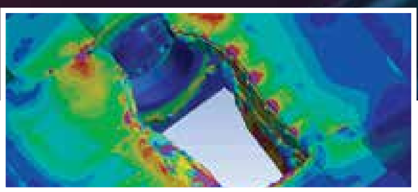
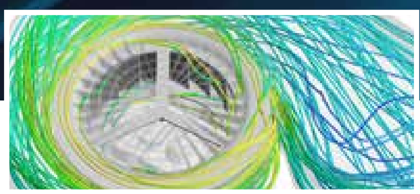
Newsletter

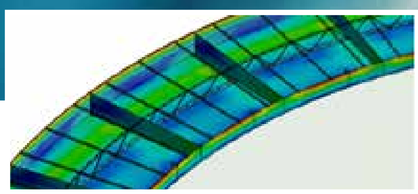
Simulation Based Engineering & Sciences

Year 11 n°3 Autumn 2014

Pierburg Pump Technology as a key shaper of the automobile future







Optimization of high-pressure **die casting dies** and the related bearing structure

Weight reduction of components for **industrial vehicles**

CFD-Driven Design of a Ventilation System for **Kitchen Hoods**

Strong Requirements of Numerical Methodologies for **Missile Dynamics Assessment**

Numerical FE Simulation of Floating Roof for **Oil Storage**

Weight optimization under all operative load conditions of **Metro Honolulu**

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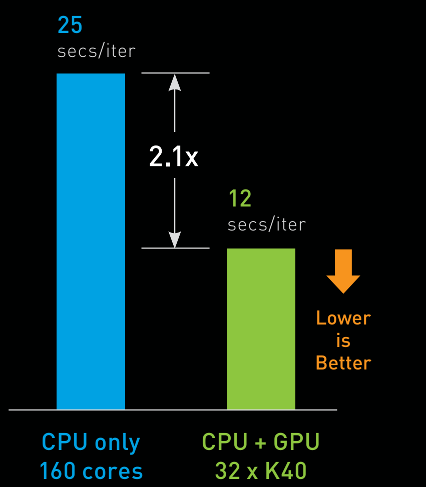

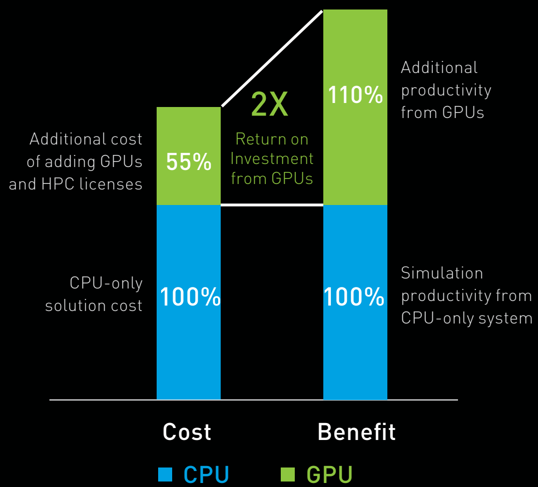

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FLASH

"All we know about the new economic world tells us that nations which train engineers will prevail over those which train lawyers. No nation has ever sued its way to greatness." - Richard Lamm

As the economies of Europe continue to push for sustainable economic growth it is important for us to consider the cultural influences that have allowed the great nations, empires and trading blocs to flourish. When looking back on the world's most influential cultures they have all been marked by engineering marvels: whether it is the grandeur of the Egyptian pyramids, the Mathematics of the Greeks or the complexity of Roman aqueducts, their achievements were driven by great engineering innovation.

However, the question could be asked, "Why was the true global potential for these early innovations only realized in recent history?" – In part, I believe the answer to this question doesn't lie in the inadequacies of their innovations but more on the teaching, training and exploitation of their ideas.

So it is for us in today's world: there is a continual need to innovate, but also the need to disseminate these practices to the world's engineers as quickly as possible. As we approach the upcoming 30th anniversary of the International CAE Conference, we are pleased to part of the annual flagship event for Simulation Based Engineering and Sciences. This dedicated platform brings together the thought-leaders from leading international organization distinguished for their innovative solutions and continued research to provide advanced solutions for the future. This year we have to thank our ever increasing Sponsors for their continued support without whom we cannot put such an exciting programme together.

I eagerly await to see the presentation of achievements accomplished with engineering simulation by organisations from a variety of sectors such as European Space Agency, GE Nuovo Pignone, Ansaldo Energia, Airbus, Fiat Group Automobile and Fiat Research Centre, German Aerospace Centre – Institute of Solar Research, NVIDIA Corporation, IBM Italy, Scilab, Newmerical, Indesit, Beta CAE, University of Padova, the Technical University of Milan, the University of Liverpool, the Euro-Med Seismological Centre and many others.

Another area of opportunity is the accessibility of advanced simulation tools to SME's (Small & Medium Enterprises). Some of the greatest innovations have come from small beginnings, but without availability to the right tools these bright sparks can soon fizzle out. The current, and all too often scenario, is for HPC (High-Performance Computing) to be the preserve of large companies who have resource to fund the hardware and license costs required. This is why we have devoted an article to the collaborative work of the FORTISSIMO project, which aims to provide a "one-stop shop" in hardware, expertise, applications, visualization and tools to SMEs on a pay per use basis. As a proud distributor of many simulation tools, we at EnginSoft have been keen to support the project in making advanced simulation technology available to the widest possible audience. If we can do that, maybe we can help to support a new flourishing economy.

While I wish for EnginSoft to support the wider economic picture, we continue to support the everyday needs of engineers in their day to day practices. In this issue we continue to highlight the broad range of engineering projects we have partnered in: from 'Missile Dynamic Assessment' with MBDA, award winning 'Optimized High Pressure Die Casting' with SAPP, to 'Muon-to-Electron Particle Detection' with I.N.F.N & the University of Salento. We thank all our partners in the continued support of this publication and hope to produce many more innovative solutions as an engine for growth in our economy.

Stefano Odorizzi, Editor in chief

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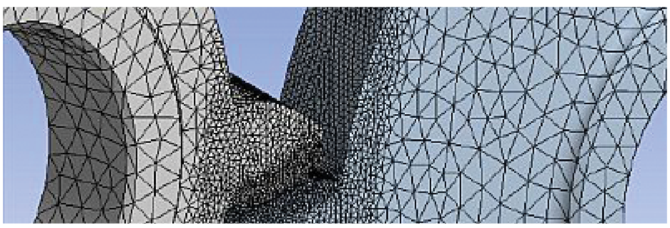

OUR ACKNOWLEDGEMENT AND THANKS TO ALL THE COMPANIES, UNIVERSITIES AND RESEARCH CENTRES THAT HAVE CONTRIBUTED TO THIS ISSUE OF OUR NEWSLETTER

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Pierburg Pump Technology as a key shaper of the automobile future

Interview with Ing. PhD. Raffaele Squarcini, head of the CAE&Testing division at Pierburg Pump Technology in Italy

The Company
Since the very origins of the auto industry the name Pierburg has stood for engine-enveloping expertise. Pierburg Pump Technology is committed to this tradition and enjoys the global reputation of a specialist in innovative and advanced pump technology. The product portfolio ranges from coolant pumps, oil pumps and recirculating water pumps to vacuum pumps. For every purpose, Pierburg Pump Technology offers a wide range of models to ensure utmost motor vehicle reliability and functionality.
Even now, Pierburg Pump Technology products target the challenges of tomorrow. Long before the debate on climate change we had been working on solutions for eco-friendly automotive technology to save fuel and reduce emissions.
Among the products developed with this objective in mind are the new generation of variable oil pumps, water pumps and vacuum pumps, mechanical and electro-actuated, the star performers that have made a valuable contribution toward a clean environment. Continuous developments in internal combustion engine technology are resulting in rising demands on the engine's lubrication and cooling circuits. Pierburg Pump Technology has devised trend setting solutions and created the preconditions for powerful yet fuel efficient engines with ingenious temperature and oil management systems. Pierburg Pump Technology continues to actively shape the future of the automobile.

The interview
CAE Technologies are used in Pierburg Pump Technologies for 20 years. We conducted an interview with Ing. PhD. Raffaele Squarcini, head of CAE&Testing division at Pierburg Pump Technology Italy.

How much relevance does innovation have (and should have) in the industrial world?
The current situation is very clear to everyone: Italy invests too little in research development in comparison with the other European countries. The main reason for that is related to the size of Italian companies: 90% are small and medium enterprises while the 10%

Fig.1 - Ing. Raffaele Squarcini, head of CAE division at Pierburg Pump Technology

is constituted big industries. Only this limited part, with more economic resources, could risk and survive in case of a failure, a condition that a small one could never afford. The main consequence is the creation of a more and more evident gap with respect to other counties, with a focus on maintaining the current state of the art instead of aiming at dynamism and excellence. Generally speaking, it could be necessary get more European funding to support companies investments and on the other side companies should create synergic collaborations and networks to become more competitive. PPT is a big German industry successfully investing in research. An example is the plant based in Livorno, founded in the thirties, acquired by FIAT in 1945 and then acquired by Pierburg in 2000. The plant has survived thanks to an accurate management of the strategic resources and to the investment in research and development, that have led to the creation of a competence centre for oil-pumps design. Thanks to the existing know-how, this is now the technical direction for automotive oil pump for Pierburg all over the world and therefore the world leading plant for auxiliary systems design and development.

What are the strategies to be innovative and what are the evaluations leading to innovation?

On a national and European level, it's necessary to define in a very precise way which framework projects and main topics are to be

Fig.2 - Intercooler Pump

Fig.3 - Electric vacuum pump

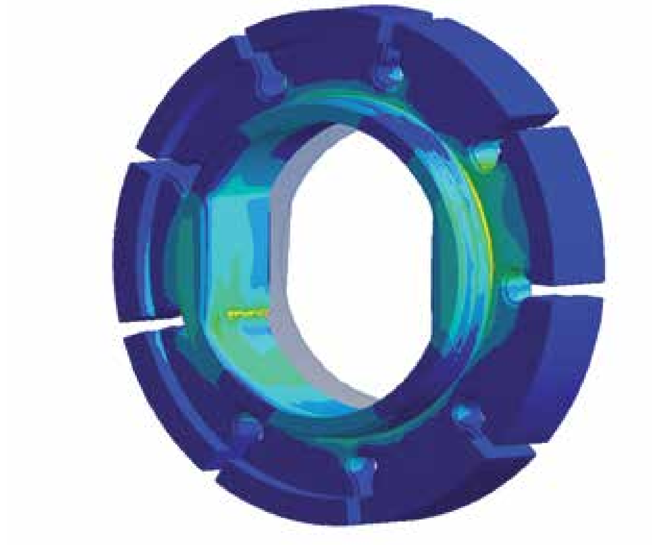

Fig.4 - Equivalent stress in the rotor from FEAs

focused on: energy, hi-tech, productive efficiency, environment, etc. The main actors are institutions, banks and industries. Looking at single initiatives, companies are nowadays acting and following two different strategies. The first is that of anticipating the market needs, presenting the customers what they should want and why. Apple is a clear example of this policy but it is the result of a visionary and successful mind and it can succeed in very specific sectors, such as media, fashion and the market of "superfluous goods", that nevertheless do move high amounts of money. The second is the one followed by PPT and all those companies producing components interpreting market trends, and trying to get the most out of limits and constraints. That is what has happened in the automotive field with relation to CO_2 emissions, engine homologations and other new solutions. Innovation strategies always require you to keep an eye on competitors' movements!

What role does CAE tools and virtual prototyping play in this context?

According to my experience, CAE tools do not help in the very preliminary phase when the new and better product is to be identified. Other evaluations have to lead to the new concept selection. CAE tools are fundamental when the new product know-how has to be designed and optimized in terms of efficiency, performance and costs. In other words, they constitute a crucial support in the product development, when facing very complex physical problems and contrasting objectives.

How have users' needs changed through the last years?

It's necessary to be quicker and quicker in getting answers to specific problems, making them easy to understand to both expert and non-expert users. The CAE expert has to provide the right elements to minimize/avoid the problem. CAE experts have to reduce as much as possible the time devoted to the model pre-processing, so to focus mainly on the post-processing and to results representation, leading to final decisions. In such perspective software needs to be more and more user-friendly and experts have to prove their great knowledge and expertise in the different competence sectors (structure analysis, fluid-dynamics), without becoming computer-addicts!

Which advantages have you detected according to your professional experience and how has the design/production changed?

During my PhD I have developed numerical codes for lubrication problem resolution in an elastohydrodynamic regime, then I have worked for Siemens VDO developing the piezoelectric gasoline injector. In my first working years I have moved from very theoretic and numerical aspects to product development, characterized by ideas validation and patents. I'm currently the Computation and Testing Manager in PPT, a role that allows me to operate on several products, combining design and analysis of complex physical phenomena. My approach to design has evolved from a very detailed focus to a product perspective till to their balanced combination. Nowadays I can fully appreciate software with complex structures providing clear and accessible results. This is the last trend for new software, which are "vertically" developed, easy to use even if less versatile in multi-scale problem solving. My approach to design is that of moving from very approximate data even to HPC in order to get sensitive and exhaustive answers.

What contribution has EnginSoft provided and in which ways has it expressed the potentiality and capacity of your company?

According to my personal experience, EnginSoft has given a great contribution organizing events such as the International CAE Conference, where industries, enterprises and universities can meet and new strategies and knowledge can be shared. Thanks to EnginSoft's events, users and software developers can get in touch, thus reducing the distance between customers and experts, providing a yearly occasion to be informed about software implementation and solutions for problem solving.

In your perspective do you forecast an need for computation codes with relation to future challenges?

I can forecast great opportunities, since computation codes are becoming more and more present in the daily life. Nevertheless it's important to apply good sense, to have right intuitions and to evaluate the most intelligent use for the tools themselves. This is the great added value to the enormous potential that computation can offer.

Which projects, objectives and new targets are you aiming at thanks to such tools application capability?

I would like to offer a relevant engineering contribution to anyone working in modeling and computation, so to overcome "dark zones". I intend to better and better understand the physical phenomena regulating product functionalities so to be always competitive and stimulated by the great interest that arise from these topics.

For instance, the volumetric and dynamic pumps, design and manufactured by PPT, although quite old machines, can still perfectly combine the different subjects of classic engineering sciences: fluid-dynamics, material mechanics, tribology,

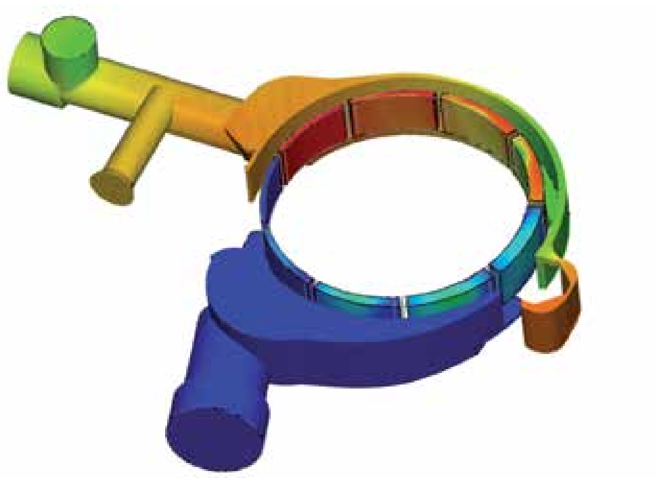

Fig.5 - CS-rotor contact forces and rotor speeds vs CS rotation angle from MBs

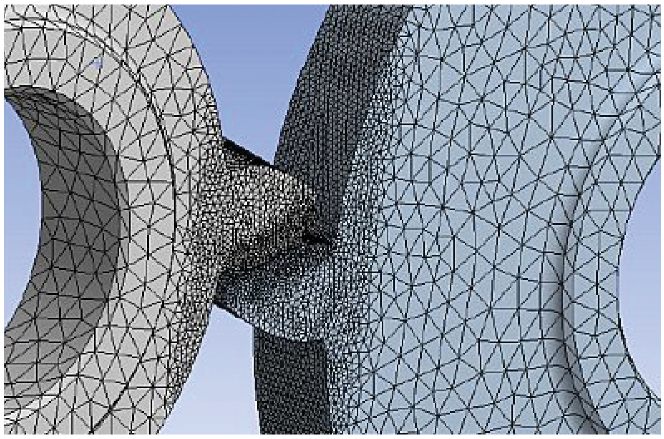

Fig.6 - Variable Displacement Oil Pump shaft under crankshaft torsional vibrations

acoustics and their different interactions. An adequate knowledge of physics, mixed with a bit of fantasy and creativeness can provide interesting innovation inspirations.

What do you wish to the world of scientific technology, always looking for a balanced dimension between creativeness and competitiveness?

I always remember an Aristotle quotation: "the free expression of one's talent, that's happiness". This thought on its own can hardly provide an exhaustive definition to happiness concept, but I'm pretty sure that a society, working only to survive or to be filled with useless goods is not contributing to happiness research and diffusion.

I do firmly believe in the team work, although even a single element with the right means can make the difference. For this reason, in this very precise economic moment, moving from crisis to very slight success, a real competition should take place, in which innovation and excellence should push progress forward. I'm convinced that those developing know-how and expertize cannot prevent themselves to their improvement and dissemination, thus longing for success.

On such regard I would like to use a famous quotation of the most distinguished engineer of any time: "Once you have learn to fly, you will always look at the sky while walking on the ground, since that is the place where you have been and you would like to get back to". Leonardo da Vinci.

CFD-Driven Design of a Ventilation System for Kitchen Hoods

WHO IS ELICA?

The Elica Group has been present in the cooker hood market since the 1970s, it is chaired by Francesco Casoli and led by Giuseppe Perucchetti and today it is the world leader in terms of units sold. It is also a European leader in the design, manufacture and sale of motors for central heating boilers. With approximately 3,400 employees and an annual output of over 18 million units, the Elica Group has eight plants, including Italy, Poland, Mexico, Germany, India and China. With many years' experience in the sector, Elica has combined meticulous care in design, judicious choice of material and cutting edge technology guaranteeing maximum efficiency and reducing consumption making the Elica Group the prominent market figure it is today. The Group has revolutionized the traditional image of the kitchen cooker hood: it is no longer seen as a simple accessory but as a design object which improves the quality of life.

AIM OF WORK

Energy consumption is becoming a main issue for designers in the field of house appliances. After the EU Directive 92/75/EC, the EU Energy Label must now always be displayed at sale, dividing energy efficiency into classes from A to G, in decreasing order of efficiency. Such regulation has forced companies to pay great attention to the design of new products, in order to find a place in the market. The presented work is a consequence of the above-mentioned directive. Elica commissioned EnginSoft to support their engineering team in the optimization of the "Tilly" kitchen hood model, shown in Fig. 1. The target was to increase the efficiency of its ventilation system, rising to higher energy classes, intensifying their position on the market.

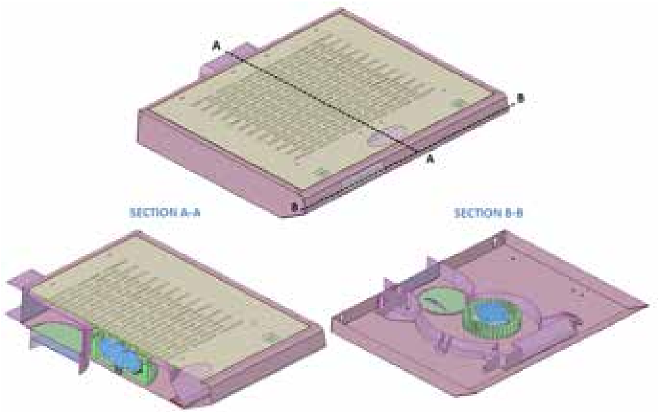

Figure 1 – Geometrical model of the "Tilly" kitchen hood, designed by Elica

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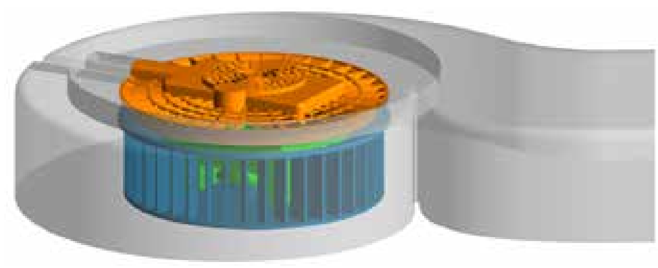

Figure 2 – Partial view of the CFD baseline model of the kitchen hood. The two plenums are not visible. Inlet grid in orange, the engine in green, the original fan in blue

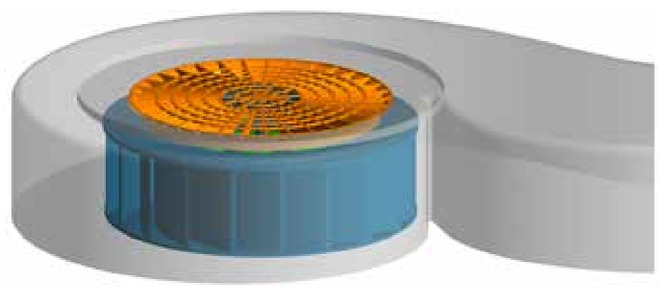

Figure 3 – Partial view of the CFD optimized model of the kitchen hood. Inlet grid in orange, the engine in green, the original fan in blue

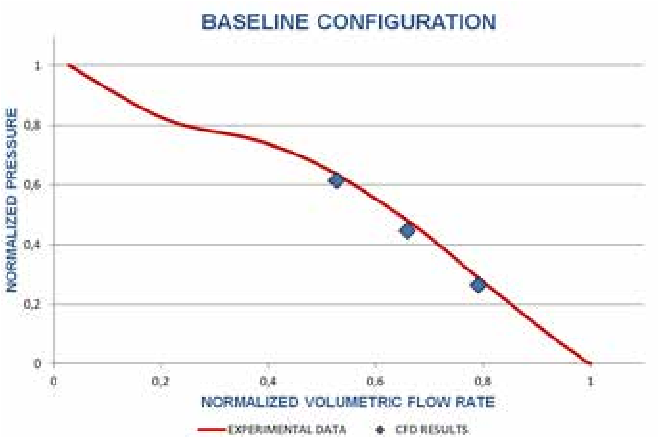

Figure 4 – P-Q curve of the baseline ventilation system and CFD correlation

CFD MODEL - *BASELINE*

A 3D numerical model of the kitchen hood was implemented by EnginSoft, on the base of CAD geometries provided by Elica. The model was built in ANSYS Design Modeler, combined with Blade Modeler, a software specialized in the parametric design of turbomachinery components (see Fig. 2). ANSYS CFX was the CFD solver used to evaluate the fluid dynamics of the system. In order to stabilize CFD accuracy, the model considered a semispherical plenum both in the inlet and in the outlet region. The boundary conditions imposed were atmospheric pressure in the inlet opening and the air mass flow rate set to exit the domain. By providing various mass flow rates, a P-Q curve could be graphed for every studied configuration.

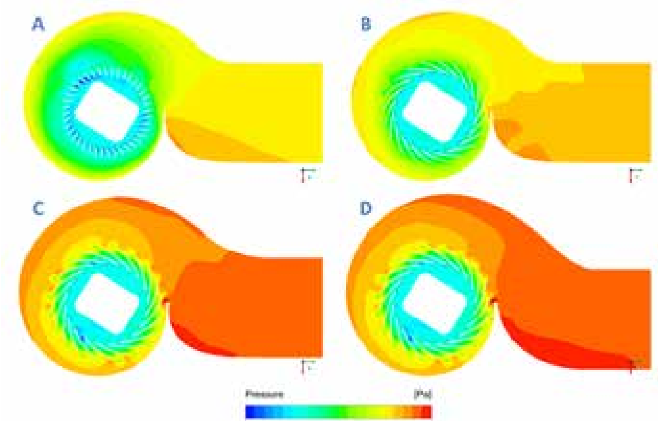

Figure 5 – Comparison of the static pressure field during the evolution of the design from the baseline (A) to the final (D) configuration

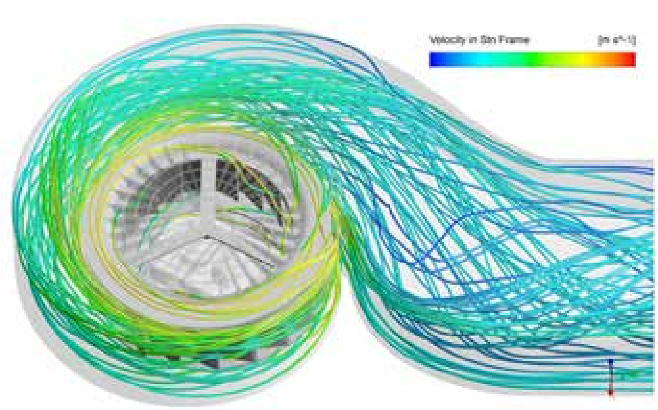

Figure 6 – Streamlines evaluation in the final optimized configuration

OPTIMIZATION

The margin of manoeuvre in the improvement of the ventilation system was dictated by the box size and by the positioning of other components inside the hood. Freezing such geometry, Elica gave EnginSoft carte blanche for the design of a new fan and an optimized volute. All the designs were tested with the same engine, another constraint which was considered in the design process, to maintain the overall cost of the product. During the optimization phase of the activity, more than 50 configurations were studied. EnginSoft initially worked on the global configuration of the ventilation system, re-arranging the coupling of engine and fan, in order to widen the suction area, and as an outcome develop a less resistive circuit. The engine was turned upside down and the fixing of the fan was modified, inserting three thin beams to allow the anchorage. The first tests with the new configuration were successful. Secondly, work was done on the blade angle of attack, in order to obtain a smoother incidence of air and determining its optimal value from fluid dynamics considerations. The blades were then curved backwards, lowering the generated torque and thus broadening the possibilities which could undergo investigation. The blade chord was lengthened, enhancing the pressure rise. Also, tests were performed analyzing the effect of a different number of blades, the insertion of splitters between blades and a possible twist in the blade profile. Furthermore, the volute profile was changed to match the ideal fan. Single modifications were compared to the baseline model utilizing the OVAT (One-Variable-At-a-Time) optimization cycle. The successful results achieved led to a combination of modifications, evaluating the improvements due to the synergy of effective factors.
Moreover, different fan types, other than the standard ones on the market, were considered and investigated. Such innovative ventilation systems are better applicable to higher quality kitchen hoods, so such work was thought to be also suitable for other models produced by Elica.
The optimal configuration (appreciable in Fig. 3) resulting from this study was soon tested in Elica's laboratory, as a result of their internal rapid prototyping capabilities. In about a week, the full process from an optimized CAD geometry to the tested P-Q curve of the system could be obtained.

RESULTS

NUMERICAL RESULTS

The baseline configuration was compared to the experimental data available, demonstrating great agreement, as shown in Fig. 4. The numerical results were slightly underestimating the system's performance, so it was thought to keep the mathematical model fixed and expect a higher efficiency from the experimental tests. Only after the confirmation of a strong correlation between CFD and laboratory assessments, was the optimization phase performed. Three solutions were presented to Elica's engineering team, which chose the ideal one to fit the kitchen hood model, considering the manufacturing needed.
Fig. 5 shows a few steps in the optimization process, indicating a gradually increasing pressure rise generated, from the baseline to the optimized model. The internal fluid dynamics was fully analyzed, assessing velocity direction, local backflows, the overall fan performance, pressure losses due to the air entrance in the ventilation system and the effectiveness of the volute (see Fig. 6). Also, the torque

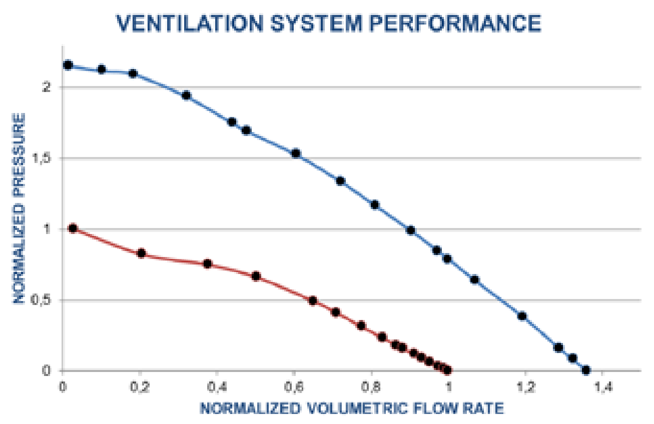

Figure 7 – P-Q curves of the ventilation system, before and after the optimization performed by EnginSoft

was monitored and the rotational speed of the fan was depending on the torque vs. angular velocity curve of the engine.

EXPERIMENTAL RESULTS

The ideal configuration designed by means of CFD analysis was tested in Elica's laboratory, allowing a full comparison between the baseline model and the optimized model utilizing the same test bench and the same engine. Fig. 7 shows the P-Q curve of the system in the two configurations. The increase of pressure rise is approximately +113% and the mass flow is 36% higher than the registered one in the baseline system. The average energy consumption in the baseline configuration was decreased by 30%.

Such improvements determined a 276% rise in efficiency. Also, the BEP (Best Efficiency Point) was brought to higher mass flow rates, now increased by 40%, as specifically requested by Elica.

CONCLUSIONS

In summary the study led to the following considerations:

- The requirements of the work, in terms of increase of the ventilation system's efficiency and obtaining higher energy classes, were achieved.
- The final improved configuration maintains the same engine and is modified in the plastic components only, so the product cost is basically unchanged.
- The ventilation system designed by EnginSoft can be fitted in various other models of kitchen hoods, improving the performance of various products.
- The prospect of new engines with higher allowable torque would increase the performance even more, and allow the usage of the different fan types conceived.
- Further developments include modeling oil particles, in a multiphase analysis, to detect their flow path and the effect of suction depending on the particle diameter.

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Structural Optimization of Metro Honolulu - Weight optimization under all operative load conditions

In this economically challenging time, it is crucial more than ever to remain competitive in the rail industry. It is necessary to push the technological boundaries to ensure compliance with top level quality standards, reaching minimal weight/cost. For this reason AnsaldoBreda has developed a new methodology for the structural design of the new Metro Honolulu car body, by exploiting the capabilities of the design optimization software modeFRONTIER.

In this context, the aim of this project was to maximize the dynamic performance, minimize the mass while achieving the project's static structural requirements for the car bodies. This was completed in accordance with the high standard structural and crash conditions of European EN 12663 "Railway applications- Structural requirements of railway vehicle bodies", ASME RT-1-2009 "Safety Standard for Structural Requirements for Light Rail Vehicles" and Honolulu High-Capacity Transit Corridor Project – TP-4: Passenger Vehicle Technical Provisions.

Starting from the original CAD model, a parameterized FE model was developed by ANSYS APDL to integrate with modeFRONTIER. This allowed modeFRONTIER to automate the design evolution process and achieve the desired goal. The activity was developed in the following steps:

AnsaldoBreda
A Finmeccanica Company

1) Preliminary Analysis to define the parameters (the FE model has been divided in two different parts):
a. the car body of the Metro (parameterized part) - as shown in Figure 1a
b. the terminal parts of the car body (non-parameterized part) - as shown in Figure 1b.

2) The fuselage (Figure 2) was parameterized as follows:
a. number of web profiles
b. web angle/position
c. web thickness
d. thickness of external/internal skin profiles

3) The terminal parts were not parameterized so they were imported from the original CAD and connected to the parameterized model through constraint equations.

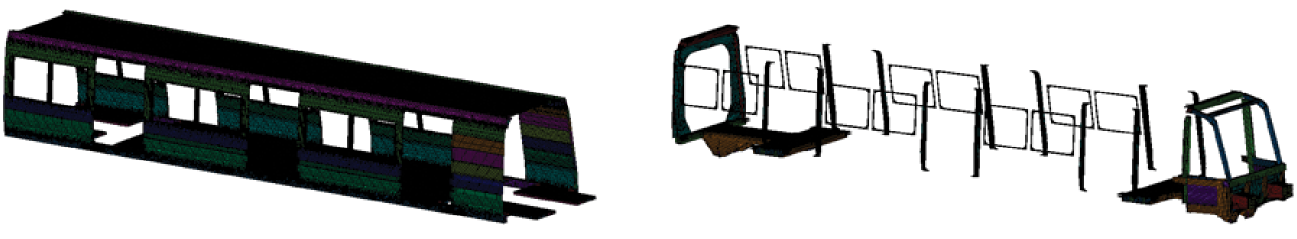

Figure 1 - (a) Parameterized Region: Developed Using ANSYS APDL, (b) Non – Parameterized Region: Terminal Parts Have Fixed Geometry

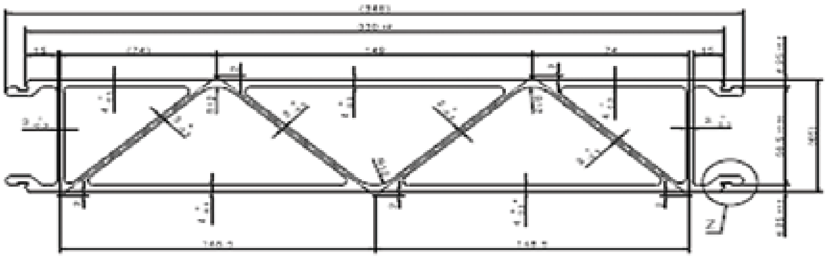

Figure 2 - Section Profile of the Car Body

4) The setup of boundary and load conditions were done according to AnsaldoBreda's technical requirements.

5) The optimization process was created in modeFRONTIER with the following objectives and constraints:
a. Objective: Minimize mass
b. Constraint: Own first frequencies within property range under both tare and maximum weight conditions
c. Constraint: Security Factor satisfaction

6) Run the optimization, post-process results, refine strategy and rerun.

7) Results and conclusions
In order to achieve the desired mass reduction a modeFRONTIER optimization loop was developed to improve the FE parametric model from an initial configuration. The optimization loop took into account the Technical Specification for the structural analysis, optimized the geometry while satisfying all the static, dynamic and instability constraints (Figure 3).

The parameterized region of the original configuration weighed 3.803 Tons. The goal was to reduce the weight by 5% (190 Kg) while maintaining the first bending frequency within a suitable range. The static structural analysis and fatigue analysis were performed for both the welded and non-welded region (Figure 4), which have different material features. The following were used:

ALLOY EN AW-6008 T6
the allowable stress of the base material was calculated as follow:
$\sigma_{adm} = \sigma_{0.2} = 200$ N/mm^2

ALLOY EN AW-6082 T6 and ALLOY EN AW-5083 H24
the allowable stress of the base material was calculated as follow:
$\sigma_{adm} = \sigma_{0.2} = 250$ N/mm^2

The allowable stress of the thermally altered area material was calculated as follow:
$\sigma_{adm} = \sigma_{0.2}/S$, where $S = 1.55$ for aluminum alloy in T state and H series.

So for the ALLOY EN AW-6008 T6 $\sigma_{adm} = 129$ N/mm^2, while for both the other materials $\sigma_{adm} = 161$ N/mm^2.

Due to the high number of time-consuming simulations and the high number of input variables, a progressive approach was used for the optimization analysis. The optimization was conducted in two phases: Phase 1 was an exploration phase and considered the most important objective weight reduction with the all the constraints. This was done in order to evolve the designs into an optimal region of the design space. Phase 2 was then used to focus in on this region with a more refined strategy to find the true optimal solution.

In phase 1 the optimization started from a Design of Experiments (DOE) with 100 random designs. This design was then evolved using the Non-dominated Sorting Genetic Algorithm (NSGA-II) with Steady State Evolution enabled. This was done to exploit the available computing resource in the most effective way possible.

For phase 2 the best results from phase 1 were used as a starting point (DOE) and a different optimization strategy was used:

1. In the phase 1 the goal of optimization was to minimize the mass in accordance with the lower value of safety factor, using the tolerance option for constraints.

2. In phase 2 a refinement phase was performed to strictly respect the constraints while finding the minimal mass.

A total of 26 different working-load cases were considered: the whole simulation took 2.5 weeks on a CPU cluster with 9 parallel simulations (36 core). The maximum number of evaluations was set at 1000 designs for this first phase and the runtime was about 72 hours (each simulation took about 40 minutes).
After phase 2 the set of optimal designs (Pareto Frontier) were verified

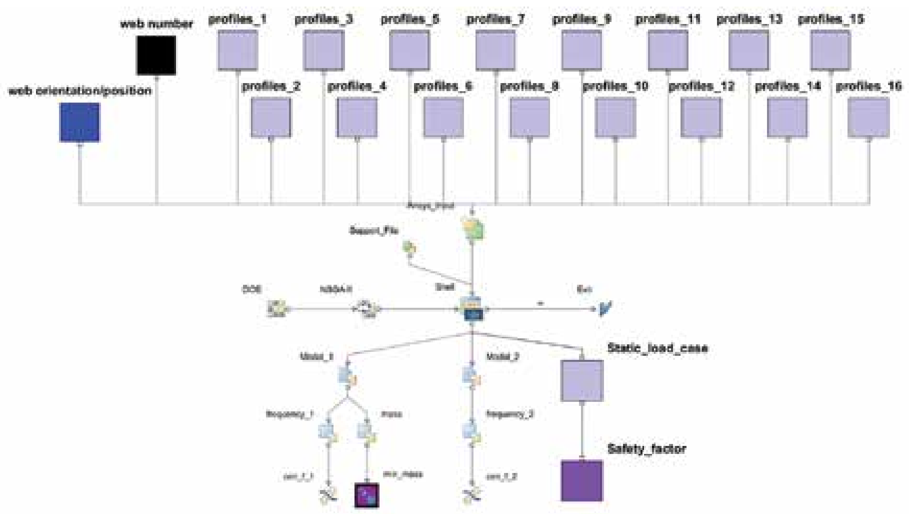

Figure 3 - modeFRONTIER Workflow

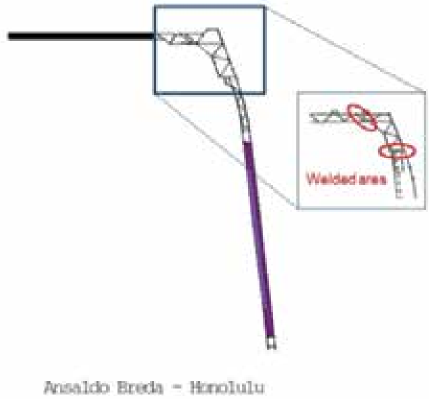

Figure 4 - Section of Car Body's Structure

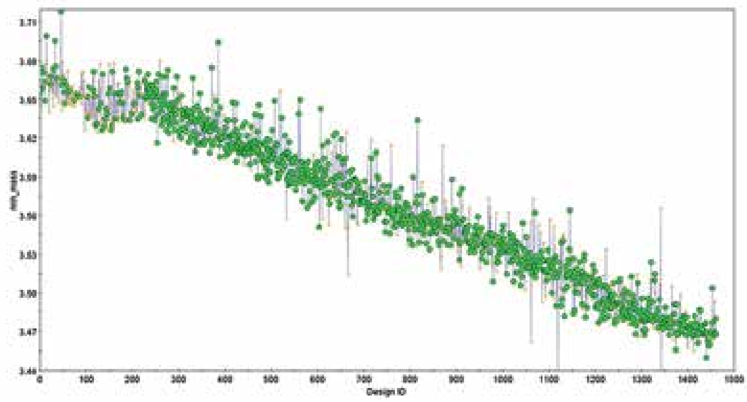
Figure 5 - Weight Convergence History

DESIGN ID	WEIGHT
STARTING	3.803
ID956 (from loop 1)	3.602
ID1440 (from loop 2)	3.451

Table 1 - Design Data Comparison

for each operative load condition. This was achieved using a decision making tool. At the end of the optimization (Figure 5) the best designs were chosen and after an accurate FE post-processing phase the two most appropriate designs were extracted (Table 1): these optimal designs have been chosen in term of maximum reduction of weight with respect to the most important load case.

The two optimal designs have a considerable variation of both external and internal skin thickness which can cause problems when manufacturing. In order to avoid this problem, further post processing analysis was done to find out the best solutions with a homogeneous distribution of thickness along the external and internal skins. Furthermore, the web angle profile located at the top and the bottom of the car body was modified in order to increase the stiffness (reduce the displacement) of the floor and roof. This adjustment caused a weight increase to optimal design 1440. Table 2 shows the comparison between the two optimal solutions in term of weight reduction respecting all structural constraints. The chosen solution, Design ID 1440_new, has a weight reduction of 6% (228 Kg) and it has a more uniform thickness variation to simplify the manufacturing.

This project has demonstrated the exploitation of new design methodologies and technologies in order to achieve the following:

1. Manage industrial design processes that involve large numbers of variables (more than 50), multiple constraints and objectives.

2. Find the best solution according within industrial time constraints.

The most important steps in achieving this are as follows:

1. Complete automation of the design process within modeFRONTIER: this makes the most of all available hardware and software resources, completely exploiting the downtime (evenings, weekends and holidays).

2. The requested weight reduction was achieved while satisfying every structural and comfort requirement: this has totally fulfilled the expectations of the modeFRONTIER industrial user.

3. The additional manufacturing requirement has been fulfilled without rerunning any analysis thanks to the new methodology approach: this has been possible thanks to the really powerful capabilities of the post-processing tools of modeFRONTIER.

4. The optimization methodology can be completely re-used for other design processes: this activity was dedicated to a specific car body, but the approach can be easily adapted to other railway vehicles.

For more information:
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	Nominal	Design 1440	Design 1440_new	Δ Nominal – Design 1440_new
Weight (tons)	3.803	3.451	3.575	-288 Kg (-6%)

Table 2 - Comparison between the last two optimal solutions

A project to support the optimization of high-pressure die casting dies and the related bearing structure

The activity carried out by EnginSoft in collaboration with SAPP has been awarded with the METEF Innovation International Prize 2014

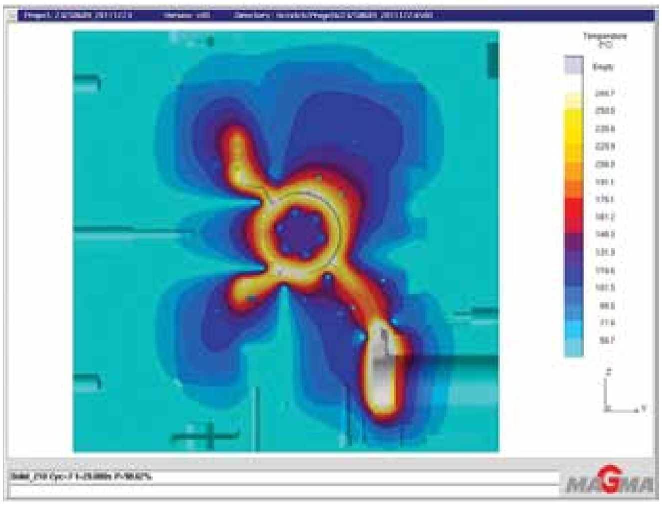

Fig.1 - Temperature evaluation using MAGMA software

VeronaFiere has hosted METEF, the International Expo of aluminum and foundry technologies from June 11th to 13th, 2014; three days fully dedicated to the whole chain of aluminum and technological metals. The 10th edition of METEF has attracted over 400 exhibitors, 30% coming from abroad, with sales delegations of 20 countries and more than 10 thousand operators.

This international event also included the 3rd edition of the "METEF Innovation International Prize". The award aims at promoting the innovative solutions of the exhibiting companies in different sectors. The nominees have been evaluated considering their originality, novelty, specific performance and their competitive advantages, taking into particular account energy saving, eco-friendly and sustainable solutions. The prize also gives emphasis to the best innovation cases related to the different industrial areas. EnginSoft, in collaboration with SAPP, has won the innovation international prize for the "Machine and plants" section.

The prize winning project introduces a new high-tech analysis method, based on numerical simulation, to support the advanced design and optimization of die-casting moulds and the related bearing structure (press and die holder).

Fig.2 - Eng. Calsolaro(ES), Eng. Peselli(ES), Eng.Mancini (SAPP)

The numerical procedure implemented is able to import the pressure and temperature data of the melt in the different cooling phases (obtained using MAGMA software) and to include them into a global FE structural model (created in ANSYS WORKBENCH), while evaluating the coupled stiffness effect of the whole structure. Taking advantage of the structural simulations, it replicates the different preload phases of the press and the operating load in the real working cycle, together with the thermo-structural loads due to the alloys injection. This is done with the following aims:

- To visualize the real internal and external stress distribution on the press, die-holder and dies.
- To evaluate the clearance between the die components and the related contact pressure during the different phases of the injection. This helps predict the forming of possible flashes.
- To analyze and predict the main risk areas of main thermal fatigue due to pressure pulsing and heat generated during the injection phases.
- To evaluate the deformation of the stamping surface during the packing and cooling phases to control the final shape of the casted components.
- To optimize the die's shape and reduce the structure weight while guaranteeing the required stiffness and thermo-mechanical resistance (gluing, wear and cracks due to fatigue).

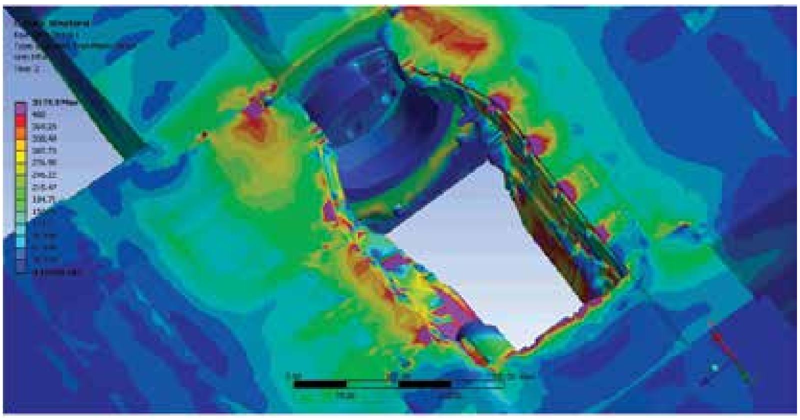

Fig.3 - Stress distribution on the whole system

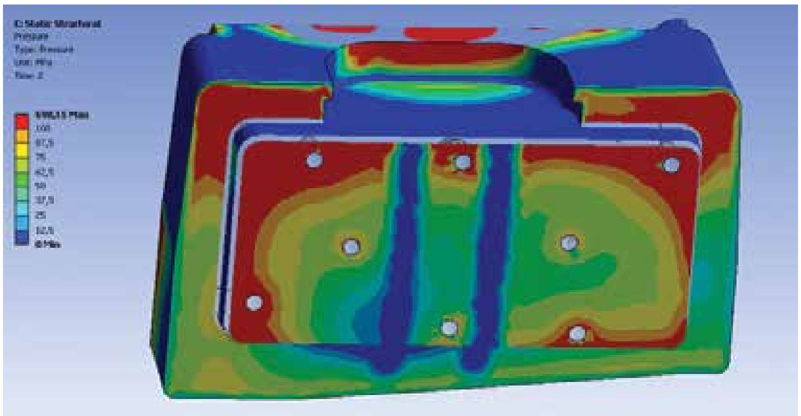

Fig.4 - Pressure distribution on the contact areas

In other words, thanks to the developed technology, the concept of multi-physic simulation, coupled with a parametric analysis, has been extended and made available for high pressure die casting equipment. This has enabled the evaluation of the structural effects of geometrical variation on the complex behavior of the whole die. This has been achieved for FE models with a high number of degree of freedom (from 1 to 6 millions) and coupling between the extremely non-linear parts (contact and friction). The procedure therefore allows for evaluating the coupled stiffness effect of dies, die-holders and the press structure, evaluating a gap of hundredths of millimeter on structures of several meters. This is something that has been never applied to such kind of equipment before. In particular, the simulation procedure has been applied and validated on an automotive die and has allowed to reduce both the size and the weight of the die from the 58ton of the original configuration, to 45tons of the optimized one. Such reduction has led to considerable benefits, permitting the use of a smaller LK3000 press instead of the larger 4000 press which is better during maintenance. The cycle time has been reduced from 110s to 95s, thus reaching an increased productivity of the press and reducing the costs and the energy consumption per cycle.

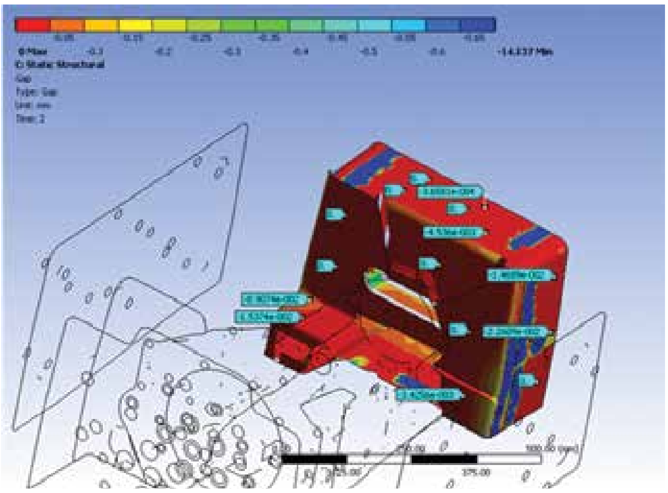

Fig5. - Prediction of the distribution on the interface areas between the different components of the dies and die-holders during the different cooling phases of the cast (useful to evaluate the flash channels formation)

Furthermore, the simulation procedure has reduced, on the same die, the scraps due to flashes or geometrical distortions from 2% to about 1.5%, thus keeping the minimum porosity under the tolerance limits. Such die is installed and operating in the General Motors foundry in Bedford, Indiana.

Such methodology has been developed and validated through the joint collaboration of EnginSoft S.p.A and Sapp S.p.A. and it can be used on an industrial die of any shape. The activity has successfully engaged the technical staff of SAPP, supported by EnginSoft's manufacturing unit team, in the process analysis; the structural analysis has been carried out by Eng. Valentina Peselli and Eng. Daniele Calsolaro of EnginSoft.
This multi-physic interdisciplinary collaboration has allowed for the achievement of this great success.

Fig.at the top of the article: Press, dies and die holder for automotive sector manufactured by Sapp S.p.A. and currently used in the General Motors plant of Bedford (Indiana).

modeFRONTIER helps Cummins improve Engine Performance

Using modeFRONTIER to integrate GT-Valve train and GT-Power models for valve

Cummins Engine, a leader in the manufacturing of diesel and natural gas-powered engines for a wide range of transportation and equipment purposes, has created a new power module ready to take on the stringent US - EPA regulations. It is significantly more compact and cost-effective than medium-speed engines at the same horsepower. It took 150 engineers to design it, and modeFRONTIER helped the High Horsepower group find the optimal valve timing, hence reducing fuel consumption.

Challenge

When designing piston engines, timing when opening and closing inlet and exhaust valves is a crucial parameter impacting the fuel consumption/power output ratio. Typically, delaying the Exhaust Valve Closing (EVC) and anticipating the Intake Valve Opening reduces Exhaust Gas Residuals, resulting in lower fuel consumption.

Among the complex models composing the 16-cylinder engine, Cummins designers used GT-Suite (Valve Train and Power modules) to simulate valve event performance and dynamics.
For optimal engine performance, valve timing and lift profile need to be perfected forgiven breathing configurations defined by engine speed, and valve and port geometry and performance.

Solution

Finding the optimal valve timing configuration required a two-step process; to start, a first workflow was created in modeFRONTIER and used to automate the calibration process. Valve train parameters were automatically adjusted with modeFRONTIER to calibrate the GT model and match measured push tube load. The second phase consisted in a second workflow, which was used to investigate the design space; initially with response surfaces and subsequently with the direct optimization algorithms NSGA and Hybrid - to find the best values for 12 output parameters measuring the exhaust and intake cam timing angles, the volumetric efficiency and the Brake Specific Fuel Consumption (BSFC) - BSFC is used for determining at what load and RPM an engine is making the most power out of the given fuel quantity.

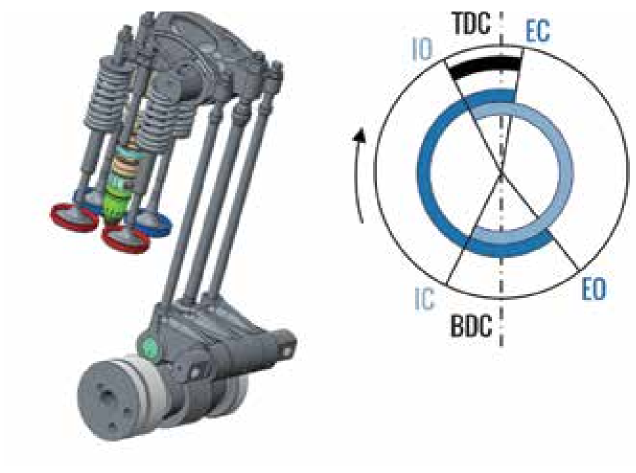

Figure 1- Valve train components

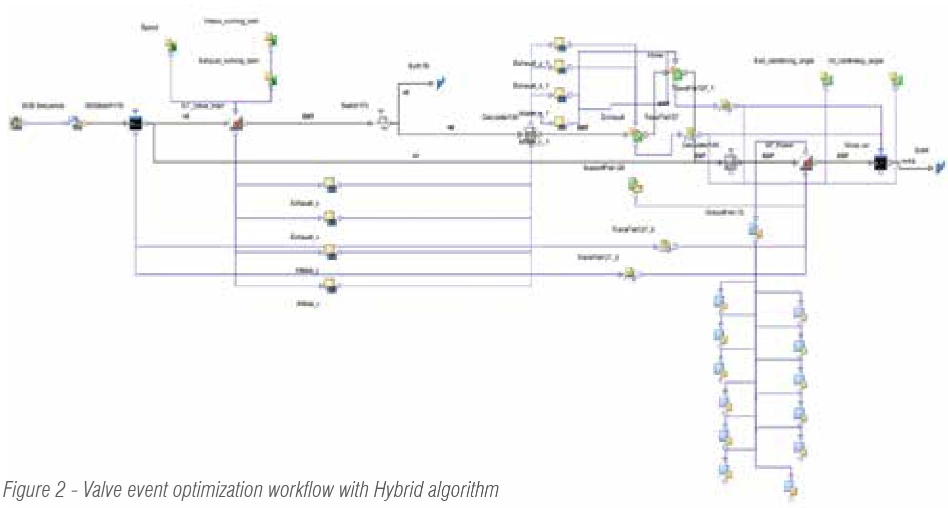

Figure 2 - Valve event optimization workflow with Hybrid algorithm

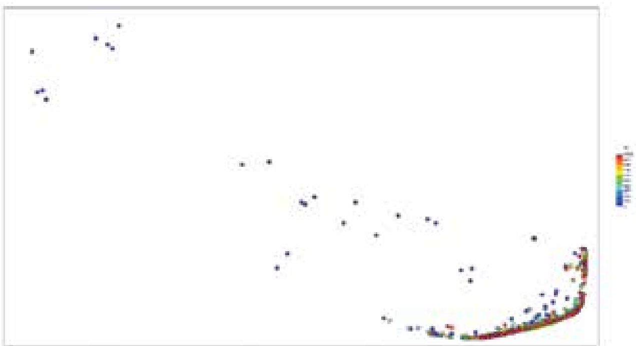

Figure 3 - Pareto Front (HYBRID Algorithm)

modeFRONTIER ADVANTAGES

During both project phases, modeFRONTIER proved highly reliable for reducing design cycle time and improving the performance of the valve train system. From the outset "it helped drastically reduce the time taken for calibrating GT models" said Ambikapathy Naganathan (Structural and Dynamics Analysis Engineer at Cummins). "modeFRONTIER has an excellent capability for integrating with multiple GT models and post processing tools." Continued Eng. Naganathan: "in fact it helped us link those GT models more efficiently and complement the in-house optimization tool, while at the same time maintaining concurrent use by different analysts in different locations."

About Cummins

Cummins Inc., a global power leader, is a corporation of complementary business units that design, manufacture, distribute and service engines and related technologies, including fuel systems, controls, air handling, filtration, emission solutions and electrical power generation systems. Cummins serves customers in 190 countries and territories through a network of more than 600 company-owned and independent distributor locations and approximately 6,500 dealer locations.
www.cummins.com

Caterina Moro, ESTECO

Numerical FE Simulation Applied to Design of Floating Roof for Oil Storage

This article presents a new methodology based on FE analyses applied to the design of floating roof for oil storage. Single pontoon floating roofs have been studied by applying prescriptions of API international standard. Extremely heavy testing conditions have been considered in order to simulate emergency situations which could occur during the roof service life. New approach based on transient FE analysis has been used and a dedicated procedure has been developed. System strength, buckling phenomena and pontoon functionality after the application of testing conditions have been checked and compared for different roof sizes. This work has been carried out in cooperation with Paresa SpA which is a worldwide leading company specialized in engineering, construction and maintenance of large steel structure in particular for Oil&Gas industry.

INTRODUCTION

Floating roofs for oil storage tanks are steel structures typically employed in the oil and gas industry. External floating roof tanks are commonly used to store large quantities of petroleum products such as crude oil. They includes an open-topped cylindrical steel shell equipped with a roof that floats on the surface of the stored liquid. The roof rises and falls with the liquid level in the tank as product is added or withdrawn from the tank. A rim seal system is mounted between the tank shell and roof to reduce liquid evaporation. This type of roofs minimize the vapor space between the pontoon and the liquid surface; since there is no large vapor space for the liquid to evaporate into, vapor losses are also minimized. Main disadvantages of the external floating roof use is that large amount of rain water and/or snow can accumulate on the roof top leading to roof structural problems and, eventually, the roof may sink. Therefore water on the roof must be drained by drain line system. Design requirements for external floating roofs are provided in Appendix C of the API Standard. Limited procedure and rules in design the floating roof are available in the technical literature and these had resulted in lots of floating roof failure during past years. The type of storage tank used for a specified product is mainly determined by safety and environmental requirement, but also operation cost and cost effectiveness are fundamental factors to

Fig. 1 – Storage tanks geometry: single pontoon (a) and double deck type (b)

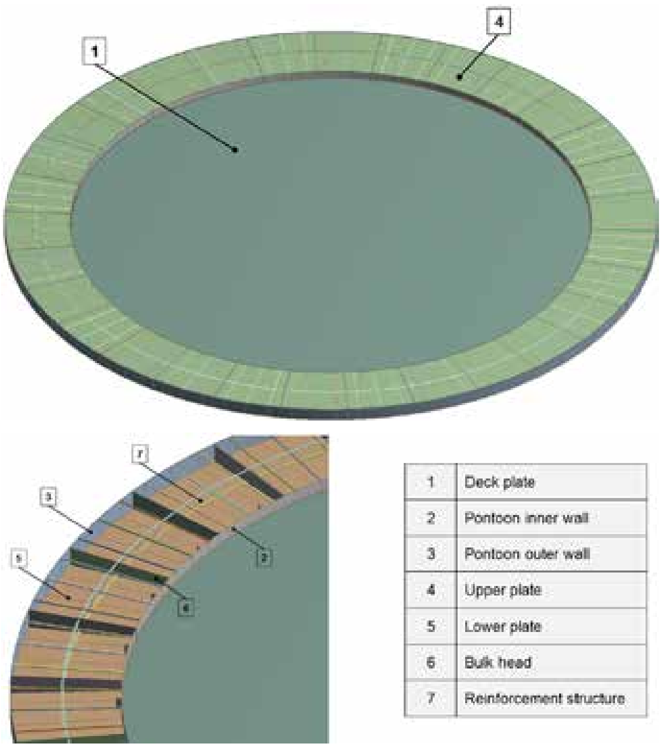

Fig. 2 - Roof modeled geometry and details of main parts

be considered. Design and safety has come to a great concern as reported case of fires and explosion for the storage tank has been increasing over the years causing injuries and fatalities. Spills and tank fires not only generate environment pollution, there would also be severe financial consequences.

As regard the classification of external floating roofs, they can be divided in to two main categories: single deck and double deck pontoon as shown in Fig. 1. In this study single deck type has been considered as its design against sinking is more challenging. The design and construction process is bounded and regulated by various codes and standards:

- American Standards API 650 (Welded Steel Tanks for Oil Storage).
- British Standards BS 2654 (Manufacture of Vertical Storage Tanks with Butt-welded Shells for the Petroleum Industry).
- German Code Din 4119 – Part 1 and 2 (Above Ground Cylindrical Flat Bottomed Storage Tanks of Metallic Materials).

Aim of this article is to present a numerical approach for the detailed evaluation of roof resistance under the action of testing loads according to API international Standard 650. Different sizes has been analyzed to cover the typical range of tanks produced by Paresa SpA. Though the codes addressed the minimum requirement on the pontoon volume, there is no mention on the structural adequacy. No proper procedures or standard rules stated in any code or engineering handbook are available for design floating roofs assessing structural integrity and buoyancy stability. For this reason a numerical methodology based on FE analysis has been developed using Ansys release 15.0 FE code. As prescribed by the API code, elastic stability against "gross out of plane" buckling and local buckling of the outer pontoon and roof functionality (no significant plastic deformations and tolerable outer rim submergence) must be checked at different testing conditions representing emergency situations, i.e. primary drain inoperative. Two load cases have been then considered:

- LC1: submergence of outer rim when 254 mm rain water is accumulated on the roof (primary drains closed).
- LC2: The submergence of inner and outer rim near the punctured compartments when deck and two adjacent pontoon compartments are punctured.

Both in-situ testing conditions (tank filled with water, nominal thickness of the steel plates) and operating conditions (tank filled with oil, 3 mm corroded thickness of the steel plates in contact with stored product) have been analyzed. FE simulations have been carried out by taking into account large deformation effects and non-linearity of applied loads. For the accurate evaluation of the roof's equilibrium position due to floating effect, a specific transient procedure has been applied for each testing condition to correctly estimate hydrostatic pressure due to submergence level. To evaluate the effect of testing loading conditions on the roofs resistance and functionality, also operating conditions (no accumulated rain water and no compartment puncturing) with stored oil have been simulated.

DECK SIZE		#1	#2	#3	#4
Inside tank diameter	ID [m]	59	43	30.5	21
Tank height	H [m]	17.15	16.2	16.3	16.7
Tank capacity	CAP. [m3]	40000	20000	10000	5000
Roof mass	m_{roof} [kg]	258424	42542	125077	69115
	m_{roof}/Area [kg/m^2]	94.5	122.8	86.1	94.6

Tab. 1 - Summary of analyzed storage tank main dimensions and mass

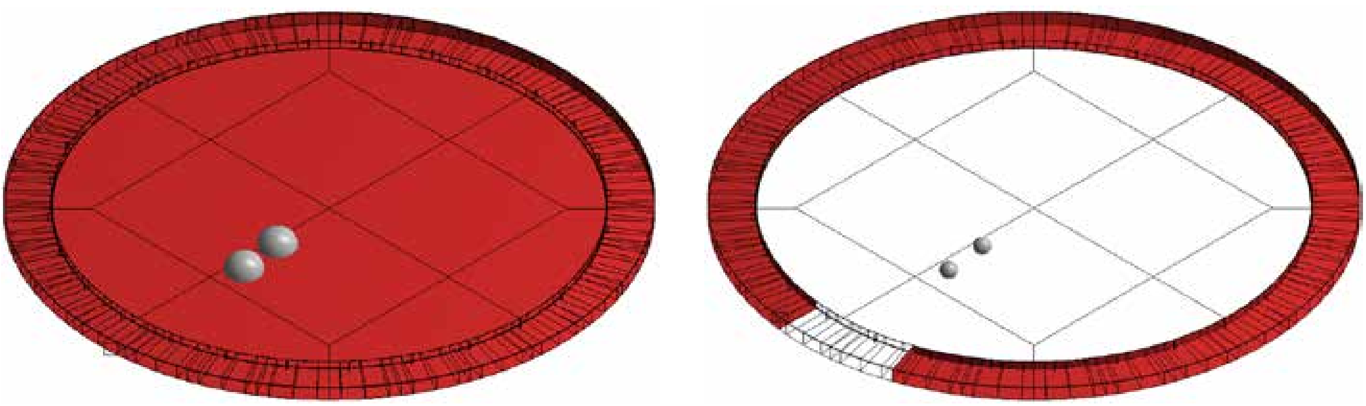

Fig. 3 – Deck lower wet surfaces for LC1 (a) and LC2 (b) testing conditions

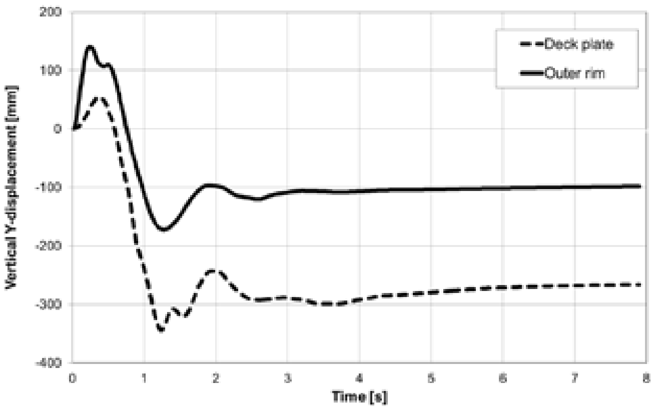

Fig. 4 - Example of monitor point vertical displacement vs. time diagram for transient dynamic analysis

SIZE		#1	#2	#3	#4
Rolling ladder mass	m_1 [kg]	1242	1155	1155	1155
Runway mass	m_2 [kg]	596	944	576	576
Position rolling ladder wheel	R_1 [m]	15.9	2.1	8.9	2.7
Position runway (center of gravity)	R_2 [m]	12.1	5.6	5.4	0.8

Tab. 3 – Mass and centroid position (distance respect to the tank center axis) of rolling ladder and runway

MATERIAL	NOMINAL COMPOSITION	PRODUCT FORM	UTS (MIN) [MPA]	YS (MIN) [MPA]	ELONGTION AT BREAK
SA 283 Gr. C	Carbon steel	Plate	380	205	22%
SA 36	Carbon steel	Bar	400	250	20%

Tab. 2 - Main material properties for deck structure plates and bars

FE MODELS

The study has been carried out on single pontoon roof type with different sizes, with deck diameter ranging from 20 to about 60 meters. The roof total masses and storage tank main dimensions for the different sizes under investigation are listed in Tab. 1. The modeled roof geometry with details of main parts is shown in Fig. 2. Analyses have been carried out by 3D FE model using a combination of 1D beam and 2D shell element for reinforcement structure and deck plates respectively. To simulate the submergence of deck plate due to accumulated rain, volume of water on the deck plate has been considered using proper 3D fluid elements (fluid80) which correctly simulate the fluid behavior and its hydrostatic effect. For all the analyzed roofs a mesh with about 250,000 nodes (1,500,000 dof) has been developed. Deck structure is composed by plates and bars, main material properties for the roof components are listed in Tab. 2. Self-weight of the deck structure and accumulated water for LC1 has been assumed as the main acting load according to the data provided by Paresa SpA. The application of hydrostatic pressure of the stored fluid is described with details in following section. A density scaling has been considered in order to obtain the total deck weight + accessories while the weight of rolling ladder and its runway have been simulated as remote mass applied on the deck plate. Mass and centroid positions of rolling ladder and runway are reported in Tab. 3. Conservatively, the rolling ladder and runway masses have been located in correspondence of punctured compartments for LC2. As can be noticed from Tab. 3, ladder and runway masses are about constant for all the analyzed tanks while roof diameters changes significantly. Therefore, for smaller roof in particular, weight of ladder and runway could critically influence the roof final position and submergence. A FE analysis of the whole roof, as described in this paper, results then fundamental to properly estimate these secondary effects which are difficult to be considered with a classical design-by-formula approach. For LC1 load condition, accumulated water has been simulated explicitly by modeling the water volume on the deck plate and assigning proper 3D fluid elements (fluid80) which can simulate the hydrostatic effect on the deck plate: the hydrostatic pressure due to the differential deck plate submergence which induce a higher water accumulation at the center is considered. Buoyant pressure has been applied on the deck wet surface according to load case under investigation. For LC1, the whole pontoon lower surface has been assumed as wet, while, for LC2 condition, the deck plate surface and the pontoon lower plates in correspondence of the punctured compartments have been considered neutral respect to the buoyancy effect. Conservatively the punctured compartments have been assumed in correspondence of ladder and runway eccentric masses. Wet surface considered for the load cases analyzed are shown in Fig. 3 where also ladder and runway point masses are indicated. According to prescription of API 650, the buoyancy pressure has been calculated by means of the algorithm described in following section assuming water (density = 1000 kg/m3) and oil (density = 700 kg/m3) as stored products respectively for LC1 and LC2 conditions. Standard earth gravity has been applied to the model and no support constraints are needed because the equilibrium is calculated step by step with the transient analysis procedure according to buoyancy force. For LC1 condition, a remote point has been assumed on the top surface of the accumulated rain water volume to impose the free surface condition for fluid elements. No vertical displacement constraint has been imposed to this remote point because the accumulated rain water free surface can change during simulation according to the deck plate deformation maintaining the total water volume. To prevent rigid body drifting in horizontal directions, and yaw rotation about vertical axis of the whole roof, tangential displacements of 4 control points at 90° on the outer rim plate have been constrained.

ANALYSIS PROCEDURE

Because of the roof is a floating structure, its equilibrium position assumed due to buoyancy effect is not a priori known and it depends on the whole roof self-weight and vertical deformation. Therefore, the hydrostatic pressure acting on each point of the roof wet surface is dependent on the vertical

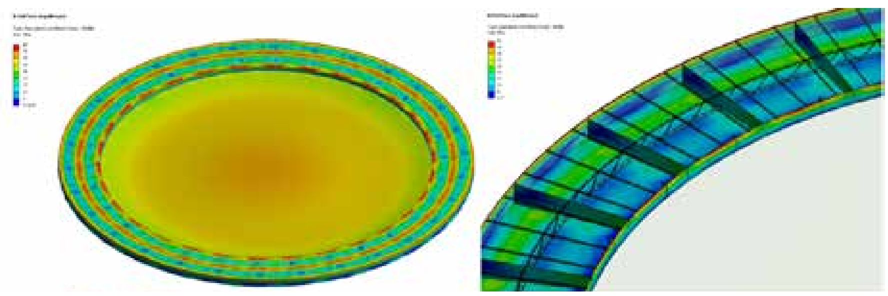

Fig. 5 – Example of von Mises stress for deck #1 and detail of stress on internal compartment plates

displacement of structure. For this reason, a transient procedure has been developed to simulate buoyancy of the floating roof. ANSYS solver can apply a spatial pressure gradient with various techniques, including the SFFUN command which uses for input an array containing hydrostatic pressures at surface node numbers calculated from node depth values. These pressures must be updated during SOLVE steps as a function of depth when a structure moves vertically in a liquid's hydrostatic pressure "field" in large displacement analysis. A dedicated procedure has been developed and main stages of the calculation algorithm are reported below.

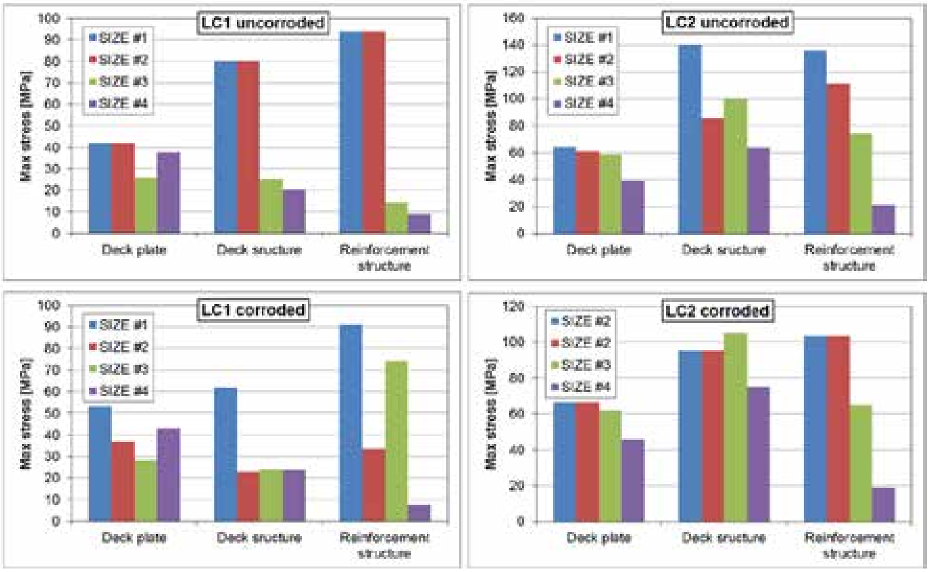

Fig. 6 – Summary of max equivalent stress for different analyzed decks

STAGE 1. Mass and Volume calculation

A preliminary small displacement static step has been solved to precisely calculate the total mass of the structure and its volume based on the meshed elements. For this step solid elements filling the pontoon compartments with air (density = 1.2 kg/m^3) has been used. The purpose of the displacement volume is to calculate a reasonable mass damping value for the transient analysis.

STAGE 2. Transient analysis

Full transient dynamic large displacements step has been then solved to calculate structure equilibrium position due to buoyancy. The hydrostatic pressure has been placed at exterior nodes on wet surface as shown in Fig. 3 for LC1 and LC2 conditions by considering a stored liquid free surface at Y=0, where Y is the vertical direction. Buoyant force has been calculated from the product of displacement volume and a liquid density. Nodes on wet surface under the liquid free surface are subjected to a pressure proportional to depth, while for nodes above free surface the pressure is set to zero. The final time step has been assumed long enough to reach the equilibrium: monitor points have been used to control the vertical deformation of the structure (plate and pontoon) and transient simulation stops when a plateau is reached in the displacement vs. time diagram. In order to initialize the transient calculation whose final result is the effective deck position, deck has been assumed to be already under the water level at the initial stage. The more the starting position is close to the equilibrium submergence level, in fact, the more the total time for the equilibrium is short and secondary effects such as local oscillation of the deck plate can be reduced. To avoid bobbing instability of the structure during the transient calculation step, a mass damping has been applied to the system with ALPHAD command. The calculation of damping factor has been done by estimating a characteristic stiffness for submersion considering cube root of structure volume as a characteristic length and liquid weight density (kg/m^3 * 1g) as a buoyant force. Given the mass of the structure and a characteristic equivalent stiffness for the buoyant force, a critical damping factor for a 1 degree-of-freedom damped system has been estimated. About 70% of this critical damping divided by total mas has been used as argument of ALPHAD command. For the total time period of the transient analysis, a characteristic time for a bobbing cycle has been calculated by considering a 1 degree-of-freedom undamped free oscillation. Due to the high size and mass of the floating roofs and its low global bending stiffness, a total simulation time equal to 2 bobbing cycle is enough for the equilibrium position calculation. Time integration is performed by executing a series of SOLVE commands inside a loop. After each integration step, the hydrostatic pressures are updated with new vertical position for each node on the wet surface. Time steps have to be small enough to maintain accuracy and avoid divergence. Number of time steps ranging from 200 to 600 has been used in the simulations for different roof sizes. Higher number of steps when vertical velocity of structure is high, i.e. higher mass to volume ratio, initial position far from the final one which induce high vertical position variation at the beginning stages and/or high structure deformation during the transient cycle. Example of plot of vertical Y-displacement diagram for size #1 roof taken during transient analysis shown in Fig. 4 point out that less than two bobbing cycle have been necessary to reach the equilibrium position.

ASSESSMENT

According to API standard, both resistance and functionality criteria have been assumed. Acceptable stress level, i.e. maximum stress under the allowable limit, elastic stability against "gross out of plane" buckling and local buckling of the outer pontoon and maximum submergence of the outer rim have been checked for all the load condition analyzed. According to API STANDARD 620 allowable stress of 154 MPa and 188 MPa have been assumed respectively for plates of deck structure and for beams of reinforcing frame. According with API standard 650 section C.3.4.2, the pontoon shall be designed to have adequate strength to prevent permanent distortions and the allowable stress and stability criteria shall be jointly established by the Purchaser and the Manufacturer. Therefore, being LC1 and LC2 not standard loading operating conditions, API standard 650 does not define a mandatory criteria for allowable stress. With conservative assumptions the allowable stress in the floating roof has been taken equal to 3/4 of YS both for testing and design condition. The value is considered reasonable in assessment of testing conditions. With such assumption, the required level of safety is the same of the shell plates in hydro-testing condition (ref to API 650 section 5.6.2.2).

Fillet welds have been also checked according to the same standard by considering specific joint efficiency (safety factor on the allowable stress) of 0.7 for double lap joints on deck lower plates and 0.35 for single lap joint on deck upper plates. In compliance with API functionality acceptance

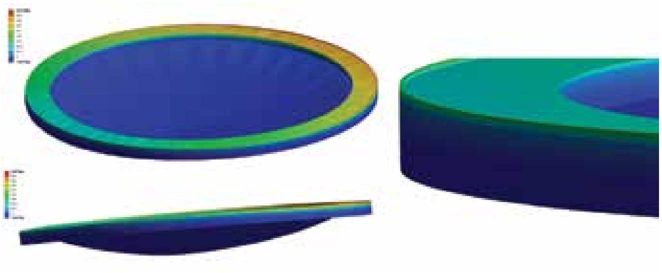

Fig. 7 – Example of submergence for roof size #3. Areas under fluid level are represented in blue

criterion, maximum submergences within 65% or 95% of the outer rim height in in testing and operating condition respectively are allowed. As regards the elastic stability acceptance criterion, the nonlinear transient analyses with large deformation option which have been performed allow the evaluation of the equilibrium condition for deformed structure and can guarantee that buckling of pontoon element does not occur for the load condition considered (buckling effects are implicitly monitored by the analysis that would result in non-convergence of the solution if buckling occur under actual loads). To evaluate gross out of plane buckling and local buckling of the outer pontoon for further load levels linear buckling analyses starting from the equilibrium condition calculated by means of transient analysis have been carried out. Therefore load factor for the first buckling mode shape must be higher than 1.

RESULTS AND DISCUSSION

In Fig. 5 example of equivalent von Mises stress map on deformed shape for deck size #1 with detail of the internal compartments plates is shown. For all sizes deck plates are mainly stressed at its central area due to accumulated rain water as expected. As regards outer pontoon, most critical areas are located in correspondence of intersection between walls and upper/lower plates. Stress intensification also occurs at junction between reinforcement structure and upper/lower plates. Stress assessment criteria for roof sheets, reinforcement structure and welds are satisfied for all the analyzed roof. Maximum stress found for different analyzed structures are summarized in Fig. 6. Results pointed out that stress in deck components are generally higher for sizes #1 and #2. For larger decks in fact, due to the lower stiffness and the considerable load induced by the accumulated rain water and self-weight of deck plate, higher bending deformations and stress occurred in particular at the upper plate and in correspondence of inner and outer rim joint. Results pointed out that testing condition generates severe stress status respect to normal operating conditions particularly for larger decks. Fig. 7 shows an example of submergence map for roof size #3 at LC2. Areas under the fluid free surface are represented in blue. Detail of outer rim submergence near the rim top limit where the gasket is mounted is also shown. In Fig. 8 the submergence levels at all analyzed conditions for different roof sizing are summarized. Results pointed out that assessment criteria are always satisfied. Both analyzed testing conditions proved to be severe from the point of view of roof submergence, confirming that a detailed FE analysis is needed to properly evaluate the roof functionality during in situ tests. Submergence levels for small roofs resulted critical respect to largest ones. The effect of accumulated rain water, reduction of buoyant surface and the influence of ladder and runway masses, in fact, have a major impact for roofs with lower diameter. Elastic stability checks are summarized in Fig. 9, where minimum load factors are reported at each analyzed condition. Buckling load factor calculated are always higher than the limit even if, especially for larger roofs, values near 1 have been found. Larger pontoon in fact are more subjected to local buckling phenomena due to the lower stiffness of their components. However, for all roof sizes, first modes are related to local buckling of bulk head plates or struts of reinforcement internal structure. Gross out of plane buckling have been found only for high load factors (> 10) pointing out that no risk of roof sinking due to structure bucking is present. A dedicated methodology for the design and analysis of floating roofs for oil storage tanks has been developed and applied to a range of roof size. Extremely severe testing conditions have been assessed in compliance with widely applied technical standard. The approach proved to be robust and allow to analyze with details several operating situations usually not systematically considered in the design stage. Therefore, a systematic application of the proposed procedure in the design chain for this kind of structure should be considered to improve the confidence level about roof behavior in testing and operating conditions and reduce risk of pontoon failures. Results pointed out that, generally, testing stages are very severe from the point of view of induced stress, submergence level and buckling risk respect to normal operating conditions. For larger pontoon in particular, stress levels and buckling phenomena could be assumed as driving factors during the design, while, for smaller pontoon, submergence level should be carefully checked especially in case of compartment puncturing.

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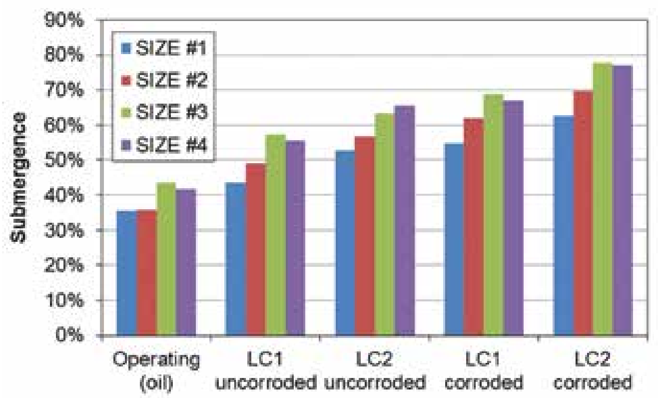

Fig. 8 – Summary and comparison of submergence levels

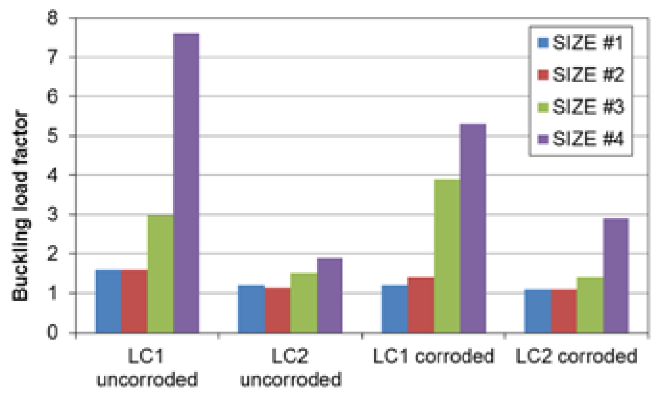

Fig. 9 – Summary of minimum buckling load factors

Analysis and Optimization of a washing machine oscillating group

SPM is an engineering company involved in the design of horizontal axis drum type washing machines. One of the first steps in the design stage is the definition of the plastic tub, the counterweights and the suspension system in terms of springs and dampers position and their mechanical properties.
This product's packaging space is a challenge due to the unceasing market demands for higher machine capacity inside a fixed external cabinet space, while also reducing the overall weight.
Therefore these new design constraints are leading to a continuous reduction in available space for oscillating group to move. This is further complicated by the unbalanced nature of the rotating load inside the drum, which increases the risk of contact between the machine's moving and fixed parts.
Even if several electronic control methods are used to reduce the imbalance, a good mechanical design is required to aid the success of any further electronic control.

Dynamics of the washing machine

In the early design stage our focus is on the dynamic displacements of the oscillating group, when it accelerates to reach the final spin speed at the end of every washing cycle. This is done in order to remove as much water is possible from the laundry.
The oscillating group is a damped mass-spring system with 6 d.o.f. in the space (3 displacements along x,y,z and 3 rotations respect to the same axis) whose trend is the typical second order unbalanced forced response: during washing phase at low speed (about 50rpm), the group operates in static condition, starting the spin ramp, the six rigid mode resonances appear, usually in a 150-300rpm range, where the highest displacements/rotations are measured with the consequent possibility of contacts against the cabinet, over this critical speed range the oscillations decrease again and stabilize at a fixed value that is no longer a concern for the purpose of this study.

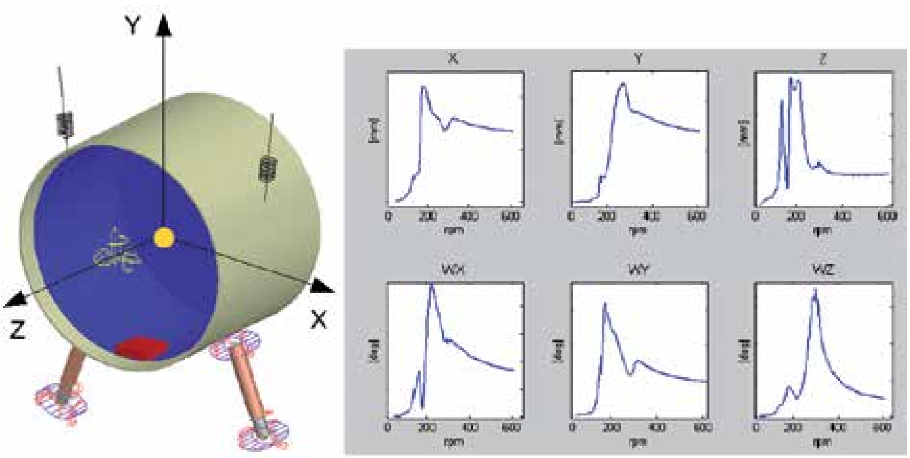

Fig. 1 - Oscillating Group: damped mass-spring system with 6 d.o.f. in the space

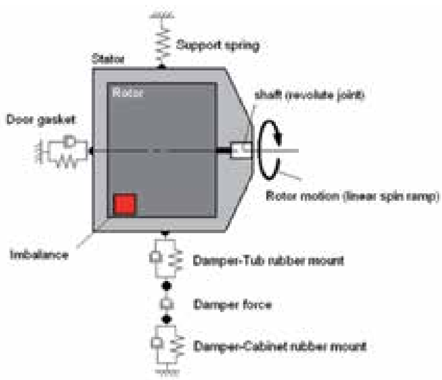

Fig. 2 - Washing machine modelling

Laboratory tests

An insight into the dynamic behavior of a real washing machine is obtained by an experimental set-up capable to capture the three-dimensional motion using six mono-axial accelerometers, properly placed on the external surface of the tub.

The test consists on a simple linear acceleration of the drum, where a concentrated mass (1kg) has been attached, from 0 to 600rpm with a 3rpm/s ratio. Usually a design of experiments with different masses and positions inside the drum is performed.

The signals coming from the accelerometers are digitized and then processed, using a MATLAB script that transforms the time functions into the frequency domain, getting the amplitude vs speed diagrams for the 6 d.o.f. of the moving group with respect to a geometric reference system placed in its central location.

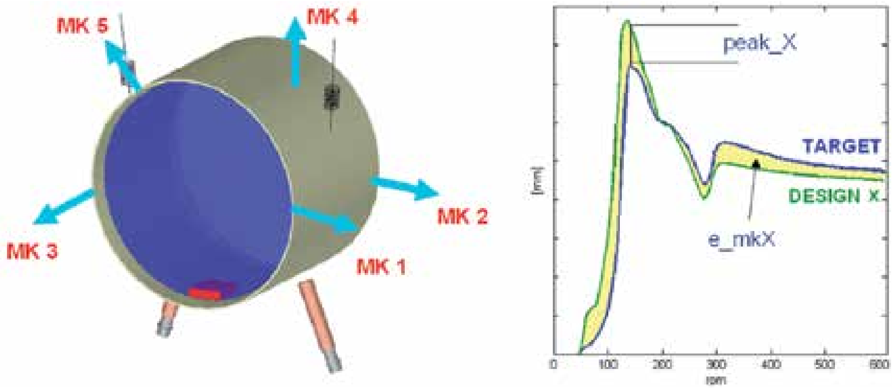

Fig. 3 - Objective Functions: fitting numerical-experimental displacements at 5 suitable checkpoints

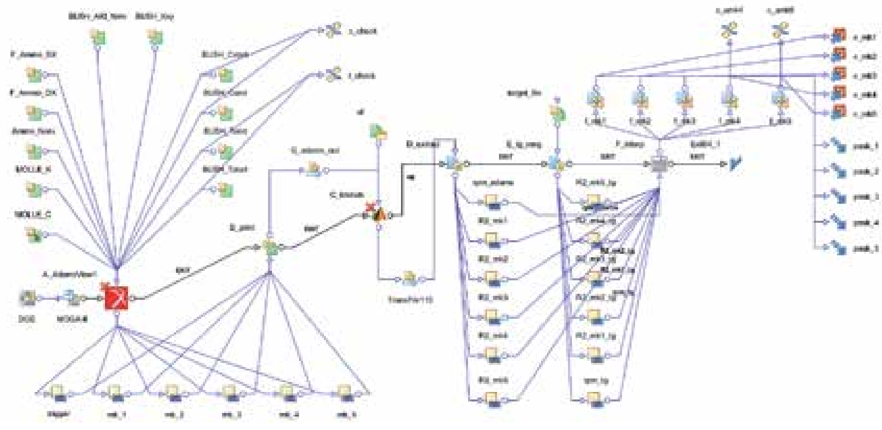

Fig. 4 - modeFRONTIER workflow

Washing machine modelling

A rigid multi-body analysis is conducted using MSC/ADAMS software to study the displacements under test conditions and compare to test results.

The model consists of the following parts:

- A stator which is the body where all the components that do not rotate are collected (tub, counterweights, motor, accessories).
- A rotor which is the body including all the rotating parts such as drum, drum support, shaft and pulley.
- Support springs (linear spring element in ADAMS: 1 parameter)
- Dampers (non linear velocity dependant force vector: 2 parameters).
- Damper attachments (6 components linear spring-non linear damper: 6 parameters).
- Sealing door gasket (6 components non linear spring-damper: 9 parameters).

The main problem is in building a reliable predictive model, which means a correct description of mass/inertia tensors for stator and rotor, easily obtained by the CAD, and of the force laws acting on the system, in particular, the elastic and damping components in the gasket and in the rubber mounts at the damper connections have the main effect in resonance conditions and becomes the most critical quantities to be modeled and identified.

The validation process of the models is based on the trial and error procedure, changing one parameter at a time and observing the new, matching with the test curves.

Even if satisfactory results are suitable for most of the cases, has been created in this way, the refining process never stops due to the need of improved models and, being a time consuming activity, has been considered eligible for a project aimed at:

- Reduce the manual working time.
- Increase the number of trials in automatic mode during nights, weekends, etc.
- Increase the knowledge of the model and its limitations.
- Increase the knowledge on the effect of each parameter.

Objective functions

The objective functions are not the translations and rotations at the origin because we have information on amplitudes but not on the phases.

To overcome this limitation we observe the displacements of some points of interest (checkpoints) located where the oscillating group is closer to the cabinet: 5 positions (MK1, MK2, …, MK5) has been considered as the most interesting for our purpose.

The displacements at the checkpoints are an amplitude and phase composition of the d.o.f., these can be easily calculated directly in ADAMS post processor or by applying the rigid body equations to the test signals, rebuilding the motion on locations where is not possible to place a sensor without the risk to damage it.

A modeFRONTIER workflow has been set up in order to get the best match between simulated curves (Design X) and test ones (Target) for each of the 5 checkpoints by minimizing two quantities:

- the mean quadratic error (e_mk1,..,e_mk5).
- the peak deviation at the test resonance speed (peak_1,..,peak_5).

In the X designs created by the software, Design 0 is the original configuration using the parameters of the best solution obtained with the old manual method.

modeFRONTIER workflow

modeFRONTIER allowed for an easy communication between the different software's involved in the process, since ADAMS and MATLAB have a specific node that let inputs and outputs to be elaborated in a straightforward way with neither the need of changes on the models and scripts already in use nor the creation of new ones.

At each design step, the input design variables are generated by the first node (DOE) in the workflow, according to user defined variation ranges and using strategies for design space reduction, the second node (MOGA-II) is the scheduler that applies the genetic algorithm for the multi objective optimization and it's by-passed when the aim of the run is a sensitivity analysis.

The input variables are collected to the ADAMS node that supply these values to the dynamic solver together with the required simulations settings.

At the end of a successful ADAMS run, 5 vectors (mk_X) are filled with the time dependent checkpoints displacements and written on a text file which is the input for the MATLAB node, here the script dedicated to the creation of the displacements over speed curves is called.

The new vectors containing the design curves (R2_mkX) are compared with the target vectors (R2_mk_X_tg), and the mean quadratic errors (e_mkX) and peak deviations (peak_X) are calculated, resulting in 10 objectives to be minimized during the optimization process.

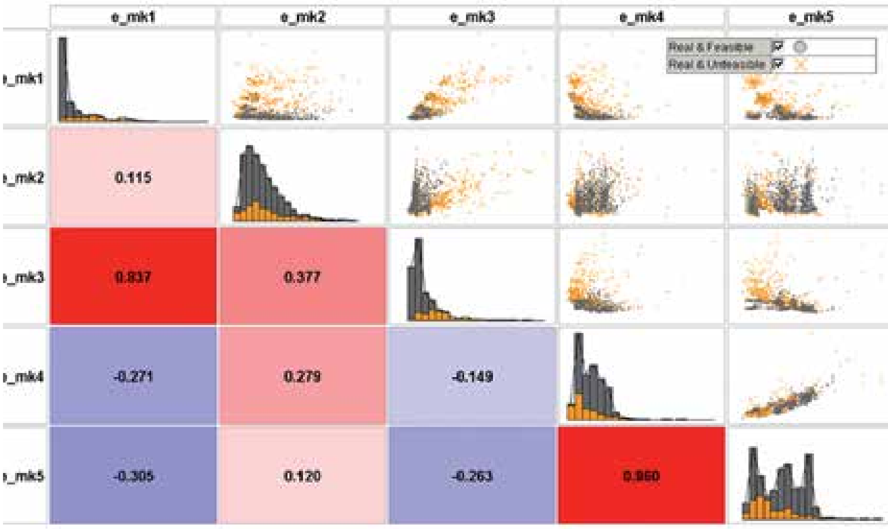

Fig. 5 - Assessment of linear relationships between objective functions

Methodology and results

Since the gasket has a heavy influence in the system dynamics it's better to decouple this item from the other elastic components.
For this reason, the complete study has been split in three steps:

S1 Analysis without gasket (10 design variables).
S2 Analysis with gasket (9 des. var.) applied on an optimum design obtained in step S1.
S3 Final refinement with gasket (13 des. var.) choosing a collection of variables and ranges basing on the knowledge gained in steps S1 and S2.

This is a profitable approach for a simplification of the problem, because even if a specific software with powerful statistical post processing functions is used, it's difficult to handle too many parameters.

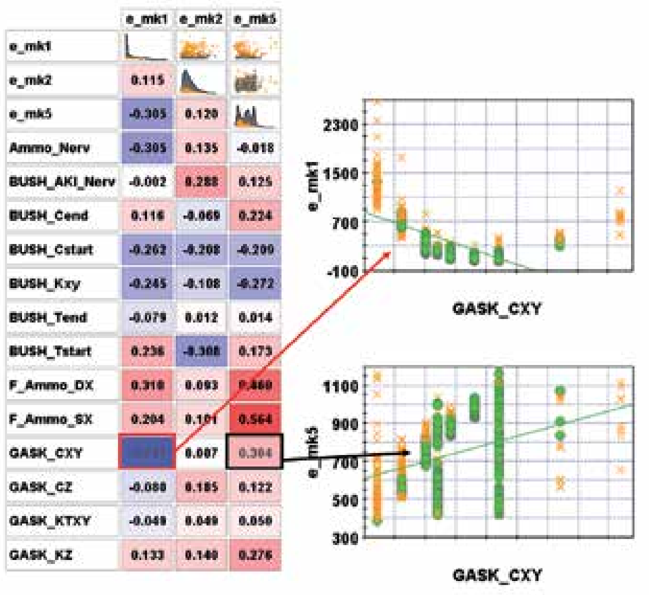

Fig. 6 - Assessment of relationships between objective functions and input variables

The methodology can be summarized in four main tasks:

T1 Correlation between objective functions (scatter matrix) to identify any dependency and reducing the complexity of the optimization process (a value close to 1 means variables are highly positively correlated).
T2 Correlation between inputs and outputs (scatter matrix, parallel coordinates chart) to identify the most important parameters for optimization convergence.
T3 Comparison of designs (bubble chart of Pareto frontier) to identify a set optimum designs to be evaluated.
T4 Evaluation of the optimum designs by visualizing the resulting displacement curves (vector chart).

For example, in Step3, as referred by the following picture, the scatter matrix of objectives vs objectives (T1) shows that not all the five objectives are independent, and the high correlation between e_mk1 and e_mk3 as well as e_mk4 and e_mk5 suggests that at least two of the original objectives can be neglected in the optimization process, being linked to the elaboration of the remaining three.

Furthermore, the correlation between input and outputs (T2) as shown by the following scatter matrix (just the 3 independent ones), there is a major influence of parameters (GASK_Cxy, F_Ammo_DX, F_Ammo_SX) on outputs e_mk1 and e_mk5. Physically that means that damping effect of the door gasket and damper forces have to be selected in an accurate way. The corresponding scatter charts provide the local trends for the correlations between e_mk1, e_mk5 and GASK_CXY. Similar charts, here not reported, can be built up for F_Ammo_DX, F_Ammo_SX. The information coming from such graphs can be used at the aim to perform the next step: the selection of the best candidate configurations (e.g. GASK_CXY should be close to intermediate values for e_mk1 minimization).

Looking for the best designs, suitable input parameters values have been filtered out by using the parallel coordinate's charts. Being in such graph every different line related to a different configuration, by switching on the "synchronization" option between the parallel and the bubble charts, the most promising results can be highlighted and compared (T3). In particular, as depicted by the following parallel coordinate's chart, as soon as the higher values of F_Ammo_DX and F_Ammo_SX parameters (i.e. the damper force) have been removed, a simultaneous reduction of e_mk1 and e_mk5 objective functions is achieved. By using the color scale bar, the designs providing minimum values for the third objective function e_mk2 can be easily identified.

According to the 3 Steps Methodology, two optimal designs have been selected: des 500 as the optimum one for Step2, while des 2675 for Step3. Both designs have been highlighted and compared in respect of the initial design 0.

Eventually, the final comparison of the optimal designs set (T4) can be done using the vector charts, allowing for a comprehensive visualization of the optimization results (500, 2675) with respect to the design 0 and the experimental targets.

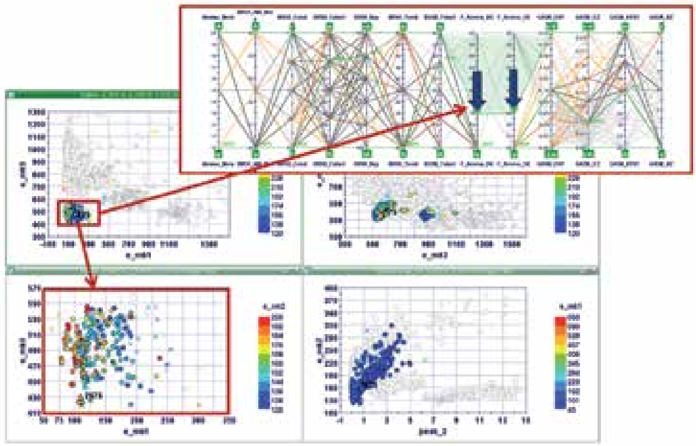

Fig. 7 - Looking for the best designs by "synchronizing" Parallel Coordinate and Bubble Charts

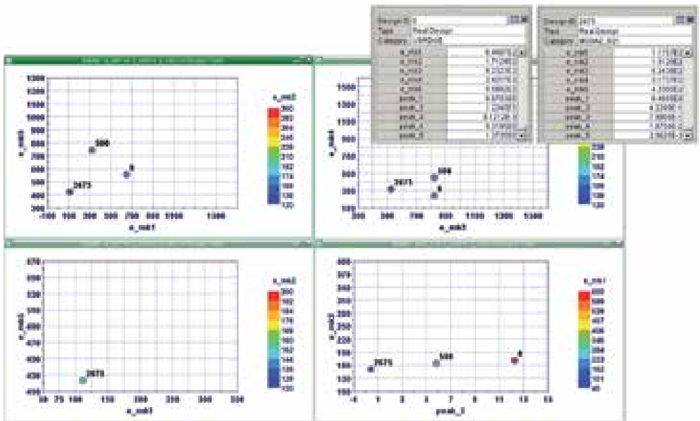

Fig. 8 - Candidate solutions: main Objective Functions for designs 500 (Step2) and 2675 (Step3)

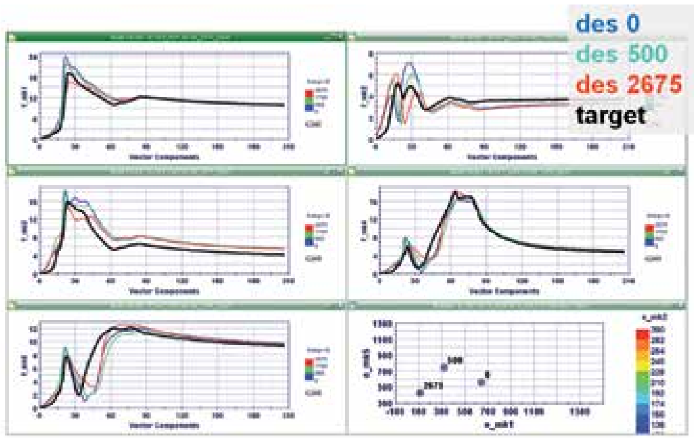

Fig. 9 - Candidate solutions: numerical and experimental curves for designs 500 (Step2) and 2675 (Step3)

Funzione Obiettivo	des 0	des 500	Δ (%)	des 2675	Δ (%)
e_mk1	645	321	-50	112	-83
e_mk2	171	165	-4	151	-12
e_mk3	823	823	0	524	-36
e_mk4	242	451	86	317	31
e_mk5	559	744	33	423	-24

Tab 1 - Quantitative comparison between initial and optimized configurations

Conclusions

The exploitation of modeFRONTIER, software platform for multi-objective optimization and advanced data mining, led to a significant improvement when matching numerical-experimental curves, especially with the last configurations provided by Step3, as the next table points out.

Furthermore, this has been achieved using a large number of designs (about 2000 independent solutions not manually achievable) and a complete set of statistic tools to understand the design. This has provided a much better understanding of the model's behavior and limitations.

The overall calculation time took about four days using an HP xw4600 workstation (3.0Ghz Core2 Extreme, 8GB RAM) making use of nights and weekends. The process allows the engineer to stop and restart the optimization several times which results in an optimal use both of the software licenses and hardware resources.

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System Control logic enhancements through Fluid-Mechanical valve dynamic transfer functions

Turbomachines performances control is strictly depending from the interactions between the system control logic and devices dynamic (i.e. valves, drivers, actuators, etc…) which can act or promote modification of main fluid systems parameters over all working conditions. In order to seamlessly link the physical behavior of the system components, the functional instructions must be properly exchanged through the same language. This is possible describing the real components evolution with a system of equations that control logic can understand. Manageable input-output relations are often achieved from simplification and most of them are usually taken as they are, without any possibility of improvements. Approximations errors are inherited from previous applications and because of these, many situations arise where machine do not work as expected with the need of fine tuning in the field. In the worst scenario errors propagation in transient run may cause system response drift which cannot be recovered, with unknown consequences.

GE Oil & Gas

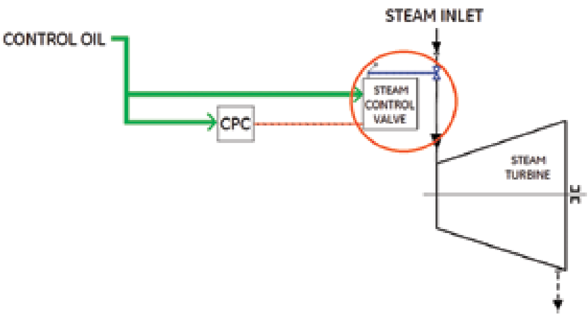

Figure 1 - Steam Turbine control system network, red circled is objective control valve

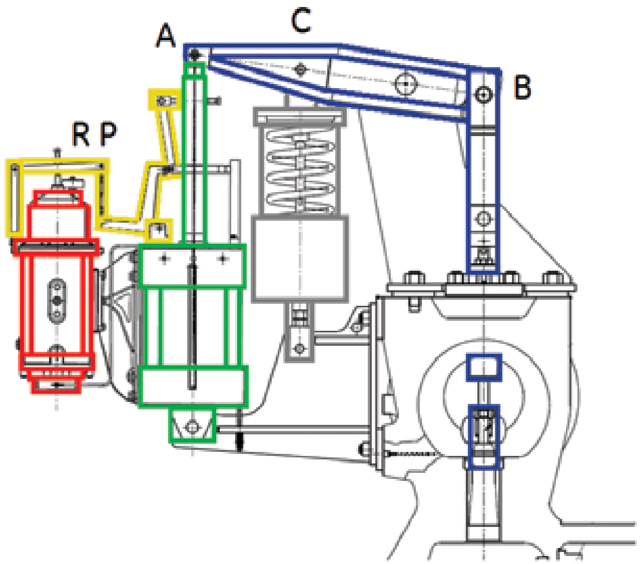

Figure 2 - Steam control valve and main components

A similar issue arose in a Steam Turbine plant, where control logic became unable to manage the bulk steam control valve dynamic, resulting in output power oscillation. This article highlights how, with one-dimension CFD software such as Flowmaster™, it is possible to improve the traditional approach on auxiliaries' characterization through analytical multi physics system study. This will lead to confirm the goodness of current approximations or rather generate an equivalent transfer function of the entire system for additional studies.

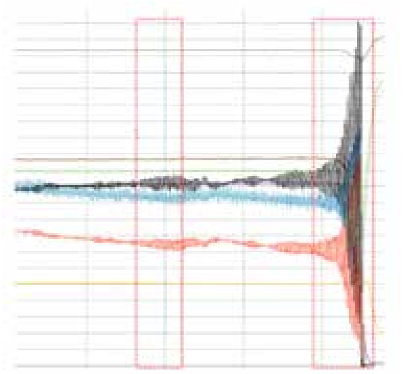

Figure 3 - Output power (black), high pressure turbine (blue) and low pressure turbine (red) command fluctuations

Pressurized oil from lube console (green line) is used for two purposes. As previously said, it is the force source to move the steam valves, but it is also used to control how much these should be opened (or closed); because of this last purpose, the system needs a fine and precise regulation to be carried out. The lube oil is properly metered by a sort of PID controller named CPC (Control Pressure Converter) and transformed in lower pressure signal (red line), which is varying in a limited range.

Figure 2 shows valve main component in detail. Control functioning is below.
Starting from the left there are: the servo-cylinder in red, the actuator piston in green, the closing spring (grey), the leverism and valve stem (blue, bottom right) through which the steam passes, and the repositioning levers in yellow.
Servo-cylinder is connected to the lube oil console and to the CPC controller, from which receives the oil pressure signal in the given range. When the control oil signal is constant, the vertical servo-piston is in balanced position, under the forces of that pressure and of a movable spring inside the top cap of cylinder. In such case the lube oil can't move to actuator cylinder, because passage areas are closed by the servo-piston. In cases of CPC pressure signal change, forces balance is missed and the servo-piston starts moving up or down, depending on pressure increasing or decreasing, respectively.

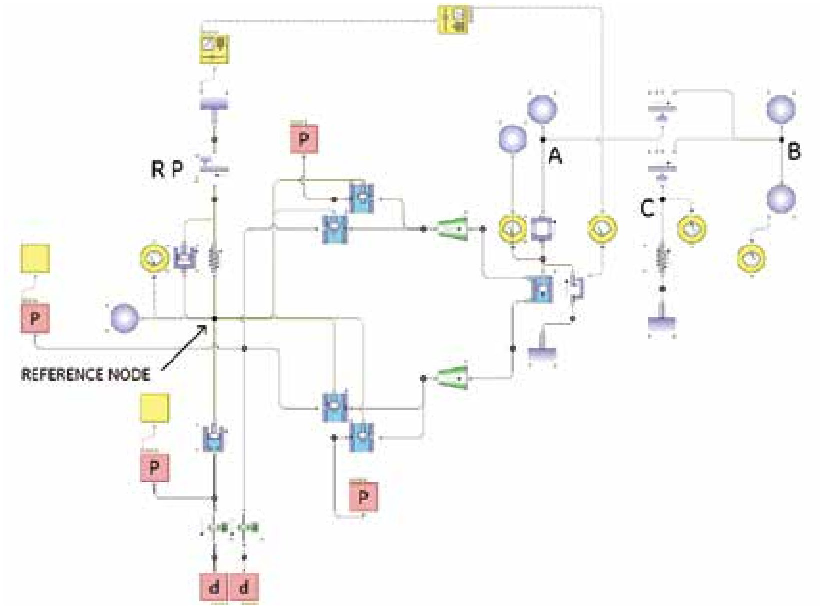

Figure 4 - Steam control valve Flowmaster network

In details, the previous mentioned steam control valve is modeled within Flowmaster software to properly reproduce item dynamic. Valve working conditions are strictly connected to feeding network behavior; the simulation will take into account these influences. Once model results are validated, advantages are expected in terms of simplification and other possible situations might be explored widely. Integration of the model in the control logic environment will make easily foreseen any related communication problems.

Steam control valve

Steam Turbine power depends on quantity of steam sent inside. Control valve manages the opening of machine inlets passage, allowing the steam to entry in turbine. Opening ratio establishes the steam mass flow rate and so the produced power. Due to steam high pressure and flow rate, forces involved are high too and require bulk elements to resist. It can be imagined just considering valve total weight, which is above 500 kg. To promote motion of these heavy components it necessary to take pressure from the hydraulic circuit of lube oil console. Nominal pressure requirement is up to 10 barG, oil consumption up to 80 l/min in steady condition. In Figure 1 a schematic view of network.

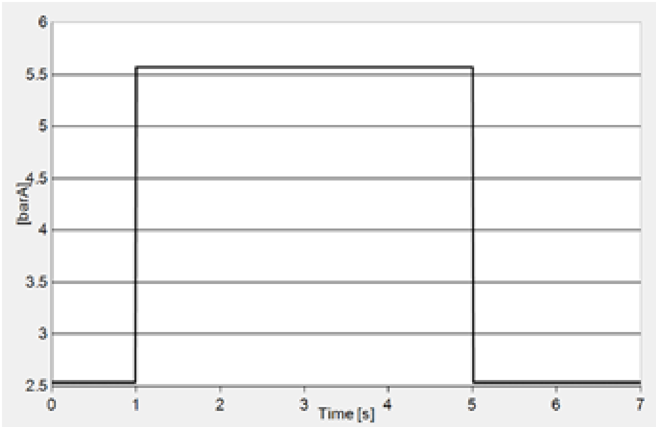

Figure 5 - CPC pressure control signal for stated test

During this movement, passages area open and lube oil can reach the force cylinder. If the servo-piston moves up, oil fills the upper chamber, the lower is emptied, force piston is brought down with all the levers winning big spring force and making steam ports to open; meanwhile the repositioning levers follow the actuator piston lift and it responds in order to carry the servo-piston down and move it in the closed position. The same evolution, but in the opposite direction, takes place when the control pressure

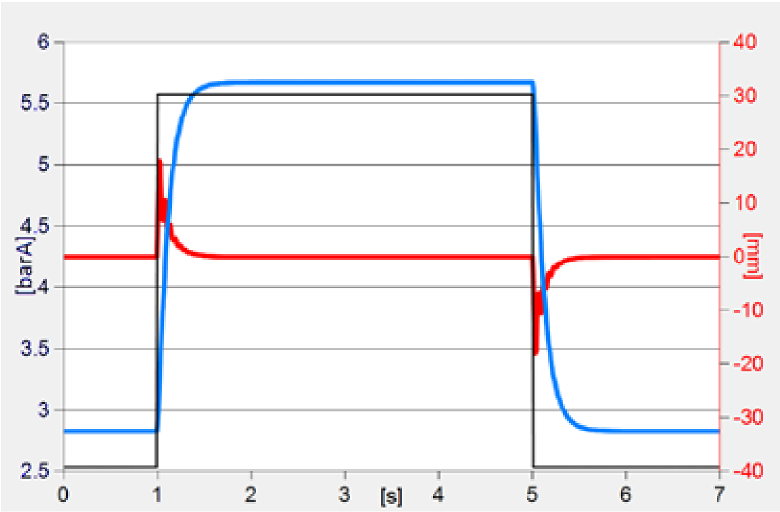

Figure 6 - Servo-piston evolution (red) and valves rod position (light blue)

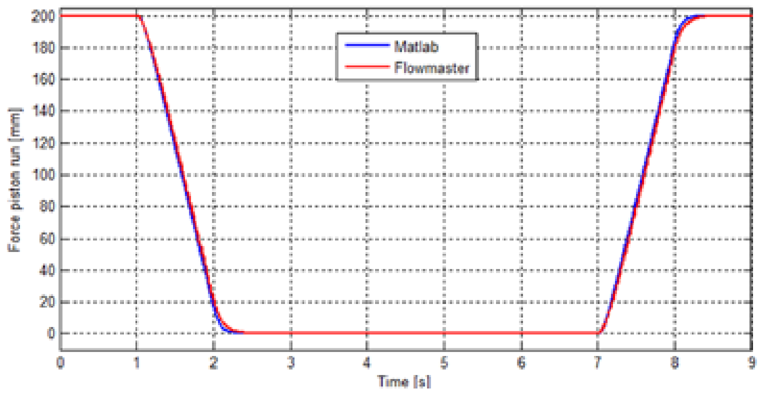

Figure 7 - Flowmaster and Matlab response comparison, force piston stroke

decreases, causing the servo-piston descendent and the steam valve to close.
Steam valves opening ratio depends on control pressure signal value: for lower bound value, valves become fully closed, fully open for upper limit and an intermediate ratio for signal value within the range.

The components which are involved in control valve kinematic are bulk and much massive elements:

- Servo-piston: 4 kg
- actuator piston: 120 kg
- Levers & valves: 357 kg

These weights play a fundamental role in valve dynamic evolution, even in relation with the control logic response speed.

Control valve manufacturing is several generations of steam plants old. Tolerance gaps are not as reduced as modern solutions. Oil leakage in steady close position (up to 80 l/min) isn't negligible considering it might have effect in the lube oil console performance and it's a mandatory constraint to be evaluated in oil pump choice.

Piston motion involves big oil quantity and heavy bulk elements displacement; dynamic response depends on these parameters. The likelihood of asynchronous evolution between load and displacement could arise in case of inadequate control logic gain. Just as happened to the Steam Turbine plant, where control logic couldn't properly follow the load dynamics, bringing the turbine in an unstable power fluctuations, as in example of next Figure 3.

Flowmaster model approach

Control valve is a complex hydro-mechanical item. Flowmaster multi-physics network has to be created using, hydrodynamic, electro-mechanical and controllers libraries.
In the following Figure 4, Flowmaster steam control valve network is reported.

Single components, as they are implemented in the code, will not be able to reproduce the complexity of real behaviors. Thus, starting from those, it is required to find a particular component linking configuration which reproduces the physics as realistically as possible.
On the left side of the network is the servo-cylinder, probably the most difficult to model in order to simulate the true evolution. To schematize the servo-piston and ports interactions, two different branches are needed. One side is referred to a pressure source from lube oil console. The oil flux to the actuator cylinder chambers is alternated: when the upper channel is linked, the lower is discharging, and viceversa. For each channel, a couple of port components are used, where one port is for charging and the other for the discharging phase, acting in counter phase. Port opening command is derived from the other branch. It is in fact necessary to create a mechanical node to which referring to establishing servo-piston balance (i.e. close position). This node is the mechanical side of Single-acting Piston. That plunger replaces the servo-piston pressure area wetted by control oil from CPC. On the top, such node is linked to the over cap spring. Balance position is reached when reference node level is equal to zero. Positive deviation brings the upper charging and lower discharging ports to open. Again, opposite reaction is for negative displacement. Bottom sources refer to pressure and control oil leakage in steady balance position. Of easier modeling is force piston, with Double acting Piston, in figure right middle. The last bulk lever isn't directly available too since the libraries do not have a simple Lever item with possibility of three mechanical connections, as required instead. A possible solution is to divide the lever in two sub levers, with pivots in same position (with respect to the datum level): the longer is connected to force piston (A) and to steam valves mass component (B), the shorter to closing spring (C) and to same node of previous mass (B). Servo-piston repositioning system is in on top middle. Actuator piston stroke is read on related End Stop and sent to the Controller Template (one on the left) where compiled transfer function is to move the RP lever end. This transfer equation replaces middle L-shape yellow lever (Figure 2). Another RP lever joint is linked to the second free end of servo-cylinder cap spring. Each member has the proper mass value assigned.

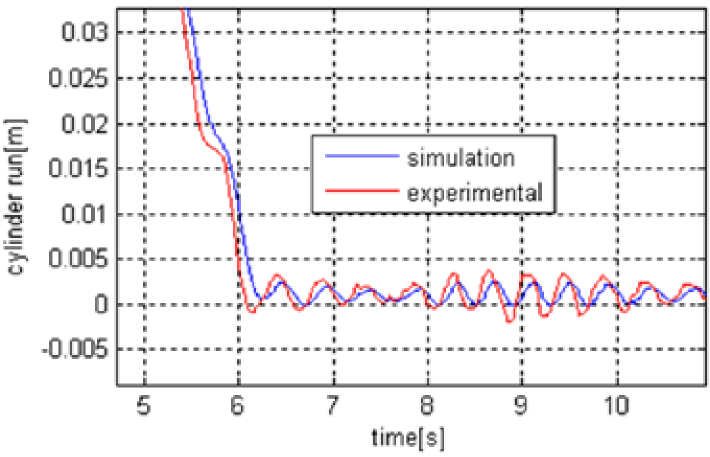

Figure 8 - control system computational model vs. experimental behavior

Test transient simulation and results

Pressure control signal from PID controller is in a range from 1.5 barG to 4.5 barG. As already said, constant value of it doesn't allow valve movement, because servo-piston is balanced under oil pressure and spring force, keeping available areas closed. When control signal changes in 1.5 barG, unbalancing take place and steam valves are turned fully closed; if control pressure become 4.5 barG, those valves move to completely open position. It is important to notice that during force piston stroke, repositioning levers act on top spring: this will restore piston balance and valve stop to move.
To establish model goodness, a variable control signal is given as simulation parameter. It is expected a valve behavior as previous described. In order to highlight the right evolution of the dynamic response, a severe control signal is chosen made of impulsive steps as squared wave:

- Between 0 - 1 s constant control pressure of 2.5 barA
- At 1 s an impulsive step to about 5.5 barA occurs
- Constant pressure of about 5.5 barA till 5 s
- Sudden negative step to 2.5 barA given at 5 s
- Again 2.5 barA till the end of simulation (7 s)

In Figure 6 are shown servo-piston and steam valves rod stroke when described signal is applied.

Any CPC pressure signal changes, causes the servo-piston unbalancing and so the ports to open. With about 5.5 barA pressure the system will carry the valve lever to the upper bound position (30 mm, fully open) and 2.5 barG to the closing reference instead (-30 mm). With reference to the picture 6, the red line highlights the servo-piston while in blue the lever motion.

Parallel to the Flowmaster simulation, a Simulink/MATLAB network was built. This because all the existing control logic as implemented in the field was available in MATLAB environment, such solution will definitely fit the best the entire control network. Whenever a complete valve multi physic Flowmaster model is available, an equivalent Simulink algorithm can be tuned with the same available data in order to retrieve a comparable valve dynamic behavior. In Figure 7 the outcome of the two models with the comparison of the actuator piston as response to a CPC impulse.

The network emulates the expected dynamic of that control valve, showing an aligned response also under severe fast changing demand.
For inputs changing in assigned range, steady state simulation brings out a response surface.
Dialing with response surface means to have reproduced all the possible evolutions over the stated inputs range. Flowmaster can further extend the usage of the above network by generating a transfer function, whereby input-output correlations are turned in a program code. This would represent control valve logic block. S-function would be created in MATLAB language, matching dialogue capability of control logic system and allowing a great opportunity to properly represent the physical problem.
However, in this specific case, the generation of such transfer function isn't possible. The valve working phenomena is intrinsically transient: if steady conditions are kept, i.e. control pressure signal is constant, no valve movement will occur. Under those statements, response surface, and thus S-function, could not be created, being not able to take into account time dependences.

To bypass this missing key, contemporary Simulink simulation took place. In view of the usage of Flowmaster model to validate the Simulink one, once that comparison gives positive conclusion, with aligned responses evolution, MATLAB network can be tuned with right field gains and parameters. Then, after the integration with logic, the whole control system was tested to verify the correct modeling in reference to experimental data.

Conclusions

Steam control valve complex dynamic was reproduced through Flowmaster network. Each component could be modeled with proper elements making clever usage of scripts within controllers so to simulate the correct mechanical or fluid-dynamical behavior. Dedicated test validated the obtained valve behavior, making such model a central point for control logic integration. Since the control logics are often available in Simulink/MATLAB environment, it is desired to have the code able to generate a more complete S-function to condensate the complex valve model in a more powerful way. Simplification is clear: with a user-friendly software as Flowmaster it might be possible to define and convert any desired device into manageable and validated transfer functions, that can be connected to the rest of the control logic network. This will of course reduce internal iterations cycle and improve the time calculation speed.

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Development of space debris capture systems through CAE simulations

…we want to avoid this!!

Active removal of large space debris, such as upper stages of elderly launch vehicles or decommissioned satellites, constitutes a technological challenge which is so far well-known and recognized by all the main players of space business, both at institutional and at industrial level, as a required step to achieve significant progress towards a safer and cleaner space environment. To accomplish such objective, a non-collaborative rendez-vous and capture procedure, to be performed by a robotic spacecraft (namely "chaser"), is required.

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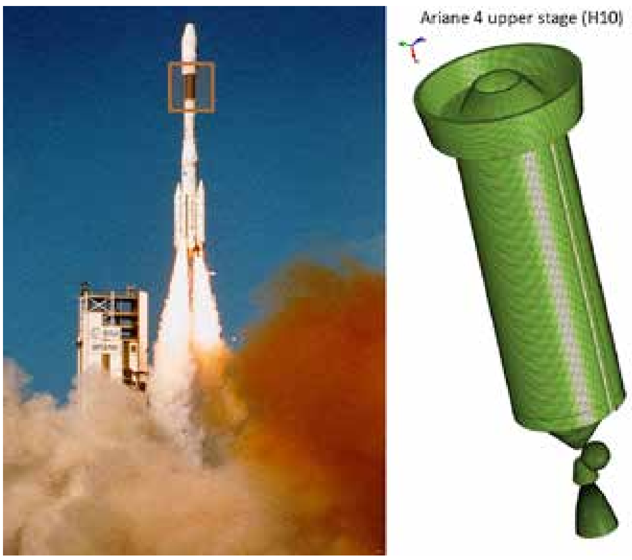
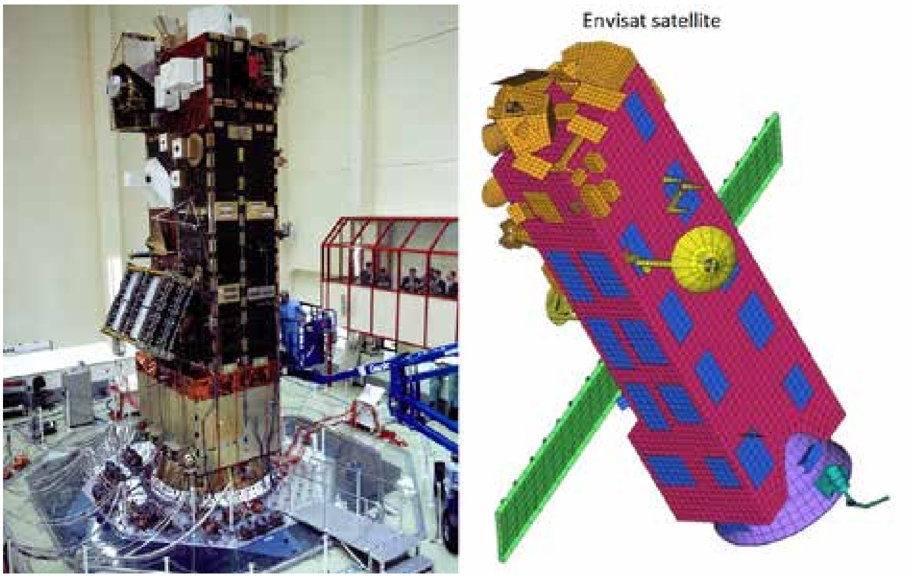


Target Debris object (sx) and FE representation (dx)

Large space debris usually have masses in the range of 1-10 tons and are non-cooperative, so they are not able to provide useful information to the chaser or ground, and usually their status may not be completely known a-priori (e.g. their rotational rates, mass properties, residual structural resistence). This requires the chaser (often a spacecraft with a significant lower mass), has to be equipped with proper "intelligence" and specifically designed capture mechanisms, to safely plan and execute the approach, contact and link establishment with the target debris object. Aviospace, italian subsidiary of Airbus Defence and Space (formerly EADS - Astrium) is well aware of the complexity and the high strategic value of this challenge, and since 2011 is operating in several projects (both R&T projects with internal fundings and ESA funded projects) with the objectives to select, develop and validate the enabling technologies required for such a kind of mission. Especially, in the frame of "CADET" (CApture and DEorbiting Technologies) project, co-funded by Regione Piemonte*, different concepts for capture systems (based on a wide variety of techniques, such as nets, robotic manipulators, belts) adopted to establish the link between the "chaser" and the target debris object,



Target Debris object (sx) and FE representation (dx)

have been studied and developed in detail, with a massive utilization of CAE methodologies and tools, such as LS-Dyna. The final objective of the project is to achieve TRL 4 by means of simplified ground demonstrations of the rendez-vous and capture operation.

*CADET project, which has started in January 2013, is co-funded by Regione Piemonte in the frame of programme: POR FESR 2007/2013 – linea di attività I.1.1. "Piattaforme innovative" – AEROSPAZIO FASE II.

LS-Dyna is an indispensable tool for the design of these types of space systems that represent the frontier of space technology and for which little background and heritage is available.

Ls-Dyna has been adopted in the following areas: study of the maneuvers of proximity between chaser (active spacecraft) and target (non-cooperative object), mechanical interaction between the two objects (exchange of forces, energy, accelerations, contact pressure), the development and optimization of mechanisms to perform the capture, assessment and verification of the dynamic behaviour during the deployment of extensible parts (arms, solar panels, deployable structures), design test environment on the ground, prediction and correlation of test data.

AVS is currently developing two alternative capture systems concepts, which are based on very different technologies and philosophical approaches.

CONCEPT A: hug created bybelts.
CONCEPT B: net fired by cannon

All bodies and parts are free in a zero-g environment (space), and the capture systems are featured by a complex interaction between flexible elements, like belts and wires, and rigid elements. The Ls-Dyna capabilities are able to simulate these phenomena faithfully.

Description of Concept A reference model

The main active part of concept A is the "net" (with a reference diameter of 30m). The wires of the net are modeled by 300'000 beam elements that represent an elementary part of each wire (typical element length: 25cm). Each element is defined by a Linear_elastic_discrete_beam material because throught this keyword it's possible to define a good behavior of a wire using 6 stiffness components and 6 damper components. The "Cannon" (using to shoot the net) and the Target Debris is modeled by shell elements with a rigid behavior (Part_inertia). At the beginning of the simulation, the system is controlled by some Initial_velocity defined on specific nodes and many Prescribed_motion_rigid defined on specific rigid beams used to lead the net. After the net shooting instant, the system evolves without any boundaries until the impact of net on the target and the subsequent interactions / rebounds. The simulation finishes when the TD is completely wrapped by the net.

Simulation time: 50s, Typical time step 3.5E-05s, Results file 95Gb, CPU time 110/115 hours (HP Z400, Intel Xeon W3550 @3.07 Ghz, RAM 24Gb, SSD 256Gb, win7 64bit)

842000 Elements: 299000 beam, 272000 mass, 271000 shell

546500 Nodes

16 materials (2 elastic, 1 null, 12 rigid, 1 linear_elastic_discrete_beam)

15 Part (10 flexible, 4 rigid, 1 part_inertia)

9 section (3 beam, 1 solid, 5 shell)

19 Prescribed_motion_rigid

6 contact areas (1 automatic_general, 5 automatic_beam_to_surface)

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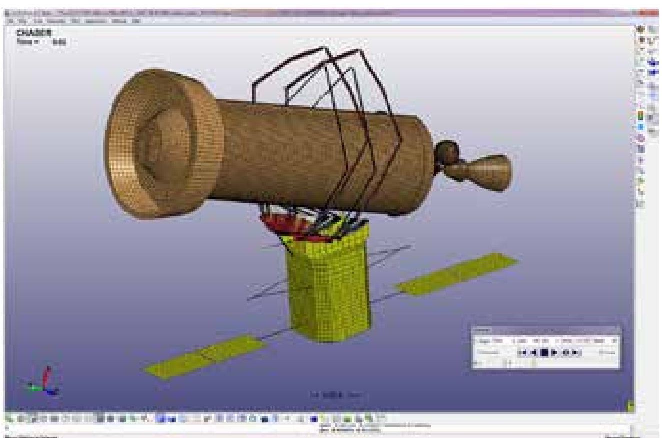
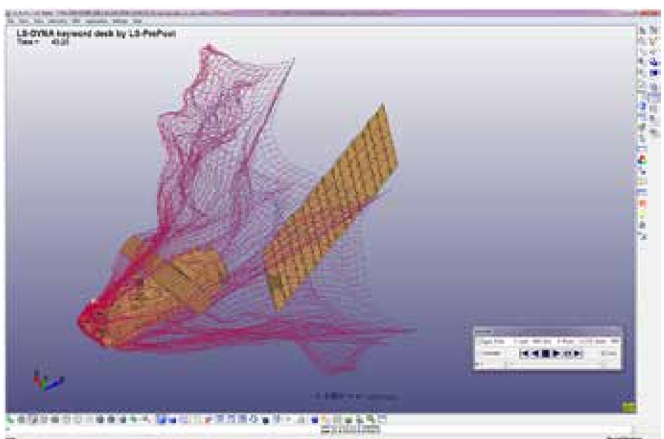


CONCEPT A: hugh created by belts



CONCEPT B: net fired by cannon

Mass Reduction and Energy Absorption maximization of automotive bumper systems

On 20th & 21st of May, EnginSoft Germany presented at the NAFEMS German Conference in Bamberg. The conference was focused on applications, developments and trends in Computer Aided Engineering. The list of participants included worldwide accredited and leading companies like Audi, Bosch, Airbus, Siemens, Continental among many others. To this audience we presented the optimization of an automotive front bumper, performed with modeFRONTIER, automating CATIA V5, HYPERMESH & LS-DYNA to find the optimal design that best meets the bumper mass and crash energy objectives. This article briefly summarizes the content of this project.

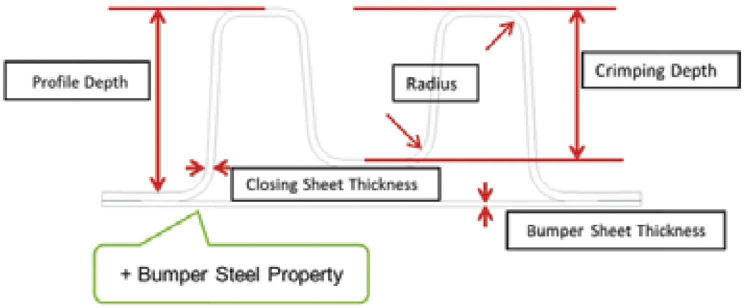


Figure 1 - Bumper Parameterization

Case description:

Bumpers are one of the most underestimated parts of a car, even though they can save lives in the event of a collision.
The main function of the bumper is to absorb kinetic energy during plastic structural deformation. Absorbing energy in this way is important when trying to prevent occupant injury, because it limits the amount of energy being passed directly to the occupants. The amount of energy allowed to act upon an occupant is restricted by law and must be kept below certain limits in order for the vehicle to be approved for release. This is achieved in legislation by limiting the amount of deceleration an occupant experiences. Because of this, bumpers must absorb as much energy as they can. Typically, the more mass a bumper has, the more energy it can absorb, since more energy is needed to move/deform the bumper; but this is only partially true. In addition to this, more mass means more material, higher production costs and worse fuel consumption. Fortunately, there are other parameters that can be modified besides mass, such as bumper profile/shape or material which contributes to the bumper's energy absorption.

In order to achieve the best energy absorption while obtaining the lowest mass, several bumper parameters have been selected for optimization (Figure 1).

The input parameters Profile Depth, Crimping Depth and Radius were defined inside the CAD-Model. Bumper Steel Properties were defined by the means of 10 different material set cards, used as meshing inputs. Bumper Sheet Thickness and Closing Sheet Thickness were defined inside the crash simulation model. The CAD-Tool CATIA V5 was used to modify the 3D geometry,

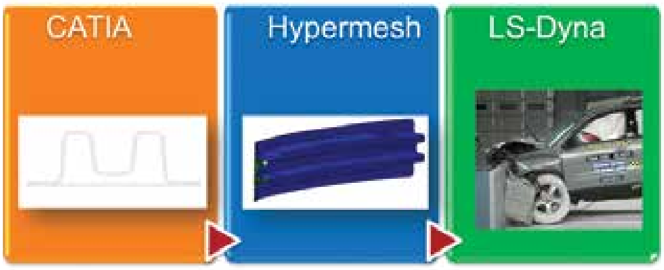


Figure 2 - Design Simulation Process

HYPERMESH to convert the CAD to an LS-DYNA mesh and LS-DYNA to run the crash simulation and asses the bumper design (Figure 2).

The design simulation process was successfully automated using the design optimization tool modeFRONTIER (Figure 3). CATIA was integrated using modeFRONTIER's CATIA Direct Integration node without the need for any complicated scripting. HYPERMESH and LS-DYNA were coupled through macro scripts, automatically recorded while setting up the meshing and simulation model. The bumper design parameters were set up in modeRONTIER according to Table 1.
The design objective was to minimize mass and the force acting on the crush cans behind the bumper. The optimization started from an initial Design of Experiment (DOE) using a Uniform Latin Hypercube technique. Firstly, this technique ensures the DOE is statistically appropriate for performing a correlation analysis (understanding the relationships between inputs and outputs). Secondly, it uniformly fills the design space and gives a good starting population for the optimization while not requiring too many designs.

The Correlation Analysis (Figure 4) helped show the Radius has little influence on the mass and only a small positive effect on the crush can forces (the bigger the radius, the bigger the forces on the crash boxes). For this reason the Radius was held constant; the number of optimization variables was therefore reduced from 6 to 5. Additionally, due to the Correlation Analysis, we were able to prove the conflicting relations between the other input and the output variables and prove the need for the multi-objective optimization.
A multi-objective optimization was then conducted using a MOGAII algorithm. The results are shown in Figure 5.
A design was chosen from the Pareto Frontier which improved the force by ~6.25% while reducing the bumpers mass by ~8.25%.

ID	Name	Lower Bound	Upper Bound	Input to:
1	Profile_Depth	3mm	18mm	CATIA
2	Crimping_Depth	30mm	35mm	CATIA
3	Radius	4mm	6.4mm	CATIA
4	Bumper_Steel_Property	1	10	HYPERMESH
5	Bumper_Sheet_Thickness	1.1mm	1.8mm	LS-DYNA
6	Closing_Sheet_Thickness	1mm	2mm	LS-DYNA

Table 1- DOE & Optimization Parameter Setup

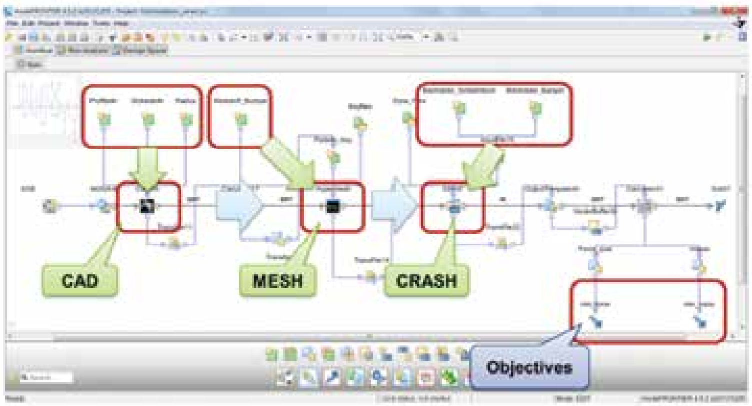


Figure 3 - modeFRONTIER bumper Simulation Workflow, integrating CATIA, HYPERMESH and LS-Dyna to minimize bumper mass and crashbox forces

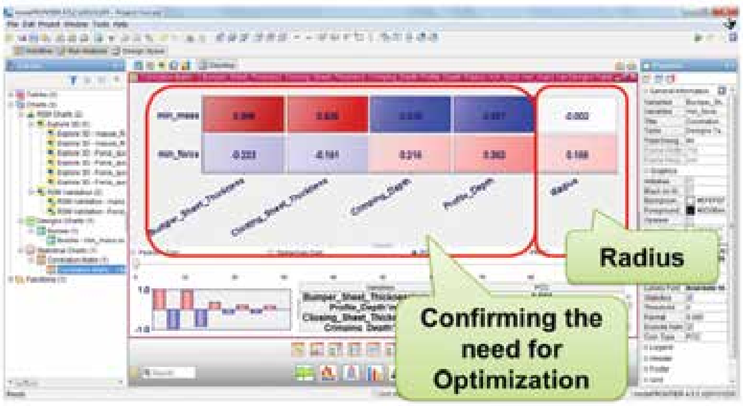


Figure 4 - Bumper Correlation Analysis in modeFRONTIER

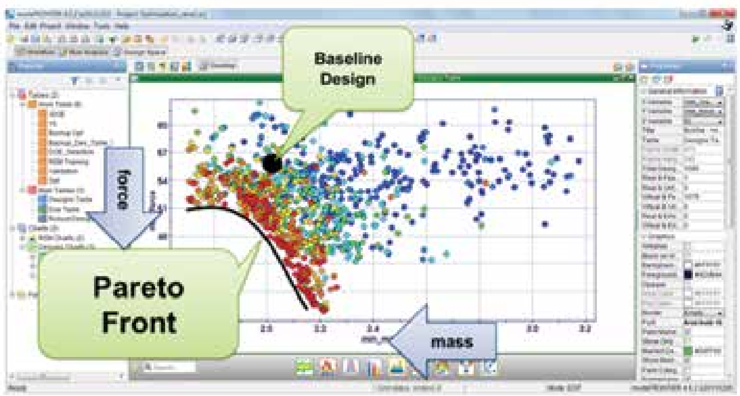


Figure 5 - modeFRONTIER bumper simulation workflow, integrating CATIA, HYPERMESH and LS-DYNA

Conclusion

This project has proven the effectiveness and reliability of the design optimization methodology and has been reproduced at many of our customer sites. Bumper designers can now concentrate on new bumper concepts while automatically performing the bumper concept optimization with the help of modeFRONTIER.

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Ice Accretion Simulation on wings

Ice has always been a serious danger in aviation. By means of Computational Fluid Dynamics and validated Ice Accretion mathematical models we are able to predict ice shapes on aircraft wings

Ice accretion represents a serious hazard in aviation: In the last 10 years ice has been identified as the cause of more than 600 crashes. Some scenarios are characterized by a loss of performance of the plane, but in the worst case there is a complete loss of control, leading to catastrophic disasters.
Ice accretes on the wings and on the control surfaces of the aircraft, modifying the shape of their profiles.
In Figure 1 we can see the main forces acting on the plane: Lift, Thrust, Drag and Weight.
As a consequence of ice accretion, there's an increase in Drag and a decrease in Lift. Weight also increases because of the ice grown and the centre of gravity of the aircraft is displaced.
So, ice on wings reduces the speed of the aircraft as well as forcing it downward.

Figure 2 - Typical ice shape on the Leading Edge of a wing

Ice accretion effects

The phenomenon of ice accretion on wings happens when an aircraft flies into the so called Icing Clouds. These particular clouds are made of Supercooled Water Droplets that are very small droplets that can maintain a liquid state even below the freezing temperature. This is also possible because the surface tension of the droplets keeps them liquid. As the aircraft flies into the cloud, these droplets hit its surfaces; the droplets' surface tension is then broken, and these droplets freeze immediately as they hit the aircraft.

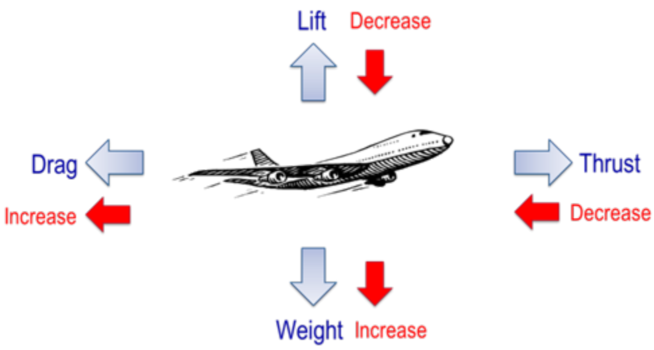

Figure 1 - Scheme: forces acting on an aircraft (blue) and change due to ice accretion (red)

The process of icing is very fast and when the ice shape is grown on the wing, as in Figure 2, the whole dynamic of the flight changes. Ice affects probes which causes flight instruments to give false information to pilots and autopilot. In addition, the wings no longer have an efficient aerodynamic, the aircraft becomes unstable and performance drops quickly.

Experiments on ice accretion

Doing experiments on ice accretion is very hard. Icing Wind Tunnels have been employed to predict ice shapes on wings in different conditions.

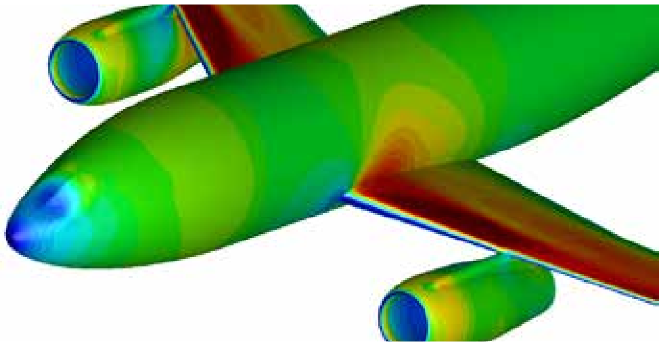

Figure 3 - Computational Fluid Dynamics analysis of the aircraft

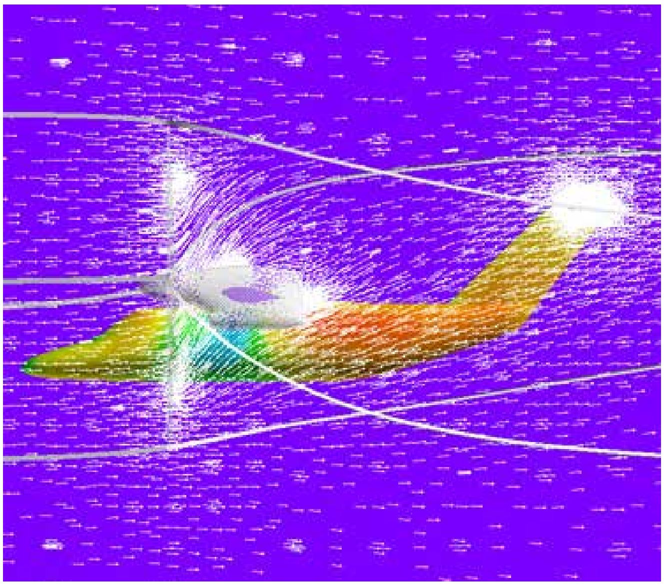

Figure 4 - Study of the impingement of the small droplets

New approach: Computer Aided Engineering simulation

This approach consists in the numerical simulation of ice accretion, by means of Computational Fluid Dynamics and mathematical models developed specifically for icing purposes.

The solution obtained with this approach is faster and cheaper than testing, almost all icing conditions as well as the whole aircraft can be entirely simulated.

The simulation procedure is summarized in this scheme:

First, the airflow around the aircraft is calculated by means of Computational Fluid Dynamics (Figure 3).

The result of this calculation is then the full aerodynamics of the aircraft, the forces that act on the wings surfaces as well as the heat transfer.

Ice grows because supercooled droplets impacts on the wings of the aircraft. Then, it is important to study how these droplets impinge on the wings and how much they collect on the surface (Figure 4). Zones in which there's a higher collection of water will experience a higher ice accretion.

The models used to study the interaction between the droplets and the wings cover all the phenomena that occur in different flight conditions and droplets size. The simulation method is fully compliant with the actual and upcoming requirements, in the regulations Appendices that the aviation authorities specify.

Moreover, it is also possible to identify the so called Shadow Zones (Figure 5) that are locations on the aircraft that experience a lower impingement or no impingement at all.

With the information provided by the flow and impingement solutions it is now possible to compute ice accretion.

One of the most widely used ice accretion simulation software is FENSAP-ICE, developed by Newmerical Technologies International. FENSAP-ICE employs the Messinger Ice Accretion Model. This model makes an energy balance between heat fluxes and from the results of this balance and the information coming from the water impingement it is possible to know if, where and how much ice grows above the wings, as shown in Figure 6.

Performance assessment and design of Ice Protection Systems

Once the ice accretion simulation is performed, it is possible to assess the performance loss due to icing, and analyze if the aircraft can be certified for in-flight icing, standing to regulations specified by Aviation Authorities.

Moreover, the described methodology allows the design of the so called Ice Protection Systems, that prevent ice accretion (Anti-Icing systems) or that remove ice after accretion on wings (De-Icing systems).

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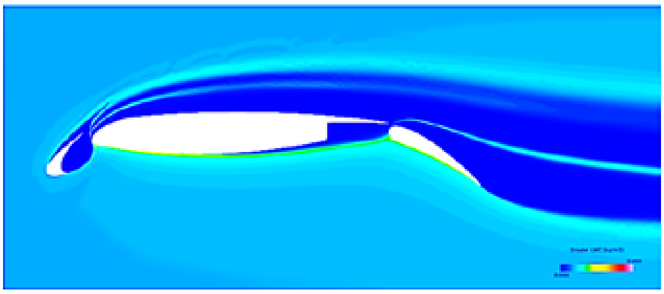


Figure 5: Automatic identification of Shadow Zones

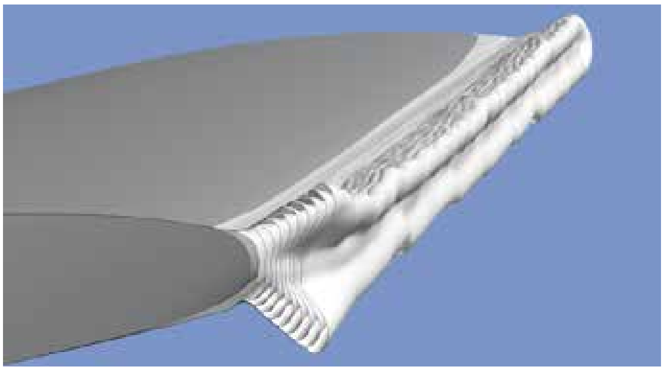


Figure 6: Final 3D ice shape on a wing profile

FEM Analysis of Ship to Fixed Offshore Platform Collision

Collision of a vessel/ship with an offshore platform is a dynamic process involving dynamic factors which could affect the structural response e.g. the way that the collision happens between the vessel and the platform structure, the contact time of collision, the pile-soil-structure interaction during the dynamic response of the platform structure.

For the problem we are speaking about, non-linear responses may take place at some critical regions of the jacket structure, as well as at the impact regions and in the pile-soil interaction.

Therefore, direct integration using explicit method (explicit Ls-Dyna solver) can be assumed as a proper approach to investigate over the ship and platform motion equations and relevant behavior under the ship collision.

There are mainly three design principles considering a ship to an offshore structure collision (see DNV-RP-C204 and NORSOK standard N-004):

- strength design, which implies that the installation is strong enough to resist the collision force with minor deformation, so that the ship is forced to deform and dissipate the major part of the energy;
- ductile design, which implies the opposite, that is the installation undergoes large, plastic deformations and dissipates the major part of the collision energy;
- shared-energy design, which implies that both the installation and ship contribute significantly to the energy dissipation.

The proposed approach can gather the above design principles and give, for each scenario, reliability response both for the ship and for the fixed structure, even if, for what the offshore installation is directly concerned, the ductile design could be the more interesting one once a ship with large kinetic energy has to be considered.

Hence, the impact energy absorbed by an offshore jacket structure impacted from a ship generally involves the following energy absorption processes:

- local denting or crushing of the tubular member section;
- elastic beam bending;

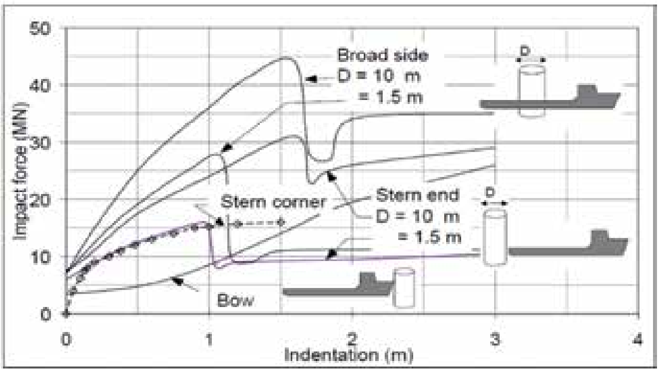


Figure 1 - Force-Deformation relationship

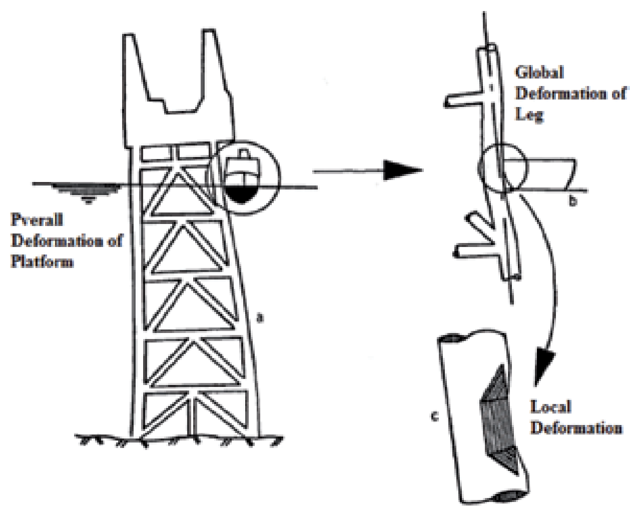


Figure 2 - Deformation modes

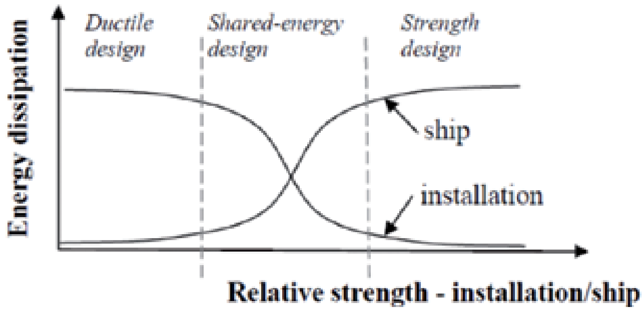


Figure 3 - Design categories

- plastic bending/hinge formation;
- global structural deformation (elastic and plastic).

Therefore a Finite Element Model is used to simulate the ship/vessel (whole or a portion in relation to the complexity and size of its geometry), the whole jacket structure, completed with foundation piles, the top-sides, completed at least with main modules (with their own mass) in relation to a reliable assessing of the offshore installation dynamic behavior.

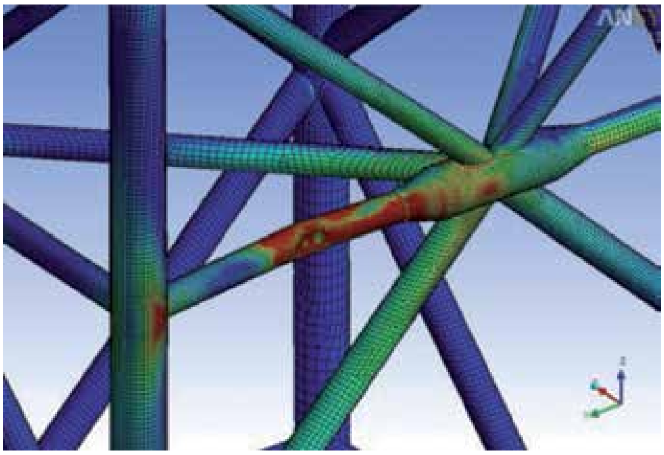
Vessel
The ship is represented via shell elements, detailing the zones near the point of impact: stern, bow, broadside.
To the ship, proper mass density in relation to the own mass and the added mass have to be assigned.
From the vessel's vertical constraint point of view (the vessel is 'supported' by the buoyancy), we can assume vertical springs located at the vessel wet surfaces and vary with the vessel draft (hence, non-linear springs reacting in relation to the vertical displacement field the vessel assumes during the impact).

In order to reduce the time consumption, either a prescribed displacement or the design impact velocity, is assigned to a position on the vessel close to the jacket.
To further reduce the computation time, the vessel's motion is restricted to a pre-defined direction, hence insuring that the ship hits the column in a desired way.
Vessel material model provides elasto-plastic behavior with isotropic hardening.

Jacket
The jacket is wholly represented via tubular elements with a formulation able to manage the interaction between axial and bending longitudinal stresses in the plastic domain.
Only at regions where the impact happens, the jacket is simulated with proper level of accuracy, via shell elements (the default shell element type in Ls-Dyna is the Belytschko-Lin-Tsay shell element – this element formulation is used as it is a computational efficient and robust element). Hence, where required, legs, braces, nodes are represented in detail laying the shell elements on the middle surfaces of the simulated tubular members.
According to convergence studies and the need to properly assess the large deformations, high stresses and strains at the jacket columns, shell at dimensions the impact zones are $5 < Le/t < 10$ (where Le is the element length and t is the shell thickness).

In order to properly consider the effect of the foundation behavior on the dynamic behavior of the whole installation, the jacket model is completed with the modeling of foundation piles, represented via beam elements laterally constrained by p-y curves and vertically constrained by t-z curves.

To the jacket model are assigned structural masses related to material density and no-structural masses (like added mass, mass of entrapped water, marine growth, etc.).
Jacket material model provides elasto-plastic behavior with isotropic hardening.



Example - Analysis is used to confirm that the structure can absorb sufficient energy to withstand impact from ship permitted within the safety zone (source: AA Oil and Gas special issue 2014)

Top-sides
In order to adequately represent top-sides stiffness and masses, the idea is to model in a rough way the main structures assigning the masses of the main modules.
Hence, the top-sides model is represented via beam element with linear elastic behavior.

Results
In terms of results the analysis can give: the distribution of stresses and strain on the impacted zone, the extent of the contact areas and of local indentations, the formation of plastic hinges along columns or at the column nodal connections, the cross sectional forces/stresses along columns axis, the force-deformation curves/relationships as function of impact development and time, the ship strength and ship deformation as function of impact development and time, and the energy dissipated by the ship and by the jacket (both due to local plastic and global elastic deformation).

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The importance of an integrated approach in Fire Protection Engineering

Engin@Fire
Fire Integrated Revolutionary Engineering

Fires happen and their spread can be sudden and very fast (e.g. wildland fires, industrial plants failures, …) causing the jeopardy of people, properties and environment.

Fire Protection Engineering (FPE) sets its own sights either on preventing such kind of events or, in the worst hypothesis, on reducing their effects in terms of release of heat and smokes as well as temperature peaks. Because of the complexities of these phenomena (involving physical and chemical processes depending on boundary conditions never equal each other), Fire Engineers need to look at these issues through multidisciplinary lenses and, at the same time, to individuate countermeasures that can be adopted without overturning the context of interest. In fact, if it is no more acceptable to neglect fire issues in any field of human activities, at the same time fire protection strategies must take into account and even exploit every operational aspect of said context aiming to accomplish fire requirements with minimum efforts; such objective can be pursued only adopting a performance-based approach.

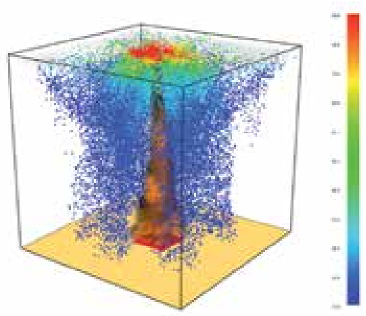

Figure 1 – Water Mist droplets temperature distribution

A current FPE design developed on the basis of a performance-based approach allows to overcome the limits of prescriptions providing an exhaustive assessment of the project, focused on actual fire scenarios, hazard and risk analyses, respect of standards and customer/end-user requests. The enhancement of the benefits of this kind of methodology is possible only with an integrated approach, involving all the disciplines forming the FPE: Concurrent Design, System Engineering, Assessment and Risk Analysis, Standards and Regulations knowledge, CAE and Testings are applied together in order to reach all the FPE goals in terms of safety, protection, compliance and even budget savings. The integrated performance-based approach is able to more easily identify the whole design weak spots and to find faster an effective solution.

In such a complex environment the relevance of Virtual Prototyping is steadily growing. Increasing of computing power and spreading of new simulation codes supports the decision-making process within the performance-based method, producing numerical models that are able to predict always better not only fires behavior and development but also fire detection and extinguishment, pedestrian dynamics during evacuation or egress (simulating the human actions under fire menace and products, i.e. Fractional Effective Dose of combustion gases).

Engin@Fire, an initiative from EnginSoft, Idesa and LAPI, is working to maximize the benefits of a wide integrated performance-based approach for all the FPE themes.

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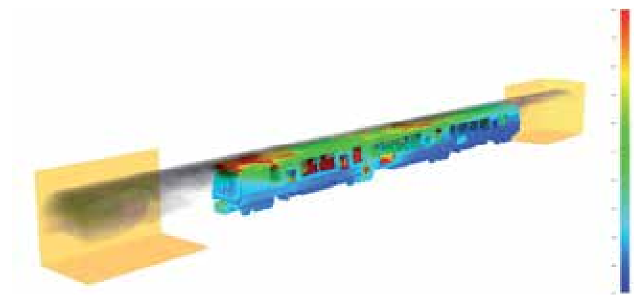

Figure 3 – Tunnel fire scenario

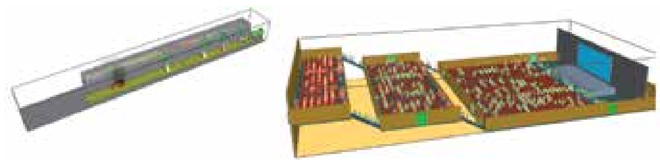

Figure 2 - Evacuation and egress simulation

FEM structural analysis of Mu2e particle detector's calorimeter

I.N.F.N. (National Institute of Nuclear Physics), in collaboration with several research centers all over the world, is contributing effectively to the design of Mu2e particles detector (Fig. 1). The "Muon-to-Electron" detector will be complete and installed at Fermi National Accelerator Laboratory, Chicago (Illinois, USA). The aim of the project is to study the conversion of a muon to an electron, inside the Coulombian electro-static field of a nucleus.

A technical collaboration has been launched among I.N.F.N., University of Salento and EnginSoft in order to design and to optimize the mechanical performances of some components within the system: one of the main components is the Mu2e detector's calorimeter, placed after the "I-Tracker", able to collect information relative to the kind of the crossing particle.

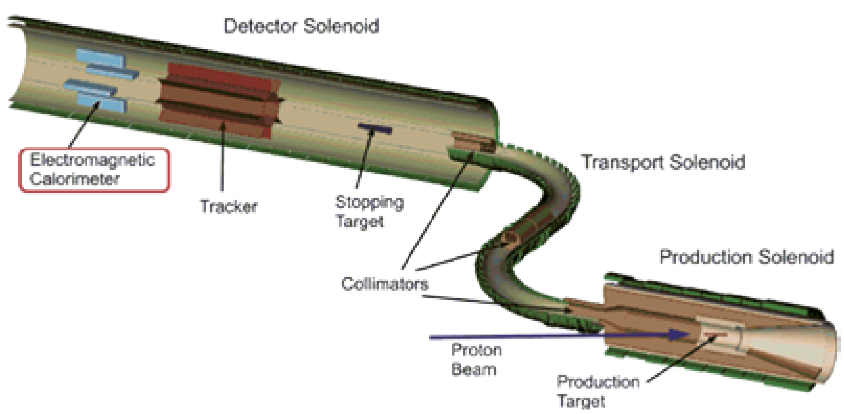

Fig. 1 – Mu2e particle detector

The starting point: geometry of the calorimeter and the BaF_2 crystals

The calorimeter is a component which reacts according to the energy released by the crossing particles and it is made of a supporting structure that defines a 3D toroidal domain, containing some inorganic BaF2 scintillators, able to maximize the light emission. The crystals are hexagonal prisms, each of them linked to a sampling electronic system placed on one of the two terminals. The crystals are covered by a thin polyester film (named "wrapping") and overlapped until they make a honeycomb texture inserted in the external supporting structure. The crystals' material, shape and dimension, the external wrapping, the geometry of the structure containing the crystals, the interfaces with the rest of the detector are all parameters previously defined, on the base of analytical/numerical calculations, performed in order to maximize the general system efficiency in terms of resolution and precision of measurements.

Dimensioning of the supporting structure and performing test through FEM analysis

The aim of the analysis, made through the support of FEM tools using an implicit solver, is to dimension the supporting structure and analyze the stress/strain field obtained on the entire system under the gravitational acceleration effect. Moreover, on the base of the crystals' layout, it's necessary to study the most robust, fast and cost-effective technique to assemble the system, eventually predicting the presence of regulation systems to redistribute the load.

The calorimeter's supporting structure is constrained through two base supports placed on two tracks. During the assembly, once the calorimeter is installed, it's put on the tracks and dragged till the nominal position. The whole system has a total weight of about 700kg, of which 600kg concern the 930 BaF2 crystals.

The 3D virtual prototype of the entire calorimeter has been built in ANSYS Workbench environment and it is made of:

- A C-section external supporting ring reinforced with radial ribs, realized with nonmagnetic steel;
- An inner ring realized with composite material, reproduced numerically through ACP – ANSYS Composite Prep/Post;
- 930 hexagonal BaF2 crystals, with an apothem equal to 16.5 mm; each crystal is strongly linked to its external wrapping layer, 65μm thick. Each subsystem made of a crystal and the external wrapping interacts with the adjacent subsystems through contact elements which allow the sliding without friction;
- A frontal disk realized in composite material (numerically reproduced through ACP) which puts in contact the two rings; both the interfaces with rings will be realized with bolts to grant the system maintenance;
- 36 metallic cores with 5 different sections, aimed to guarantee the most consistent support to the crystals in the bound areas of the inner domain; moreover these cores fill the space between the supporting rings and outward crystals, in order to reduce the relative displacements caused by gravity.

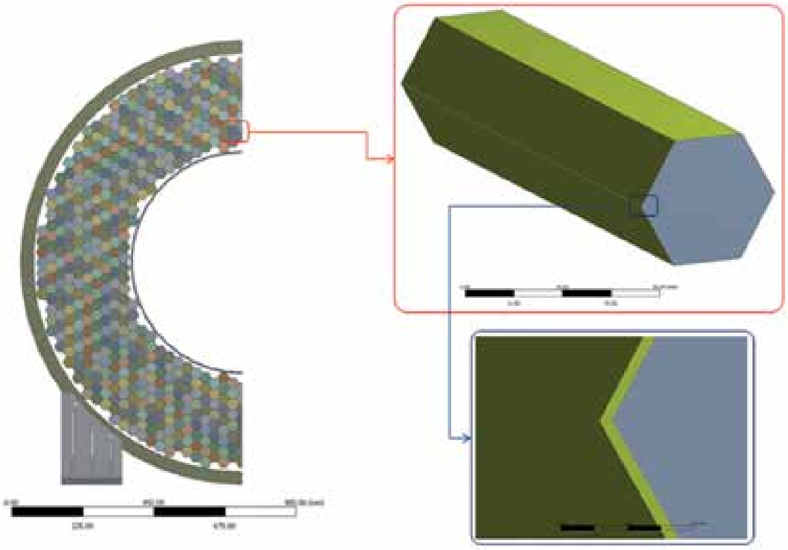

Fig. 2 – Parametric layout BaF2 crystals, multi-body part with the external wrapping

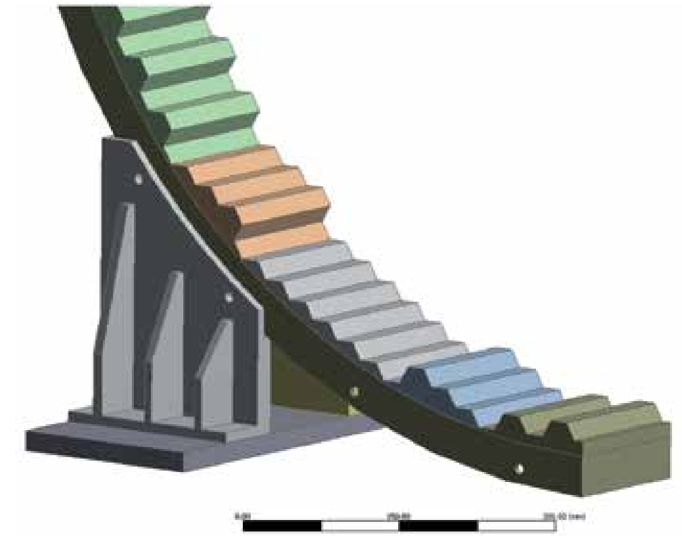

Fig. 3 – Inner cores between BaF2 crystals and external disk

Conclusions

The structural dimensioning made through the FE technology has allowed to:

- define completely the thickness and materials of the external metallic structures and composite ones;
- define types and quantity of cores to fill the cavities between the outward crystals and rings;
- define the best pilling sequence to follow during the system assembly;
- define the mechanical interfaces between the components of the supporting structure in order to guarantee the possibility to assemble/disassemble and maintain the system;
- verify the displacements field due to the gravity's action, calculate the stress/strain status on the components and identify the most critical areas in which the stresses could be partially reduced acting on counter-thrust elements applied on the inner cores.

The obtained results highlight the robustness of the structural solution considered, guarantying a high margin of safety compared to the yield values of the used materials.

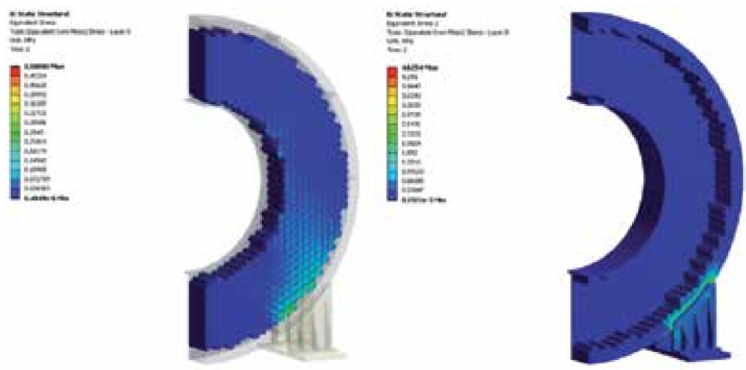

Fig. 4 – Equivalent Von Mises stress evaluated on crystals (left) and on support structures (right)

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Damage Estimation of Vehicle through Tsunami Simulation using Particleworks and LS-DYNA

Particleworks is a Particle Method Based CFD Software developed by Prometech Software Inc. Japan

In recent years, various particle methods have been developed as numerical simulation techniques and used in product design and development. The particle method provides some advantages which can be summarized as follows:

(1) Complex spatial mesh generation is not necessary.
(2) Special treatment to track free surface motion is not necessary.
(3) No mesh distortion in the case of large deformation.

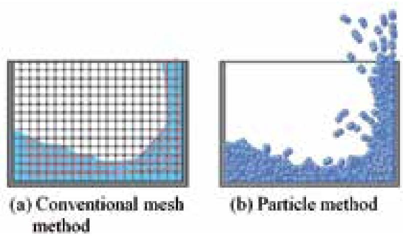

Fig.1 - Schematic images of numerical method

Since the particle method is fully Lagrangian, the advection term can be omitted in the governing equation. Hence numerical diffusion coming from the advection term treatment can be eliminated through the computation. A unique particle method called MPS has been developed and used in various CAE application problems. MPS was originally developed as a discretization scheme of incompressible viscous flow and the first paper dedicated to MPS was published in 1996[1]. The original MPS adopted a semi-implicit time integration scheme, and the abbreviation MPS stands for "Moving Particle Semi-implicit" method. In the meantime, also a fully explicit version of MPS has been developed. Today, MPS is known as a "Moving Particle Simulation" method. MPS is a suitable numerical procedure for the simulation of ordinary incompressible flow, it is applied in particular for different fluid flow problems in the engineering field. In this article, an efficient one-way coupling technique to estimate deformation of products using the MPS-based CFD software Particleworks and the explicit FEM software LS-DYNA is presented. The numerical procedure of MPS is also discussed briefly.

[1] Koshizuka, S. and Oka, Y., Moving-Particle Semi-implicit Method for Fragmentation of Incompressible Fluid, Nucl. Sci. Eng., 123, 421-434, 1996

An efficient technique to treat Fluid Structure Interaction problems

FSI problems need to be solved very often in industrial product design and development. LS-DYNA offers capabilities for modeling FSI problems using SPH (Smoothed Particle Hydrodynamics) or ALE (Arbitrary Lagrangian Eulerian) methods. However, computation of FSI problems with SPH or ALE is very time consuming because a compressible flow solver needs to be used in an explicit time integration scheme with very small time steps. In contrast, MPS, as an incompressible flow solver, can take larger time steps and treat the fluid region very efficiently. Thus a combination of Particleworks and LS-DYNA may be a practical solution to treat the FSI problem. The application example using Particleworks and LS-DYNA presented here is a tsunami simulation of a vehicle. The purpose is the damage estimation of a vehicle drifted by tsunami. If passengers can escape from the drifted vehicle by opening the doors, more people may survive the disaster. A safer design to protect passengers from the impact of a tsunami may be realized. In this context, the suggested procedure of the simulation is as follows:
(1) Perform tsunami simulation using Particleworks in the first phase

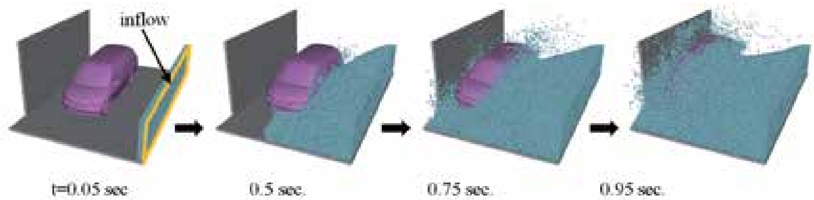

Fig.2 - Results of tsunami simulation using Particleworks

Fig.3 - Example of mapping results of pressure distribution at time = 0.85 sec.

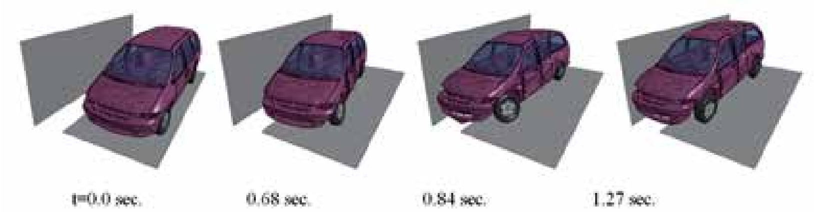

Fig.4 - Motion of the vehicle caused by the pressure of the tsunami

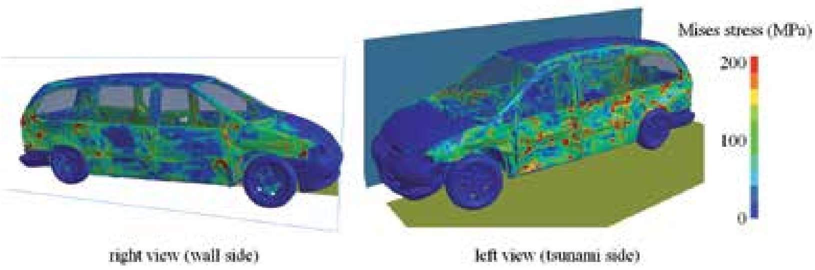

Fig.5 - Deformation and Mises stress distribution of the vehicle at 1.0 second

of the simulation. The vehicle is modeled as a rigid body using the STL format geometry. The vehicle is constructed using rigid body particle cluster generated in the given STL geometry. The vehicle is washed away and impacts with a rigid wall.

(2) Pressure history on the surface of the vehicle is obtained from the first stage of the simulation. Pressure is calculated on each rigid particle and it is mapped on the STL vertexes.
(3) Pressure at the particles on the surface of the vehicle is converted to the pressure history load data acting on each finite element. During this data conversion process, we search for the particle closest to a shell element.
(4) Execute crash simulation of the vehicle against the rigid wall in the second phase of the simulation. The vehicle is pushed towards the rigid wall by the pressure load and causes damage.

The flow of the tsunami and the behavior of the vehicle are obtained in the first stage as shown in Fig.2. The vehicle is placed at the position of 1,000 mm from a rigid wall at the beginning of the simulation. Water entries the model from the inflow with a velocity of 4,000 mm/s. The vehicle is washed away and crashes against the wall.
The event interval was 1.35 seconds. With this simulation, we could obtain the pressure history acting on the surface of the vehicle. The pressure was calculated on each particle during the simulation and then it was mapped on the STL vertexes by post processing. After the tsunami simulation, the pressure history was converted into pressure load for the LS-DYNA crash simulation. Figure 3 shows the mapping

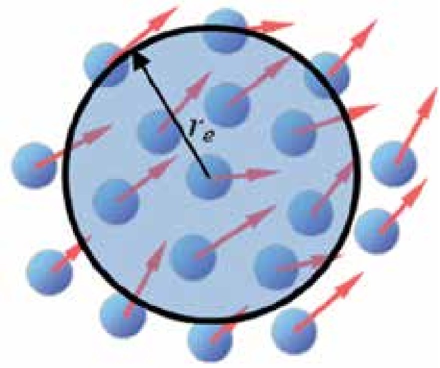

Fig.6 - MPS kernel function

process of the pressure distribution through particles to finite elements. In the second phase, a transient analysis of the vehicle model using LS-DYNA was executed and deformation and stress distribution was obtained through the simulation. The vehicle motion caused by the tsunami is shown in Fig.4. As the illustration details, the vehicle is pushed towards the wall, hit against the wall and lifted up by the pressure of the tsunami. As a result, large deformation occurs on the vehicle body. Figure 5 shows the deformed geometry and von Mises stress distribution of the vehicle. Large deformation can be seen not only on the right hand side where the vehicle contacts with the rigid wall, but also on the left hand side.

Algorithm of MPS method

The governing equations for incompressible flow are the continuity condition Eq.1 and the Navier-Stokes equations Eq.2,

$$\frac{D\rho}{Dt} = 0 \qquad (1)$$

$$\frac{D\boldsymbol{u}}{Dt} = -\frac{1}{\rho}\nabla P + \nu\nabla^2\boldsymbol{u} + \boldsymbol{g} \qquad (2)$$

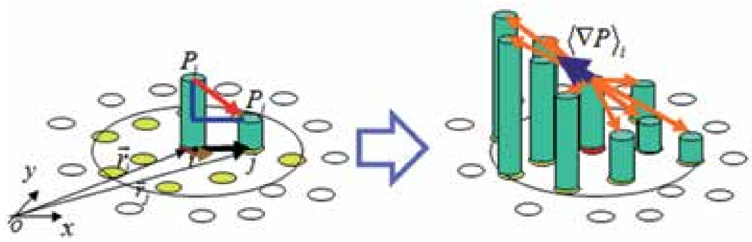

Fig.7 - Particle approximation of gradient

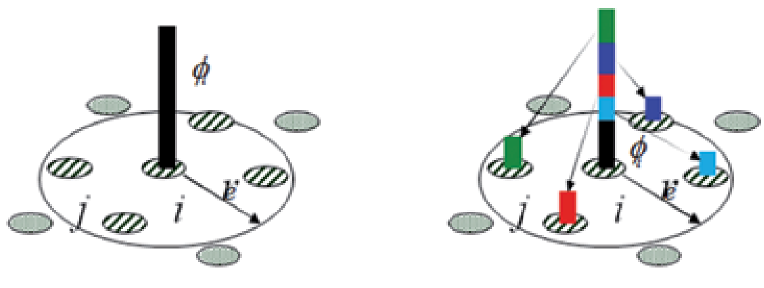

Fig.8 - Particle approximation of Laplacian

where, ρ; density, $\boldsymbol{u}$; velocity, $\boldsymbol{P}$; pressure, $\boldsymbol{v}$; diffusion coefficient, and $\boldsymbol{g}$; gravity. MPS defines the kernel function of the form as,

$$w(r) = \begin{cases} \frac{r_e}{r} - 1 & (r < r_e) \\ 0 & (r \geq r_e) \end{cases} \qquad (3)$$

A particle interacts only with surrounding particles within the radius $\boldsymbol{r_e}$. Particle number density is defined using the kernel function as follows:

$$n_i = \sum_{j \neq i} w\left(\left|\boldsymbol{r}_j - \boldsymbol{r}_i\right|\right) \qquad (4)$$

Particle number density is proportional to the fluid density and it should be constant during the computation for incompressible flow. So the coordinates and velocity of the particles are compensated to maintain the particle number density to be constant during each time step. Discretizations of spatial differentials acting on arbitrary scalar ϕ at particle $\boldsymbol{i}$ are defined as the particle interaction approximation model, and can be detailed as follows:

<gradient model>

$$\langle \nabla \phi \rangle_i = \frac{d}{n_0} \sum_{j \neq i} \frac{\phi_j - \phi_i}{\left|\boldsymbol{r}_j - \boldsymbol{r}_i\right|} \frac{\left(\boldsymbol{r}_j - \boldsymbol{r}_i\right)}{\left|\boldsymbol{r}_j - \boldsymbol{r}_i\right|} w\left(\left|\boldsymbol{r}_j - \boldsymbol{r}_i\right|\right) \qquad (5)$$

<Laplacian model>

$$\langle \nabla^2 \phi \rangle_i = \frac{2d}{\lambda n_0} \sum_{j \neq i} \left(\phi_j - \phi_i\right) w\left(\left|\boldsymbol{r}_j - \boldsymbol{r}_i\right|\right) \qquad (6)$$

where, $\boldsymbol{d}$; spatial dimension (2 or 3), $\boldsymbol{n_0}$; initial particle number density, and λ; correction coefficient. The governing equation Eq.2 is discretized using Eq,5 and 6 and solved under the continuity condition Eq.1 with a semi-implicit algorithm similar to the conventional Simplified MAC method.

Conclusions

An efficient one-way fluid structure coupling technique using Particleworks and LS-DYNA was presented. Because MPS in Particleworks can be applied for incompressible fluid dynamics, this simple procedure can be used widely for product design, development and manufacturing in various industries. The numerical procedure of the particle method MPS was also introduced briefly.

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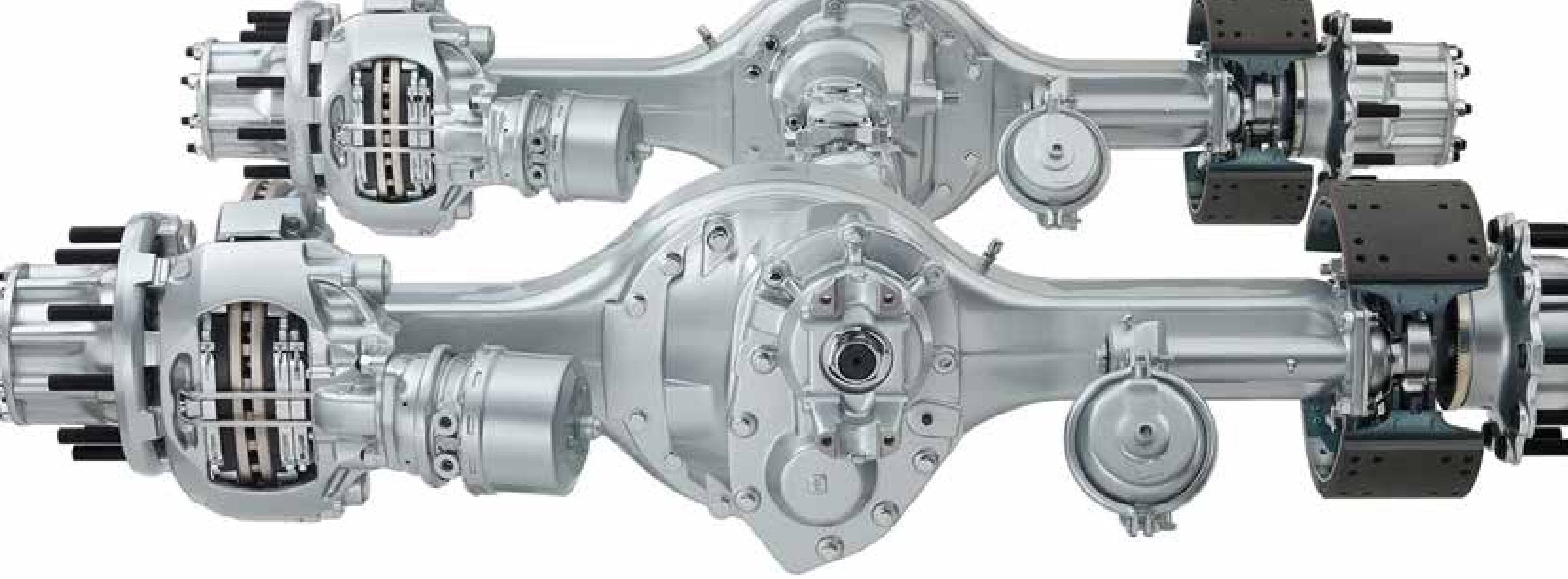
Technical Advisor for Prometech Software Inc.

A memory to Ted Belytschko

Ted Belytschko, Walter P. Murphy Professor and McCormick Distinguished Professor of Computational Mechanics at Northwestern University (Evanston, IL, USA), passed away on September 15, 2014 at the age of 71. His innovative contributions revolutioned the solution of several problems in computational solid mechanics. He developed explicit finite element methods that are widely used in fast dynamics problems like crashworthiness analysis, meshfree methods, multiscale techniques and, recently, the extended finite element method, aimed at dealing with arbitrary singularities and discontinuities independently of the mesh layout. The interest of his scientific production for the community is evidenced by the authorship of more than 500 papers receiving over 33000 citations, with the most cited work having nearly 3000 citations.
Among his many distinguished honors and awards, Belytschko received ASCE's Walter Huber Research Prize in 1977, the Theodore von Karman Medal in 1999, the John von Neumann Medal from the U.S. Association for Computational Mechanics in 2001, the Timoshenko Medal from the American Society of Mechanical Engineers in 2001, the Gauss-Newton Medal from the International Association for Computational Mechanics in 2002 and the William Prager Medal from the Society of Engineering Science in 2011. He was also Editor-in-chief of the International Journal for Numerical Methods in Engineering. If his scientific excellence is recognized worldwide, it is worth mentioning that he was also a unique teacher and mentor. Many people had the honor of working with him, and I can personally remember the crystalline classes to his students, his daily visits to each of his many Ph.D. and Post-Ph.D. students and the human and scientific respect and consideration he was giving to them. Living in his research group was being part of an amazing flux of ideas and new hints that were transforming the way of looking at the problems in every single day. I can clearly remember the many afternoons spent in discussions and the way he was introducing his new thoughts. He was never overhanging the person in front of him. On the contrary, discussing the different aspects of the problem, an idea was progressively coming out, so that one could not say if the idea was in his mind or was born in the person in front of him. So, remembering his bright smile I feel that I can say, in the name of the many people privileged by having worked with him, thank you, Professor Belytschko, for all you taught us.

Giulio Ventura - Politecnico di Torino



Weight reduction of components for industrial vehicles thanks to optimization techniques

With more than 100 years of axle-manufacturing experience, Meritor has become the world's largest independent manufacturer of commercial truck axles for a broad range of vehicle applications. The company offers the widest range of axle capacities and options in the industry.

Meritor recognizes that fleet operators need vehicles that can perform reliably and cost effectively. These vehicles perform important duties: making commercial deliveries on time, keeping children safe on school buses, and responding promptly to fires and accidents. Meritor axles help fleets enhance mobility and maximize vehicle uptime through superior engineering and materials. Meritor products offer greater strength at lighter weights for increased payloads and higher operating efficiencies.

We have interviewed Ing. Marco Bassi: Sr. Director Axle Engineering & Product Strategy EU & SA.

MERITOR

"The product development has followed the technologies evolution along the years and this allows us to considerably reduce the bench validation of what is created and computer-designed. Thanks to forefront software, it is possible to precisely calculate stress and strains of the axle, of the main structure of the axle itself and of the axle housing. As a consequence, the bench validation at a final stage, although still necessary, becomes a simple verification on real parts of calculation results, since we already know that the calculations and the measurements, and therefore the validation of the stress on the axle housing, are extremely precise in the CAD model".

Figure 1 - The MS-17X single reduction hypoid drive axle

At Meritor, they're dedicated to rear axle solutions that enhance mobility to give their customers the leading edge. Meritor rear axles are at the heart of this heritage. They've mastered the combination of precision engineering, component durability, and lightweight options – all to bring customer's operation enhanced movement.

The MS-17X single reduction hypoid drive axle is designed for on-highway applications and European linehaul operations. To meet increasingly demanding specific needs, the 17X offers increased capacity, higher efficiency and, due to laser welding of gear and differential cases, superior rigidity.

"The Meritor®17X is our forefront product as far as the production volume is concerned. It's an axle which is used by three main industrial vehicle producers in Europe and South America. It has been optimized in all its parts in relation to weight and it is one of the lightest axle in its category. The carrier weighs around 175 Kg, 20 Kilos less than similar axles; we have definitely managed to dramatically reduce the weight of the differential gear and this extraordinary result is due to the new optimized computation tools".

Figure 2 - Ing. Marco Bassi: Sr. Director Axle Engineering & Product Strategy EU & SA

Strong Requirements of Numerical Methodologies for Missile Dynamics Assessment

MBDA is a multinational group with 10000 employees working across France, UK, Italy, Germany, Spain and US. Created in 2001 from the union of the main missile producers in France, Italy and UK, MBDA collects their huge technological background.

A new team of engineers was born and is growing in MBDA Rome, whose mission is the assessment of weapons effectiveness against targets, dealing in particular with missiles and their integrated subsystems.

EnginSoft, MBDA partner for more than 10 years, has been chosen for its expertise in applied numerical methodologies within industry. This is important in supporting the partnership with a long period of knowledge transfer, because the aim of this plan is not only to provide solutions but also to transfer EnginSoft best practice to the MBDA team.

The activities are related to the high velocity impact of missile and internal subsystems against evolved targets, like reinforced concrete walls and complex weapons.

Ls-Dyna as Key Technology for Predicting Missile/Target Interaction

MBDA has introduced LS-DYNA into its activities as a main technology for predicting missile effectiveness against a representative target, for which it is designed. One of the main applications has been the tuning of a complete missile model according to experimental measurements.

"As the focal point of lethality & vulnerability for MBDA IT, I have started to work with EnginSoft when a new team with particular skills in hydro-FEM was required. The company has applied Computed Aided Engineering to missile impact dynamics using LS-DYNA for many years, but because this science is rapidly developing, a dedicated knowledge into new technologies was required.

LS-DYNA was used in the past to develop a semi-empirical tool for trade-off studies and preliminary evaluation of new missile concepts. This tool is very important for rapid assessment saving time.

In detailed design (once selected the missile technology or concept) LS-DYNA is used for:

- *Detailed requirements definition (for system and sub-systems)*
- *Procedure test definition*
- *Performances assessment according to requirements*

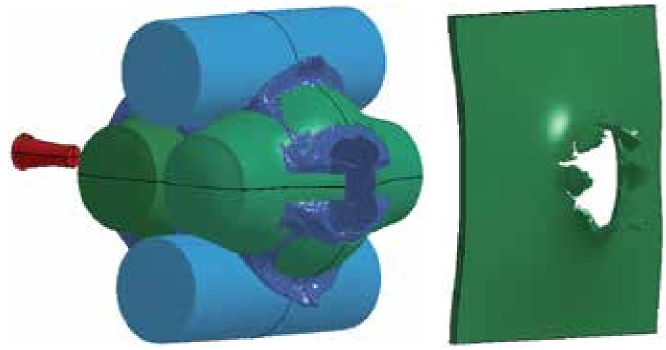
As it is a powerful tool, the background in static linear analysis was not enough to manage the high non-linear phenomena. With the support of EnginSoft and its Emerging Methods and Technologies team, located in Mesagne (BR), we have started a training on-the-job road-map, this is allowing us to simulate missile lethality scenarios, from the hit-to-kill, going through the warhead explosion-fragmentation, up to the consequence of intercept."

Simone Gubbioni
Focal Point of Lethality & Vulnerability – MBDA IT

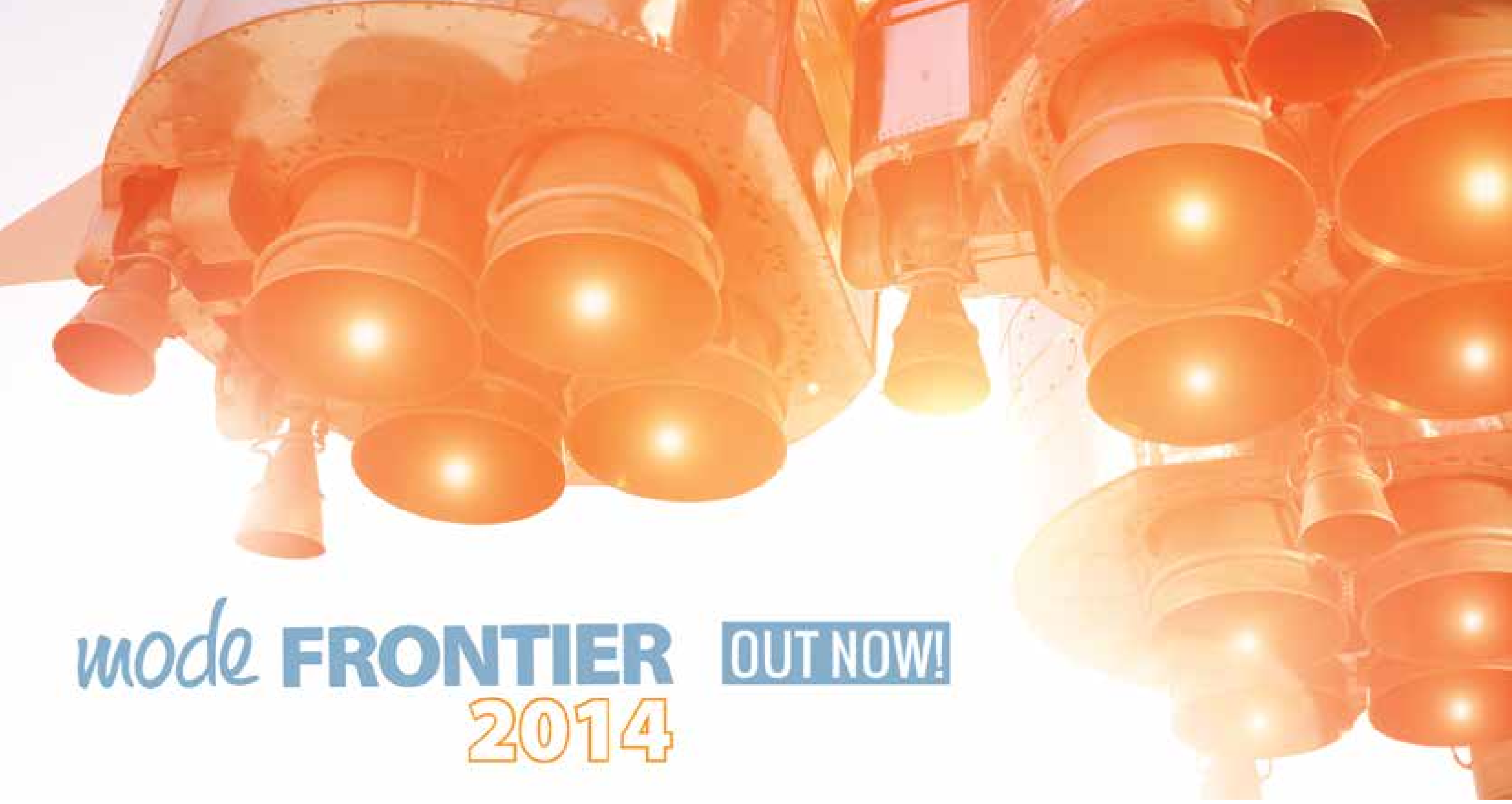
As Head of MDI (Missile Dynamic Italy), the APL (Aerodynamic Propulsion and Lethality) capabilities are very strategic for missile design.

"We found in LS-DYNA an important tool to design and to assess the performances. This hydro-FEM supports the whole product life cycle: from conceptual design to test verification. Due to the complexity of the design and CAE tool, we have identified EnginSoft as the support provider. They appear not only as provider of hydro-FEM assessment, but also as key partner-company, to transfer their knowledge and expertise. I think that the success of this experience is due to:

- *The strongly integrated team that worked effortlessly overcoming the confines of the two companies.*
- *A "win-to win" approach: both companies obtained relevant advantages thanks to the strong cooperation with focus on achieving the objective."*



Tonino Genito
Head of Missile Dynamic Italy – MBDA IT



modeFRONTIER 2014 OUT NOW!

Experience the advantages of the new release

A new powerful, self-adapting optimization algorithm, enhanced data mining and database handling and three new direct integration nodes: the latest release of modeFRONTIER reaches new performance levels by streamlining the management of highly complex design scenarios.
ESTECO SpA has announced the release of modeFRONTIER ® 2014 - the latest version of its multi -disciplinary and multi-objective optimization and integration platform that comes with a range of innovative functionalities and improvements aimed at making life easier for designers:

- **PilOPT**: the new optimization algorithm created by the ESTECO numerical team, needs nothing more than a single parameter to be initiated: the number of design evaluations. It has been created to offer a "one-click" optimization experience and ensures substantial time savings through a broad exploration of the optimal design region and the efficient use of computational resources.
- **POWELL**: the Powell optimization algorithm has been added as a valid and efficient alternative for local search, requiring considerably less computational effort due to its derivative-free approach. This single-objective optimization algorithm is particularly useful for calculating the local minimum of continuous complex functions - especially those without an underlying mathematical definition.
- **New RSM – Stepwise Regression**: the newly added Stepwise method returns more robust polynomial models, adapting the surface to problem complexity and evaluating their quality based on one or more user-defined statistical criteria. It provides an automatic procedure for selecting the polynomial regression model with the optimal number and combination of predictor terms, yielding the lowest approximation error and highest prediction capability
- **DOE Designer Node**: the DOE Designer Node generates DOE configurations at runtime, allowing the user to expand the coverage of the design space and to focus on precise regions in order to fine-tune the exploration phase in accordance with problem characteristics. This feature further enhances the user experience by enabling an efficient and interactive management of databases in modeFRONTIER.

On the integration side, three new direct nodes - NX CAE by Siemens, Solidworks Flow Simulation and PowerFLOW suite by EXA – developed to automate data extraction and simulation execution and fully exploit modeFRONTIER optimization capabilities.

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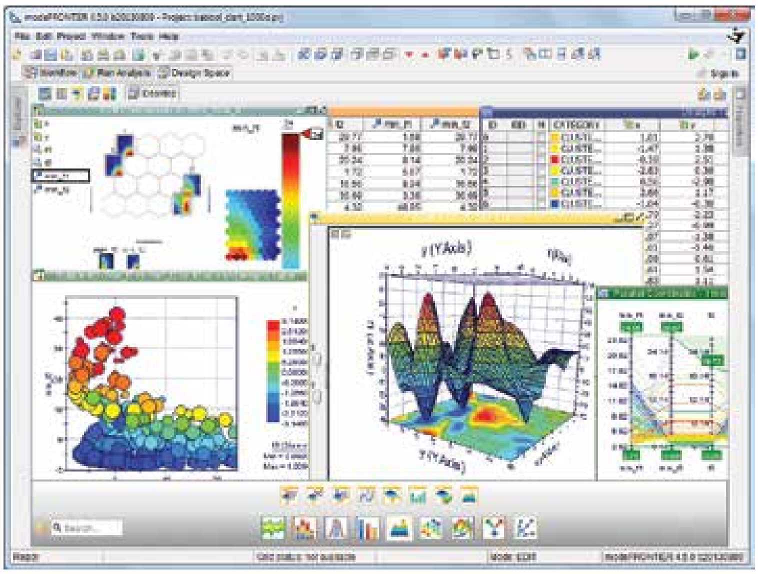


Fig.1 - The new design space

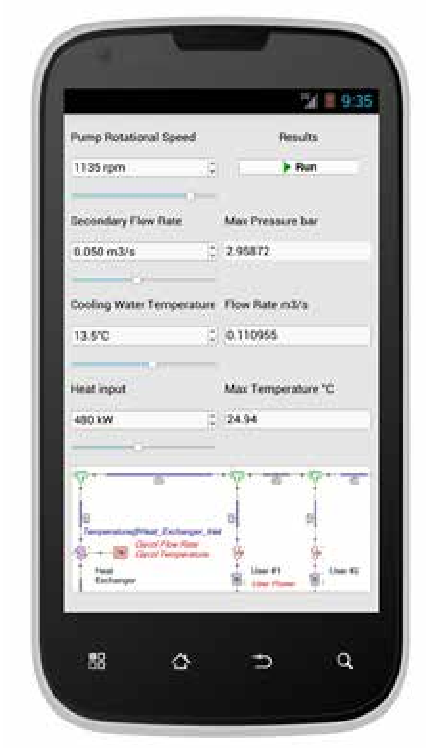


Fig. 1 – The App

Flowmaster goes Mobile

Introduction

People can complete all sorts of tasks with a smartphone or tablet now — order tickets, check the weather or call a taxi. In this ever-growing world of technology, savvy engineers are becoming more and more dependent on their mobile devices while out of the office. Taking advantage of the Response Surface Modeling capability, we put together a brand new App for mobile devices capable to predict plant performances at a glance.

How it works

In the EnginSoft Newsletter n°4 – Winter 2013 the new Response Surface Modelling capabilities of Flowmaster were presented in details in the article "Accurate Thermo-Fluid Simulation in Real Time Environments". The new App was created based on these capabilities. We started by creating a system network in Flowmaster. We then defined the parameters that can vary (input variables) as well as monitored results (output variables). Once input and output variables were defined, a DOE (Design of Experiment) was performed. From the results of the DOE we created a response surface for each output parameter. These response surfaces represent a meta-model of the system that can be exported in C-codes, one for each output parameter. Finally, the generated C-codes were embedded into a simple App to be used for evaluating system performances on mobile devices.

Example

The system

The network shown in Fig. 2 is considered in this example. This represents a water cooling system for three users in parallel. Water exchanges heat through a heat exchanger with a mixture of 50% glycol and 50% water flowing in a secondary cooling system. The primary loop is modelled in details considering the free surface reservoir, the pump, manifolds, pipes, valves and fittings. The secondary loop is not explicitly modelled but a flow source imposes fluid flow rate and temperature.

The parameters that can vary in the systems are:

- Pump rotational speed (from 800 rpm to 1200 rpm);
- Heat input at each user (from 300 kW to 700 kW);
- Glycol flow rate (from 0.01 m^3/s to 0.1 m^3/s);
- Glycol temperature (from 5°C to 20°C).

The monitored results are:

- Flow rate through the pump;
- Pressure at the pump outlet;
- Temperature at the heat exchanger inlet.

Creating the Meta Model

Once input and output variables were defined, a DOE (Design of Experiment) was created based on the Latin Square algorithm; 20 levels were considered so that a total of 400 steady state analyses with heat transfer were performed. The 400 analyses run in less than 2 minutes on a standard desktop computer. Based on the results of the DOE, a response surface was created for each output parameter. In particular Duchon's Polyharmonic Splines were used for fitting the response surfaces for flow rate through the pump and for pressure at the pump outlet while Hardy's MultiQuadrics were used for fitting the response surface of temperature at the heat exchanger inlet. These response surfaces were exported in three C-codes, one for each output parameter.

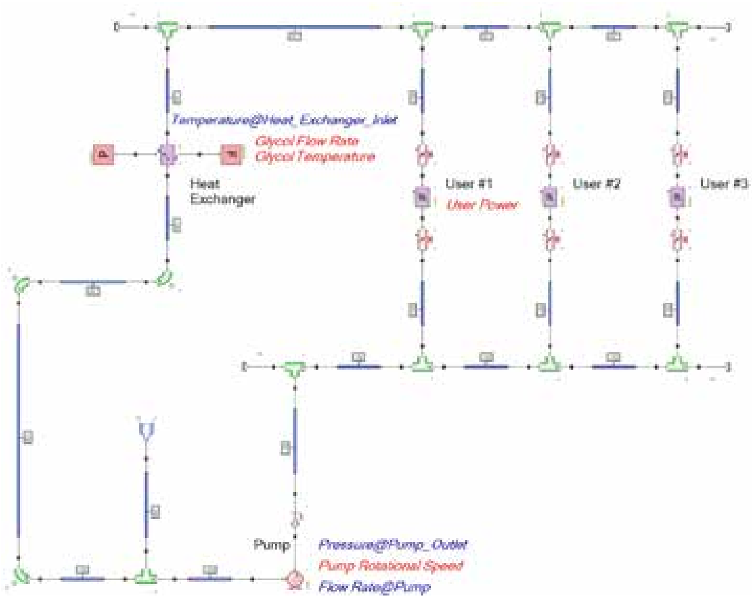


Fig. 2 – Flowmaster network of the system under study. Input parameters are highlighted in red, results in blue

The App

The three exported C-codes were embedded into a simple program written in C and based on the QT graphical libraries. The App GUI (graphical user interface) presented in Fig. 1 was created. With this simple and easy-to-use App, engineers can evaluate system performances at a glance moving the sliders on their mobile devices.

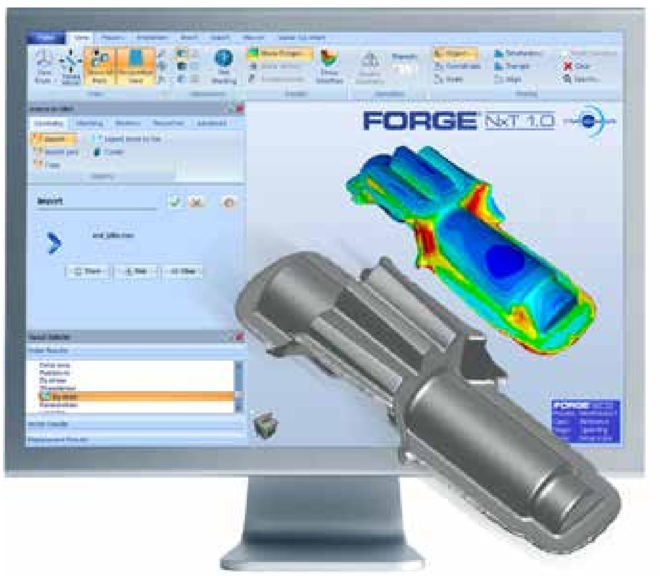
Conclusions

This example showed how it is possible to create a meta-model of a real life system and embed this model into an App for mobile devices. There is no limitation in the complexity of the system to be analyzed and the meta-model will always run in real time. This opens the possibility of having an effective simulation tool always at hand and always ready to predict the system performances.

Alberto Deponti, Edoardo Di Lorenzo
EnginSoft S.p.A, Italy

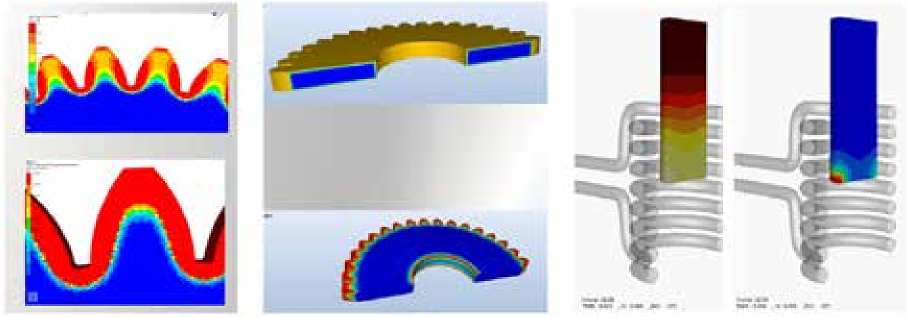
The Best-in-class simulation solutions for the forging industry

The annual Forge International User Meeting (http://www.transvalor.com/en/actualites/detail/forge-international-user-meeting-2014.18.html)took place in June and consisted of two days (June 2nd and 3rd) in which Transvalor together with the International Users delivered their presentations to a wide audience. For instance: Muraro, Italy - Angelo Sartori – "External Piloting with FORGE for Ring Rolling Application: A collaboration between Muraro et Transvalor", University of Padua Vicenza, Italy - Fabio Bassan / Zoppelletto S.p.A, Italy - Luca Zoppelletto –"Process Analysis and Investigation of Defects in Multistage Cold Forging by using Finite Element Method", Faurecia, France – David Even – "Improvement of Heat treatment simulation: A collaboration between Faurecia and Transvalor" e Otto Fuchs, Germany – Dr. Mauricio Santaella

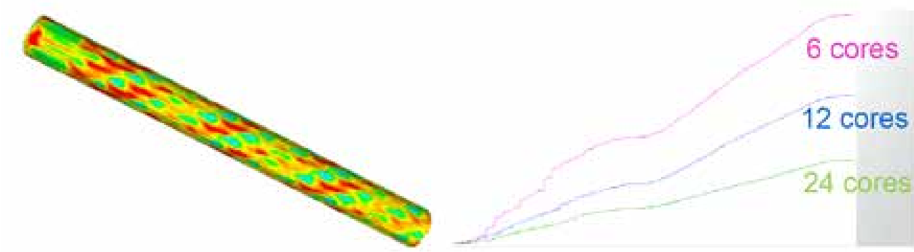


– "Process chain simulation: from raw billet to finished part with FORGE". The Italian users together with EnginSoft successfully participated in this event which was also the occasion to celebrate the 30th anniversary of Transvalor and of visiting CEMEF (http://www.cemef.mines-paristech.fr/), Center for Material Forming in Sophia-Antipolis, other location of the International renown Research Centre of MinesParisTech, Traditional partner for Forge development.

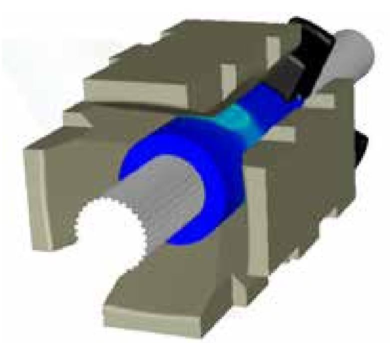
"Forge International User Meeting 2014" marked also by the last release Forge NxT 1.0, proving once more the its worldwide leadership in process simulation of hot forging and cold forming of metals for variety of industrial sectors: automotive, aerospace, defence, energy, building, medicine, etc.
FORGE NxT improves its capacity of simulating deformation kinematics of any kind and offers the possibility of analyzing heat treatments, such as induction heating, quenching, carburizing and tempering.
FORGE NxT new release also has a new intuitive graphic interface (Workbench) that offers a quick and easy workflow. The implementation of simulation data (Pre) and the results visualization (Post) are possible using a unique interface, presetting for different processes, products, specific functions and pre-set forging sequences. The possibility of recording standard production processes allows to create a "Forging Intelligence" database in FORGE NxT.



Induction Hardening *Carburizing* *Induction Heating*



The increasing requirements for metallurgical properties prediction have led to some novelties in Forge NxT 1.0, e.g. heat treatment simulation including the tempering and the carburizing. The heat treatment module can support the CCT curves and the new user-friendly graphic interface is perfect for rheology definition and cooling curves visualization. FORGE NxT allows the microstructural prediction during heating and deformation also for high-tech components. A wide range of materials is available (low-carbon steel, austenitic stainless steel, nickel-based super alloys, ..) and their recrystallization data.
With Forge NxT 1.0 the induction heating can be analysed (considering the initial billet or the final forged before quenching) using electromagnetic modelling of the process. The induction heating is caused by the Joule effect of the parasitic currents in the electromagnetic field due to the alternating current of the inductor; by solving the Maxwell equation, FORGE NxT is able to apply the solution to the heating simulation. The main advantage is to obtain a high precision in temperature local distribution, which is necessary for the thermo-mechanical computation of the whole process and for a good prediction of the final mechanical properties and microstructure.



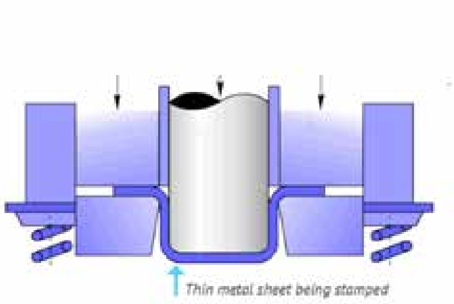
FORGE NxT offers the best solution for the optimization of the metal forming process, allowing a complete automatic design of the components. ProE Wildfire and SolidWorks are currently supported for parametric geometric modelling. FORGE NxT, which is extremely stable and robust, permits to reduce scraps in complex forging sequences, thus guaranteeing the final product quality requirements.
The main benefits are: material savings, by reducing the initial billet, reduction in energy consumption, decreasing the press load, increase of the equipment life, minimizing the die stress, …
Forge is the only forging simulation software which has been offering since more than 10 years a unique parallel capability. It is based on domain decomposition with thermo-mechanical solving, remeshing and transport being performed in parallel. With the falling cost of multi-core systems, parallel processing is becoming accessible to all business size. FORGE NxT parallel capability enables to get the highest scalability and the best of the hardware for fastest computation times.
For open die and incremental forging processes, FORGE NxT brings a state-of-the-art numerical technique which allows significant computation time reduction and increases accuracy. This method, known as a bi-mesh method, relies on the automatic split between two meshes: one fine mesh to perform the thermal calculation and to store all the historical variables, and one adapted mesh for the mechanical computation in order to capture localized deformations.
Multiple innovative mesh improvements have been integrated in FORGE NxT 1.0 to have quality mesh and best results. For processes like multi-layer reducer rolling , extrusion or more generally forming processes with different material properties, a multi-material meshing technology is integrated, providing a high accuracy solution. For thin products forming, the new dedicated meshing technique offers the possibility to create adaptive and non-isotropic meshes. The mesh is optimized in the thickness and captures temperature and deformation at very little expense to computation time.
Thanks to its innovative technologies, functionalities, unbeatable performance and new graphic interface, FORGE NxT is the best in class solution to evaluate new processes, validate and optimize forging sequences and design innovative forged high-tech products.

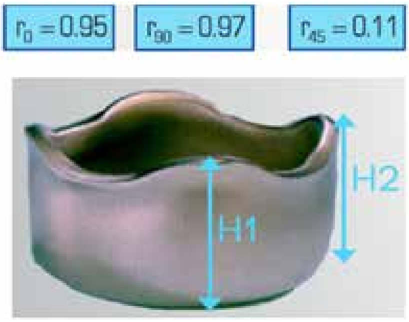
COLDFORM 2014

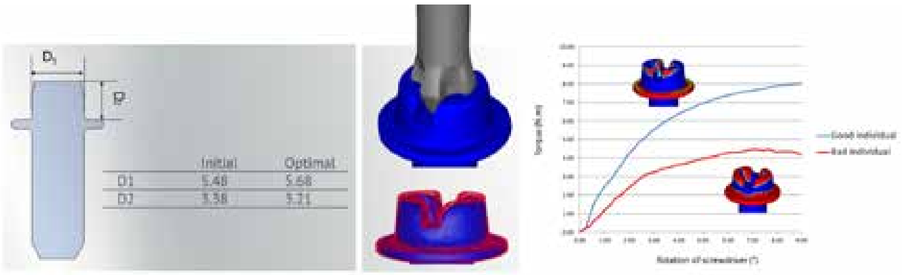
The new release of COLDFORM 2014, worldwide leader in the cold forming of metals, answers to the need of simulating incremental forming processes in shorter times and with accurate results, adapting and integrating the new forefront technique of "bi-mesh". COLDFORM 2014 has integrated the functionalities and kinematics required by Italian users, interested in their development, having a great relevance for their core business.

COLDFORM 2014 combines maximum precision and minimum computation time for the simulation of the deformation of thin products, using its new functionalities of adapting and anisotropic remeshing The picture highlights the material anisotropy, as final effect on the product shape, when applying the forming simulation of a thin products. Using the Reverse Analysis, it is possible to identify 3 parameters of the anisotropy law of LANKFORD, according to which the simulation should correspond to experimental data in H1 and H2.

The flexibility and the development of the automatic optimization module plays a great role not just for Reverse Analysis (identifying the optimum process parameters to fit the numerical simulation on real experimental values), but also as an integrated design tool which permits to reduce material usage, energy, cost and to improve quality and productivity. The picture shows the benefits to the design of a screw. All deformation operation on this component are simulated in chaining starting from the initial wire. The objective is to improve the forging design of the screw head, finding the optimum combination of diameter (D1) and height (D2), ensuring the correct filling and the best torque application and fastening force. The graph shows the torque (blue), combined with the best filling in an optimum geometric condition.







COLDFORM 2014 represents the best investment for:

- Reduction of design and production time
- Reduction of real test costs
- Reduction of material costs
- Design of new complex components
- Reduction of the time to market
- Optimization of the current production processes
- Increase of the equipment life
- Maintain and improve the company know-how

Andrea Pallara

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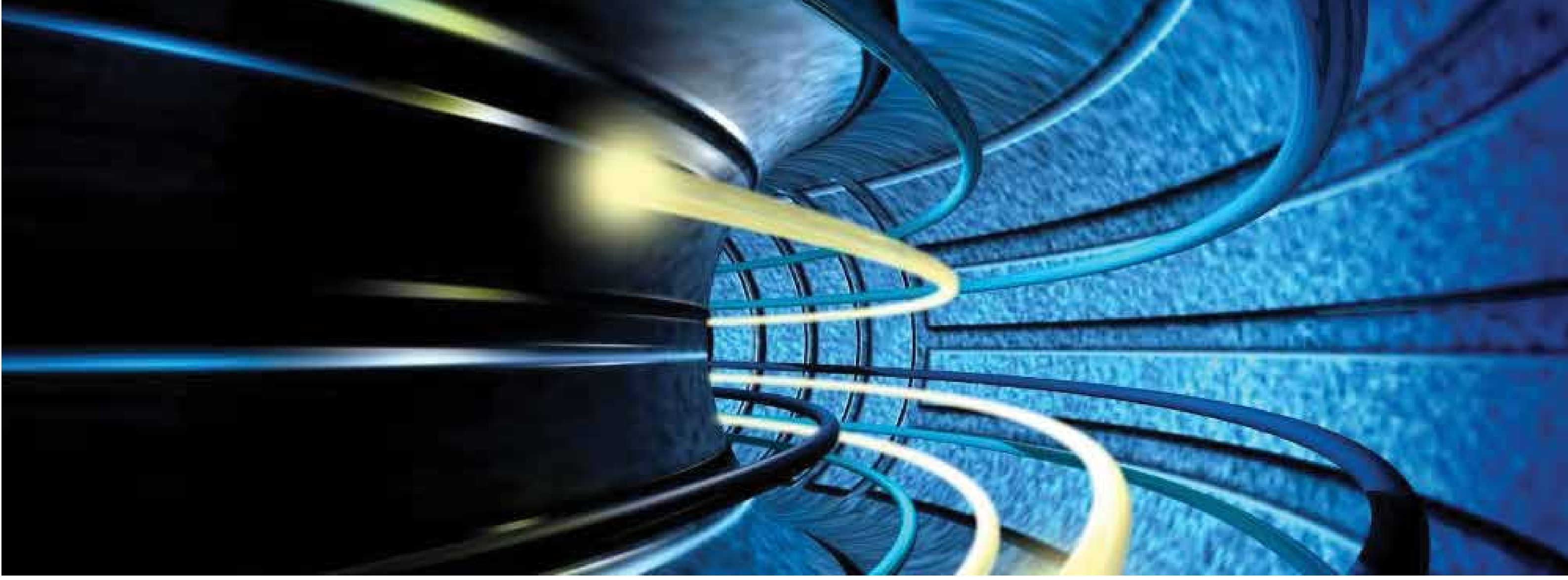
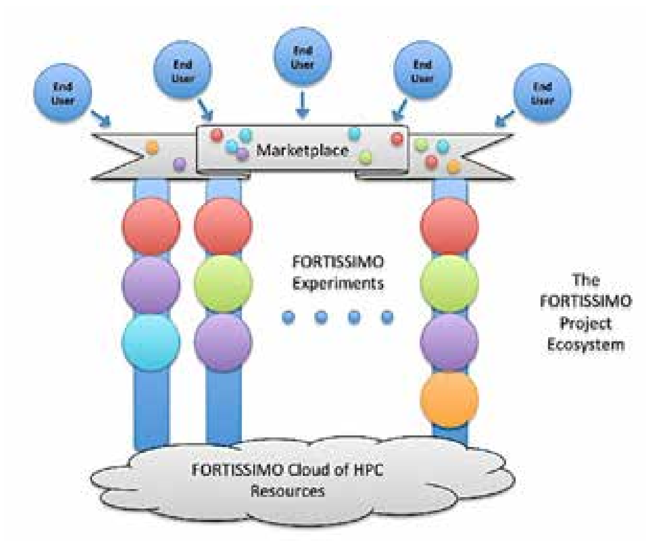


FORTISSIMO – Factories of the Future Resources, Technology, Infrastructure and Services for Simulation and Modelling

The project

The importance of advanced simulation to the competitiveness of any company is well established. The principal objective of Fortissimo is to enable European manufacturing, particularly SMEs, to benefit from the efficiency and competitive advantage inherent in the use of simulation, as practiced successfully by numerous high-tech industries. Simulation often requires enormous computing power and specialized software tools and services. Generally, large companies, which have a greater pool of skills and resources, find access to advanced simulation easier than SMEs, which can neither afford expensive HPC equipment nor the licensing cost for the relevant tools. This means that SMEs are not able to take advantage of advanced simulation, even though it could clearly make them more competitive. The goal of Fortissimo is to overcome this impasse through the provision of simulation services running on a cloud infrastructure making use of HPC systems also making appropriate skills and tools available in a distributed, internet-based environment.

Fortissimo will make advanced simulation more easily accessible, particularly to SMEs, through the realization of a "one-stop shop" where hardware, expertise, applications, visualization and tools will be easily available and affordable on a pay-per-use basis. In doing this it will create and demonstrate a sustainable commercial ecosystem where actors at all levels in the value chain can realize sufficient commercial benefit to enable that ecosystem to persist independently of EU funding and continue to provide affordable services to manufacturing industry, particularly SMEs.



Fortissimo will be driven by end-user requirements where about 50 business-relevant application experiments will be used to develop, test and demonstrate both the infrastructure and the "one-stop pay-per-use shop". The project participants represent all roles in the value chain:

- End-users who will be involved in application experiments relevant to the competitiveness of their business. These application experiments may make use of an in-house code or may be implemented using an Independent Software Vendor (ISV) code;
- ISVs who will work with end-users who can benefit from implementing their application using the ISV's code running on the HPC cloud;
- Simulation service providers who will work with ISVs and HPC software experts to optimize their service offerings on the HPC cloud and who will work with end-users who can benefit from implementing their application using the service provider's simulation offering;

- HPC software experts who will work with end-users, ISVs and HPC service providers to ensure that both in-house and ISV codes and simulation services make full and effective use of resources available via the HPC cloud;
- HPC resource providers who will make available managed HPC resources enabling the effective and efficient functioning of the overall HPC-Cloud infrastructure and who will work with the HPC software experts to optimize the functioning of the HPC-Cloud infrastructure.

In Fortissimo innovation will be addressed at three levels:
1. End-users, particularly SMEs, will get a “one-stop, pay-per-use shop” access to simulation technologies adapted to their needs, including expertise and the necessary tools combined with dynamic, easy and affordable access to computing resources;
2. ISVs and simulation service providers will port their applications to a cloud of HPC resources and be able to evaluate and gain experience with cloud-based service and business models in a controlled environment;
3. HPC resource and service providers will combine resources to create a prototype of a sustainable commercial European cloud of HPC resources, including the necessary orchestration and access services, suitable for cost-effective use by the manufacturing, engineering and other sectors.

Not only will Fortissimo contribute to the increased competitiveness of European manufacturing industry through the innovative infrastructure that it will develop and test, but it will create commercial opportunities for European ISVs, as well as for service and HPC infrastructure providers, through the creation of a new market for their products and services. Fortissimo places considerable emphasis on the exploitation of opportunities at all levels of the value chain ranging from the end-user to the HPC infrastructure provider.

Fortissimo involves 1,132 months of effort, a total cost of €21.7m and EC funding of €16m over a duration of three years, commensurate with achieving its ambitious goals.

Motivation
Manufacturing is still the driving force of the European economy, representing over €6,500 billion in GDP and providing more than 30 million jobs. It covers more than 25 different industrial sectors, largely dominated by SMEs. Manufactured goods have value greater by €1,500 billion over that of the raw materials from which they were produced.

The European Factories of the Future Research Association (EFFRA) states that the immediate challenge is putting the European economy back on an upward path of growth and job creation, whilst long-term global challenges comprise inter alia globalization, pressure on resources and an ageing population. Their strategy underlines the role of “technology” as the ultimate solution-provider for tackling these challenges: investing in key enabling technologies will help innovative ideas to be turned into new products and services that create growth, high-skilled adding-value jobs, and help address European and global societal challenges. Manufacturing has a critical “enabling” role. Every high value product or service has a manufacturing process behind it.
EFFRA identifies Information and Communications Technology (ICT) as a key technology, and regarding simulation states that complex environments need to be consistently described by models in order to correlate information, describe the dynamics, and forecast their behavior. Knowledge from different sources (e.g. human, experience, research) could be available and fully exploited by dedicated simulation tools.

Fortissimo is strongly aligned with these priorities through its goal of establishing a prototype European infrastructure for HPC-Cloud simulation services offering European manufacturers, particularly SMEs, access to a one-stop shop for simulation applications.

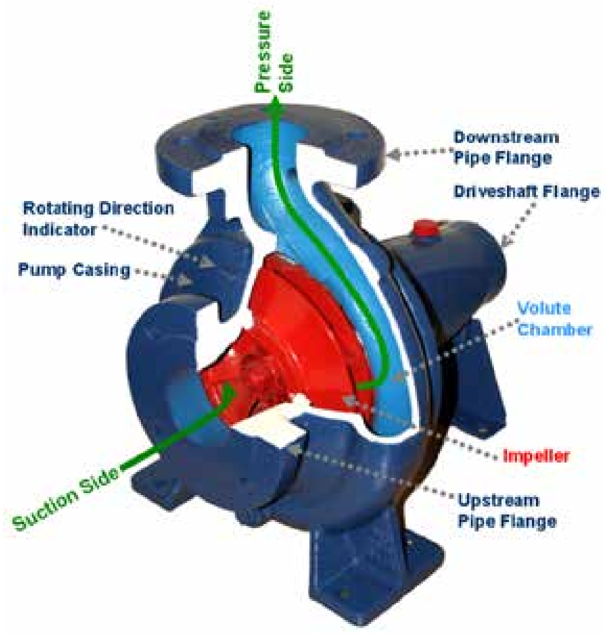
Simulation
Today, talking about the scientific method, simulation plays an essential role together with theory and experiment. Used where the problem is “out of scale” for physical experiments, many scientific breakthroughs and technological advances now rely on models simulated on high-performance computers.
Simulation has become a common technology in many industrial areas. Their success can be illustrated by many examples, as the great improvements in fuel efficiency of aircraft in the last few decades (the fuel used per passenger per km today is around 30% of what it was 40 years ago!), or in the automotive industry, where the cost and time to market of a new model of car has been drastically reduced.
Despite the obvious success, economic impact and commercial value of simulation, its use has been largely limited to large organizations or specialist companies. This has been for a number of reasons.

- HPC systems are not, in general, accessible by SMEs on affordable, flexible, pay-per-use terms;
- many small organizations which could benefit from advanced simulation are not aware of its capabilities and benefits;
- many organizations, even those aware of the capabilities of advanced simulation, lack the necessary in-house expertise to exploit those capabilities to improve their competitiveness and profitability;
- lack of HPC expertise;
- licensing issues.

Given the demonstrable benefits of simulation, it is clear that its use can greatly improve competitiveness for all organizations. The challenge facing Europe is to take full advantage of these benefits to improve the competitiveness of European industry relative to that of other economic areas.

The Cloud and the HPC-Cloud
Cloud computing offers organizations easy access to large computing resources, processing power, memory and data storage. The current implementation of the Cloud is based on large clusters of compute servers with associated data storage located anywhere on the globe. An application may run on servers which are geographically close or dispersed and may use databases which are close to or remote from the servers to which or from which they exchange data. Many successful applications now run on Clouds, but these tend to be those where the movement of data between servers can be relatively slow related to computing speed.

On the other hand, HPC systems are based on lots of processing cores, connected by high-speed, low-latency networks. These processing cores need to exchange data quickly and with very low waiting times. If data cannot be exchanged in this way, then applications may run very slowly and the benefits of using many cores to achieve high processing speeds are lost.



This is the key point in the comparison between current HPC hardware and the Cloud. Of course, technology is developing rapidly and it may be that in the not-too-distant future Clouds will support high-bandwidth, low-latency communication, but at the moment this is a real obstacle to performing advanced simulations on the Cloud.

Fortissimo will implement an HPC Cloud which goes well beyond existing Cloud infrastructures in order to meet the needs of real-world HPC application users and the needs of Europe's manufacturing sector. The intention of Fortissimo is to create a "one-stop shop" bringing together all the components needed to support all levels of manufacturing in the exploitation of advanced simulation and so to create a new market for the provision of HPC infrastructure, services, software and end-user applications.

The role of EnginSoft

EnginSoft is one of the 44 beneficiaries involved in Fortissimo. In particular, EnginSoft collaborates with CINECA in work package WP418 "Experiment 18: Cloud-based CFD turbomachinery simulation", which objective is to test the commercial CFD code ANSYS CFX on Cloud-based HPC services.

As the largest CAE provider in Italy, EnginSoft was keen to be involved in the initiative, with a large offer of simulation tools in a multidisciplinary environment. Furthermore there is a wide staff of know-how engineers with strong competence in several industrial sectors. Therefore as a know-how and end user of the tool's, EnginSoft is an attractive partner in the Fortissimo frame with CINECA which is the largest computing center in Italy, thus supplying the infrastructure for the cloud computing.

The object chosen for this experiment is a centrifugal pump. The reason of this choice has to be found in the wide use of such devices in many industrial applications, from oil & gas to power generation, from automotive to water treatment. In this way, a very large number of SMEs in the Italian scenario could be potentially interested in the Fortissimo HPC Cloud solution.

Centrifugal pumps may be required to operate over a wide flow range, so a reliable prediction of characteristic curves is essential for designers. Unfortunately, all theoretical methods and experimental tests are unable to determine the source of poor performances. In these terms, Computational Fluid Dynamics (CFD) becomes an important and common tool for pump designers. Many tasks can numerically be solved much faster and cheaper than by means of experiments and, most important, the complex internal flows in water pump impellers can be accurately predicted. As a result of these factors, CFD is now an established industrial design tool, helping to reduce time to market and improve processes throughout the engineering world.

Numerical simulation of centrifugal pumps is not easy due to some difficulties:

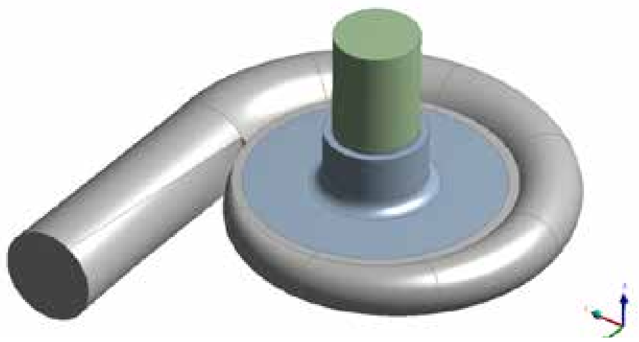
- complex geometry
- unsteadiness
- turbulence
- secondary flows
- separation
- boundary layer
- etc.

In terms of application of CFD, these aspects require high fidelity CFD models, or, in other words, very fine computational grids and transient analysis. This approach, which call for a scale-up of computer resources, is quite prohibitive for a typical Italian SMEs scenario, where EnginSoft operates:

- a quite large number of simulations is required to verify the performance of each design;
- each simulation runs for ~160h, operating on 16 parallel threads on EnginSoft systems;
- typical SMEs installations do not comprises more than 8 parallel threads, and a single software license cannot be locked for a whole week.

On the other hand, several low-end numerical tools are available on the market for a rough sizing of turbomachinery. However, due to the high competitive worldwide market, high fidelity solutions are necessary to take into account:

- secondary flows, which are responsible of 5-to-20% efficiency reduction;
- transient analysis, which gives more accurate solutions relative to simple, fast steady state analysis (2-to-5% difference in performance).



Another key point to be considered is that today the designer has to cope with competitive market sale target and strict energy efficiency regulations. The designer is then driven to "raise the bar" every day, and he knows that a few percentage points often make the difference in a sale scenario. Hence an accurate prediction tool coupled to a computing system easily accessible, like Cloud Computing, will allow SMEs to gain a competitive edge. In this way, the designer can achieve robust solutions of the flow field in a reasonable time all over the wide flow range of the pump, hence speeding up the design procedure.
So the aim of the Fortissimo HPC Cloud solution is to provide an extremely attractive solution in terms of business and technological perspective for any SME which can hardly deal with high fidelity calculations by its own efforts.
In this scenario, EnginSoft and CINECA cooperate to develop a solution that provide to SMEs:

- a tool able to improve their products
- a better performance per core
- a much improved parallelism

The above mentioned tool is based on ANSYS Workbench technology, in which the centrifugal pump is defined in parametric way for all its aspects, as:

- Geometry
  - o Impeller
    - Flowpath
    - Blades
      - o Number
      - o Angle distribution
      - o Thickness distribution
    - Labyrinth
  - o Volute
    - Area distribution
    - Cutwater position & diameter
    - Clearance
    - Outlet section
- Mesh
  - o Global sizing
  - o Local sizing
  - o Inflation
- Operating Conditions
  - o Mass Flow Rate
  - o Pressure
  - o Rotating Speed
  - o Fluid properties

This tool is implemented in collaboration with CINECA porting on a Cloud service and will be accessible by pump designers as a simple "pay-per-use" service. The designer will have to specify a set of parameters that identifies the desired geometries, the operating conditions to investigate, and submit the jobs. Then, the tool automatically set the optimal number of CPUs needed to have the best compromise in terms of scalability efficiency and run the simulations. Once they are ended, the user will be advised so that he can evaluate the results and take further actions concerning the design procedure.

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More than €4 million invested to improve cell-life of batteries

SIRBATT (Stable Interfaces for Rechargeable Batteries) is funded by the European Commission's Framework 7 Programme and is a collaborate project consisting of 12 academic and industrial partners from across Europe and an International Advisory Board of leading battery research groups from the US and Japan. The Project is coordinated by the University of Liverpool's Department of Chemistry within their newly initiated Stephenson Institute for Renewable Energy. The Institute brings together scientists dedicated to exploring the future of renewable, clean and sustainable energy technologies.
The scientific aim of this innovative project is a radical improvement in the fundamental understanding of the structure and reactions occurring at lithium battery electrode/ electrolyte interfaces. It brings together a wide range of complementary research expertise covering both the experimental and theoretical aspects of this emerging area.

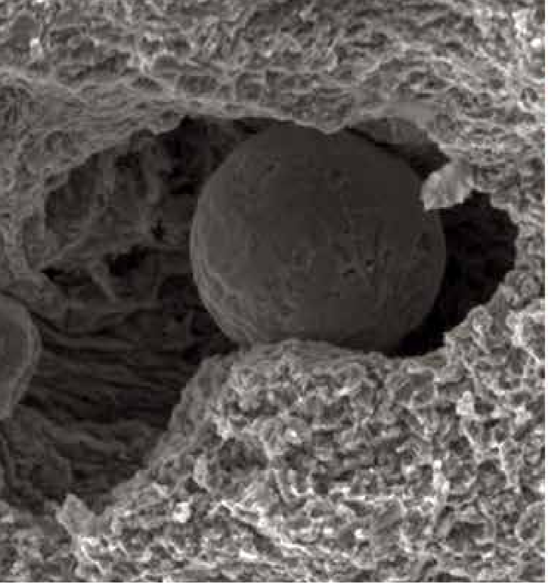
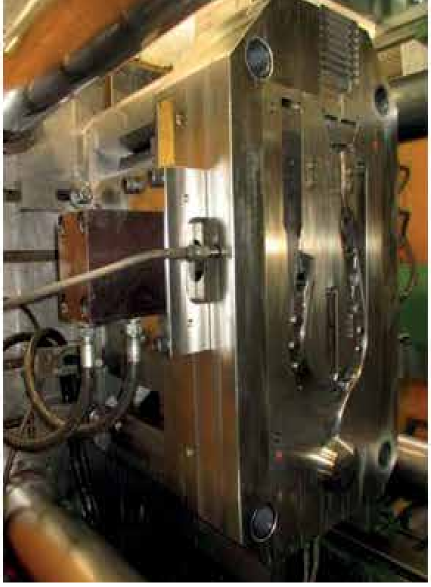
"Collaboration with leading battery research groups at an international level will play an important part in the SIRBATT project. The diversity of the organizations in the network provides a wide range of complementary expertise in areas relating to the study of battery electrode interfaces, at both experimental and theoretical levels". (Dr. Laurence Hardwick, Project Coordinator, University of Liverpool)

The need to reduce carbon dioxide (CO_2) emissions from the burning of fossils fuels has led to Europe looking towards increasing the development and use of alternative 'green' energies. However, electricity supplies gained from, for example, wind, wave and solar power are intermittent as they are dependent upon external factors. As a result the storage of energy produced by these means is now crucial in the levelling out of supply and demand. If such energies are to be used on a larger scale there needs to be a mass market solution, therefore major improvements in stationary energy storage technology are now paramount.

Batteries are one of the main contenders for stationary energy storage with lithium-ion batteries having applications for providing uninterruptible power supply, power quality, transmission, distribution and load shifting. Whilst at the moment energy storage in bulk power management is served by pumped hydro power and compressed air storage, their geographical specific locations may not be the most practical energy storage solution. Batteries now have to demonstrate the ability to store energy efficiently, within certain power, lifetime and safety specifications, at a price-point that is ultimately affordable by the energy industry, before they can be considered for bulk power management.

Dr Hardwick said: *"The current shelf life for lithium batteries used in stationary energy storage needs to be 5-10 times longer if companies are to invest in stationary battery storage to counter Li-ion batteries existing price premium".*

Further information about the project and its research can be found at http://www.sirbatt.eu


MUSIC Public Training on Sensoring, Process Data Management and Process Simulation

An innovative network to exploit the High Pressure Die Casting potential

The MUSIC Training Course on sensoring, process data management and process simulation is the first open public event in which the project can present its major achievements and results up to now. After a quick project introduction, this training session is mainly dedicated to an up-grade in product and process requirements and in tooling & sensoring device, especially for HPDC processes. The idea behind this event is to promote an innovative monitoring network to get the most out of the HPDC manufacturing process, in terms of product quality and defects minimization, by better understanding and enhancing the single elements influencing the whole process. For this reason, the training will consist of a sequence of presentations focused respectively on: Product and process requirements in relation to defect classification and Quality Maps; Impact of machine parameters in the production line; Die monitoring by means of advanced innovative sensors; Design of new generation dies, equipped with sensors and self-adaptive devices; Quality improvements thanks to lubrication and thermal monitoring systems.

The training course will offer the opportunity to release the first official publication collecting the MUSIC achievements and results of the research obtained up to now: "The MUSIC guide to key-parameters in High Pressure Die Casting".

Training Summary

- MUSIC project introduction
- Guidelines for process monitoring and product quality in HPDC
- Development of Process vs Quality Maps in HPDC
- Production line: selection of HPDC machine parameters
- HPDC Process control by advanced die monitoring
- Design of new generation dies, equipped with sensors and self-adaptive devices
- Improving quality of HPDC products by lubrication and thermal monitoring
- Round table and conclusions: the potential of innovative monitoring networks in HPDC

Tutor

Eng. Nicola Gramegna, EnginSoft
Prof. Franco Bonollo, DTG University of Padova
Eng. Martina Winkler, HTW University of Aalen
Eng. Uwe Gauermann, Electronics GmbH
Eng. Filippo Voltazza, SAEN
Eng. Luca Baraldi, Motultech Baraldi

Who should attend?

This initiative is mainly addressed to Manufacturing experts and end-users, that are daily involved the HPDC processes, looking for innovative solutions to improve products quality, optimizing resources and increasing production efficiency.

October 27th, 2014 Hotel Parchi del Garda,
Pacengo del Garda (Verona) - Italy
14:00 – 18:00
http://music.eucoord.com

Numerical simulation in the mining-energy sector: an opportunity for complex problems solution

Last May 15th the seminar on numerical simulation applied to the mining-energy sector took place in Rome at the Ministry for Economic Development

The initiative, sponsored by the General Direction for mining and energy resources, provided a privileged context for experts of different sectors, institutions, academia and industries, to meet and talk about efficiency, reliability and development trends of numerical simulation tools applied to mining-energy activities, with a specific focus on geo-mechanic modeling.

Stefano Odorizzi, EnginSoft CEO, participated as speaker presenting the state of the art and the opportunities provided by modern simulation systems coupled with the increasing availability of computation power of modern computers and HPC – High Performance Computer.

"Numerical simulation tools are nowadays a great opportunity for companies and institutions, also in the mining sector", - stated Stefano Odorizzi – "Modern management of deposits using such tools allows to maximize productivity thus taking the most out of the underground resources, respecting both the environment and safety regulations.

Franco Terlizzese, General Manager of mining and energy resources, opened the seminar. "The availability of more and more powerful computing systems and the efficiency of the numerical computation to solve equations governing physic models, have led to the success or virtual simulation" - declared Terlizzese – "It nowadays constitutes a useful tool to identify the right answers to extremely important issues such as control and security and it is a strategic asset for any company, since it allows to carry out complex projects related to underground resources valorisation.

Ministero
dello Sviluppo Economico

The lectures were coordinated by Dott. Marco Cattaneo, Director of "Le Scienze", "Mente&Cervello" and "National Geographic", who gave his contribution to a stimulating debate between speakers and audience.

At Hotel Ambasciatori Palace, an afternoon session was dedicated to detailed technical descriptions of the best available solutions, thanks to the expertise of EnginSoft Application Engineers that could also presented Kraken software belonging to ESSS.

Further information and documentation of this event is available at: http://unmig.mise.gov.it/unmig/agenda/dettaglionotizia.asp?id=183

EnginSoft & the National Technological Cluster "Transports Italia 2020": Montecatini forum

On July, 11th, in the historic thermal location of Tettuccio in Montecatini (PT), the third forum of DITECFER - District of rail technologies, high-speed and net safety - has taken place, with the patronage of Tuscany Region and European Commission.

The theme of this edition, deliberately organized at the beginning of the semester of the Italian presidency in EU, was "Railway as element for European cohesion. What is Italy planning and how it faces the European challenge?", offering the occasion to discuss the position of our country in the European contest with regards to railway field, starting from the ambitious project of the "National Technological Cluster for Italian Transports 2020", which should operate as hub of research and development, to the collaboration with European Railways Districts, ERCI's members (European Rail Cluster Initiative). Governor of Tuscany Region Enrico Rossi has presented the economic, social and environmental conditions, followed by a note from Minister of Education Stefania Giannini and an intervention of Transportation undersecretary Riccardo Nencini. The Italian Rail System has a 1000 billion turnover (10% of GNP), takes on 10000 people and it is now involved in cancelling the gap between investments in high-speed rail and traditional industry. The brief and clear message by the minister and the Governor suggests that the best solution lies in the organization systems of clusters: they represent the best form of collaboration and integration among University, large and medium companies. As evidence of that, the President of DITECFER, Eng. Lorenza Franzino, has presented the main initiative of the district, the Tesys Rail project, Techniques and instruments for the increment of eco-friendly rail transport which today involves 11 companies, 3 Univesities and the CNR (National Research Center). The Tesys Rail, beyond the intrinsic economic value, is important especially for having tested the cluster mode of operation, which has been able to take and develop this opportunity, projecting towards the future challenges of Horizon 2020.

Among the speakers that participated to the event, some deserve mention as CEO of Ansaldo Breda, Maurizio Manfellotto, who gave prominence to the most recent highly technological orders, FIAT Centre of Research CEO, Nevo di Giusto and ERCI (European railway Clusters Initiative) coordinator, Jean Verrier, who has emphasized the Cluster internationalization process.

The Italian technological Cluster is the youngest, considering that in Germany the first was created in 1997, in France in 2002 and in UK in 2005. A brief summary of the meeting clearly highlights the countless work opportunities generated by the project of innovation at both national and international levels, a project in which EnginSoft can and wants to be involved as protagonist. In

The participants at the round table: Maurizio Manfellotto (AD Ansaldo Breda); Vincenzo Soprano (Ad Trenitalia) Nevio Di Giusto (Ad Centro Ricerche Fiat), Carlo Garganico (Ad ITALCERTIFER), Michele Elia (Ad Ferrovie dello Stato Italiano), Angelo Chiappini (Unità ERMTS Agenzia Ferroviaria Europea), Amedel Gargiulo (Direttore ANSF Agenzia Nazionale per la Sicurezza Ferroviaria)

the Tesys Rail project EnginSoft is involved either in the vehicle design, thanks to the contribution of EMT team directed by Eng. Francesco Franchini, and in the system for the use of the Lyon software applications provided by Reactive Search. The Research & Development manager, in EnginSoft, Eng. Angelo Messina, stated: “I must note, not without regret, that the weak points of Italian presence in the European contest are the “fear” manifested by the companies in front of the complex procedures that must be followed for obtaining credits and the difficulties caused by the linguistic barriers. Other countries, as for example Netherlands, are able to get big credits although they lack a long design tradition (the first rail tunnel, the Frejus, was realized in 1876) or specific and distinctive competences, however they boast a perfect organization able to promptly respond to every technical-administrative requirements, respecting the deadlines and with no extension.
I can recognize in EnginSoft the ability to fill this gap thanks not only to its technical contribution but even proposing appropriate responses to every single announcement and then generating many job opportunities”

DITECFER S.c.a.r.l., the society of “District of Rail Technologies, High Speed and Nets Safety” in Tuscany Region

To confirm the intention proclaimed during the Forum in Montecatini, few weeks later an agreement has been signed at Pistoia for the constitution of a new society: DITECFER S.c.a.r.l., that is the “District of Rail Technologies, High Speed and Nets Safety”
The charter members are 25, 23 companies and 2 scientific foundation: AnsaldoBreda SpA, Argos Engineering Srl, Centro Ricerche e Attività Industriali Srl, Ciesse SpA, ECM SpA, EDIT Engineering Srl, ELETTRIFER Srl, Elfi Srl, EnginSoft SpA, Fratelli Casipoli Srl, Knorr-Bremse Rail Systems Italia Srl, IDS Ingegneria dei Sistemi SpA, Intecs SpA, Italcertifer SpA, Nuova I.T. Srl, Resiltech Srl, Sistema Ingegneria Srl, SICE di Rocchi Roberto & C. Snc, Sitael SpA, Stern Progetti Srl, Tecnau Transport Division Srl, Te.Si.Fer. Srl, VDS Rail Srl, Scuola Superiore di Studi Universitari e di Perfezionamento Sant’Anna, Fondazione per la Ricerca e l’Innovazione. The strength of this new institution, which will have the chance to take part to important initiatives and projects at both national and international levels, lies in its numbers: 4.300 employees and a sum of turnover of 900 million euro. The activities of R&D and Innovation in 2013 amount to 60 million, with a medium cost for any member equal to 13% of the turnover, in some case they reach 58%. On the whole, today the society has 110 patents, while other 5 have been requested; geographically speaking Pisa (51 patents + 5 requests) and Pistoia (49 patents) rule the roost, revealing an environment open to innovation and research of new solutions for the future challenges.
According to Lorenza Franzino, “ this represents the accomplishment of a course started with the creation of the District in 2011 under the guide of the Tuscany Region, which has demonstrated how many important result can be obtained even in hard times as the present, notwithstanding the lack of funds to support the activities. We have founded this society to better organize the District and this way get all the regional, national and international opportunities.

Per maggiorni informazioni:
Francesco Franchini, EnginSoft
newsletter@enginsoft.it

UM14: MODULARITY MASTERING COMPLEXITY

UM14 the two-day conference dedicated to modeFRONTIER celebrated the 15 years from the foundation of ESTECO with record figures: 221 participants, 48 speakers, 7 industry&methodology sessions besides the keynote speeches, 7 technology & channel partners exhibiting, 2 thematic roundtables and the 1st edition of the ESTECO | illy competition launched

Carlo Poloni, President of ESTECO, kicked off the first day of the International modeFRONTIER UM14 by hinting at the multifaceted scenarios characterizing the design and simulation technology industry today: complexity is stratified and embedded in the majority of products and services that all of us are in contact with daily. Turning such complexity into an advantage is the challenge of every big player aiming to excel in the innovation race. This year's edition of the modeFRONTIER Users' Meeting wanted to show the over 220 attendees how ESTECO customers and partners leverage design optimization technology to gain and maintain leadership in their respective industries.

The UM14 agenda saw the contribution of many important players at the forefront of research: Mr. Yamazaki form Fujitsu Labs demonstrated how modeFRONTIER is indispensable in his team's mission to ensure high product reliability by "visualizing of un-visualized data" when performing physical and chemical analysis of hardware.

Kazuma Goto illustrated Arup's design process as a holistic approach that "draws upon our multidisciplinary skills from planning and architecture to building design incorporating structural, civil, MEP engineering and other specialist skills". The example of the Taiwan Tower project illustrated how parametric modelling and optimization are crucial to filling the gap between designers expressing their creativity in architectural shapes and time, regulation and budget constraints faced by manufacturers.

Reliability and energy efficiency are, on the other hand, the drivers of ABB's product development strategy. Daniel Wäppling, Global Research Manager at ABB, explained that optimization-based development will become increasingly important in the industrial automation industry in order to meet these targets.

The Automotive Roundtable provided a stimulating overview of the nature of complexity both at vehicle development level and organizational process level: Mikael Törmänen (Volvo Car Corporation), Tayeb Zeguer (Jaguar Land Rover) and Yan Fu (Ford Motor Company) brought their experience of using optimization to manage articulated workflows and hit significant cost and time savings.

Technical best practices and remarkable results linked to these macro topics were further analyzed during the industry and methodology sessions that ranged from automotive to aerospace, energy, electronics, mechatronics, architecture and civil engineering, logistics and biotechnology.

Whirlpool orchestrating system modelling, Bombardier enhancing the aerodynamics of the fastest train in Europe for Trenitalia, Atkins optimizing the cost of flooding and Nidec enhancing an under-patenting induction motor are just a few examples of the variety of applications and domains where ESTECO technology has become a strategic asset. Fostering this role is precisely the vision driving the growth of ESTECO's product portfolio: CTO and Product Managers presented modeFRONTIER, SOMO and mF4LV new releases and features, representing an ever evolving set of solutions that cover the concept, simulation and validation phases of the design process and supporting engineering teams by nurturing a collaborative and modular mindset.

ESTECO not only helps industrial players stay ahead of the competition but, over time, it has brought together a remarkable group of modeFRONTIER users from academia, as reflected by the talks of professors and researchers coming from 13 different universities and research centers including MIT, VTT Technical Research Centre of Finland, DCTA/FUNDEP Brazil, Politecnico di Milano, MTU Friedrichshafen and the universities of Warwick, Strasbourg, Pisa and Troyes. While these presentations focused on advanced research projects with considerable impact at an industrial level, the Academic roundtable at UM14 was dedicated to the role of optimization theory and practice at an educational level.

The icing on the UM14 cake was the official launch of the ESTECO | illy Design Competition that will challenge students of Engineering, Chemistry, Physics or other scientific disciplines in the search for the most sustainable hot water pressurization system for one of the illycaffè espresso machines.

Once more, thanks to the contribution of the modeFRONTIER community, UM14 offered up a rich collection of best practices in the development of complex products and systems and laid the groundwork for the next generation of engineers to get closer to the design optimization world. By supporting designers in the quest for the most advantageous tradeoff between model accuracy and risk of misinterpretation, ESTECO shows its commitment to provide a flexible framework for integrating and enhancing all aspects of the simulation process. As Marc Halpern – VP Research at Gartner – cleverly pointed out during one of the keynotes, understanding the different facets of complexity and defining precisely what is to be modelled and how, is critical to effective system design.

For more information: www.esteco.com

EnginSoft reinforces its presence in Piemonte

CEO Stefano Odorizzi has inaugurated the new office in Torino – C.so Marconi 10

Last September, 23rd, Stefano Odorizzi - president of EnginSoft Spa – has inaugurated the new branch in Torino, in Corso Marconi 10. The offices, located at few minutes from Porta Nuova Rail Station and from the city center, have been since their construction in 1955 the historic headquarter of FIAT management and, exactly for this prestigious function, they have gained a special importance both in urban contest and in citizens' collective memory. The ceremony, happened in "Gianni Agnelli" room, has seen an active participation of ES' customers, partners and friends, whom the President has later guided through a visit of the offices.
Odorizzi has commented that "the increase and intensification of our presence on the territory, becoming more and more widespread, works to improve our ability to respond to the customers' need of direct communication"; and then he has added that: " Our aim is to become the reference point for small, medium and large companies which operate with CAE. The motivation of this high ambition lies first of all in the EnginSoft is one of the simulation operators which most distinguishes for quality and quantity of services".
Alfonso Ortalda, Chief Technical Officer, states that "moving to a larger and more prestigious location is a strong sign of reinforcement and confidence towards this territory, which has always been and it is yet today, hive of unmatched innovations".

EVENT CALENDAR

COME TO MEET US AT:

October 27-28, 2014 Pacengo del Garda (VR), Italy
International CAE Conference
http://www.caeconference.com
EnginSoft will be the main sponsor of the International CAE Conference. Many of our engineers will be engaged in presenting industrial case stories during the parallel sessions of the Conference and technology updates during the workshops.

CAE WEBINARS

EnginSoft continues on proposing CAE Webinars on specific topics referring to virtual prototyping technologies. A great opportunity to improve the knowledge of detailed context of use of the simulation tools and techniques. Thanks to our thirty-years' experience, we can explore the whole range of tools application and the better way to employ them in the specific industrial cases.

Next topics: Meshing, Aeroacustics, Optimization of the Design Process, Multi-physics analysis, Optimization of the Response Surfaces, Non-linear analysis with LS-DYNA...

Stay tuned to www.enginsoft.it/eventi
for the complete program of webinars.
The podcasts on past CAE Webinars are available at:
http://www.enginsoft.it/form/downloadwebinar.html

2014-2015 CAE EVENTS Stay tuned to:
www.enginsoft.it/eventi - www.enginsoft.com/events/
for the complete program of the events in 2014 and 2015

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Pacengo del Garda, Verona - Italy
October 27-28, 2014

INTERNATIONAL CAE CONFERENCE

SOME SPEAKERS HIGHLIGHTED

ANIYAN VARGHESE, European Commission

EU Research for innovation and competiveness
in CAE and Simulation

CARLO SBORCHIA, Iter

Status of Design and Construction
of the ITER Project

BERNHARD A. SCHREFLER, University of Padova

Modelling of pressure
induced fracture (fracking)

BRUNO LABOUDIGUE, Eramet Research

Modeling & Simulation
in the metals industry

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