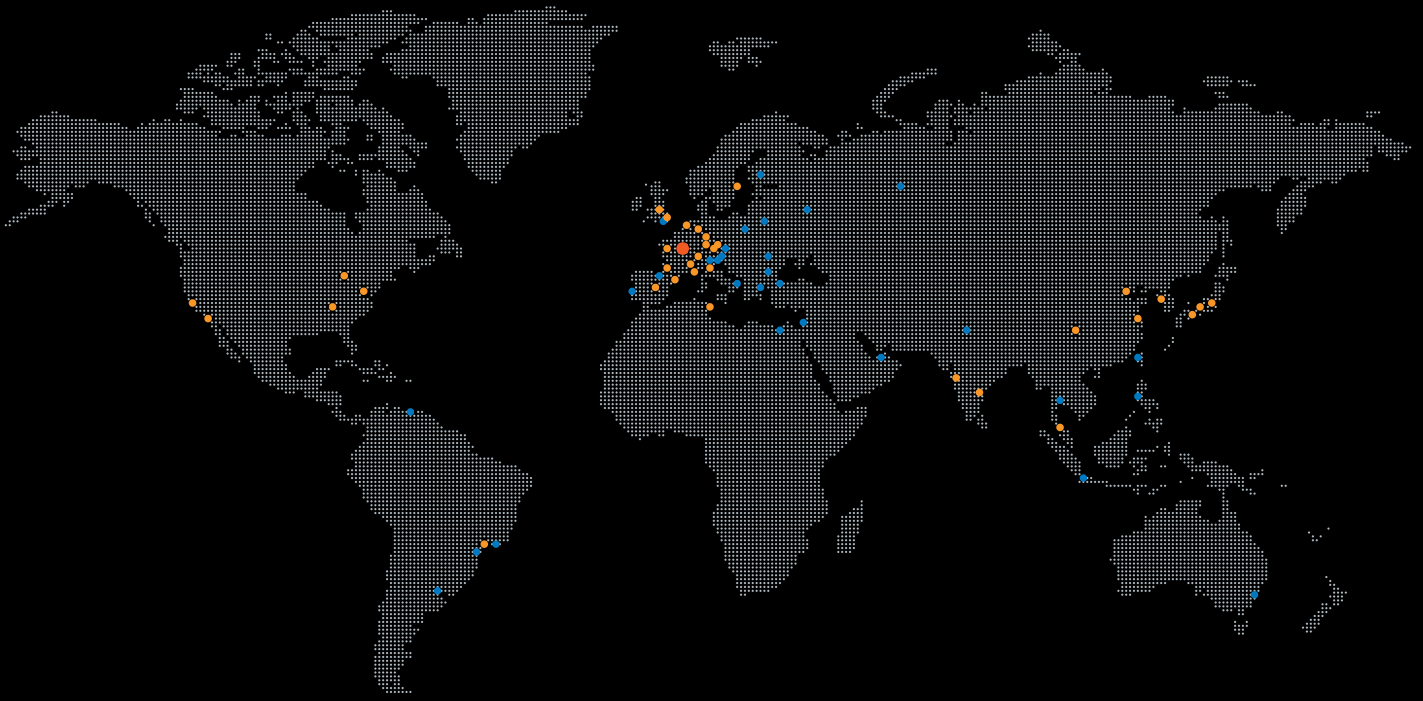
transformation of leading industrial firms to the smart digital factory. This structural trend drives strong growth of Licenses, particularly in the installed base, and is indicative of the strength of ESI's industry standard solutions and the Group's robust business model. The restructured Services division, although held back by some cyclical effects, posted healthy growth in high value added engineering studies, which eventually lead on to recurrent License sales. The cost control policy also delivered further substantial improvements to profitability without reducing the R&D investment which

is core to the Group's development strategy.

Notably, ESI Group continues to differentiate itself clearly from its competition by technological innovation and adoption of disruptive technologies, including those represented in recently acquired activities. The unique positioning of ESI's solutions in the future markets for Virtual Engineering, coupled with high-performing strategic international partnerships, amplifies the solidity of the Group's activity and enables us to look ahead with confidence over the short and medium term."



● Headquarters ● Subsidiaries ● Agents and Distributors



Customer Portal
myesi.esi-group.com

ESI WORLDWIDE

ARGENTINA	GERMANY	PORTUGAL	TAIWAN
AUSTRALIA	GREECE	ROMANIA	THAILAND
BELARUS	INDIA	RUSSIA	TUNISIA
BRAZIL	INDONESIA	SLOVAKIA	TURKEY
BULGARIA	ISRAEL	SLOVENIA	UNITED ARAB EMIRATES
CHINA	ITALY	SOUTH KOREA	UNITED KINGDOM
CZECH REPUBLIC	JAPAN	SPAIN	UNITED STATES
EGYPT	MALAYSIA	SWEDEN	VENEZUELA
FINLAND	NETHERLANDS	SWITZERLAND	VIETNAM
FRANCE	POLAND		

