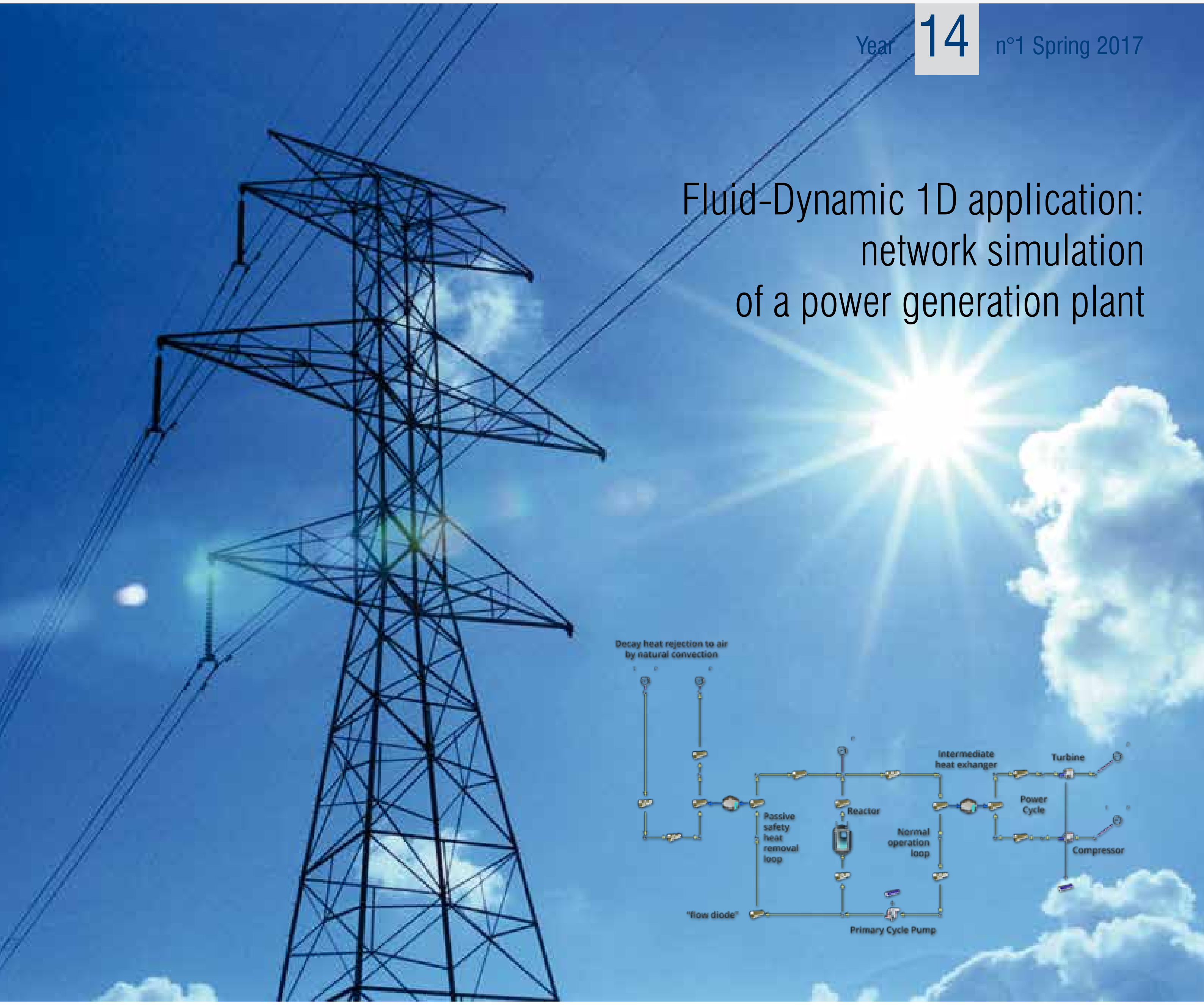
ENGIN SOFT

Newsletter

Simulation Based Engineering & Sciences

Year 14 n°1 Spring 2017

Fluid-Dynamic 1D application: network simulation of a power generation plant



Extensive use of CFD & FEM multi-physics simulation in **electrical motor and generator design**

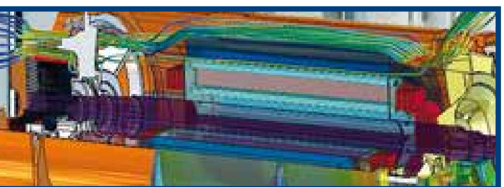
Analytical modeling for reaction, diffusion, and volatilization in **chemical processes**

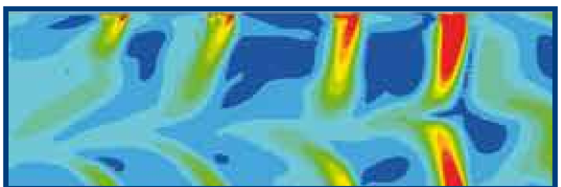
An Antarctic Greenhouse to investigate **plant cultivation techniques in space**

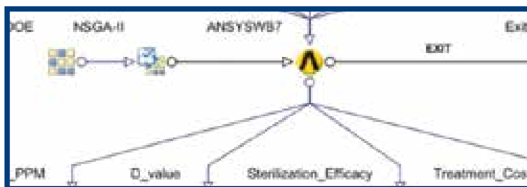
How to optimize an **external gear pump** in highly constrained conditions

Optimization of the VHP Pouch **Packaging Sterilization Process**

Real-Time HPDC Quality Prediction supported by **Trained Cognitive Model**







FLASH

We all know that famous saying: "time is money". In industry, time is a major hurdle which needs to be negotiated, any hold-ups in the process can have a significant impact and be costly to rectify. The typical mantra is to reduce the design time, limiting the opportunity to collaborate, in order to create value. What if we could turn that around such that more collaboration equals more value?

ESTECO has announced the release of VOLTA, the state of the art collaboration environment allowing organizations to store, version, run and share complex simulation processes. The web-based platform enables engineering teams to gain value through collaboration by reducing process complexity, reacting quickly to requirement changes and thus reducing time to market. Find out more on page 45.

Also, though time cannot be cheated it can be utilized: the market leaders of today are utilizing the latest technology to put time on their side; meeting time to market deadlines, increasing engineering productivity, reducing engineering risk, maximizing the use of engineering resources and much more.

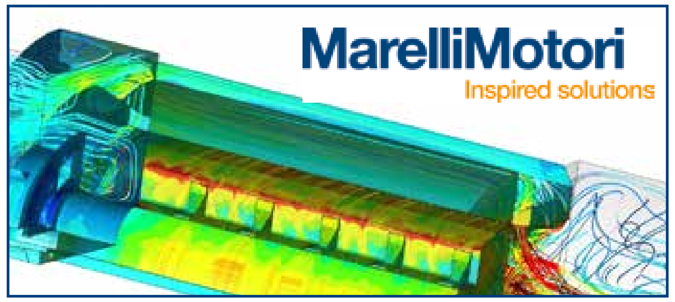
On page 12 Eng. Giovanni Sabbini from Cimolai Technology, shares how they achieved around 50% saving on time and resources to enable them to concentrate on the valuable computation/verification with improved accuracy.

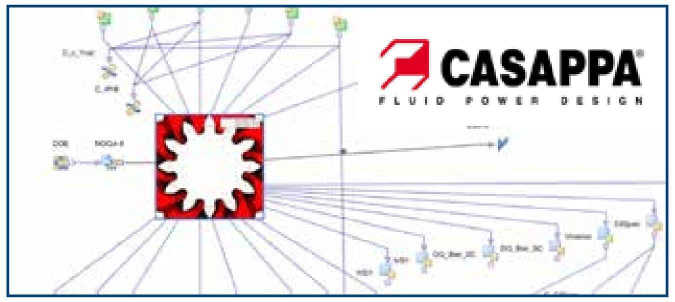
It is true, 'time is of the essence', please continue to read the articles to hear how many companies are 'turning back the clock' through the latest advancements in numerical simulation.

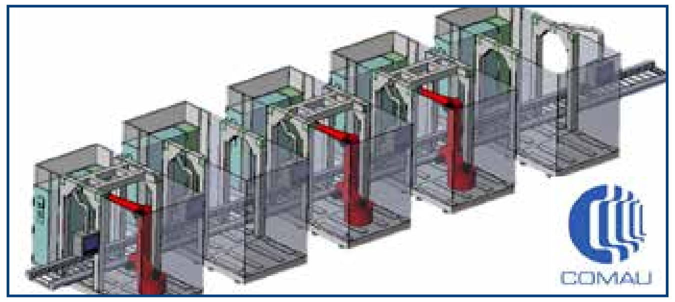
Stefano Odorizzi, Editor in chief

Contents

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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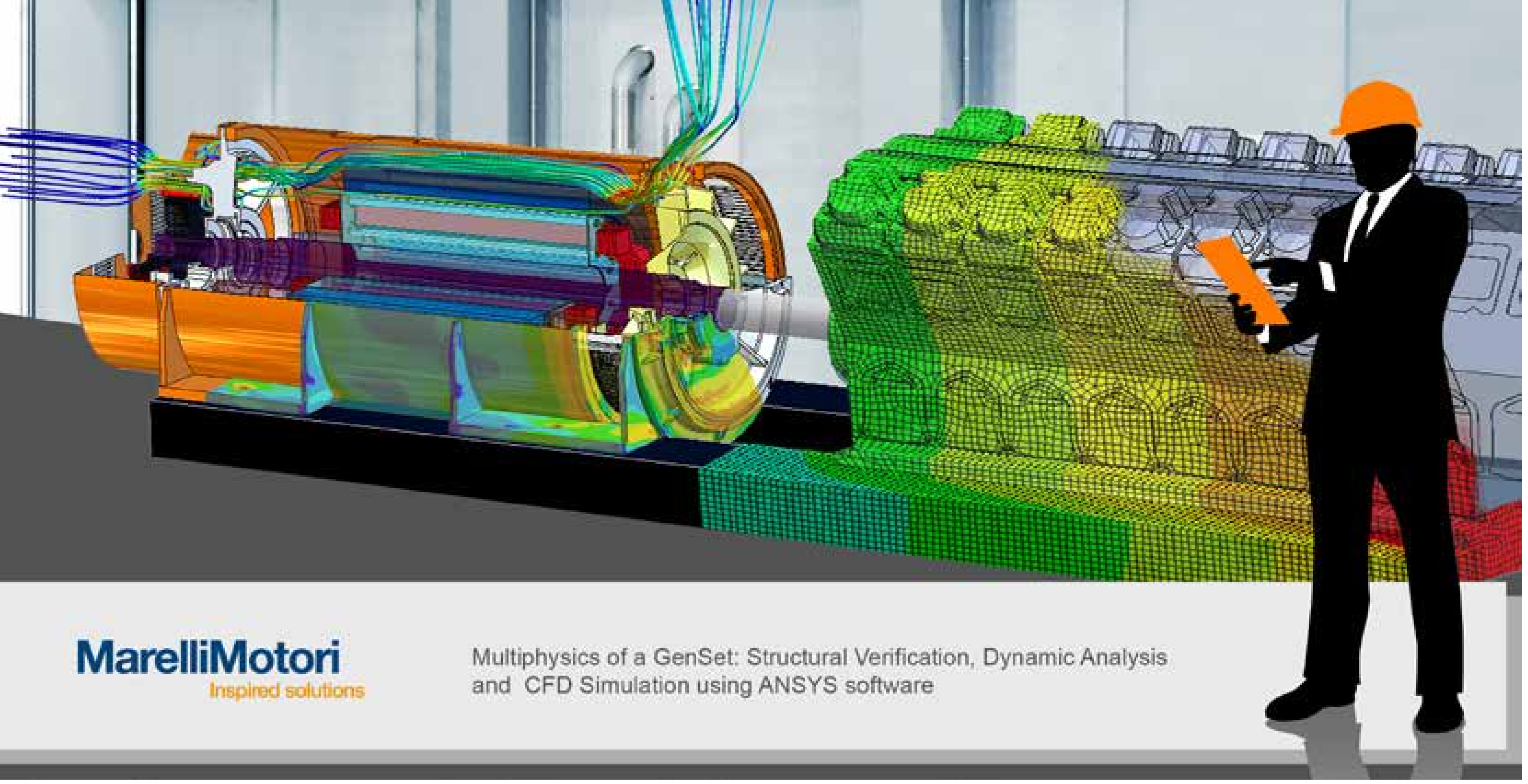

Cost Effective High Performance Design: Innovation is the Answer

Improving efficiency while reducing cost is a very complex engineering challenge: Marelli Motori hits the target through extensive use of CFD & fem multi-physics simulation in electrical motor and generator design

Marelli Motori is one of the world's leading generator and electric motor manufacturers. The company was founded in 1891 and enjoys worldwide brand recognition thanks to its extended sales, distribution and service networks across four continents. With two manufacturing facilities in Italy and Malaysia Marelli Motori sells these technologically advanced products in more than 120 countries. The business model is based on a successful combination of strategic key elements that enable Marelli Motori to offer innovative and inspired solutions to create value for customers: a wide range of innovative products, skilled people to provide sales & global support and continuous investment in R&D.

OBJECTIVES

Day-by-day power generation is becoming more competitive, reliable and eco-friendly. Marelli Motori is focused on innovation, aiming to match the market needs (Hydro, Cogeneration, O&G, Industrial applications, Marine) by increasing efficiency, reliability and lowering environmental footprint as much as possible.
These targets can't be achieved independently: improving the overall performance can lead to overly expensive products, making them "unsellable", so any activity aimed to increase the efficiency of the machine must be accompanied by cost reduction: this is the only way to be competitive in a global market.

It is therefore important to develop multiphysics simulations for all the components: Structural analysis to evaluate strength and deformation, Dynamic analysis to thoroughly study the operating behavior of the machine and Thermal CFD to improve cooling efficiency. This is all done while reducing the cost of product development and shorting the time-to-market.

SOLUTION

Numerous ANSYS simulations have been conducted to achieve optimal results: Structural simulation is done on the frame, shields, fan and shaft to reduce mass and while getting a better design by reducing waste material. In addition, the construction operations are considered by keeping mechanical safety and reliability in the foreground for each potential operating condition.

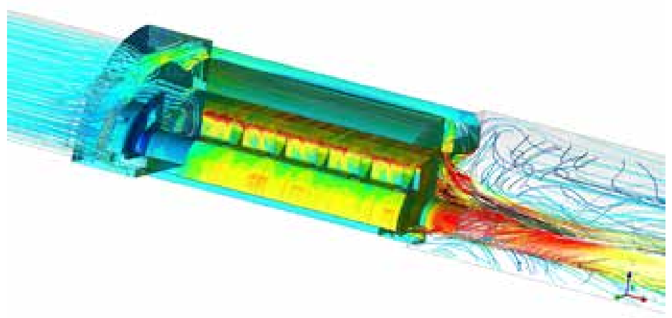

Fig. 1 - CFX_Velocity Streamline and Wall heat exchange contour of a Stator-Rotor submodel

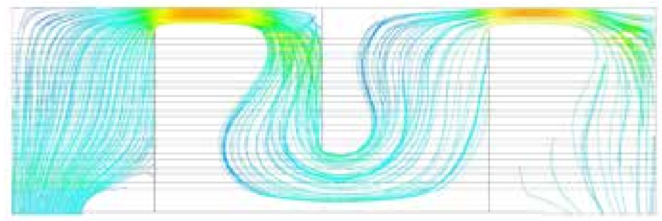

Fig. 2 - Velocity Streamline

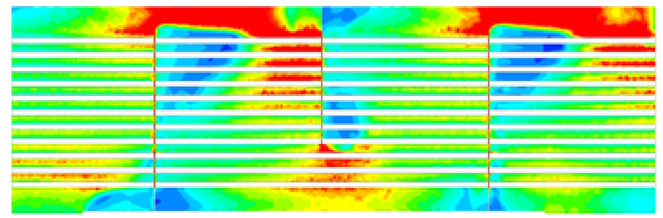

Fig. 3 - Wall Heat Exchange

The rotor assembly (including the fan), the stator and heat exchangers (where needed) have been simulated multiple times to find the optimal trade-off point between cost reduction and thermal efficiency, these components are the core of thermal exchange of the entire machine. Indeed, the subsequent design modifications arise from Structural and CFD calculations to increase cooling efficiency and thermal exchange, lowering hot-spots inside the Generator with the purpose to maximize power output. Doing the job in this way is complex because the aim is to design the entire family of components in the best way to extract heat from inside the machine, but at the same time there are many constraints about the feasibility of the individual shapes, the cost of production and the ease of the final assembly. Each component needs to overcome a Structural Assessment: parallel with the process described thus far, there has been the development of Dynamic simulations on sub-group of components inside of the machine and on the entire assembly. Modal Analysis to find Natural frequencies and subsequent Harmonic Response according to operating conditions were the key points to analyze the dynamic behavior of the machine. These simulations ensure mechanical reliability of the GenSet during the working phase. Talking about the design of new components or else the modifications done on the existing ones, drastic reduction of development times has been reached taking the advantage of using SpaceClaim: defeaturing, 3D Modeling as well as the ease of handling geometric parameterization inside Workbench interface, allowed to manage modifications very quickly.

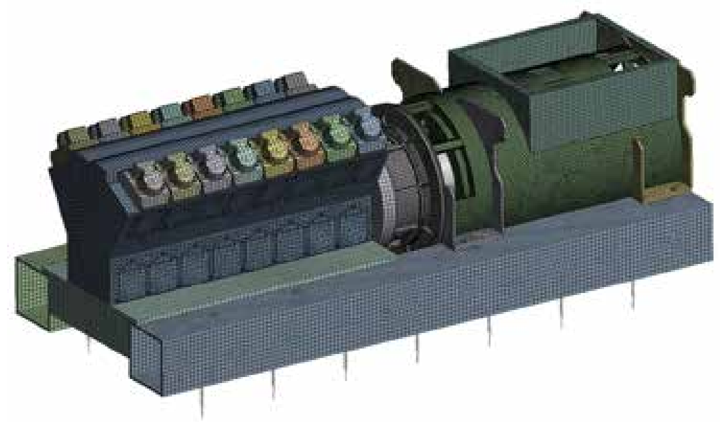

Fig. 4 - Entire GenSet model Meshed to realize Modal Analysis

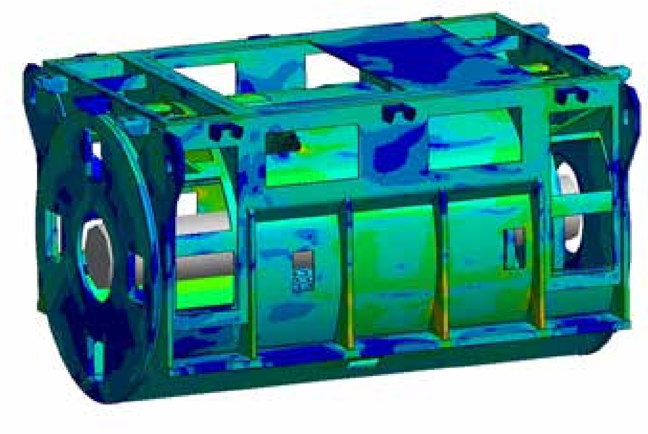

Fig. 5 - Structural analysis of a Frame loaded with Torque arising from the Stator

Given all these actions taken in terms of product improvement, what could be the other poits for future development? What about considering the possibility to snap-off dead times during product development?

Often the CAE analyst who is working on simulations, needs to leave their Workstation, for example going to the Test Room, on a meeting or to another Company headquarter; this involves the lack of possibility to follow the progress of computing operations, check the trend of convergence nor to modify any parameter. Moving away always with a laptop is not feasible, the easier way is to exploit the most common connection device. The idea is very simple and It is based on an ordinary smartphone (or a Tablet) connected on VPN, a dedicated APP with notifications about the simulation status and the possibility to manage only many Key parameters via Remote Control. Even better, if the application has push notifications that are activated only for some specific events, such as divergence of the calculation, or the completion of a point solution. The development of this concept could means Zero additional costs about devices and considerable time saved. A rough calculation can demonstrate that the hours saved in a given year exceed a few hundred.

RESULTS

By applying multiphysics simulation to different aspects of electrical motor and generator design the best result for each single component has been achieved. The combination of Marelli Motori expertise and ANSYS software capabilities were key to achieve better competitiveness in today's market place.

Increased efficiency, cost reduction of components, reduced development time have been achieved for different product – series. Final results can be synthetized by the ratio "Power output over Final cost" which in many cases raised a double digit percentage improvement.

This Engineering simulation Project was honored with the award "ANSYS Hall of Fame 2017 - Top 10 Commercial entry "

Nicola Pornaro
R&D - Mechanical Technologies
Marelli Motori S.p.A.

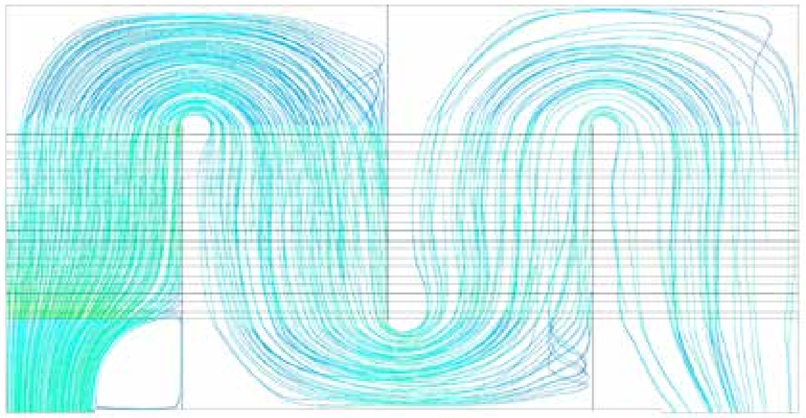

Fig. 6 - Velocity Streamline

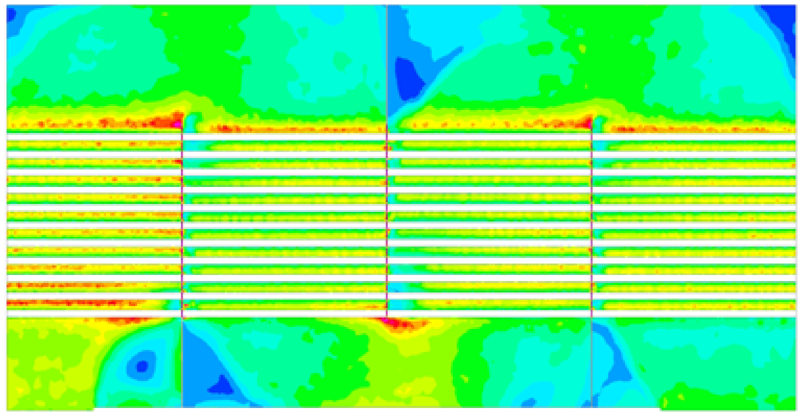

Fig. 7 - Wall Heat Exchange

NATIONAL PLAN INDUSTRY 4.0

Opportunities to foster investments for innovation and competitiveness

The plan foresees a set of tools available for Italian companies without any size, sector and territory constraints, that are willing to grow and invest in innovation.

Several are the opportunities included in the National Plan Industry 4.0:

- Super-amortization at 140%
- Iper-amortization at 250%
- New Sabatini
- R&D tax credit
- Fiscal benefits for SMEs and innovative Start-ups

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Our monitoring action and the direct experience consolidated through the participation in several research projects, combined with our in-depth knowledge of the software and hardware available resources, can be placed at your disposal so to get further information regarding advantages and benefits for your company and for your investments in research and development.

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How to optimize an external gear pump in highly constrained conditions

Figure 1a - Casappa POLARIS 20 external gear pump

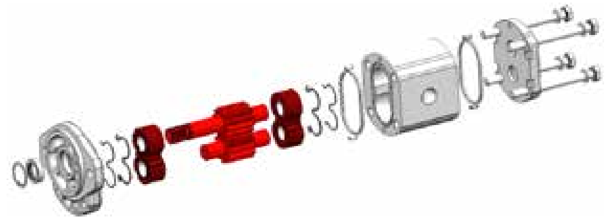

Figure 1b - POLARIS 20 pump exploded view

Today, any kind of hydraulic subsystem has to guarantee high performances and reliability in order to meet customer expectation while minimizing the price and time-to-market of each product. In this context, external gear pumps are simple machines that play a primary role thanks to their incomparable mix of features: extremely low-cost and simple production but with high performance and reliability at the same time. Their major limitation is their fixed displacement because variable speed electric motors are likely to become more widespread for many applications. In addition, the last few years have seen significant attention to noise reduction, especially for electrically powered systems such as indoor forklifts or hydraulic control units.

The objective of this project was to take a standard series pump (PLP20, Figure 1) with a displacement of about 20 cc/rev and to minimize its noise emission, while maintaining same level of performance.

From an optimized pump to a better one

The target was not to redesign the whole pump, minimize the time-to-market of the new version, but to review its core feature, the design of its gears and lateral plates that interface with them (light and dark red highlighted components in Figure 1b). These parts are geometrically constrained by its connection to a pre-existing housing.

The main purpose of the optimization was to reduce the overall noise emission of the pump: from huge internal oscillating forces inside the pump able to excite the structure (structure-borne noise) and from pressure fluctuations propagating through the hydraulic circuit (fluid-borne noise) pressure waves arise (air-borne noise) and cause annoyance in their surrounding environment.

The other main purpose of optimization is the maximization of both volumetric and hydro-mechanical efficiencies (this means to reduce leakages and friction between internal components) in order to minimize power absorbed from the prime mover and consequently energy consumption of the overall system.

Optimization

The first step of optimization was the gear design: an internally developed software was used to calculate not only standard features like gear contact ratio and tooth strength, but also more specific parameters important for a hydraulic pump, like specific displacement (quantity of oil the gear can draw for each mm of length), tooth tip,

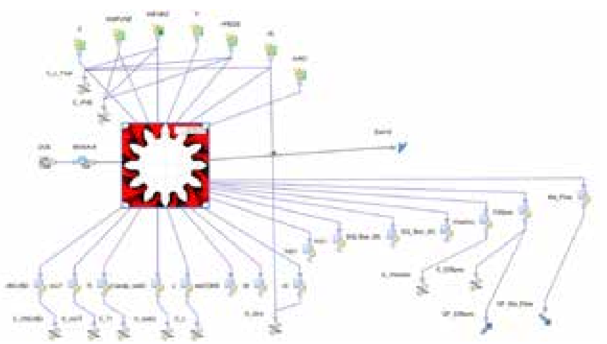

Figure 2 - Phase 1 - gear optimization

minimum tooth space volume and kinematic flow pulsation (directly related to pressure ripple and noise).
This software was included inside a modeFRONTIER workflow (Figure 2) and a really fast MOGAII optimization simulated 100'000 designs in a short time: 1630 designs were feasible (better performances compared to current pump, Figure 3). The best solutions suggested an increase in the number of teeth compared to the current gear. As a further verification, the new design has been validated with KISSsoft commercial software.

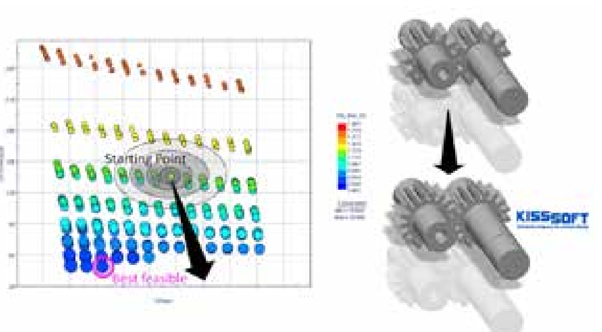

Figure 3: - Phase 1 - results

Once the gear design is fixed, it is crucial to deeply analyze the meshing process (Figure 4) from a hydraulic point of view: small oil compressibility combined with trapping phase of each vane leads to huge pressure peaks and cavitation insurgence, both of them being sources of pressure ripple and noise emission. The standard solution is to machine some grooves on lateral plates in order to accurately fix the pump timing: they define when and how to connect each pumping vane to external ports.
After having parametrized lateral grooves' geometry, a precise model is necessary to properly simulate the pump's behavior. Casappa R&D Department can count on HYGESim (HYdraulic GEar machines SIMulator, Figure 5): it is a completely customized virtual platform able to simulate gear pumps, starting from 3D CAD files. Its functioning is based on a pump lumped parameter model developed in Siemens- LMS AMESim that can simulate fluid-dynamics and basic mechanics inside the pump; also, it is coupled to other independent modules able to perform acoustic, tribological and FSI calculations. This platform has been developed through years of cooperation with University of Parma and University of Purdue.
HYGESim is composed of a hydraulic part, where each vane and all the fluid connections are described, as well as a mechanical part. It is able to predict pressure and cavitation distribution, flow/pressure ripple in

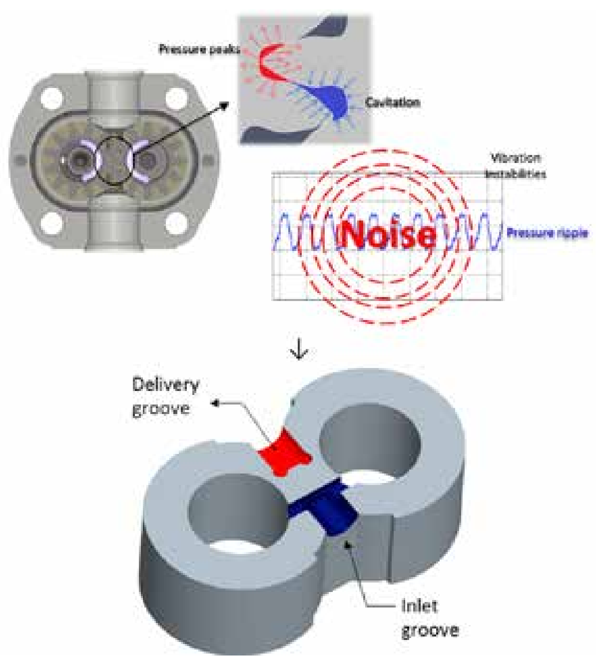

Figure 4 - Pump timing through lateral plates grooves

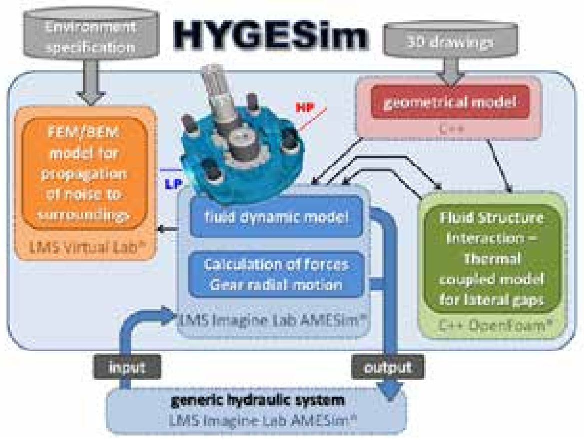

Figure 5 - HYGESim simulation platform

the circuit, contact forces between components and as a result the volumetric and hydro-mechanical efficiencies of the pump.
The optimization of pump timing has been performed with modeFRONTIER workflow depicted in Figure 6. Starting from the CAD generation of lateral plate's grooves, a C++ code combines all components geometries together and gives input to HYGESim circuital model, that simulates the pump in different working conditions; the resulting data is post-processed by an Octave script.

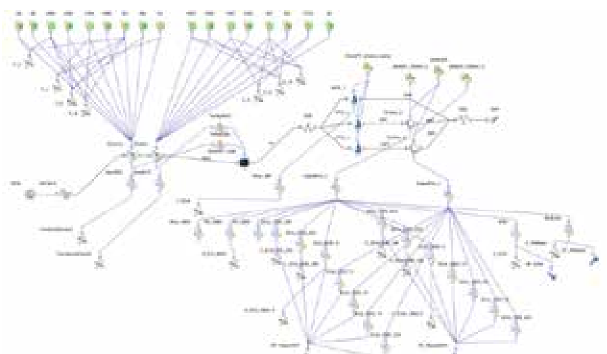

Figure 6 - Phase 2 – pump timing optimization

7 constraints on input variables are necessary to ensure a good interface between components; 10 constraints on output variables guarantee that the new pump will perform better than previous one in every aspect and every working condition (feasibility condition). It is a hard job for the optimizer to respect so many constraints, but at the end it properly reflects the target of this activity.
4 objective functions manage the physical quantities mostly related to noise and efficiencies.

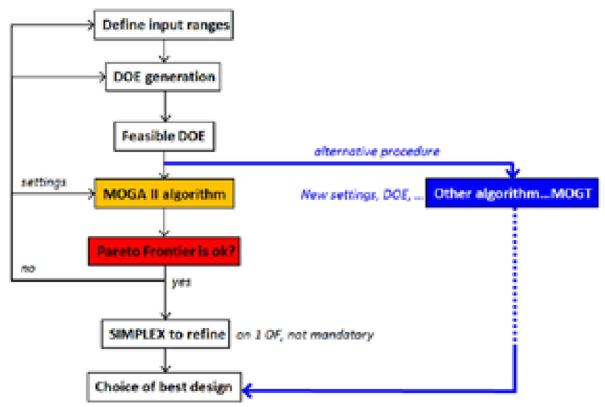

Figure 7 - Optimization procedure

The standard procedure (Figure 7), usually followed to solve this problem, is to define a range for each input variable, generate a good and feasible DOE population and then run the optimization with MOGAII algorithm. In case the Pareto frontier is acceptable, a further single objective optimization can be done to refine the best solution; if the frontier is not good enough, it is used to reconsider the input ranges and MOGAII settings to loop the process once more.
In this specific case MOGAII results were not properly satisfying and an alternative procedure has been followed: MOGT algorithm, based on John Nash theory, was chosen because of its potentials for super-constrained problem, while adapting each setting to its requests. Following is reported the comparison between results obtained with both the procedures described above.

	MOGA II best design	MOGT best design
Pressure ripple↓	- 41%	- 43%
Cavitation ↓	- 1.0 %	-1.5 %
Pressure peak ↓	- 45%	- 77%
Vol. Efficiency ↑	+ 0.7%	+ 0.7%

Table 1 - Best design for each optimization in respect to current pump

Comparison between algorithm performances

MOGAII optimization consists of 1'175 designs, for a total amount of 392 hours of computational time. Looking at the chronology of some input variables (Figure 8) there is no evidence of a proper convergence and it can also be noticed that there are only 20 feasible designs, that means 1.7% of the overall database. The bubble chart representing 4 OFs together denotes a fragmented Pareto frontier: as a consequence it would be hard to choose the best compromise solution.
MOGT algorithm requires only one design as initial DOE population and not a big set like the previous one: in order to have a comparable analysis, one design of MOGAII DOE has been chosen as the new starting point. MOGT optimization was stopped after 194 designs, for a total amount of 65 hours of computational time. In the history charts of input variables (Figure 9) it is clear that a convergence was achieved; 74 designs are feasible, that means 38.1% of the whole set.

The bubble chart shows a lower and more populous Pareto Frontier, therefore more and better designs are available in this case.
As to conclude, a super-constrained optimization was performed in order to find better gear and lateral plates for a new low-noise version of Casappa PL20 pump. MOGT algorithm demonstrated to be 22 times more efficient than standard MOGAII in 1/6 of time, leading to better solutions.

Advantages and prototypes

In Table 1 the advantages obtained with best design of each optimization are highlighted.
On the basis of these promising results, MOGT best configuration has been prototyped (Figure 10) and is going to be tested in the Lab Department.

Manuel Rigosi, Casappa

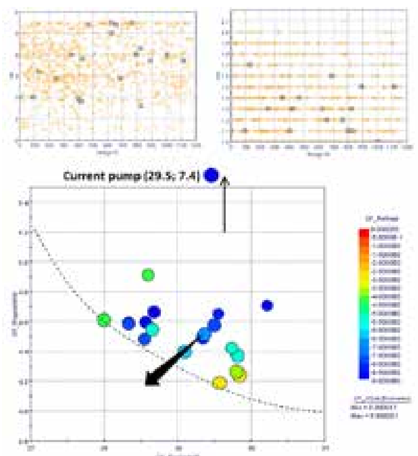

Figure 8 - MOGAII optimization results

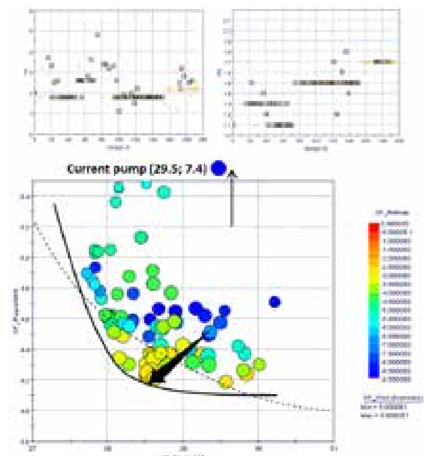

Figure 9 - MOGT optimization results

Figure 10 - MOGT best design prototypes

Cimolai Technology chooses ANSYS

Cimolai Technology designs and produces special machines and plants for lifting, handling, transport and launching operations

Cimolai Technology Spa is located in Carmignano di Brenta - a few kilometers from Venice - in modern premises with a total area of 53'000 square meters.
In 2004, the Cimolai family, who founded and ran the Cimolai group - a world leader in steel construction - for nearly 60 years, decided to invest in new production fields. The key idea was to create a new production based on the solid foundation of the Cimolai group, the versatility of a young group of engineers with proven experience in specialized transport and lifting systems. Thus Cimolai Technology Spa was formed with the vitality of advanced technology and innovative potential. At the same time, it was founded on the strong and stable platform of design and production collaboration. Therefore Cimolai Technology Spa Special Equipment has become a worldwide partner for the study and optimization of any lifting, handling, transport or launching operation.

The company works closely with customers and is always ready to find the right solution for the specific field and application required. The customer can count on experienced staff in the design, electrical and hydraulic departments, capable of meeting the various needs. The considerable production capability, the group's synergy and state-of-the-art facility in Carmignano di Brenta - where all machines are pre-assembled and tested - enable short delivery times, always guaranteeing a 100% Italian-made machine which complies with the highest levels of quality. Furthermore, specialized assemblers are available, qualified to interact with the end-user. Not only do they assemble and commission the machines but they also guarantee a prompt global after-sale service.
Cimolai Technology Spa Special Equipment is UNI EN ISO 9001, ISO 14001 and BS-OHSAS 18001 certified. For the USA and Canada, the machines manufactured by the Company are UL certified. In addition, all of the machines comply with the terms and the provisions of EEC Directive 2006/42/CE and are marked "CE". Cimolai Technology Spa Special Equipment has also been certified by SOA Nord Alpi and is qualified to participate in Italian public tenders.

CIMOLAI Technology spa
Special Equipment

Taking into account all these activities, most of them requiring a tailor-made approach to the project to meet customer requests and specifications, but also complying with stringent regulations, it is essentials for Cimolai Technology to calculate and check all its metallic structures precisely and so in February 2016, the previous computation system was replaced by the new ANSYS WORKBENCH and SPACE CLAIM.


Fig. 1- Gantry cranes on rails installed on a floating dock


Fig. 2 - Mobile boat hauler for construction/refit yards

Eng. Giovanni Sabbini, who led the introduction of ANSYS into the project in the technical department, was interviewed five months after the software installation and he could satisfactorily affirm that: "the main benefit we have obtained, by adopting the ANSYS technology in the development of our products, has been that of simplifying and improving the iterative flow between design/project and computation/verification.

The cycle can be closed now more effortlessly and the necessary enhancement iterations are easily performed. Previously, the geometric modification and preparation used to cover the 80% of the total activity, while now it has been reduced up to the 40%, thus saving time and resources to be oriented to the real computation. The target we are focused on now is that of reducing the refined geometric preparation by up to 20%. The other great advantages we have achieved have been the quality and the velocity of the mesh that, together with new hardware installations, have allowed us to reach inconceivable overall velocities.
In substance, we can currently evaluate a saving in time for the whole calculation activity of more than the 50%.

Furthermore, the possibility of designing complete models, including bolted joints, has allowed us to quickly obtain an improved accuracy in the prediction of complex structures and therefore to avoid corrective measures during the executive phase. This element is particularly important since our structures are often unique and are assembled in the construction yard. An improved reliability in this sense enables to be faster and more precise in the prediction of delivery time, thus reducing unexpected events."

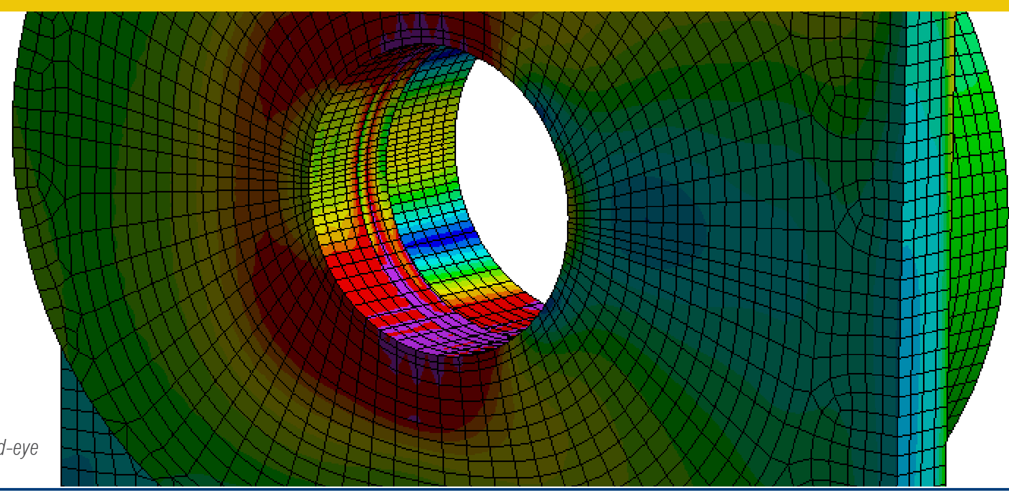
Fig. 3 - Detailed analysis of a pad-eye

Analytical modeling for reaction, diffusion, and volatilization in chemical process using Particleworks

Mitsubishi Chemical Corporation (MCC) is a subsidiary of Mitsubishi Chemical Holdings Corporation, the largest chemical company group in Japan. It operates a wide range of businesses involving "Performance Products" and "Industrial Materials". In the automotive industry, it produces materials such as polycarbonate for use in vehicle headlights, carbon black used in tires while also producing batteries and organic EL lights.

MCC's research and development center has invested heavily in the chemical processes necessary to develop these products, which has improved the processes of mixing, reacting and separating materials of solid, liquid and gas. For this, CAD and CAE tools have been used for over 25 years, and more than 80% of such tools are in operation at any one time. These chemical processes have inevitably involved fluid materials and CFD simulation has been conducted for many years. However, conventional grid based CFD tools have a weakness in not being able to calculate surface free problems with a satisfactory shape accuracy and are not able to evaluate large deformations in the interface. In order to overcome this, Particleworks was purchased about 8 years ago. Thanks to Particleworks' quick GPU computation support, they are now able to achieve the goal of improving the calculation costs. Now, 4 engineers are using Particleworks with 2 or 3 simulation jobs in constant operation, which is high usage.

Particleworks case study

Various chemical process simulations are performed including multi-phase problems such as air-liquid and solid-liquid. For example, such processes can be seen in stirring tanks and reactor vessels; Stirring tanks are generally vertical, which are mainly used to mix low viscosity materials. Impellers are located in vertical stirring tanks while boiling, evaporation, bubble coalescence and fragmentation occur around the impeller.

A catalyst is used in some cases to ensure that solid particles precipitate. It is possible to simulate using the grid based CFD method to some degree, but Particleworks has been adopted to take advantage of the free surface capability and model the large deformations.

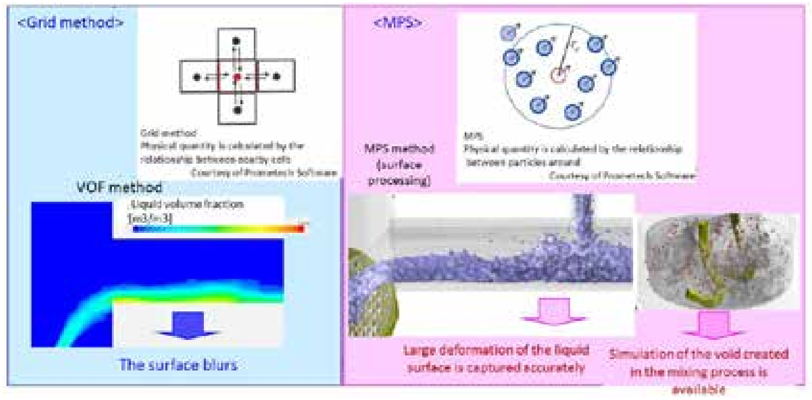

Fig.1 Comparison of formation of free surface between grid method and MPS

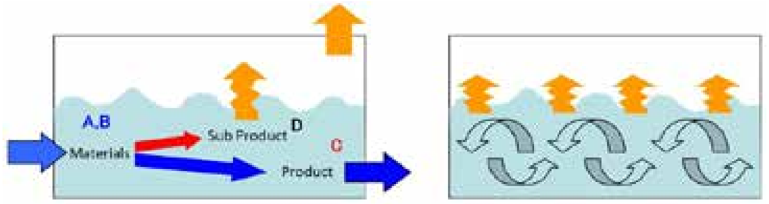

Fig.2 Reaction process by using a horizontal stirring tank

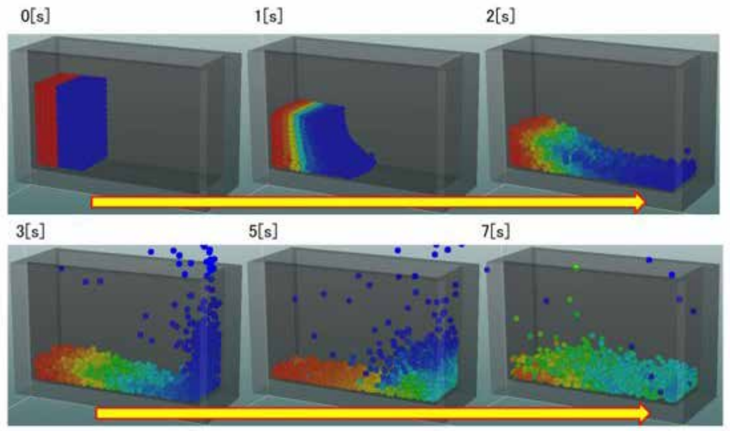

Fig.3 Historical change of the concentration of component A in the diffusion model

In some cases, horizontal stirring vessels are used when handling high viscosity materials. For instance, the polymerization reaction process has a material with low viscosity at the beginning of the mixing process (0.001Pa.s) and high viscosity at the end (1000 Pa.s). In this case, a horizontal reactor vessel is used for high viscosity, but MCC's required more experience to simulate the process using the grid based CFD method because the complex shape of the impellers complicates the fluid dynamics. In addition, the typical grid based method used for such problems, VOF, can't form the interface between the two materials clearly and free surface may be smeared in the computation. Fig.1 shows the comparison between the grid method and MPS. It was realized that MPS could present the interface very accurately when the liquid surface deforms dynamically and that the method is very suitable for simulating horizontal vessels. Therefore the choice was made to proceed using Particleworks.

To specifically explain the reaction process using horizontal vessels, product C and side product D are obtained by the reaction of material A and material B as shown in Fig.2. During this process, there is a problem called equilibrium reaction, which is if creating too much C and D, those will be decomposed and return to A and B. Therefore, the reaction doesn't proceed unless the sub product D is removed. So, the impellers in the stirring tank are rotated to remove D, retaining the liquid inside, from the surface to remove it. In actual behavior, the reaction speed is relatively fast, but the removal speed is very slow, because the liquid is high viscosity and the sub product inside isn't removed from the surface quickly. As it's important to encourage the removal, all of the liquid is mixed enough to increase the interfacial area and the mixing performance to encourage the removal. This reaction speed can be measured through experimentation, but it's difficult to know the removal speed. So we had been predicting the approximate speed based on the operation record. Besides, it's not easy to predict how the removal speed will change when using different conditions. So they used Particleworks to evaluate the interfacial area and the mixing performance and succeeded to obtain the removal speed.

A case study using the software development kit SDK

Although MPS is superior in terms of capturing the interfacial area accurately, only the standard capabilities of Particleworks couldn't calculate how the sub product D was removed. So, they decided to use Particleworks SDK, the software development kit, and had considered analytical modeling of reaction, diffusion, and volatilization in the stirring tank. As the way of modeling in SDK, the equation of component X concentration is expressed by 3 source terms of solution which are diffusion, volatilization from surface, and reaction. The same equation in Particleworks was used for the diffusion Laplacian. They used the equation of the chemiosmotic hypothesis for the volatilization from surface, and used the Particleworks free surface judgement and interfacial area calculating formula for the interfacial area. Regarding the calculation of the reaction, the chemical equation written in common text was used.

They had examined if the model for reaction, diffusion, and volatilization worked correctly by using the dam break problem. Here, 4 components of A, B, C, and D were set, the initial concentrations inside and outside were defined as the same, and only the diffusion coefficient was changed to see the tendency. The initial distance between particles was set at 1m. At the beginning, they validated the diffusion model. Like Fig.3 shows, the liquid flowed rapidly by the dam break, and the component inside diffused gradually, so they could confirm the model was created correctly.

Then they evaluated the reaction model. Seeing the transformation of component A, for example, the concentration of A decreased as time proceeded, which is shown in Fig.4. And finally the

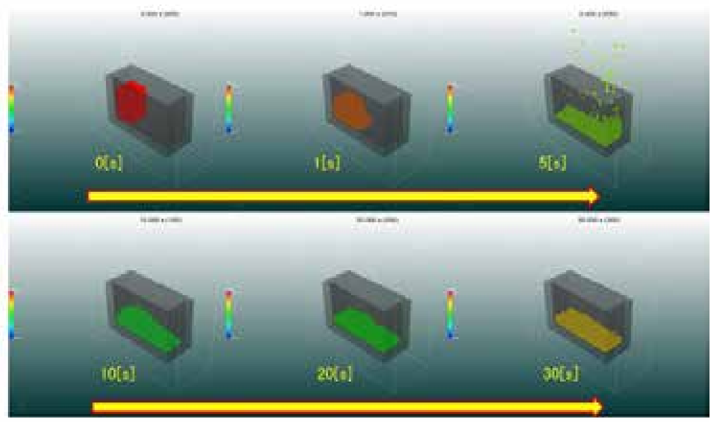

Fig.4 Historical change of the concentration of component A in the reaction model

concentration increased again like they can see that the color returned to orange. This is the equilibrium reaction which was explained before. The theoretical result was obtained by hand calculation as the reaction formula was simple, and it corresponded to the simulation result well and they could know that the reaction model was created correctly. Finally, they evaluated the volatilization model. By defining different diffusion coefficients for A, B, C, and D, they changed the degree of volatilization. Like the results shown in Fig.5, especially D is easier to understand, the surface concentration is low and the inside concentration is still high. So they could understand that the component was removed only from the surface and the volatilization was modeled correctly.

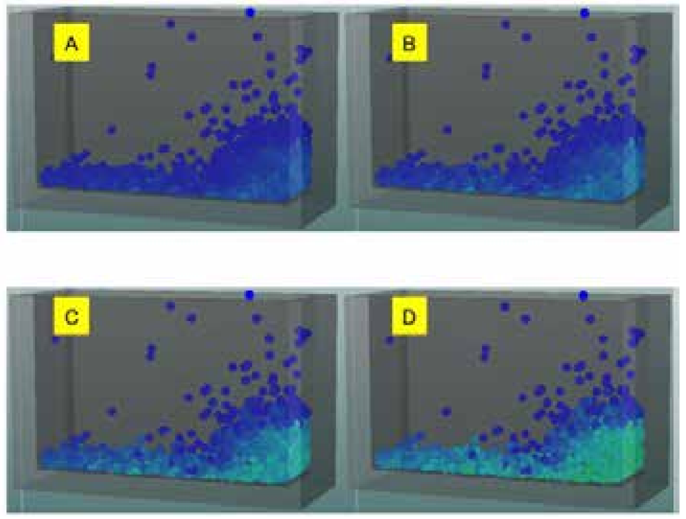

Fig.5 Historical change of the concentration of each component in the volatilization model at 5 seconds

It seemed there was no problem so far, but in fact they found that the volatilization occurred after 1 second near the wall which should not be an interface. It happened because of the problem that the interfacial area was calculated near the wall after 0.1 second. Besides, the interfacial area was wider than the theoretical result at the steady state level, and they also realized a problem that there is a gap in the interfacial area calculation, which was important for volatilization. Later, they knew that it occurred by the default free surface judgement parameters and the calculation way, so they improved it by changing the calculation way of the interfacial area with the cooperation of Prometech Software, the Particleworks developing company. After making some improvements on the free surface judgement and calculation using a different equation from a standard pressure calculation, they could obtain the result which almost corresponded to the theoretical result, and finally, the way they choose was evaluated as enough to use.

There are many multi-fields problems in chemical processes and there are numerous opportunities to use MPS, but in fact there are still some cases not being able to evaluate enough by the standard capabilities of Particleworks. However, the analytical modeling of special phenomena such as reaction, diffusion, and volatilization became realized by using SDK, and it could make their research go forward.

Reference: Prometech Simulation Conference 2015 presentation material

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Particle-based simulation software for CAE

Particleworks is a CFD software based on an advanced numerical method known as the Moving Particle Simulation (MPS) method. The mesh-free nature of MPS allows for robust simulation of free-surface flows at high resolutions, saving the need to generate meshes for the fluid domain. Since its first release in 2009, Particleworks has been introduced to a wide range of industries.

Particleworks enables engineers to model and simulate large-scale problems related to free surface flows integrated with interactions such as fluid-rigid or fluid-powder, dealing with complex boundary geometries.

What is a particle method?

Do you know what a particle method is? It is a method for fluid simulation, "fluid" meaning liquid and gas. We can simulate fluid behavior with the particle method on a computer. These days the particle method has been getting much attention in industrial and academic worlds because the particle method allows us to simulate very complex phenomena.

The particle method simply simulates fluids.

There are various traditional methods, such as the finite difference method, the finite element method, the boundary element method etc. These methods have achieved outstanding success. However, there are still a lot of phenomena that are very difficult to simulate with the traditional methods. The particle method may become a solution for the problems.

Particleworks is supported in Europe by EnginSoft.

EDEN ISS project: an Antarctic Greenhouse to investigate plant cultivation techniques in space

Introduction

Future manned-missions to explore space has brought to light many challenges, including one of the most critical; the supply of edible food. The development of plant cultivation technologies for safe food production in space is a research field which will contribute to the success of future missions in space. Although humanity's journey to the Moon and Mars is still part of a long term project, the development of the required technologies starts today, in order to be ready for implementation into the mission architecture.

The aim of the EDEN ISS project is the development of a bio-regenerative life support system (BLSS) to be incorporated into space stations, exploration vehicles and planetary outposts. On the one hand, the project explores plant cultivation technologies using an International Standard Payload Rack (ISPR) for potential testing on-board the International Space Station. On the other hand, a Future Exploration Greenhouse is designed for planetary system deployment. These facilities will first be tested in a laboratory setting (DLR center in Bremen, Germany) and later it will be shipped to the German Newumayer Station III in Antarctica, where the extreme environment and logistic are a terrestrial reproduction of space conditions. The man-mission to test the facility in Antarctica will start at the end of 2017, where the challenges faced are: a highly-isolated environment, strict weather conditions (-40°C, high wind speed, heavy snow storm) and six months of almost complete darkness. During this one-year mission, the container-size greenhouse will provide fresh food for the station crew.

Figure 1 - the German Newmayer III station in Antarctica

The EDEN ISS project (Evolution and Design Environmentally-closed Nutrition-Sources) is funded by the European Union's Horizon 2020 research and innovation program. The consortium is made up of 14 members; EnginSoft is collaborative partner with strong experience in FEM, CFD and various simulation expertise's and is appointed to the thermal, fluid dynamic and environmental simulation tasks. In particular, EnginSoft is involved in the optimization of the air distribution system of the greenhouse to ensure the proper climate conditions for plant growth.

Baseline design of the Greenhouse Module

Looking at the global structure of the mobile test facility, the evolution of design during the study has led to a baseline design which is composed by three compartments:

- Cold Porch: a small room providing storage and acting as a buffer to the external cold environment
- Service Section (SS): hosts the ISPR and the primary control, air management, thermal control and nutrient delivery system
- Future Exploration Greenhouse (FEG): consists of multilevel plant growth racks operating in a precisely controlled environment.

Figure 2 - Internal view of the container, hosting the Clord Porch, the Service Section and the Future Exploration Greenhouse

The primary activity of EnginSoft's workpackage was to perform a CFD study on the FEG, to guide the optimization of the system, checking the global and local aspects. In the growth chamber particular attention is paid to the temperature, relative humidity and velocity. In fact, a typical problem occurring in Greenhouse conditioning is that big volumes easily lead to stagnation areas, causing high temperature and humidity gradients.

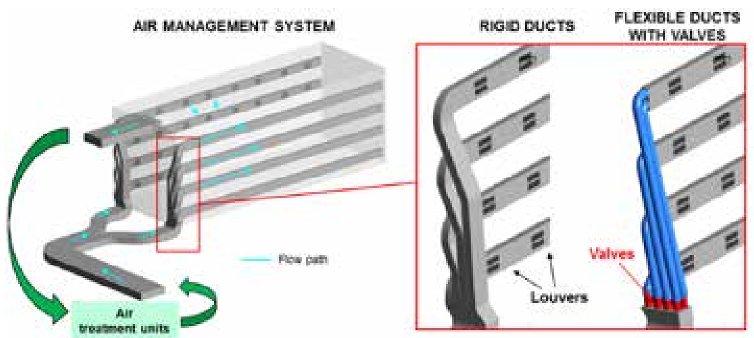

Figure 3 - Structure of the Air management system (left). Details of the ducts: baseline geometry with rigid ducts, improved geometry with flexible ducts and valves

CFD analyses of the Greenhouse

The Future Exploration Greenhouse (FEG) houses eight multi-level growth racks, for a total of 40 growth trays. Carbon dioxide is brought to each tray by a system of channels shown in Figure 3 (Left). After the air treatment unit, air is split in two branches, one for each side of the greenhouse. Each branch is divided again into 4 horizontal ducts which enter the chamber. On the side of each duct there are 8 adjustable louvers which convey oxygen to the plants on the trays. On the top side of the greenhouse there is a suction duct, which collects air and brings it back to the air treatment units, closing the cycle.

This Air Management System (AMS) was optimized in the following way. Firstly, starting from the initial geometry with rigid ducts, the solution with flexible ducts has been selected. In Figure 3 (Right), the 4 rigid ducts are substituted by 8 flexible ducts with the correspondent valve. This choice is made because it allows a direct control on the mass flow split among the 8 horizontal ducts and because the additional pressure drop due to valves is manageable by the AMS fans. Secondly, the shape of the horizontal duct has been changed to allow a balanced flow across louvers. In fact, the air distribution at louvers level was not balanced for the initial geometry, the last louvers received more mass flow than the firsts (see Figure 4 left). The final geometry with a variable width has a more balanced flow and plants oxygenation. In this configuration, the cross section of the ducts decreases and the improved results can be seen in Table 1.

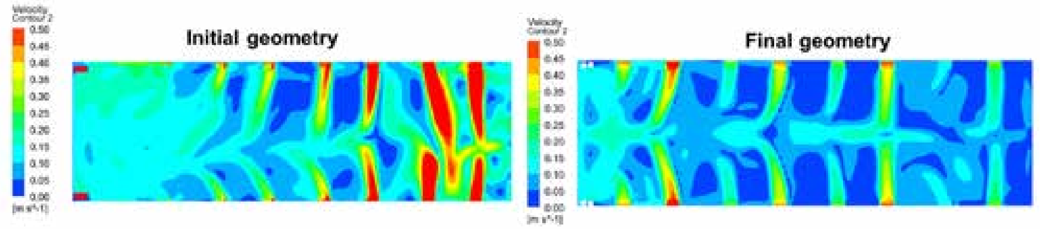

Figure 4 - Velocity contours in the two configurations: Initial geometry with constant width ducts (left), final geometry with decreasing width ducts (right)

For the chamber occupied by the plants, a CFD model of the greenhouse was set, taking into account all the aspects involved in the fluid dynamics: plants evapotranspiration, heat loads, ambient conditions, humidity. The summer day scenario was considered, with an external temperature of 5°C, the maximal temperature reached in Antarctica. The two solutions were compared: the baseline model and the final geometry where 8 fans were introduced to improve air mixing. In fact, these fans collect hot air from the top-side of the FEG and blow it downward into the corridor in order to avoid high gradient and stagnation area. The air mass flow at inlet is 1400 m^3/h, with a temperature of 20°C and a relative humidity of 70%. Plants are modelled as porous media and are categorized with respect to their different volumes of evapotranspiration, therefore there are tall and short plants, cucumber and germination. They are considered at their maximum level of growth, with the correspondent values of energy sink and water production. The heat load of LED is introduced and split in the radiative and convective component, while one part is dissipated by the water cooling system which is not directly included in the simulation. At the lateral wall of the chamber, the heat transfer coefficient is computed, based on the walls material and thickness.

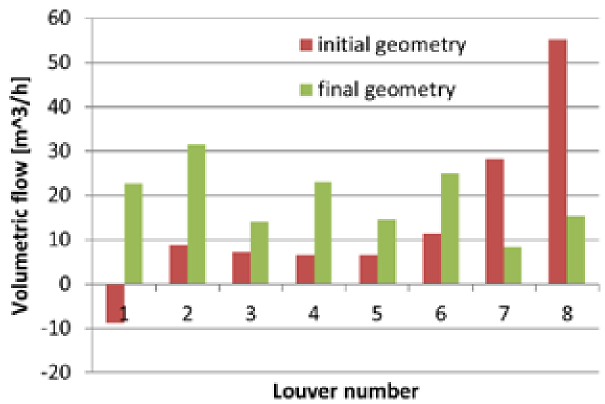

Table 1 - Comparison of the louvers mass flow in the two configurations

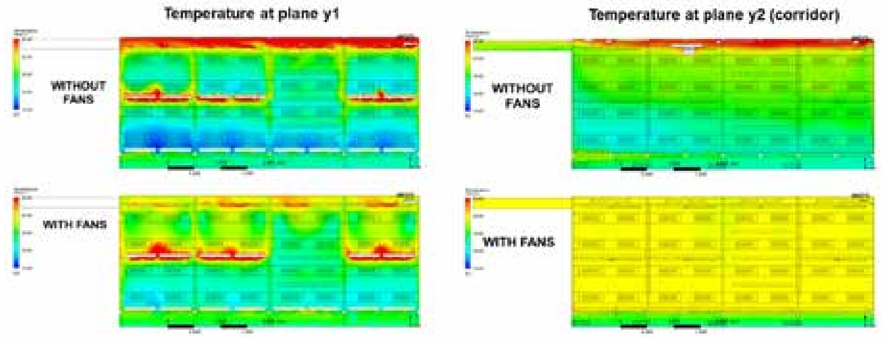

Figure 5 - Contour of temperature in the two simulations: without fan (left), with fans (right)

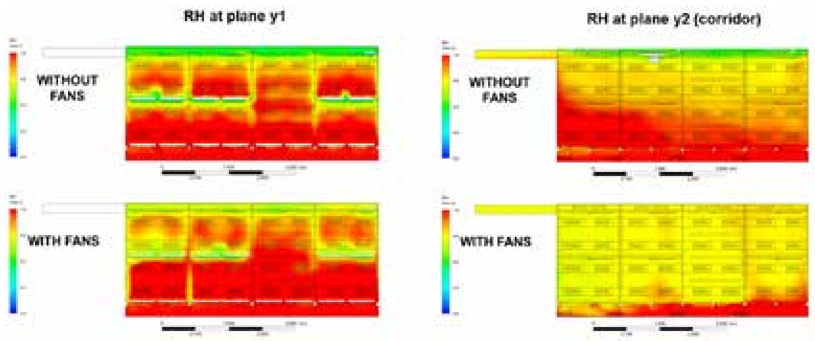

Figure 6 - Contour of RH in the two simulations: without fan (left), with fans (right)

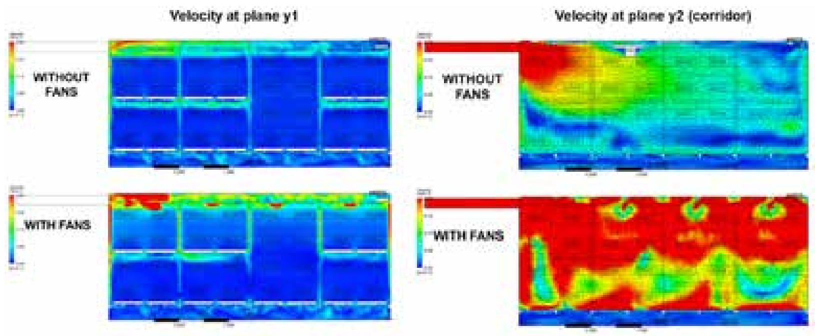

Figure 7 - Contour of velocity in the two simulations: without fan (left), with fans (right)

A comparison between the two simulations is done, to understand the air distribution inside the chamber and taking into account some monitor points at the plants, to check local values and gradients. In the post processing, two planes are inserted: one at the plants (plane y1), to check the distribution across them, and one at the corridor (plane y2), to check the mixing in the central part of the FEG and the behavior of the suction duct.

The effects of natural convection and stratification are dominant in the case without fans, as shown in Figure 5, where the temperature is reported. Adding the fans, the temperature gradient decreases from 5.7°C to 2.2°C and the stratification effects are reduced leading to a better mixing inside the chamber.

The introduction of fans decreases also the RH gradient, from 0.25 to 0.17 (Figure 6). When plants are full grown, RH reaches 100%. In this case, the simulations show that at the inlet, air should enter in the chamber with a humidity less than 70%.

Looking at the velocity profile in Figure 7, in the simulation with fans, air is not forced by the suction effect at outlet section (see cut plane y2) with a general mixing effect. Moreover, the velocity distribution near plants slightly changes, due to the plants' porosity model.

Conclusion

In conclusion, during this project, Computational Fluid Dynamics analyses have been carried out to ensure the proper climate conditions for plant growth. Particular attention was set to obtain a homogeneous temperature, RH and velocity distribution inside the greenhouse.

For this reason, an in-depth study was performed on the Air Management System layout and its relationship with the design of the Future Exploration Greenhouse, taking into account internal thermal loads and external climate conditions: LED lights, evapotranspiration, isolating material, external temperature, and wind.

The Air Management system layout was optimized to balance the mass flow that is provided to the greenhouse and the carbon dioxide supplied to the plants. The Future Exploration Greenhouse has been simulated in a worst case scenario and it has been proven how additional fans improve mixing and reducing temperature and RH gradients.

Simulations played an essential role in the design process of the mobile test facility, starting from scratch, with the conception of the baseline model and continuing in all the development steps, which lead to the final configuration. During the complete workflow, it was possible to test and compare different configurations, putting together the information and expertise of all the partners of the project, to design a facility which will help to investigate plant cultivation technique in space, paving the way for future missions.

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ESTECO sponsors Hyperloop Makers UPV

ESTECO optimization technology will serve the Hyperloop Makers UPV Team in finding the best solution in the second phase of Elon Musk's Space X International Challenge. The contest aims at perfecting the ultra-fast "levitating rail-free" train that will revolutionize land transport

Trieste, 25 November 2016 – ESTECO is proud to sponsor the Hyperloop Makers team from the Universitat Politécnica de Valencia in the next phase of Elon Musk's SpaceX International Challenge.

The team has already won the Top Design Concept and Technical Excellence awards in the first round of the competition, which aims at perfecting the revolutionary land transport system driven by compressed air, capable of arriving from Los Angeles to San Francisco (600km) in just 30 minutes.
For their winning project, the Hyperloop Makers UPV used ESTECO's optimization platform modeFRONTIER to select the best design in terms of travel experience, while maximizing energy efficiency and accelerating the development time. Satisfied with the experience, they will continue using ESTECO technology in the second round of the competition. ESTECO will sponsor the team with a free ESTECO Academy membership, which will enable them to take advantage of state-of-the-art engineering software.

"modeFRONTIER allowed us to obtain a family of optimum solutions for a range of inputs in a mere fraction of the time that would be necessary with a traditional approach" said Germán Torres, the Technical Director of the Hyperloop Makers UPV team. "We are now developing a small levitation demonstrator for the next phase of the SpaceX international challenge and we plan to use modeFRONTIER to optimize our new Hyperloop design proposal", Torres concluded.

"As a company founded in the context of university and research – said Enrico Nobile, ESTECO Scientific Advisor - we are enthusiastic in front of projects like the one of the Hyperloop Makers Team of the Valencia University. It is our honor to be able to offer our software technology for designing a train that could revolutionize the way we conceive land travel. Through our Academy Program, we aim at collaborating with universities from all over the world and to contribute towards the education of the future engineers by providing students with the best of our technology.
Whereas the majority of the competing teams opted for passive magnetic levitation or designing the passenger pod suspended on air bearings, Hyperloop UPV developed a system that enables levitation through the magnetic attraction of the pod to the top of the tube. This rail-free solution saves up to 30% on Hyperloop tube construction costs.

For more information about the Hyperloop bullet-fast train:
hyperloop-one.com

Smart Factory Competitiveness Based on Real Time Monitoring and Quality Predictive Model Applied to Multi-Stages Production Lines

The Industry 4.0 is the industrial revolution based on Cyber-Physical-Systems (CPS) in the context of Factory of Future. The digital innovation is not an exclusivity of new and advanced technology and production processes. The traditional production processes and plants are evolving following this digitalization combining the long experience and the new fast methods to improve the production efficiency, to accelerate the fine-tuning and real-time adjustment of the process parameters oriented to the zero defect quality.
Manufacturing current trends show an improvement in demand for light products considering the material substitution for complex structural parts, the design and technology innovation as well as the evolution in smart production. Due to the high number of process variables involved and to the non-synchronisation of all process parameters in a unique and integrated process control unit, High Pressure Die Casting (HPDC) is one of the most "defect-generating" and "energy-consumption" processes in EU industry showing less flexibility to any changes in products and in process evolution. In both, sustainability issue imposes that machines/systems are able to efficiently and ecologically support the production with higher quality, faster delivery times, and shorter times between successive generations of products.
The FP7- MUSIC project (funded in the frame of the Call FoF-ICT-2011.7.1 Smart Factories: Energy-aware, agile manufacturing and Customization) is giving a new age to the traditional multi-stages production processes such as High Pressure Die Casting (HPDC). The use of sensors, the totally integrated systems, as well as the data mining and cognitive model are the key ingredient of the MUSIC project to be a reference in the Industry 4.0 context.

Introduction
European Aluminium foundries are a group of about 2600 companies, which produced 3 million of tons of castings in 2011. Key players are Germany and Italy, with 60% of total production from Europe (0,931 and 0,844 Mio tons for Germany and Italy corresponding to a turnover of 5.092,00 and 4.051,00 Mio of euro) - source CAEF. The 50-60% of Al alloy castings are produced by HPDC process. High Pressure Die Casting (HPDC) of light alloys is one of the most representative large-scale production-line in manufacturing fields, which are strategic for the EU-industry largely dominated by SMEs.
The development and integration of a completely new ICT platform, based on innovative Smart Prod ACTIVE platform linked to real time monitoring, allows an active control of quality, minimizing the presence of defects or over-cost by directly acting on the process machine variables optimization or equipment boundary conditions. The Intelligent Manufacturing Approach (IMA) works at machine-mould level to optimize the production line starting from the management of manufacturing information. An Intelligent Sensor Network (ISN) or CPS monitors the real-time production acquiring the multi-layers data from different devices and an extended meta-model (the Cognitive model) correlates the input and sensors data with the quality indexes, energy consumption cost function. Data homogenization, centralization and synchronization are the key aspects of control system to collect information in a structured, modular and flexible database. Process simulation, data management and meta-model are key factors to generate an innovative Cognitive system to improve the manufacturing efficiency.

The Intelligent Sensor Network to capture the process data
The Smart Prod ACTIVE platform (Fig. 1) predicts the quality, energy and cost of the injection process in real-time, covering the 100% of products, and suggests the appropriate re-actions to adjust the process set-up and/or mechanism. The client-server connection works in combination with the real time monitoring system (the Intelligent Sensor Network) to elaborate instantaneously the production data set with respect to quality/energy/cost prognosis.
The dynamic Database is collecting all process data, via OPC_UA protocol, coming from all existing devices and active sensors in the production line.
A fundamental innovative characteristic of Smart Prod ACTIVE platform is the predictive Quality model integrating multi-resolution and multi-variate process data.
The real-time visualization of elaborated data, including warning and safety messages and statistic production diagrams, can be

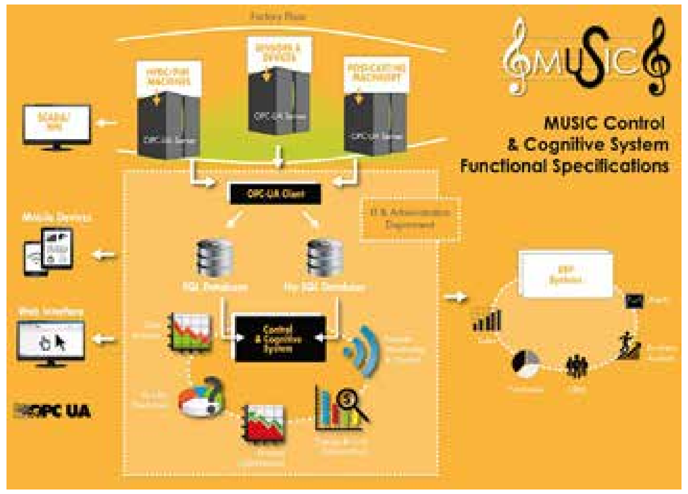

Fig. 1 – Introducing the Smart Prod ACTIVE platform with the client–server structure in the factory floor

customized for multiple users' interfaces as machine operator, production manager and plant director. The standardization Quality classification and investigation methods, as well as the traceability, are fundamental to train the Quality model guiding the minimization of relevant indexes affecting the scrap rate. The final Smart Prod ACTIVE platform has a smart web application to visualize, share and communicate the significant data and to support the decision making with proper reactions in real-time (retrofit) based on the captured signals from the process.

The multi-stages Die Casting production line has been the place to implement the innovative intelligent sensor network (ISN) and the Cognitive system from the design to the validation. As test-product on which evaluate the new technology, a diecasted Gear Box Housing has been individuated, as well as the priority list of defects/imperfections to be minimized/avoided: Lamination, Cold shots, Flash, Blister and Incomplete casting.

The training of the Quality predictive model

A new die has been designed and built (fitting the requirements of the existing Colosio HPDC machine, on which the production was scheduled), introducing various sensors in positions sensitive to process parameters variations. The sensor acquisition system adopted allows connection with conventional HPDC machine, to monitor the injection curve as well as the achievement of data from sensors implemented in the die. The challenge is the positioning of proper and sufficient number of sensors where it's necessary to individuate the risk of defect generation. If the metal contact sensor or different sensor are invasive and complex to be applied, an external I.R. Thermo camera (the dual TTV system from MotulTech-Baraldi) can be applied to monitor the temperature evolution on the die surface before and after the lubrication phase, taking measurements from 10 different Region of Interest (ROI). The ROIs are often defined closed to the area of interest for quality prediction.

All process parameters possibly affecting the quality of Gear Box Housing have been taken into account, and used in the training stage of a meta-model, both virtual and real, correlating input process variables and data from sensors with quality indexes in the areas of interest.

Of course, the virtual design of experiment (DOE) adopted to train the virtual meta-model is at "low cost" in term of time and resources; it typically constitutes the first model to be applied in production.

The correlation matrix, based on 185 evaluated designs (Fig. 2), is one method to visualize the dependency of quality indexes from process parameters and virtual sensor measurements (e.g. temperature, pressure, velocity). As expected, defects such as misruns are strongly affected by the plunger position, when switching from first phase velocity to second fast velocity – the quantitative correlation is now available – but there are small opposite effect due to second phase velocity of the plunger and initial temperature of the alloy. Similar comments are possible for shrinkage porosities depending from overpressure and spray time, or blister correlated with second phase velocity. The model needs to be trained with reference to a specific product and process, because the quantification of correlations are unique and not generalized.

Similar approach has been applied to train a model based on really produced and investigated castings. The same DOE has been performed, to validate the virtual meta-model generated by casting process simulator.

With this new approach, the sampling stages is used to train the model understanding the genesis of all possible defects. The traceability of the castings, during the training or during the production is a mandatory task.

Die Casting Process Optimization

The introduction of the Smart Prod ACTIVE platform in the factory floor needs a simple installation of LAN network connecting all devices of the production line.

The production starts normally, using the best process setup. The stability and repeatability of the best shot is monitored with real time comparison of reference curve previously selected and the instantaneous verification of thresholds satisfactions to quality prediction. The scraps or good castings are visualized in PC, Tablet (Fig. 3) or smart-phone with available web connection to the system. The example shown in Fig. 3 is the results of the optimization procedure applied during the production: the scraps were expected during the warm-up of the die and good quality achieved at thermal steady state; a 30 minutes break generated some scraps at re-start (e.g. casting number 157) and good production after 5 castings (e.g. casting number 162) has been recovered.

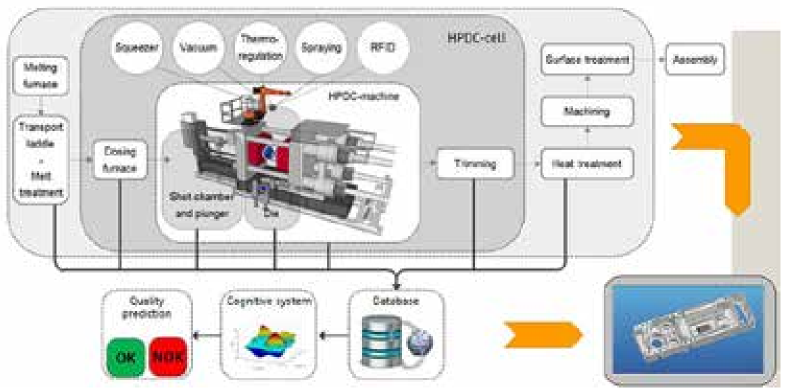

Fig. 2 – Implementation at HPDC production cell in RDS Moulding Technology foundry site

The expected impacts

The Smart Prod ACTIVE platform is a new ICT technology at manufacturing plant introducing significant potential impacts: (i) strengthened global position of EU manufacturing industry; (ii) larger EU market for advanced technologies such as electronic devices, control systems, new assistive automation and robots; (iii) intelligent management of manufacturing information for customization and environmental friendliness.

The expected benefits are:

- Scrap Rate: the involved HPDC foundry is expecting for a 40% reduction in scrap rate
- Production: flexibility, stability and efficiency is generating 10% of no-quality-cost
- Quality Control: in good exploitation scenario the cost of quality control can decrease of 40%
- Energy: energy consumption will be reduced by 5-10%, due to scrap reduction and more production efficiency with reference to the single cast part

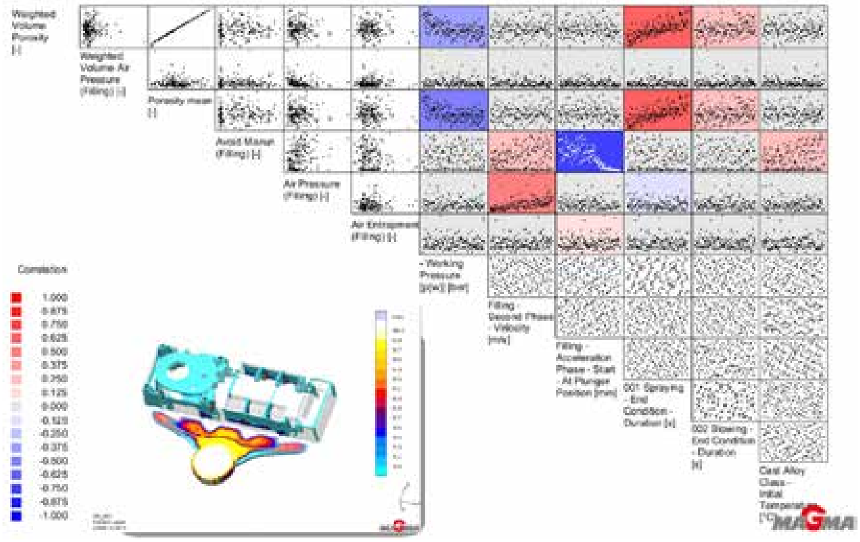

Fig. 1 - Correlation matrix based on 185 designs simulated by MAGMA5

Fig. 2 – LAN network connection and real time prediction of Waste and Good castings

Innovation by Smart Prod ACTIVE platform:

- Full remote control of multi-stages production process
- Deeper knowledge of production process to support the Reactive actions:
- max production efficiency (OEE); no failure, no pause, reduced cycle time...
    - stability of production; max quality reproducibility
    - best die life;
    - intelligent reaction/optimization
- Process data management: Traceability and statistical elaboration of quality and cost
- Flexibility in production: re-use and re-start production; multi plants company
- Real-time quality prediction; Scrap reduction; quality control at 100%
- Reduction of time and cost of Quality control (the quality control is applied only for the predicted products)
- Process optimization and reduction of energy consumption
- Reduction of time to market and minimization of trial&error approach

Conclusions and future developments

The application of Smart Prod ACTIVE platform has been demonstrated and validated at foundry. In the frame of HPDC production process, Operator and Process manager take advantage by adopting a centralized remote control system supporting process monitoring and quality prediction in real time. The decision is supported by cause-effect correlations, and proper reactions suggested by a continuously updated meta-model. Re-usability and flexibility of the Smart Prod ACTIVE platform also allow agile re-start in case of small batches production.

The "zero defect" target is always the first priority of the approach, to minimize the defects with real-time retrofit suggested by the tool. The scrap rate reduction is focused on those defect factors mainly contributing the overall quality requirements of the product. Being the energy consumption connected to the production rate, the cycle time optimization (more pieces per hour) and the improved management of energy-demanding devices (furnace, thermo units, etc) lead to cost reduction.

The extension of application to further multi-stages and multi-disciplinary production lines (e.g. sheet metal forming, forging, rolling, thermoforming, machining, welding, trimming, or the innovative additive manufacturing) is planned to exploit the same methodology in different industrial contexts.

Acknowledgments

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MapleSim application example: PID tuning of a DC motor control system

The purpose of this example is to demonstrate the PID tuning of a DC motor control system

Solution

In order to perform the PID tuning two different strategies have been applied: the parameterizing the PID gains, followed by a parameter sweep; and linearization of the controlled subsystem, followed by the actual PID tuning by means of the dedicated tool available in MapleSim, Figure 1.

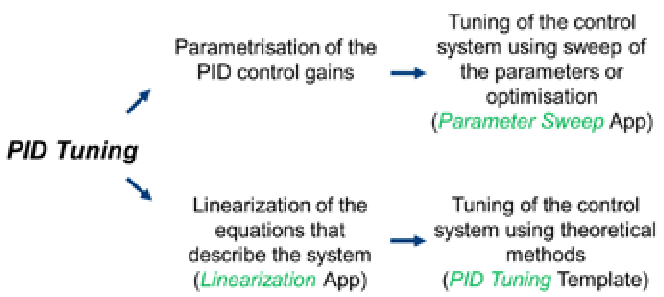

Figure 1 - PID Tuning strategies

Results

With MapleSim it is possible to study how the PID controller's parameters affect the time required to stabilize the system and establish the magnitude of the oscillations around the equilibrium point.

With a parameter sweep analysis it has been possible to determine the most suitable set of values for the three gains of the PID controller, while understanding the effect of each one of them on the behaviour of the system. On the other hand, the dedicated PID tuning tool has made it possible to determine an adequate set of controller gains in a straightforward way.

Application description

The reason why PID control systems are so widely used in almost all branches of industrial automation is that they can be implemented to control electric engines, so a tool that enables engineers to design them in an efficient way is extremely valuable.

In this application the model of a DC motor has been built in MapleSim. The engine, then, has been connected to a rigid beam with a mass on the opposite end, Figure 2.

The DC motor - beam system have been connected in a closed loop involving a PID controller. The PID control was meant to provide the appropriate input signal to the DC motor, in order to maintain the beam in a horizontal inclination. The starting position of the beam was 0.1 radians below the horizontal direction: at the beginning of the simulation, not only had the engine to provide the torque needed to absorb the impulsive force coming from gravity, but also the torque needed to bring the beam in the desired configuration.

Finding the most suitable values for the PID controller gains reduces the amount of time the system needs to stabilize the beam and reduce the magnitude of the oscillations around the desired configuration.

In this example the PID tuning has been performed by using two different strategies. The first option consisted in a parameter sweep of the gains of the control system. By means of this type of analysis the tuning can be done in a very accurate way, as it is possible to isolate the effect of each parameter and then compare the responses coming from many different parameter combinations. The second technique consisted in linearizion of the DC motor - beam subsystem and usage of the dedicated tool provided by the Control Design Toolbox in MapleSim. This second course of action has two advantages: linearizing the DC motor – beam subsystem significantly reduced computation time (if compared to the original model), and the tuning procedure is easier as the dedicated tool of MapleSim implements efficient theoretical methods that can be used to find the most suitable control values.

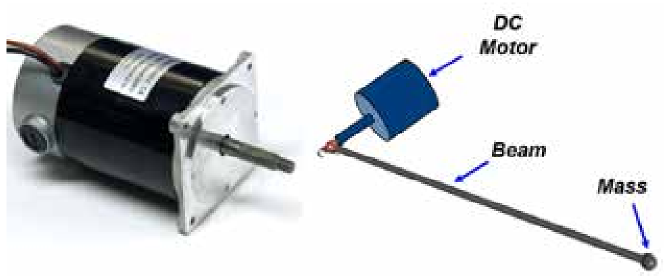

Figure 2 - DC motor and motor-beam system

Model development using MapleSim

The DC motor has been built using components belonging to two different domains (1D mechanical and electrical), leveraging the multiphysics modeling capabilities of MapleSim. The motor model was created using a signal voltage component, a resistor, an inductance, a capacitor, an EMF (a component which transforms electrical energy into rotational mechanical energy), a reference and a mechanical component that represent the output shaft of the DC motor, Figure 3.

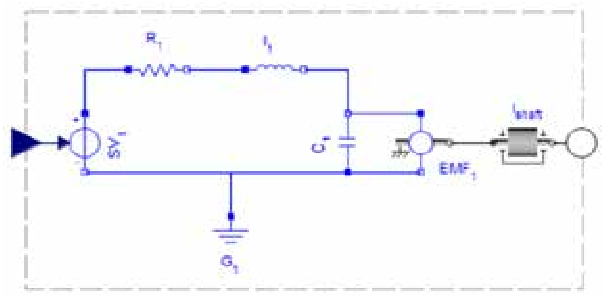

Figure 3 - MapleSim DC motor model

The beam – mass system has been modelled using a revolute joint component, a rigid body frame (the beam), a rigid body (the mass) and an angle sensor by means of which was possible to know the angular position of the beam and calculate the tracking, Figure 4.

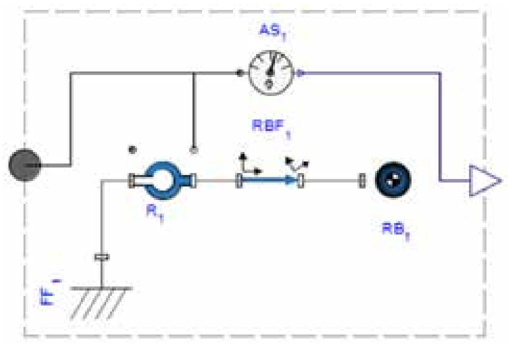

Figure 4 - MapleSim motor-beam system model

The components of the DC motor and the mechanical part of the model, the beam – mass couple, have been grouped into two distinct groups, called subsystems, in order to improve model scheme readability. Another higher-level subsystem, containing the former two subsystems, was created so as to separate the controller and the controlled elements.

A constant component (used to set the target inclination of the beam) and a PID controller were added in order to complete the closed loop reported in Figure 5.

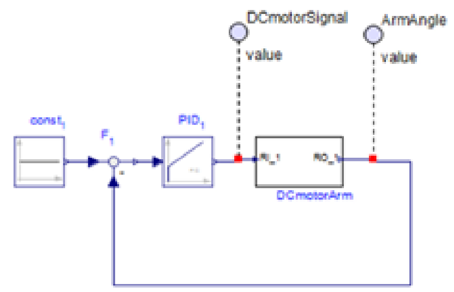

Figure 5 - MapleSim model of the complete system

PID tuning using MapleSim

The first strategy used to tune the gains of the controller was a sweep of the parameters. In MapleSim a parameter sweep can be performed by means of the dedicated app which allows the user to investigate the effect of each parameter on the system response, Figure 6. This analysis highlighted which combination of gains values could cause the system to become unstable, and which of them were more effective in addressing the minimization of stabilization time and the reduction of oscillations magnitude.

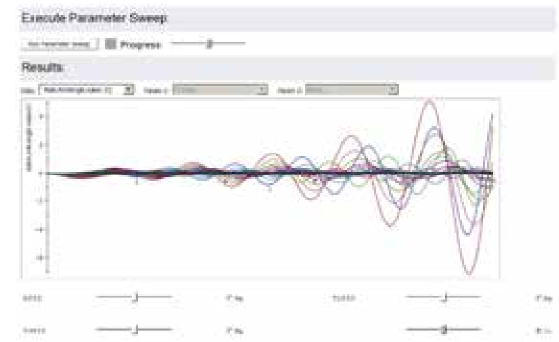

Figure 6 - Parameter sweep output

With the second strategy the tuning was performed using the PID tuning template available in MapleSim. Thanks to this tool it is possible to find an adequate set of gain values chosen from many different theoretical methods: Cohen-Coon, Dominant Pole, Gain & Phase Margin, Ziegler-Nichols Frequency Domain and Ziegler-Nichols Time Domain. In Figure 7 it is possible to see the response of the system with the PID controller tuned through the Ziegler-Nichols Frequency Domain method. The diagram on the left shows that the system reaches the desired configuration very quickly and the entity of the oscillations remains small.

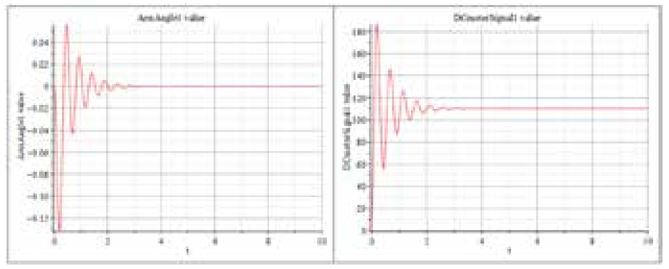

Figure 7 - Ziegler-Nichols Frequency Domain method output

Summary

Two different techniques to perform the PID tuning have been used. The parameter sweep made it possible to understand the effect of the PID control parameters on the response, therefore the behavior of the system, and the ability to find a set of values that minimized the stabilization time and the magnitude of the oscillations around the equilibrium point. By means of the linearizion of the DC motor – beam system, however, the calculation time was reduced, and the dedicated tool in MapleSim for PID tuning made it possible to determine an adequate set of gains leading to quick stabilization of the system and reduced oscillations around the equilibrium point.

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Modelling and Multi-objective Optimization of the VHP Pouch Packaging Sterilization Process

Food packaging sterilization is one of the most critical phases of aseptic processing from a technical and environmental point of view

Introduction

Food packaging sterilization is one of the most critical phases of aseptic processing from a technical and environmental point of view. During the last 10 years, many experiments and studies have been conducted to identify the most suitable sterilizing agent for each product packaging combination. In particular, polymeric- based packaging has acquired a key role in aseptic packaging because of its low cost and ease of storage and transportation. For these kinds of packaging materials, both chemical (wet peracetic acid, wet and vaporised hydrogen peroxide, etc.) and physical methods (pulsed light, β- and γ-radiation) have been adopted for sterilization. The two techniques primarily adopting vaporized hydrogen peroxide are the "vaporised hydrogen peroxide" (VHP) and "condensed hydrogen peroxide" (CHP) methods: VHP is the main method adopted in the food sector, as gaseous hydrogen peroxide is easier to remove from inside the packaging.

Based on these premises, this article shows how the pouch packaging sterilization process used in aseptic technology has been optimized within a real project. Starting from an initial position of the nozzle inside the pouch the process is simulated, firstly varying the flow rate and the position of the nozzle (in order to ensure the contact between VHP and all areas of the packaging wall) and then varying the process time and hydrogen peroxide concentration in order to reach the sterilization target of 5-log microbial reduction with minimal processing costs.

Fig. 1 - Different views of pouch packaging and sterilization

Computational Fluid Dynamics (CFD) analysis was used to understand the velocity and the concentration of the chemical solution during the sterilization process. ANSYS CFX version 14.5 was used as fluid dynamic simulation software and modeFRONTIER version 4.5.4 was used as multi-objective optimization tool in order to select the optimal solution among the configurations which tend to achieve a defined sterilization effect (5-log reduction).

A multicomponent CFD model was designed and used to simulate the VHP sterilization process on spouted pouches. The CFD simulations were performed using a transient state approach, as it was necessary to show flow behaviour during the initial phase of the process and determine the correct sterilization time. Figure 1 shows the shape of the simulated pouch packaging.

CFD modelling

CFD simulations were performed using the ANSYS CFX v.14.5, which allows the simulation of multicomponent fluids. In a mixture, each component has its own equation for the mass conservation. After Reynolds averaging, it can be expressed in tensor notation as shown in Figure 2 where $\tilde{\rho}_i$ is the mass-average density of fluid component *i* in the mixture, $\tilde{U}_j = \Sigma(\tilde{\rho}_i \tilde{U}_{ij})/\tilde{\rho}$ is the mass-average velocity field, $\tilde{U}_{ij}$ is the mass-average velocity of fluid component *i*, $\rho_i(\tilde{U}_{ij} - \tilde{U}_j)$is the relative mass flux, Si is the source term for component *i* which includes the effects of chemical reactions.

$$\frac{\delta\tilde{\rho}_i}{\delta t} + \frac{\delta(\tilde{\rho}_i\tilde{U}_j)}{\delta x_j} = -\frac{\delta}{\delta x_j}\left[\rho_i(\tilde{U}_{ij} - \tilde{U}_j) - \overline{\rho_i'' U_j''}\right] + S_i$$

Figure 2 - Reynolds-averaged Navier–Stokes equations in tensor notation

Furthermore, for a multicomponent mixture, additional equations must be solved to determine how one component interacts with the other fluids. In a multicomponent flow, one of the components is usually set as the "constraint component", meaning that its mass fraction is calculated to ensure that all the components' mass fractions sum to unity at any given moment. This means that the mass fraction of the "constraint component" is set equal to the total mass fraction of the other components in the mixture subtracted from unity. In our case, the "constraint component" was hot air. The physical properties of general multicomponent mixtures are, instead, treated using the assumption that the components form an ideal mixture, i. e. a mixture of components such that the thermodynamic properties of the mixture can be calculated directly by means of a mass averaging of the component material properties. Thus, the mixture density ρ can be calculated from the mass fractions Y_i and the thermodynamic density of each component ρ_i, which may require the knowledge of the mixture temperature and pressure, as well as an appropriate equation of state for each component (see Figure 3).

$$\frac{1}{\rho} = \sum_{i=A,B...}^{N_c} \frac{Y_i}{\rho_i}$$

Figure 3 - mass average of the component material properties

Extending the use of the Reynolds-averaged conservation equation to be an energy equation of a single-component fluid but for a multicomponent mixture involves adding an additional diffusion term. In the special case that the diffusivities of all the species are the same and equal to the thermal conductivity divided by the specific heat capacity, the energy equation becomes

$$\frac{\delta}{\delta t}(\rho H) - \frac{\delta P}{\delta t} + \frac{\delta}{\delta x_j}(\rho U_j H) = \frac{\delta}{\delta x_j}\left[\left(\frac{\lambda}{C_p} + \frac{\mu}{Pr_t}\right)\frac{\delta h}{\delta x_j}\right] + S_E$$

Figure 4 - energy equation

The advantage of this equation is that only a single diffusion term has to be assembled, instead of one for each component plus one for heat conduction. In this way, the numerical cost is lower, and it is particularly important when the fluid consists of more than one components. The shear stress transport (SST) turbulence model was adopted. This model, proposed by Menter, is an eddy-viscosity model, which is a combination of k–ω and k–ε models. The first is used in the inner boundary, while the second in the outer region and outside the boundary layer. The SST model was used to overcome the problems of both these models. These features

Figure 5 - surface and volume pouch mesh

make the SST model more accurate and reliable for a wider class of flows than the standard k–ω and k–ε models.

The fluid domain of the pouch was obtained using ICEM CFD, the modeller associated with ANSYS CFX. The volume of the pouch is divided into a finite number of volumes, on which the analysis is made. Figure 5 shows the generated mesh used for the calculation: an unstructured tetrahedral meshing scheme was used. The number of cells used in the simulations was determined beginning with a coarse mesh, which has been subsequently gradually refined evaluating the changes in the results. The mesh was initially set by creating a uniform subdivision and then thickened in the critical areas of the fluid volume. In particular, a finer mesh was used near the outlet section of the nozzle, where it is foreseeable that the shear rates would be higher and close to the pouch walls, in order to accurately simulate the flow boundary layer. The final mesh was determined at the point when increasing the quality of the mesh made no significant improvements in the results. The overall number of cells created was about 4,100,000.

Three-dimensional, multicomponent and two-fluid simulations were developed to investigate the VHP pouch packaging sterilization process. The aim of the first series of simulations is to determine the most suitable position of the nozzle inside the packaging during the sterilization phase. The fluids involved in the simulation were hot air, which is initially inside the pouch and also used as a carrier gas for the sterilizing agent and VHP. Time-dependent simulations were carried out to obtain the best fluid dynamic configuration. In particular, the speed profile of the sterilizing mixture inside the pouch was evaluated in order to select the configuration with the most homogenous flow. A total simulation time of 18.5 s with time steps of 0.05 s, and a constant flow rate of 1,800 N L/h (0.5 L/s) was adopted for the first series of simulations. Four nozzle positions were set, namely at 15, 45, 75 and 105mm from the bottom of the pouch. The initial concentration of hydrogen peroxide was set at 5,000 ppm. The results of each simulation are reported in terms of mixture velocity (air and hydrogen peroxide) and hydrogen peroxide concentration (ppm). The average value of hydrogen peroxide concentration (ppm) inside the pouch was then determined exporting the results from ANSYS CFX to Microsoft Excel. For each simulation, the hydrogen peroxide concentration values calculated in all the mesh nodes were exported. These values were plotted into an Excel table, and the average hydrogen peroxide concentration was calculated. The speed profiles were

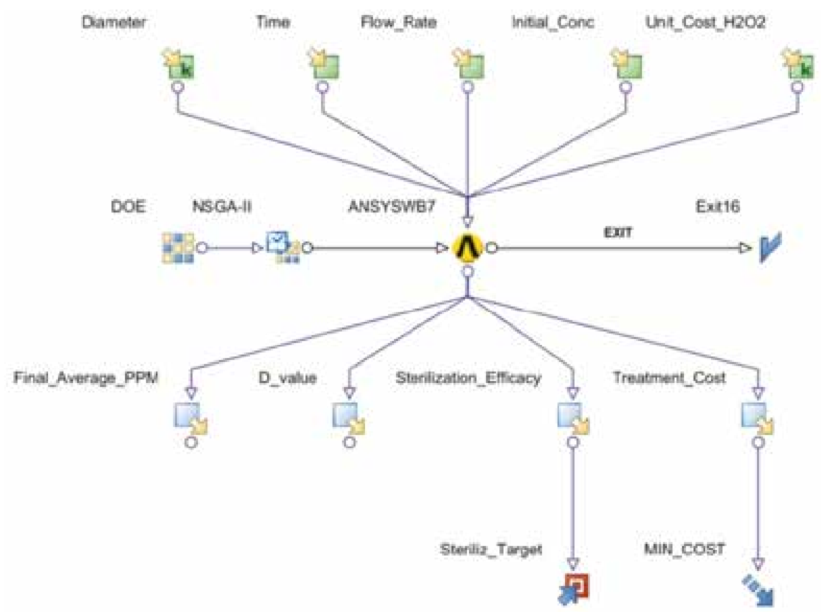

Figure 6 - modeFRONTIER workflow

also evaluated by setting a reference value and evaluating the percentage of volume where the speed of the sterilizing mixture is lower or higher than the fixed value.

Optimization modelling

The setting of the optimization model is one of the most important phases of the process, given that it is necessary to define the optimization strategy. modeFRONTIER is a multi-objective optimization software package, which combines a comprehensive process integration platform with sophisticated optimization algorithms and statistical post-processing capabilities. This software is able to connect with and act on existing models in order to optimize one or more objectives using specific optimization algorithms. After the first series of simulations, the modeFRONTIER software analyses the results and, on the basis of chosen criteria, automatically generates new simulation trials. The setting of the optimization model starts by creating the workflow (Figure 6). The workflow is composed of a process flow and a data flow. The process flow describes the sequences of actions, and the data flow decides which data should be moved from one step to another. First of all, the input variables of the system have to be defined. In this case study, five inputs were identified: two of them were kept constant: the nozzle diameter (5mm) and the cost of the hydrogen peroxide (0.57€/kg), while the other three were considered variables. In this study, the inputs (i) mass flow rate, (ii) the initial concentration of hydrogen peroxide and (iii) the time of the sterilization process were considered as variables in order to assess the optimal configurations. All the input parameters are defined by dedicated nodes, where it is possible to specify their range of variation or keep them constant. Figure 7 shows the input variables and their relative range of values. All the input nodes are linked to an application node. In this study, the ANSYS Workbench node was implemented as the application node and the following outputs were selected in order to optimize some of them. We inserted (i) the final average hydrogen peroxide concentration, which was the average value of the hydrogen peroxide concentration in the whole pouch volume at the end of the treatment, (ii) the decimal reduction value (D_{value}), which was calculated using some experimental data and considerations made in related literature as explained above, (iii) the sterilization efficacy, which was calculated as the time divided by the D_{value} and finally (iv) the treatment cost for each bottle, which was obtained as the product of the unit cost of hydrogen peroxide, the mass flow rate, the initial hydrogen peroxide ppm concentration and the time (Figure 8).

Input variables	Type	Range of values
Diameter nozzle	Constant	5 [mm]
Unit cost H_2O_2	Constant	0.57 [€/kg]
Mass flow rate	Variable	[1E−04 kg/s; 5E−04 kg/s]
Initial H_2O_2 conc	Variable	[0.0050; 0.0090]
Time	Variable	[15 s; 21 s]

Figure 7 - input variables

Output variables	
Final average conc. in PPM	Ave(H_2O_2.Mass fraction)1,000,000
Decimal reduction value (*D*-value) [s]	6,187.90•(Average PPM) − 1.312
Sterilization efficacy	Time/*D*-value
Treatment cost	Unit cost Mass flow rate Initial H_2O_2 conc. Time

Figure 8 - output variables

The objectives of the simulations were then connected in the modeFRONTIER workflow to the output variables. The two main objectives of the study to be achieved were as follows:

1. to reach the efficacy target (5-log reductions) of the sterilization treatment;
2. to minimize the cost of hydrogen peroxide consumption.

The efficacy of the sterilization treatment has been expressed considering the square difference between the logarithmic reductions obtained by each simulation and the target value of 5 log of microbial reduction. With regard to the second objective, the total cost of hydrogen peroxide consumption is obtained by multiplying the unit cost of hydrogen peroxide, the mass flow rate of the sterilizing mixture, the initial hydrogen peroxide concentration and the time of the sterilization process. To connect the input and output variables (with their objectives), the Workbench application node was inserted. This latter node was connected to the package composed of the "DOE node" and the "Scheduler node" and to a logic end node (Figure 6), in order to perform the simulations. The DOE node provides the initial population for the optimization phase. The Sobol-DOE design was chosen, as it is able to create sequences of "n-tuples" that fill the "n-space" more uniformly than random sequences. Starting from the initial population, the scheduler node, by means of a defined scheduling agent, determines which designs need to be evaluated. modeFRONTIER offers many types of modern optimization algorithms, which can be useful for different optimization strategies. The NSGA-II scheduler was selected for the current application: it is a fast and selective multi-objective optimization algorithm. The solution adopted performs a clever sorting strategy; furthermore, NSGA-II implements elitism for multi-objective searches using an elitism-preserving approach. Selectiveness is introduced storing all non-dominated solutions so far discovered, beginning with the initial population. Selectiveness enhances the convergence properties, thus moving them towards the true Pareto-optimal set. Finally, a suitable number of initial design and generations for the scheduler were defined according to the number of input and output variables and the number of the objectives (Figure 9).

DOE method		Optimization algorithm	
Sobol	9 designs	NSGA-II	16 generations

Figure 9 - setting for DOE and Scheduler nodes

144 process configurations were simulated using the modeFRONTIER software. 19 results of these simulations make up the Pareto frontier, which is defined as the sum of non-dominated solutions. Scatter charts provide a useful visual representation of the data and help the discussion phase showing the relationships between the variables. The first scatter chart (Figure 10) correlates the two objectives: the ability to reach the sterilization target [x] against the minimization of the cost of hydrogen peroxide consumption [y]. Since the two objectives conflict with one other, in the upper left area, there are the configurations showing the minimum difference between the targeted microbial reduction value and that achieved by the simulation, despite a high treatment cost. However, in the area located in the lower right part of the graph, there are the configurations with the minimum cost but with high differences between the targeted microbial reduction value and that obtained (positive or negative). In any case, since there is more than one optimal solution, a multiple criteria decision making (MCDM) method should be applied in order to select the most suitable one.

The MCDM module is a post-processing tool, which helps the user to select the best design from a family of Pareto solutions; it is extremely useful when there are several conflicting objectives. The Pareto's designs are the optimal designs because for each of them, it is not possible to reduce the treatment cost and simultaneously reduce the difference from the sterilization target. The MCDM tool is able to select the most suitable solution from among a set of reasonable alternatives thanks to particular relationships between the results' attributes. In the current study, three attributes were selected: Treatment time and treatment cost (both of which have to be minimized) and sterilization target (which also has to be minimized since it is calculated as the square difference between the microbial reduction achieved with a particular configuration and the desired microbial reduction of 5 log). The linear MCDM algorithm was chosen to perform the MCDM analysis. Once the relationship is set, the MCDM module provides the most suitable configuration specifying its treatment time, treatment cost and

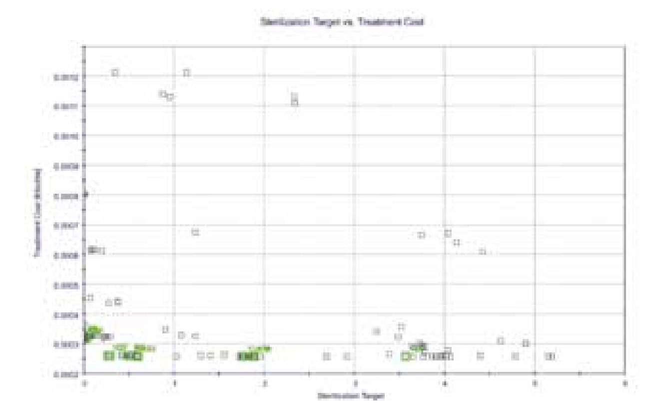

Figure 10 - scatter chart of minimum cost vs sterilisation target

sterilization target. A value between 0 and 1 is assigned to each design, 1 being the most suitable solution and 0 the least. The ID designs are then ranked starting from the highest value. Within the Pareto set, design 127 has been identified as the preferred configuration able to achieve good treatment efficacy and a limited cost. It has a cost of 2.61×10^{-04} €/bottle, a treatment time of 15.2 s and a square difference of 2.96×10^{-01} between the sterilization achieved and the target.

Conclusions

The aim of this study was to optimize the sterilization process for a specific type of pouch packaging used in aseptic technology. The aim of the optimization is to maximize the performance of the sterilization treatment and minimize its relative cost, considering five decimal reductions as the optimal level of microbial decontamination. The two conflicting objectives determined a Pareto frontier composed of 19 non-dominated solutions. Finally, a MCDM software tool ranked all the optimal designs and identified design 127 as the optimal configuration. The chosen configuration shows a microbial reduction of about 4.456 log and can consequently be considered suitable for the purposes outlined above. This configuration is part of the Pareto frontier obtained with the multi-objective optimization process and was selected through an MCDM analysis where a great importance was assigned to the reaching the sterilization target. This was done in order to create a safety margin against possible container recontamination in the later stages of the packaging process and to avoid problems relating to initial packaging contamination higher than the average values. During the optimization procedure, however, the sterilization target was set at 5-log reduction. This was primarily done because the ability to reach the sterilization target was evaluated considering the square difference between the log reduction achieved by a particular configuration and the target. In fact, with this method, if the target had been set at 4-log reduction, the multi-objective optimization software would have selected too many configurations, showing a decimal reduction of less than 4 and consequently the Pareto frontier would have been composed of too many designs unable to meet the objectives of the project.

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State of the art **cloud-based manufacturing**

Simulation software is well established within the manufacturing industry and is considered a strategic tool for decision making and the optimization of business objectives, both in off-line and online processes (Figure 1). The growing interest in simulation is demonstrated by a 40 % growth in articles dedicated to this topic during the periods 2005-2009 to 2010-2014 ("Simulation in Manufacturing: Review and Challenges", M. Jahangirian & others, 2014).

In a typical manufacturing company, simulation can be used to support:

- Processes related to the product life cycle (Value Proposition)
- Processes related to the production system life cycle (Business Model)

In order to reap the benefits of simulation for the widest range of companies and professionals accessibility is key. Therefore, for SME's, whose frequency of use may not justify the purchase of licenses and hardware, can now access this software using cloud based services.

Despite the adoption of this technology it is still relatively new to digital manufacturing, but the market for Cloud-based Manufacturing services is growing fast: estimations predict a global growing trend of 23% per annum up to a total value of 130 billion USD in 2022 (Infoholic Data Research) .

The cloud doesn't act directly on the manufacturing processes but provides the necessary support to access the powerful resources in a convenient, ubiquitous and elastic way, as well as taking advantage of the computational capacity and strategic software directly, to transformation processes, without the cost constraints typically experienced by SMEs.

Xun Xu, who published the first paper on the subject ("from cloud computing to cloud manufacturing", 2011), highlights how cloud enables ''a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.''

Xu, a lecturer at the University of Auckland, has recently highlighted that the hurdles in achieving an effective cloud service, such as the safety perception on sensitive data management and the latency time, [i.e. the time frame between the request and the related provision of requested service] have now been overcome. This is because safer and more efficient services are now possible, even though computers or telephones connected to the network are vulnerable to attacks.

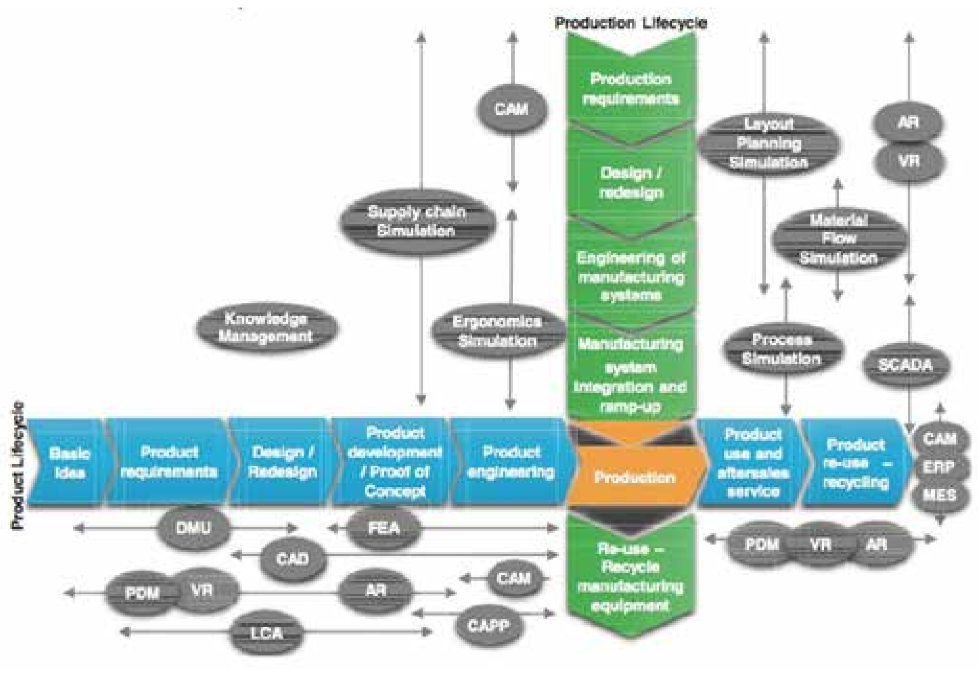
The Cloud enables a very attractive service provision model for SMEs: in the 'pay-per-use' form, making it possible to perform powerful yet expensive simulation for a limited duration, thus accessing the same advantages that larger companies enjoy. The first clear advantage is the financial one, since the 'service' mode allows the immobilization cost of productive assets to be spread into the operating account, transforming CapEx into OpEx, in accordance with the typical mode of utility delivery in the services form.

The first software used with this mode are those related to 'off-line' in processes, such as those for a new product development: in this category we have the CaX, FEA, CFD, etc. The advantages lie mainly in the 'on demand' form, allowing SMES to access the necessary resources to reduce the product development time, anticipating any errors and inconsistencies in the specification implementation and avoiding redesign loops.

In order to verify the applicability of the simulation, as far as operating flows and new product development are concerned, it must be considered that the current manufacturing processes overlap great material flows to its impressive data streams: both are integrated and managed as a function of the combination of times and volumes of the corresponding production processes.

A wide range of software is currently in use in industrial companies to manage processes at different levels of reactivity, in agreement with the model ISA 95 (Figure 2). At every level we have different aggregations of times and volumes, starting from the milliseconds for cycle times of a PLC (levels 1, 2, 3, for direct controls on machine through sensors, actuators, NC, etc.) up to a month for the management of orders (for the highest levels of operations and business management such as MES, ERP, PLM,CRM, SCM).

Therefore, the simulation applied to 'on-line' operational processes will involve physical and temporal events consistent with the importance of the decision-making: from the fast elaboration of a part program or a machining cycle, to the of the big data analysis for predictive maintenance.



Fig, 1 - Product and Process Lifecycle
(From "Simulation in Manufacturing: Review and Challenges", Mourtzis, D.; Doukas, M.; Bernidaki, D., 2014)

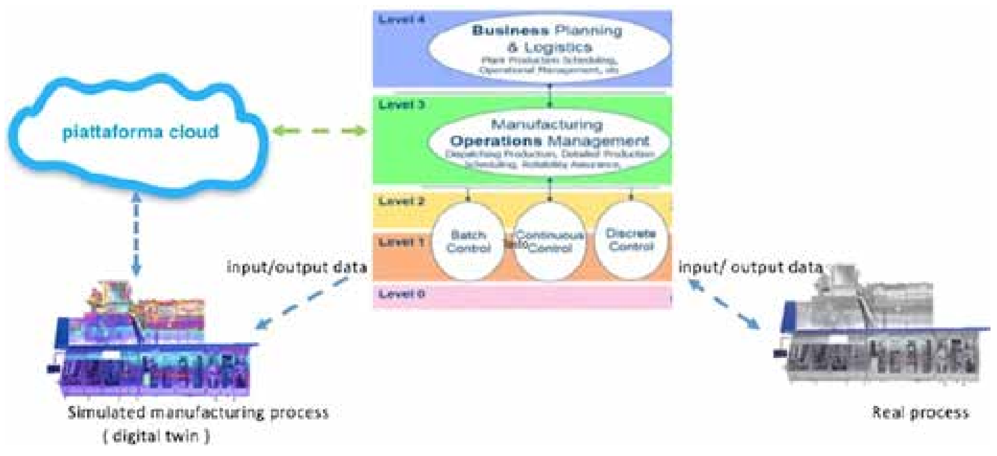


Fig. 2 – - ISA levels 95 and Digital Twin Project

A recent and extensive analysis conducted by Erik Brynjolfsson at MIT, author of the essay "The race against the machine', and Kristine McElheran, University of Toronto, carried out among 18,000 American manufacturers about the benefits of the use of data-driven decision (DDD) has demonstrated that:

- The adoption of DDD occurs initially in larger firms with a long operation history
- The average increase of added value for companies that adopt DDD systems is greater than 3% with respect to those businesses that do not adopt it
- DDD and high investments in the IT area generate mutually benefits, in terms of DDD and workers training level
- ("date in Action: Data-Driven Decision Making in U.S. Manufacturing" E. Brynjolfsson, , K. McElheran, 01/2016).

The study clearly shows the importance of accelerating the adoption of DDD, where simulations are a fundamental part, by manufacturing companies and in particular by SMES, with the aim of increasing the production added value.

Saponelli - SACMI IMOLA

Valves: Best Practice for Gasket Sealing Simulations

During the design phase, gasket performance is a major consideration when ensuring the functionality of valves. Component failures or unreliability can dramatically affect the valve's operating performance, impact product delivery time, increase component replacements or in the worst case require a valve redesign. However, the performance of gasket sealing systems can be predicted by numerical simulation. Different geometries and severe operating scenarios can easily be assessed by means of FE analysis. Therefore best practices to ensure robust and reliable simulation will be described in this article.

Figure 1

FE simulations: challenges and application examples

Due to a general lack of knowledge on the mechanical behaviour of the gasket, numerical analysis is more complex and the reliability of the results is dependent on the accuracy of the available input data. There is a wide range of elastomeric materials available on the market and their properties are subject to significant variability depending on their chemical composition, fabrication process, ageing, etc. Furthermore, the choice of numerical model is a main contributor to the accuracy of the results. From simple linear elastic to complex viscoelastic and viscoplastic models, the gasket behaviour can be described by using several material definitions. Hyperelastic material models are generally the best choice to take into account extremely large elastic deformation that typically are associated to gasket installation and behaviour under operating conditions. Hyperelasticity allow to easily take into account for:

- Nonlinear stress-strain curve with different traction/compression behaviours
- Volumetric incompressibility
- Energy absorption (damping)
- Temperature, time and frequency depending behaviour

The most famous constitutive models (mainly based on Strain Energy Density functions and Strain Invariants or Stretch Ratios) are:

- Neo-Hookean : simple model – only two parameters - based on 1st invariant;
- Mooney-Rivlin: widely used model based on 1st and 2nd invariants;
- Yeoh: based on first invariant, reduced computational cost;
- Ogden: based on Stretch Ratios, computationally onerous;

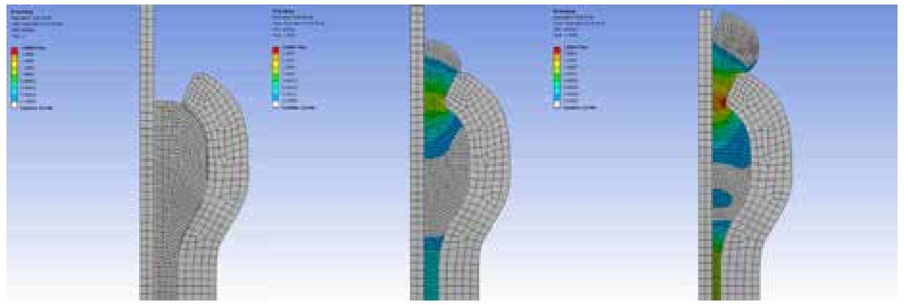


Figure 2

- Arruda-Boyce e Gent: model based on Statistical Mechanical properties;
- Blatz-Ko and Ogden Foam: best fitted for high compressible foams;

To properly select the best material model for the specific problem under investigation, experimental material characterization under operating conditions is mandatory. Uniaxial tensile, Equi-biaxial tensile and Shear tests are required by international standards for incompressible or nearly-incompressible elastomers characterization.

Volumetric compression must be added for compressible ones. Supplementary experimental investigations can be considered for friction coefficient determination and hysteresis assessment. Material model coefficients are calculated to fit the experimental tests data. The curve fitting procedure is the best approach to smooth the raw data from experimental tests, allow the definition of a robust material behaviour and avoid numerical singularities which can be introduced with the direct use of experimental curves.

Examples of experimental device for elastomer characterizations are shown in Fig.1 as well as the resulting curve fitting on experimental curves. Although a reduced set of experimental data is usually available, e.g. uniaxial tensile test only, numerical models for hyperelastic materials, provided by FE codes, allow to estimate the complete material characteristic extrapolating the available data. The compressive behaviour for instance is assumed from the initial part of tensile curve.

Nonlinear large strain analyses are usually necessary for gasket simulation, care must be taken in the developing of numerical model: avoiding non-convergence of the solution, correct definition of nonlinear contacts, proper selection of element technology and application of loads. In order to limit the computational effort and simplify the analysis, 2D linear elements with mixed u-P formulation (axysimmetric, plain strain or plane stress) are usually employed. Fine and regular elements are mandatory to avoid elements distortion.

Thanks to recent improvements of FE solvers, the use of automatic remeshing technique has become increasingly more efficient and can be applied to solve problems where extremely large deformations with considerable geometry modification occurred. An example of high distortion of the gasket section with remeshing is shown in Fig.2.

Gaskets sealing systems are always installed with interference with their grooves. The interference solution step is very challenging for FE analysis. Proper contact formulations must be selected and calibrate.

In ANSYS for example, Augmented Lagrange or Normal Lagrange formulation are suggested. Solving the initial interference with ramped approach to avoid distortions of the elements at contact surface is another best practice.

The pressure load application, is one of the main issues that must be considered for the gasket simulation. The wet surface in fact cannot be defined a priori: in ANSYS an iterative procedure allows to apply the fluid pressure depending on the contact status: this technique is very robust in order to predict an incorrect design of the gasket.

A typical example of gasket analysis is shown in Fig.3 where elastomeric lip-seal has been simulated. Elastic metal ring for the gasket initial energizing has been considered in the calculation as well as initial gasket compression and sealing effect due to deformation induced by pressure application. The aim of the analysis is the calculation of contact pressure to check that sealing effect is guaranteed at operating conditions at ambient and high temperature (140 °C).

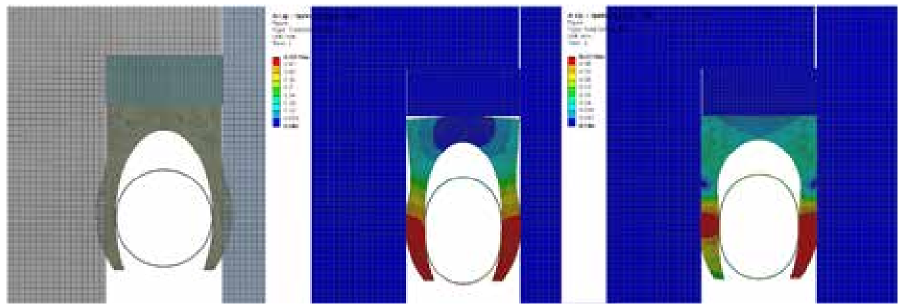


Figure 3

Stress-strain status at lip-seal ring section has also been extract to assess its resistance and identify critical areas of possible local failures.

The application of numerical simulation has been shown to be a powerful tool in improving the knowledge of the gasket sealing system for valve applications. Redesign of the geometry to improve the gasket's performance and durability can be easily implemented as well as checking the resistance and functionality at several operating scenarios, e.g. high temperature, high pressure. A sensitivity analysis and the optimization process can be used to explore which parameters affect the gasket performance. In addition, the effect of geometrical and dimensional tolerances as well as the degradation of material properties can be studied to define the operating limits or identify where effort must be focused in order to improve product performances.

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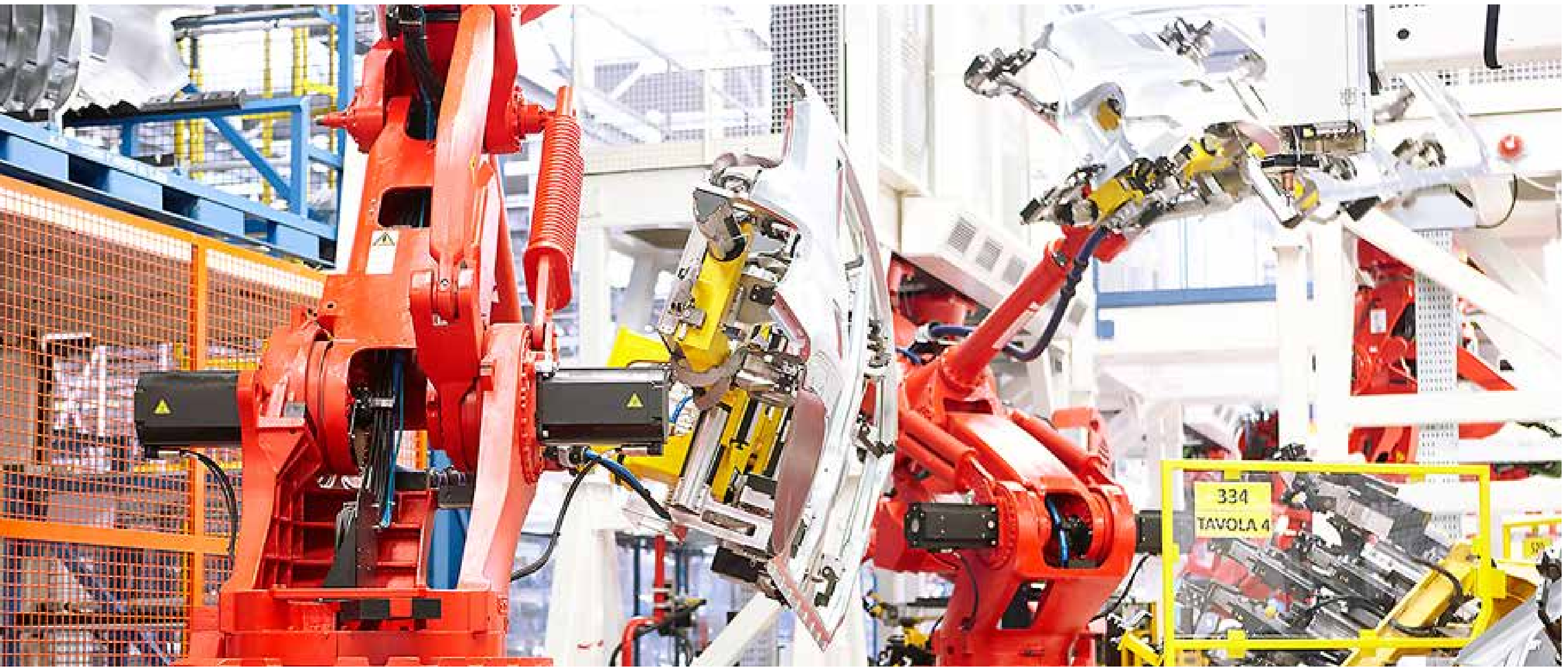
Optimization of an automotive manufacturing system design taking into account regional requirements



A new solution for Proposal Engineering design in COMAU

COMAU Spa, a subsidiary of Fiat Chrysler Automobiles, is a leading provider of advanced manufacturing systems: the company operates in 33 locations spread over 17 countries. The design of automotive manufacturing systems is a core competence of COMAU: who are the largest supplier of automotive assembly line systems in the world and its customers are all the major automotive OEMs. COMAU's challenges are those of every automaker: increased production volumes and line capacity demand, increased line efficiency, car mass reduction and usage of multiple materials and joining technologies in a single line, just to mention a few.

Designing a new automotive manufacturing system represents a complex task that relies heavily on knowledge and experience. COMAU is continuously improving its manufacturing systems design processes in order to reduce the system design lead times, shorten the time to market and increase the "first time right" designs.

The work presented in this article is grounded on a novel approach to the preliminary design of production systems (Proposal Engineering, see fig. 1). This is the crucial manufacturing system design phase in which timing and evaluation of alternatives are very important. In fact, most of design costs committed during this initial phase will affect the whole project. Moreover this phase is crucial for COMAU projects acquisition and business success.

Fig. 1 - Proposal Engineering is the first step of the manufacturing system design process (courtesy of COMAU)

The traditional approach to Proposal Engineering starts from a Customer Request For Quotation (RFQ), that initiates a bidding phase. Different manufacturing system providers (COMAU and its competitors) will participate in the bid. A manual design approach for systems is traditionally adopted, based on specific competences and past experiences from one side, and customer requirements from the other. In response to the RFQ, COMAU provides the customer with a technical solution, complete with production line description, the envisioned 2D line layout and a cost estimation.

In recent years problems emerged with the traditional approach, such as the need for COMAU to manage global operations with a growing manufacturing systems demand from emerging markets. This has pushed COMAU to identify more integrated approaches capable of taking into account; engineering and throughput constraints, equipment and lifecycle costs, and including region-dependent requirements.

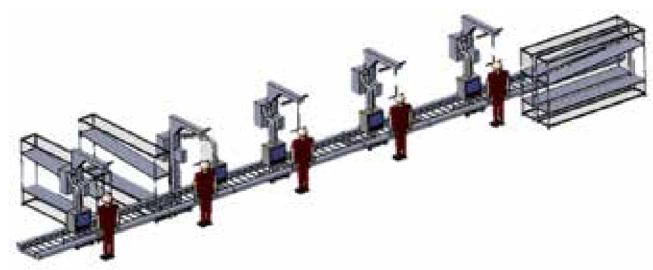


Fig. 2a - Exemplary models of a series of manual assembly workstations

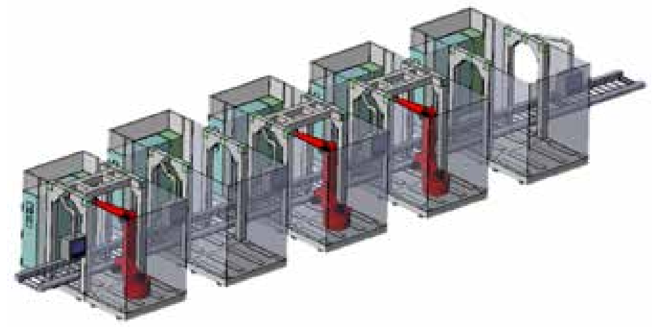


Fig. 2b - Exemplary models of a series of automatic assembly workstations

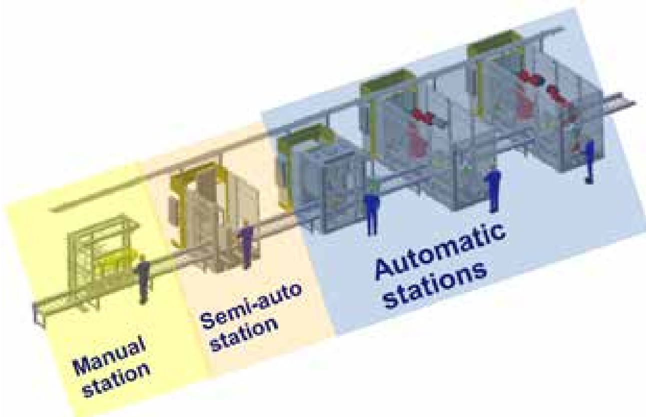


Fig. 2c - COMAU standard modules offer different levels of automation


Fig.3 - Cylinder head assembly line (courtesy of COMAU)

Among the objectives of the new Proposal Engineering solution is the ability to re-use existing technical knowledge that has been previously captured and stored (via KBE – Knowledge Based Engineering techniques). Additionally, design input and requirements are considered, such as product information, manufacturing system design constraints, and the target KPIs (such as OEE, cycle time, etc.). Finally, region dependent parameters are considered, such as the desired automation level, local norms and regulations, and the local cost of energy and personnel of the country where the line will be put in operation.

A specific objective of the new solution is the ability to utilize standard COMAU manufacturing modules; in fact, this modular approach provides a direct answer to the growing manufacturing systems demand, and to the related higher volumes and production flexibility requirements. To enable this approach a manufacturing component and corresponding reliability database is connected to the new solution as the source of necessary data.

The Case Study: a car engine assembly production line

In order to develop, verify and validate the new Proposal Engineering design solution COMAU provided access to the expertise and data related to a traditional car engine assembly production system (e.g. cylinder head and cylinder head). This represents a relatively well-known product and process that can support different levels of automation: COMAU modular system architecture actually provides several automation level options for each assembly operation, going from manual stations, to semi-automated stations, to fully

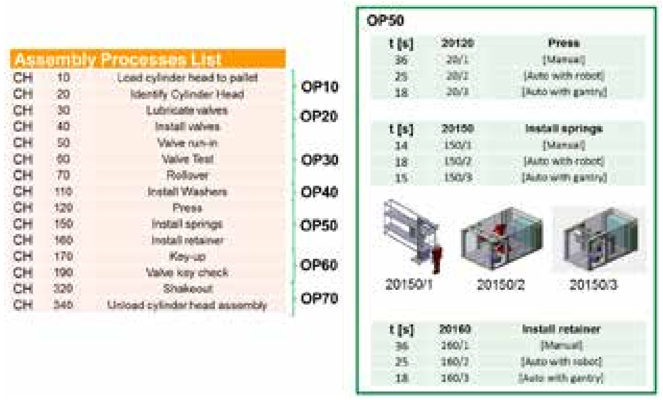


Fig. 4 - Manufacturing process / stations technological alternatives

automated stations with different automation technologies (see fig 2a, 2b, 2c).
A Cylinder Head Assembly case study has been developed: this manufacturing process includes the valve train assembly (fig. 3). This process was selected because it is very well defined and detailed information is available, and therefore it is ideal to be compared to existing design solutions and processes in order to derive further development ideas and suggestions.
The manufacturing process is composed of 16 operations, starting from "Load cylinder head to pallet" and ending with "Unload cylinder head assembly" (see fig. 4). Each operation can be assigned to a different station, but this assignment is subject to technological constraints: for example, it is necessary to lubricate the valve steams and insert them in the same station, in order to avoid lubricant spills.

Furthermore, each station can have a different level of automation, which entails different performance (cycle time, reliability, etc.), and, of course, different costs and flexibility levels. For example it is possible to design fully automated stations characterized by low cycle time, high cost and still retaining a high level of flexibility, but it is also possible to design fully automated stations with low cycle time, relatively high cost and lower flexibility (the so-called "hard automation" solutions). As previously said, different levels of manual and semi-automated stations are also possible.
The manufacturing system design problem is therefore characterized by different parameters, some of them region-dependent, such as:

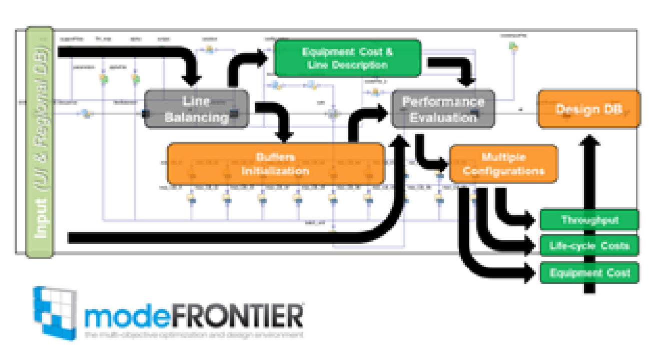


Fig. 5 - modeFRONTIER manufacturing system optimization workflow (courtesy of EnginSoft)

- A complex bill of process
- Technological constraints
- Equipment automation, costs, flexibility, reliability (expressed for example MTTR and MTBF values)
- Lifecycle costs, depending mostly on labour, maintenance (either corrective or preventive), and energy costs
- Other Customer requirements, such as the number of years the system will be in operation

A multi-objective optimization workflow for manufacturing systems design

In the described scenario, and moreover for complex processes, several manufacturing system designs are generally feasible, depending on the constraints that are chosen by the Customer or by COMAU engineers. Depending on the objectives targeted for

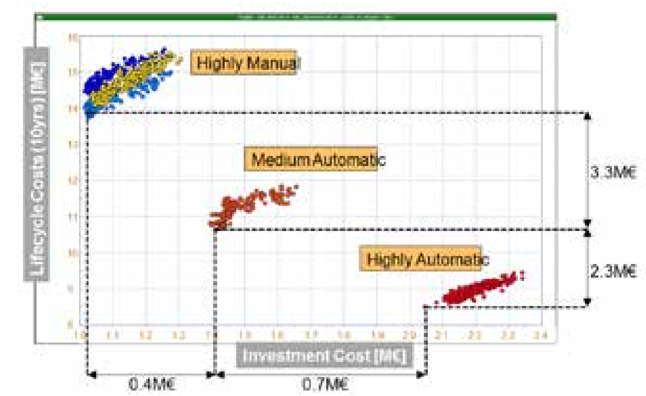


Fig. 6- EMEA region: production line Investment Vs Lifecycle costs

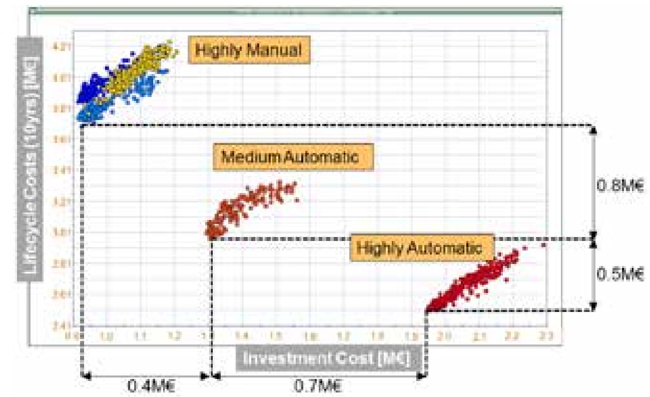


Fig. 7- APAC region: production line Investment Vs Lifecycle costs

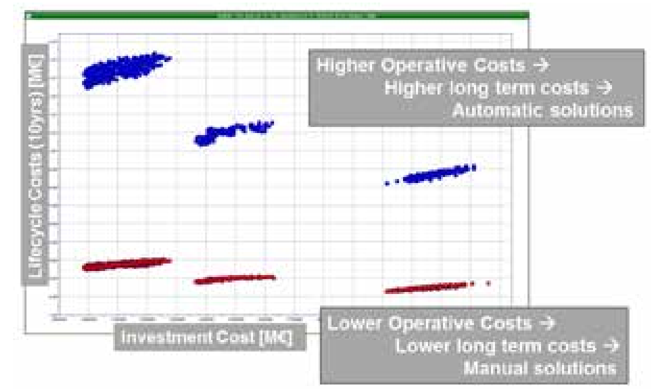


Fig. 8- EMEA Vs APAC production line designs.

maximization or minimization, and on the constraints, some of the feasible designs will also be optimal in the Pareto sense, as they represent different but equally optimal alternatives on which a decision can be made.
It is self-evident that, especially when designing systems for complex processes, the traditional Proposal Engineering approach cannot take into account all the possible combinations and feasible designs. In order to automate the Proposal Engineering manufacturing system design, an optimization workflow has been created using modeFRONTIER (fig. 5).
The workflow receives as input the production bill of process, the manufacturing system technological alternatives and constraints, together with the cost, reliability and the other necessary data. The workflow integrates different solvers, capable to generate and evaluate manufacturing system designs alternatives. Among these solver we can identify the line balancing and the performance evaluation solvers.

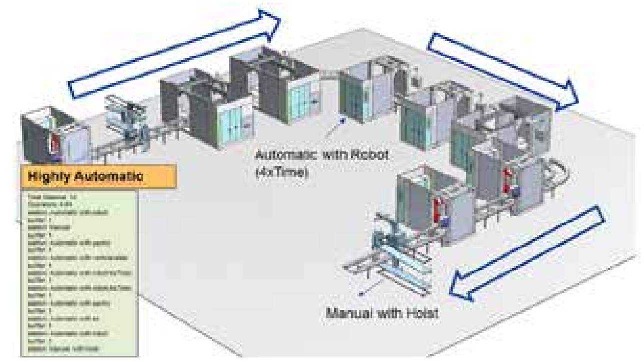


Fig. 9a - 3D visualization of the resulting highly automatic production line (courtesy of Politecnico di Milano)

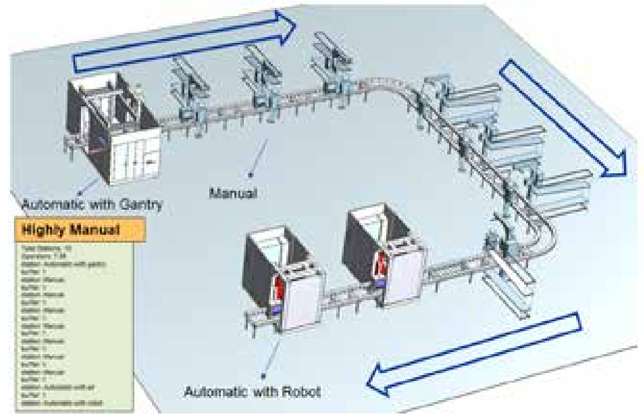


Fig. 9b - 3D visualization of the resulting highly manual production line (courtesy of Politecnico di Milano)

Overall, the workflow is capable of evaluating hundreds of different system designs in a few hours of computation. Each design that is generated by the modeFRONTIER workflow is characterized by its layout, type and number of stations, efficiency and throughput, equipment and lifecycle costs, etc. . Unfeasible designs, those that do not respect the given constraints (e.g. throughput or efficiency constraints), are automatically discarded. Feasible designs are collected and, as the optimization process continues, further refined.
Some results of the optimization process are presented in figures 6, 7 and 8. Each dot on the charts represents a different manufacturing system design. Fig. 6 presents the results for a manufacturing plant designed for a European country (EMEA region), when Investment costs for the desired production line are plotted against its Lifecycle costs computed over a 10 years period. These are competing objectives for the optimization.
It can be noticed that, in this example, the feasible results tend to group together into three main clusters, corresponding to Highly manual, Medium automatic and Highly automatic designs. This effect is due to the provided technological constraints for the system. A Pareto front is provided, composed by different designs belonging to the three clusters: these Pareto optimal designs represent the set of optimum designs among whose a decision should be made. The distance between some of these designs, in terms of costs, is plotted in the chart: referring to Fig. 6 (EMEA region) the investment (CapEx) on a Highly automatic production line will exceed that of a Highly
Manual by around 1.1 M€, but over 10 years it is expected that a Highly manual production line will cost 5.5 M€ more. Taking fig. 7 as a comparison, for the APAC region (e.g. China), the investment cost on a Highly automatic production line will also exceed that of a Highly Manual by around 1.1 M€, but over 10 years it is expected that an Highly manual production line will cost only 1.3 M€ more.
Fig. 8 presents the cost analysis for a similar production plant for the two EMEA and APAC regions together on the same chart. While it can be inferred, in a simplistic way, that Highly Automatic solutions are to be preferred in EMEA (due to the higher operative costs) with respect to Highly Manual solutions in APAC (lower operative costs), this analysis can be further enhanced by considering different scenarios for the evolution of the cost parameters over time, etc., in order to carry out what-if analysis of the investment.
Figures 9a and 9b provide a 3D visual representation of two Highly Automatic and Highly Manual production system designs respectively.

Conclusions

The new Proposal Engineering system configuration design platform developed provides several advantages:
- Reduction of design time, that translates into the possibility of fast quoting in response to a Customer RFQ. This also reduces the time to market of a manufacturing system configuration.
- The knowledge based engineering and knowledge reuse, adopted to automatically extract the required data and constraints for the optimization, is capable to capture, store, and re-use existing technical knowledge. This, together with the automation of the manufacturing system design process increases first-time-right designs, improving the feasibility of the system design directly from the proposal engineering phase.
- Design of systems under region-dependent requirements: regional and Customer dependent requirements are automatically taken into account by the solution.
- The solution can be also easily integrated with visualization tools and tools for analytics and simulation for advanced Customer interaction.

Acknowledgment: this work has been carried out in the context of the European Union Programme H2020. The ProRegio – Customerdriven design of product-services and production networks to adapt to regional market requirements - project has received funding from the
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ANSYS 18: Pervasive Engineering Simulation

Today's industries are undergoing the most fundamental transformation in manufacturing since the introduction of the assembly line more than a century ago. Trends like the Internet of Things, additive manufacturing and machine learning are merging the physical world and the digital world, resulting in products that defy imagination. As products become smarter, companies are also changing the way they manufacture and operate products. These changes require pervasive engineering simulation, in which simulation performs a central role in all aspects of the product lifecycle — from concept, through engineering design and into operations.

Engineers can save time and money by performing simulations earlier in the design cycle, using digital exploration to explore a larger design space faster before making design decisions and locking in costs. Similarly, simulation is moving downstream into operations, where real-time simulation using digital twins is providing insight into a product's real-world performance and maintenance. ANSYS 18 is our next step in delivering pervasive engineering simulation. Placing simulation into the hands of more engineers throughout the product lifecycle.

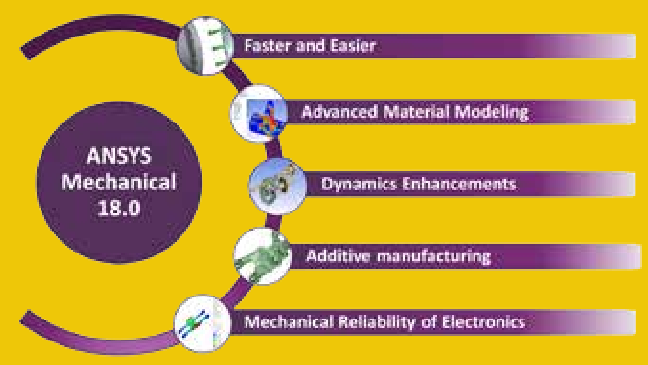

Fig. 1 – ANSYS R18, main improvements areas

ANSYS 18 is finally available from the end of January, 2017. This new release confirms the ANSYS vision to enable the customers to reach lighter, stronger and more efficient products. The today's main industrial challenges are strongly dependent to the fundamental transformation in manufacturing. Some trends like the Internet of Things, additive manufacturing and machine learning are merging the physical world and the digital one. As products become smarter, companies are also changing the way they think products. A pervasive engineering simulation is essential along the product lifecycle, is the today's key of success!

STRUCTURE PRODUCT HIGHLIGHT

In the current release, new tools and technologies are available to analyze complex systems, optimizing designs and shapes for new manufacturing methodologies and ensuring results reliability and accuracy. Some of the main technical improvements are reported:

- The ANSYS Mechanical interface is improved in terms of easily of usage, here is now possible to use new hotkeys, to specify the location of supports and loads on a volume of material, to assign spatially dependent materials like composite parts, 3D printed components, bones and tissues.
- About product lifecycle evaluation, new spectral fatigue capability allows you to achieve accurate FE models and estimate product lifecycle and reliability of electronic components.
- About Meshing improvements, is now possible to better analyze the mesh quality thanks to new Target Quality and Diagnostic Tools; furthermore, the Size Function and Defeaturing controls are available at global and local level as well.

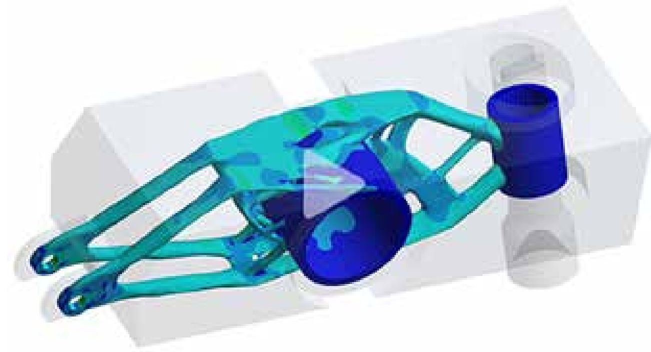

Fig. 3 – Topology Optimization in ANSYS Mechanical

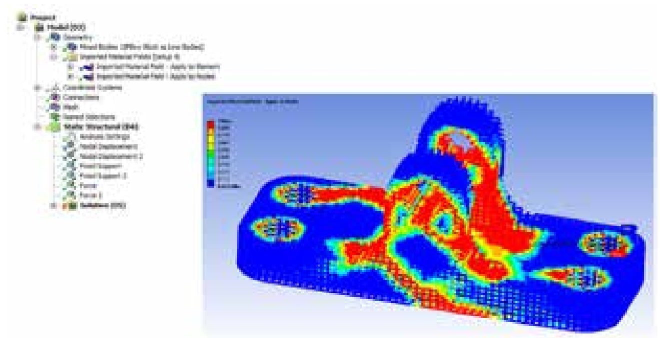

Fig. 4 - Variable Material Fields applied in ANSYS Mechanical

- On Submodeling technique, the beam extraction in SpaceClaim is improved to better handle connections and native submodeling from beams to shell/solid is now available.
- For Civil and Nuclear application fields, new concrete material laws are introduced, along with the ability to easily define reinforced structures, important aspect to study performance of tires as well.

By the way, there are several improvements in material models, as well as better modeling for thermomechanical fatigue

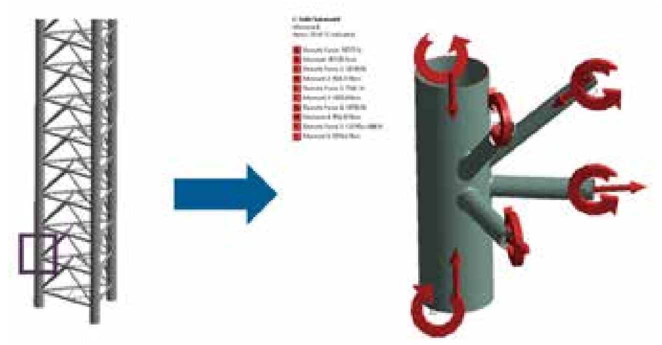

Fig. 2 – Beam to Solid submodeling technique

behavior, concrete structures and other geomechanical structures.

- Optimization is one of the main areas developed in this release: in particular, with the new parallel Topology Optimization technology, you can obtain lighter structures, easily extract CAD shapes and quickly verify the optimized design.
- Within ANSYS Workbench platform is now possible to import Legacy FE models, e.g. Classic ANSYS, Abaqus or NASTRAN in Mechanical and MAPDL, enabling the customers to run simulations on FE data with or without geometry in a seamless manner.
- In Electronics field, it's now really easy to import PCB models via trace mapping, ensuring more accurate assessment of structural reliability of electronics components such as chips and boards.

Moreover, accurate modeling of hollow vias and variable via dimensions are now supported.

- The Mechanical Enterprise license allows the access to the Multi-Material Euler capability to simulate short duration fluid-structure interaction cases (e.g. sloshing).
- About Rigid Body Dynamics, new time stepping scheme means big solution speed-up for models with contact. Moreover Joint Friction effects can now be included, deformed geometry from a RBD simulation can be exported, damping effects can now be included for deformable parts and Trace Plot is available in RBD Postprocessing.

more details in the next newsletter issue....

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Fig. 5 – Digital Twin with ANSYS

Flownex Simulation Environment: the advanced technology for complete system simulation

FLOWNEX®
SIMULATION ENVIRONMENT

Simulation has revolutionized flow and heat transfer dependent systems by minimizing the costs of physical testing and accelerating the time for engineering design. However, for many companies, such simulation has largely focused on component design through the traditional use of 3D CFD, but neglects the overall impact on the entire dynamic system.

Flownex SE (Simulation Environment) allows a fast and accurate approach to the simulation of complete systems and subsystems because it defines components through lumped parameters and connects them in a thermo-fluid network. The technology advancements delivered by Flownex are the following:

- Library of pre-defined and customized components
- Steady and transient analyses
- Incompressible and compressible fluids (water hammer, chocked flow)
- Heat transfer (convection, conduction and radiation)
- Liquid and real gas data from NIST database
- Gas Mixtures
- Two phase flows (gas-liquid multiphase flow, phase separation, transportation of incondensable gas)
- Phase change flows (cavitation, boiling, condensation, flashing)
- Non Newtonian fluids such as slow/non-settling slurries
- Adiabatic flame model for gas combustion
- Integration with ANSYS 3D software (ANSYS Fluent and ANSYS Mechanical)
- Integration with Excel, Matlab Simulink, Mathcad and Labview
- Analog and digital controllers
- Parametric design, sensitivity analyses and optimization

Focusing on three industrial sectors (Renewable Energy and Power Generation, Nuclear and Turbo-machinery) this article will describe some of Flownex SE advantages in these industries.

Flownex SE for the Renewable Energy and Power generation

Flownex SE allows transient and steady state analyses for the design of power generation plants (Figure 1), covering:

- Feed water systems
- Cooling water circuits
- Steam turbine and supporting systems
- Ash slurry
- Natural circulation boiler
- Boiler auxiliary system
- Condensers

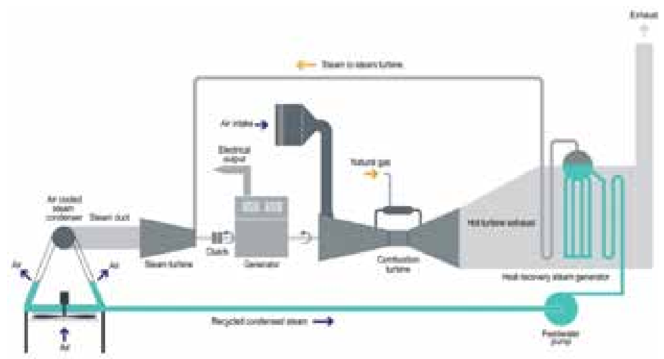

Figure 1 - Power generation plant

Flownex SE, as a thermo-fluid process analysis tool, provides a large library of components related to power generation systems: common heat exchangers, shell and tube heat exchangers and the functionality for users to specify their own correlations for the heat definition. Detailed two phase heat transfer theory is implemented this enable users to examine boiling regimes and boiling stability in heat exchangers: these features allow engineers to design plants and their auxiliary systems for stable operation as well as safe start-up and shutdown (Figure 2).

Flownex SE also contains a library of both analogue and digital control components allowing users to build entire control systems which can be integrated in their thermo-fluid models. With this functionality users can analyze plant transients such as accident scenarios and plant start-up/shutdown events. Using Flownex SE, users can also pre-tune controllers in a simulation environment thereby saving commissioning time or evaluate the performance of control philosophy changes and quantify the improvement of the change before implementation in the plant.

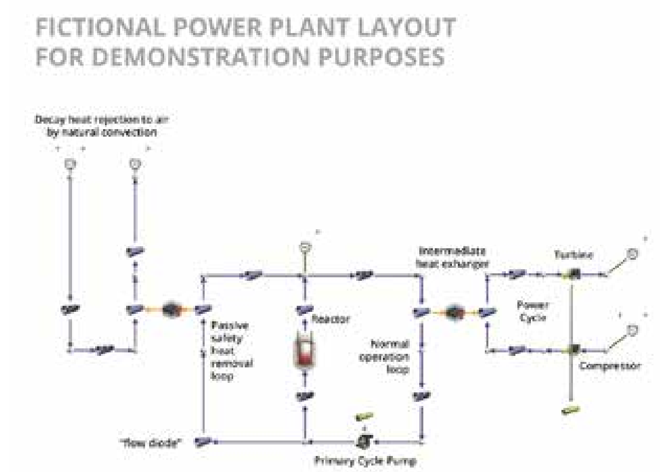

Figure 2 - Flownex network of a power generation plant

Although Flownex SE provides excellent functionality for modelling entire systems it is also suited to modelling small sections of a plant and can be used for many sizing operations. Some common applications include the sizing of orifice plates for flow measurement, the sizing of pumps to provide the required pressure rise at the desired flow rate and the sizing of valves to ensure controllability with different loads: this kind of problems can be handled using a dedicated designer module.

The solver in Flownex SE uses models derived from fundamental physics that are enabled in all simulations. This allows users to be confident about the results of their simulations without having to worry about enabling or disabling additional solver features as they work on different simulations. Furthermore the solver is capable of capturing phenomena such as thermal inertia, buoyancy driven flow, water hammer and branching flow. The solver has been developed to provide very fast solution times – typically in the order of seconds – hereby allowing engineers to run detailed parametric studies for optimizing systems without having to wait days for results and without the added cost of expensive high performance hardware.

Flownex SE is a tool for engineers that have to manage either the design stage, the commissioning stage, the operator training or the general maintenance of the plant. This simulation approach is the preferred solution for many power generation companies around the world like Babcock, Eskom, Hatch, Dominion etc.

What Flownex SE can do in the nuclear industry

Flownex SE main features for the design of a nuclear power plant are (Figure 3):

- Pressurized Water Reactor component modelling
- High Temperature Reactor component modelling
- Feed water systems
- Cooling water circuits
- Accident analysis
- Condensers
- Research or materials test reactors
- Steam turbine and supporting systems
- Integrated system simulation
- Reactor library with point kinetic neutronics
- ASME NQA-1 accreditation with approved verification and validation documentation

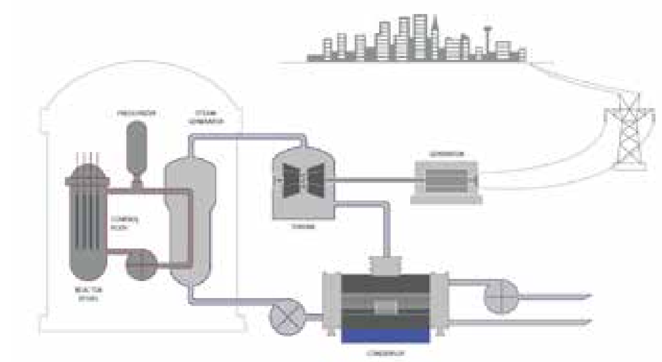

Figure 3 - Nuclear power station

Flownex SE is suited for developing thermal systems from the ground up, as it offers a wide range of components, such that one always finds the component that matches the appropriate level of complexity for a particular phase of development. This is the reason why several Small Modular Reactor (SMR) companies are using Flownex SE for the integrated development of primary reactor coolant loops and secondary power generation loops (Figure 4). Particularly for nuclear plant transient simulations, Flownex SE has a discretized reactor thermo-fluid model and a built-in point kinetic neutronics model, as well as capability to link neutronic behavior to external neutronics calculations.

Further along the power plant life cycle, Flownex SE is capable of calculating flow rates, pressures and temperatures in typical gas or liquid handling systems based on equipment geometry and layout. This is particularly useful when doing root cause analysis or when designing retrofits and modifications to existing plants.

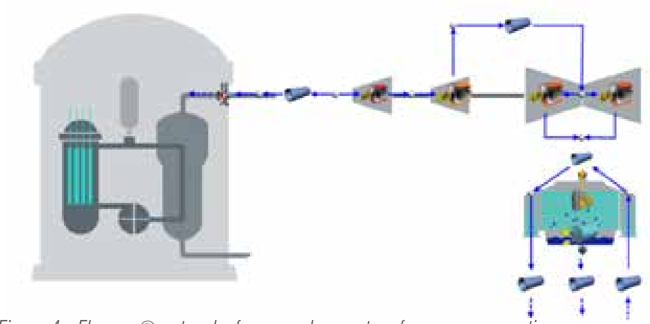

Figure 4 - Flownex® network of a secondary system for power generation

For nuclear safety relevant calculations, Flownex SE is developed in a quality framework that complies with the requirements of ASME NQA-1. Extensive verification and validation have been done on Flownex SE, which is available as a data pack for submission to nuclear regulators.

Flownex SE allows the design of gas turbines

Flownex SE, in gas turbine integrated system design, can calculate the flow distribution, pressure drop, heat transfer for the connected components of a complete gas turbine engine during both steady-state as well as transient events. Typical Flownex SE solutions in both the aerospace and turbomachinery sectors include combustor design, secondary flow analysis and overall system integration (Figure 5).

The key features are described below.

Integrated combustion chamber design and optimization including coolant flow:
- Combustion product gas composition calculation.
- Combustion process adiabatic flame temperature calculation.
- Flow distribution between cooling slots and main flow path.
- Axial (2D) conduction.
- Linear and solid conduction heat transfer.
- Jet impingement cooling.
- Film convection heat transfer.
- Solid-Solid radiation heat transfer.
- Gas-Solid radiation heat transfer.
- Convection heat transfer

Internal cooling system pressure, flow rate, power and heat transfer distribution for ensuring effective film cooling on hot surfaces:
- Swirl calculation through integrated swirl solver.
- Labyrinth seal pressure drop calculation.
- Rotor-Rotor (or Rotor-Stator) pressure differential and power transfer calculation.
- Free/Forced Vortex pressure differential and power transfer calculation.
- Rotating nozzle pressure differential and power transfer calculation.
- Rotating channel pressure differential and power transfer calculation.

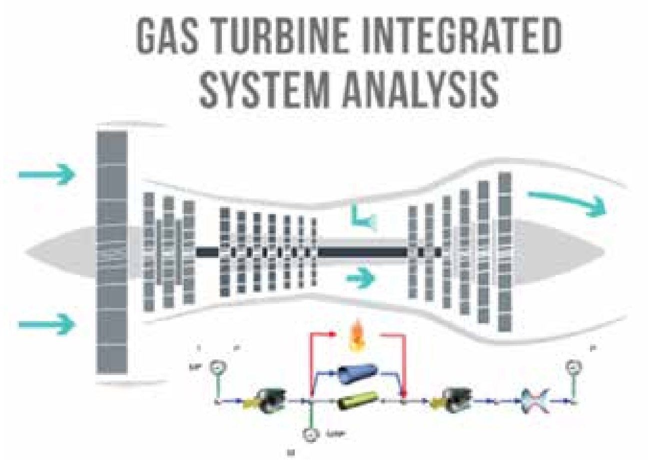

Figure 5 - Flownex network of a gas turbine

- Convection heat transfer between solids and cooling air.

Preliminary combustor design requires that an extensive number of geometrical and operational conditions have to be evaluated and compared. Especially during this phase Flownex SE is an essential tool for combustor design engineers as it accurately captures important parameters such as the mass flow rate distribution through air admission holes, product gas composition and radiation, convection and conduction heat transfer, thereby predicting linear wall temperatures. A 1D approach is a substantial development in cost savings because it reduces the number of detailed 3D simulations and tests required. A further advantage is the ability to use the Flownex SE results as boundary conditions in subsequent localized 3D models.

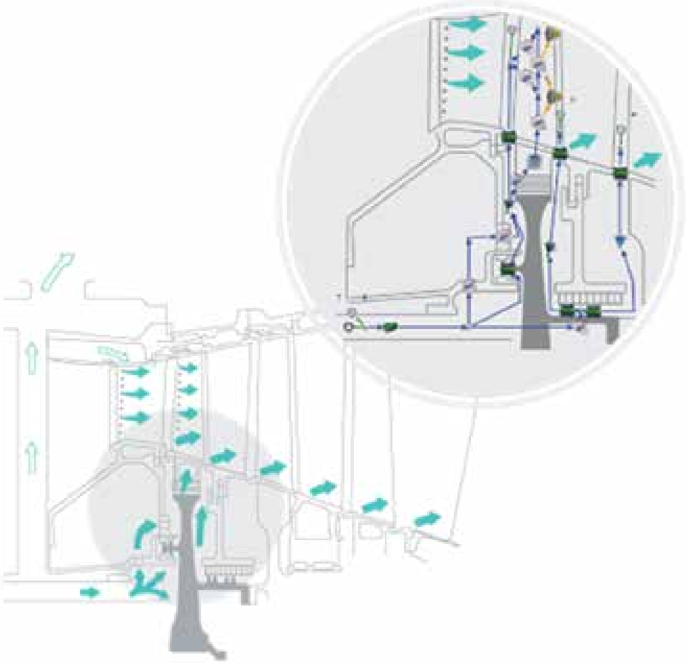
Figure 6 - Secondary flow in a gas turbine

Flownex SE has a comprehensive rotating component flow library for analysing the coolant rotational flow field inside the gas turbine engine (secondary air system). Through the application of the Flownex SE swirl solver, angular momentum transfer, windage power, heat transfer as well as pressure losses are accurately predicted throughout the secondary air system, featuring components such as stator-rotor and rotor-rotor cavities, rotating channels and orifices, vortices and seals (Figure 6).

Flownex SE furthermore allows engineers to investigate overall engine performance such as expansion thrust calculations, compressor surge margin calculations and power matching between compressors and turbines. The dynamic modelling is useful in integrated engine simulations for predicting engine performance of numerous transient events such as start-up, load changes and emergency situations.

Conclusion

Flownex SE is frequently used for the preliminary and conceptual design of industrial plants. Using a themo-fluid network, Flownex SE can perform transient simulations to capture water hammer effect or breakdown events: this allows a complete study of the system including the testing and tuning of the control logic. The combination of advanced physical models (multiphase flows and phase change) with an extensive component library (turbines, pumps, heat exchangers, etc.) and correlation data (properties of fluid and real gas) makes Flownex SE a versatile tool to cover different industrial sectors: energy renewable, power generation, nuclear, turbomachinery, aerospace, oil & gas and many others.

Flownex is distributed by EnginSoft, for more information:
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Flownex Simulation Environment: fluid networks with ANSYS power

Introduction to Flownex SE - ANSYS link

Simulation tools of 1D networks are easy to use and have fast solving times, however, they don't always contain all the features needed in system simulations. 3D CFD packages become necessary when

components have complex 3D geometry which cannot be characterised in one dimension or in systems where three dimensional flow results are required. However, simulating an entire system in 3D is often computationally expensive: for this reason a hybrid 1D-3D simulation is a good compromise. In this contest Flownex SE is linked to both ANSYS CFD and FEA codes for more localized results where required. In particular Flownex SE can be coupled with ANSYS Fluent to provide an interactive communication between a CFD 1D system and CFD 3D analyses. This allows to include the effect 3D complex geometries in terms of pressure losses, multiphase flows and non-homogenous heat transfer.

Flownex SE can also be coupled with the FEA code ANSYS Mechanical: thermal and pressure stress analyses can be performed starting from the temperature and pressure calculated by Flownex SE. Co-simulations between 1D network and FEA 3D code can be used to model conjugate heat transfer with 3D geometries: this approach keep the accuracy of temperature distribution in the solid domain and reduce the computational effort on the fluid side.

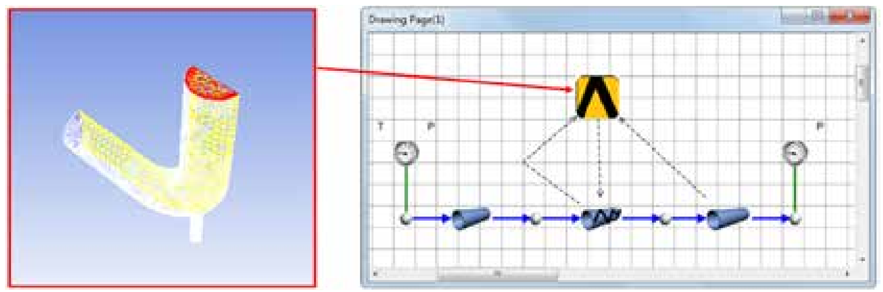
Figure 1- Flownex SE interface with ANSYS Fluent link

CFD 1D and CFD 3D: Flownex SE and ANSYS Fluent integration

Flownex SE can be linked directly with ANSYS Fluent to run co-simulations: 1D and 3D flows are solved together and information are exchanged at the boundaries. The entire simulation is controlled by Flownex SE interface (Figure 1). This functionality provides the best aspects of both tools:
- Global reduced solving time, due to the fact that the majority of the system is solved in Flownex SE
- High detail and accuracy of some components, due to the 3D fluid dynamic simulation.

One application of the coupling with ANSYS Fluent can be illustrated in the simulation of the HVAC system in a server room (Figure 2). In this case Flownex SE is used to simulate the fan, heat exchanger and ducting to the server room while ANSYS Fluent is used to simulate the heating of the air by the electronics and the air flow in the room. The interface points are chosen at the vents that supply air to the room, where the temperature and flow results from Flownex SE are transferred to Fluent and the backpressure results from ANSYS Fluent are returned back to Flownex SE. In this simulation, control elements are added to automatically adjust the fan speed and the vent openings in order to study the transient scenario of the system.

CFD 1D and FEA 3D: Flownex SE and ANSYS Mechanical integration

Flownex SE also adds value to structural simulations and can be used to transfer 1D flow results to a FEA simulation package such as ANSYS Mechanical.

The ANSYS Mechanical coupling finds application in many industries. The example illustrated in Figure 3 involves modelling the temperature distribution in an engine block. Flownex SE is used to model the heat transfer from the combustion gases and the water cooling flow

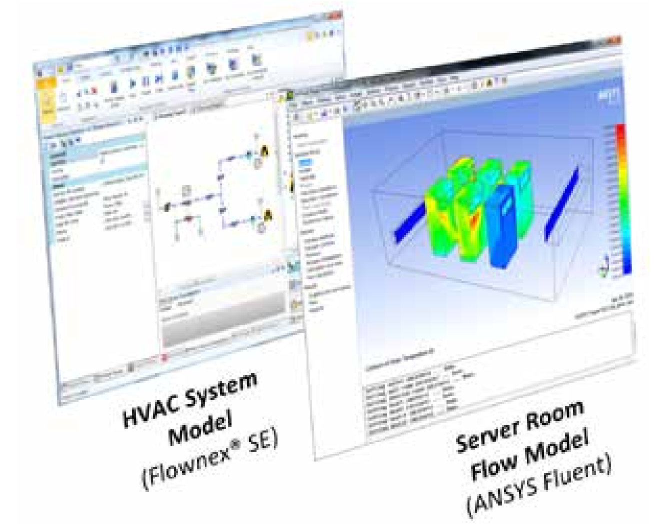

Figure 2- Flownex SE and ANSYS Fluent link: HVAC system in a server room

through the block, and ANSYS Mechanical is then used to model the conduction heat transfer in the engine block. The remainder of the engine cooling system, including the radiator, hoses and water pump are also modelled in Flownex SE and are adjusted until suitable engine block temperatures are achieved.
Another example of the ANSYS Mechanical coupling in the power generation industry is illustrated in Figure 4. It shows a model of a boiler where the flows are calculated using Flownex SE and the thermal stresses are calculated using ANSYS Mechanical. Using this analysis technique, start-up conditions can be simulated in a transient environment and boiler design can be modified to ensure the stresses are all within allowable limits before construction begins.
Flownex SE can also calculate pressure forces on elbows and pipes: these can be used as an input to mechanical design for the calculation of pressure stress analyses and frequency analyses bases on pressure signal (using Fast Fourier Transform).

Conclusion

Coupling 3D and 1D codes, the overall computational effort is reduced while the 3D fundamental modeling aspects are maintained at the same time. Following this approach, Flownex SE can be linked with ANSYS Fluent and ANSYS Mechanical in a unique simulation environment. In this way the coupling is completely automatic and be can used for sensitivity analyses to improve the system design.
By combining Flownex SE with ANSYS Fluent and ANSYS Mechanical, simulations can be optimised for both accuracy and minimization of run time, providing engineers with a robust set of simulation tools that meet industrial demands.

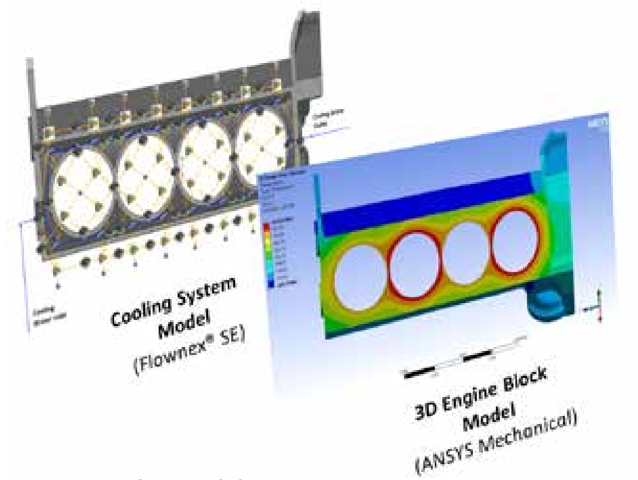

Figure 3- Flownex SE and ANSYS Mechanical link: heat transfer in an engine block

Flownex is distributed by EnginSoft, for more information:

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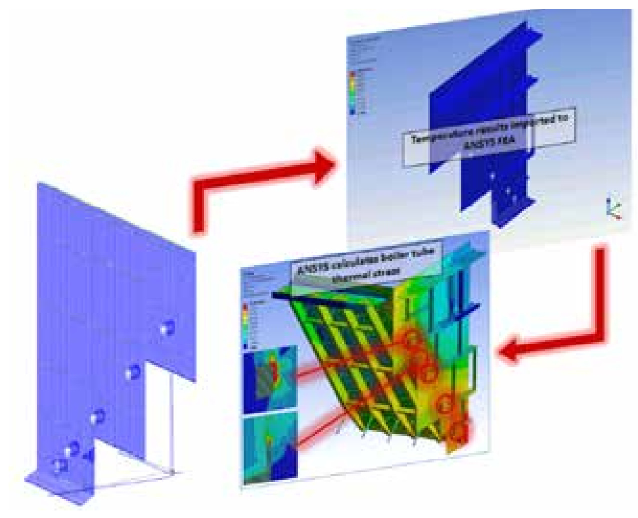

Figure 4- Flownex SE and ANSYS Mechanical link: thermal stresses of a boiler

Marie-Christine OGHLY, President of EnginSoft France, elected as President of the World Association of Women Entrepreneurs (FCEM)

For the first time in History, the Association of Women Entrepreneurs has just elected a French woman as World President. Mrs. Marie-Christine OGHLY, former World Vice-President took over the international association. The election was held at the Meridien Hotel of Monaco, during the committee of the World Association of Women Entrepreneurs 2017, organized from the 14th to 17th March. As a reminder, the Association of Women Entrepreneurs was created in France in 1945. Today, the network is represented in 40 countries over the 5 continents.

ESTECO releases VOLTA: the state-of-the-art environment for advancing agile product development

The new web-based, collaboration environment helps companies leverage enterprise engineering knowledge and processes on a global scale

Trieste (Italy) – On February 8th 2017 | ESTECO announced the release of VOLTA — the state-of-the art environment that takes enterprise-engineering processes to a new, collaborative dimension. With VOLTA, protecting company Intellectual Property and accelerating innovation processes now requires no effort. VOLTA expertly orchestrates simulation data and multidisciplinary business processes to enable conscious decision-making and innovative product development.
VOLTA leads the way towards a newer, more effective approach to product development.
Multidisciplinary teams will now be able to manage all cross-functional, concurrent design steps by integrating multiple modelling formats and capturing the interactive and incremental continuous innovation process. With its service-oriented architecture, VOLTA facilitates the sharing and reuse of enterprise engineering knowledge and provides all innovation process stakeholders with a solid environment for distributed execution and access to key design data and performance indicators.
"In order to shift to agile product development, innovative companies require comprehensive solutions that help them orchestrate design data generated across globally-dislocated teams that collaborate on simulation and optimization projects. As the role of integrators becomes essential in the global value chains, ESTECO technology helps engineering departments create a reliable, protected virtual prototyping process where organizations co-operate seamlessly in designing new products", says Carlo Poloni, President of ESTECO.

Collaborative, Agile: Optimization-driven Design

Over the years, ESTECO has gained an in-depth understanding of engineering workflows and procedures by working closely with its customers. This knowledge propelled the evolution of ESTECO technology toward a comprehensive environment for integrated management of simulation process and data – SOMO (Service Oriented Multidisciplinary Orchestration).
"ESTECO has now moved one step further with the next generation of its enterprise platform, renamed from SOMO to VOLTA." explains Matteo Nicolich, Product Manager of ESTECO Enterprise Solutions. "VOLTA embraces this experience and provides an environment tailored for digital model generation and detailed analysis that actively supports organizations in the adoption of a formal optimization-driven design approach, tightly connected to existing PLM systems"
By mapping the set of possible design solutions and enabling interactive, multi-user cycles of trade-off analysis, VOLTA expands the benefits of simulation across the process, ensuring its impact from the early stages of design, down to validation and failure prediction. This results in a double advantage. With shared access to key design information, design teams ensure early and continuous delivery, reducing physical document exchanges and incrementally enhancing designs. On top of that, VOLTA provides an information structure that helps organizations manage engineering data related to product digital twins, resulting in quicker reactions to changes in scenarios or requirements and consequently reducing time to market.

Engineering Data Management & Intelligence

"Complex product and systems development requires expertise, simulation data and design IP archives to be readily available and tailored to each stakeholder. VOLTA ensures that all this information is captured and codified to build tailored design performance metrics for advanced analytics and informed decision-making," continues Nicolich.
VOLTA keeps teams on track by allowing them to concurrently compare, validate and decide on design scenarios. Leveraging work-in-progress models and aggregating product data and engineering information is now effortless with the new web-based platform, delivering full data traceability and airtight security. Key engineering information is no longer displaced, it is always available to the right people, with consistent reference to higher-level enterprise processes.
Read more at: esteco.com/volta

G-Modeling: a new resource to achieve Multi-Flexible-Body-Simulation using RecurDyn

RecurDyn is a software for simulating multibody systems dynamics with an optimized solver (the fastest available on the market) and unique technologies for analyzing flexible bodies and contacts between them. For these reasons, RecurDyn is widely recognized as the reference technology for Multi-Flexible-Body-Dynamics (MFBD) simulation, an essential tool for studying the dynamics of a mechanical system influenced by its component's flexibility. With its V8R5 release, RecurDyn has further enhanced its ability to manage rigid and flexible bodies by introducing a new modeling technique: G-Modeling.

G-Modeling stands for Generalized Modeling, a revolutionary opportunity to increase the efficiency and productivity of MFBD in RecurDyn. The G-Modeling tools automate the conversion of bodies from rigid to flexible type and from flexible back to rigid type, as well. This allows the user to create one single model of a system assembly

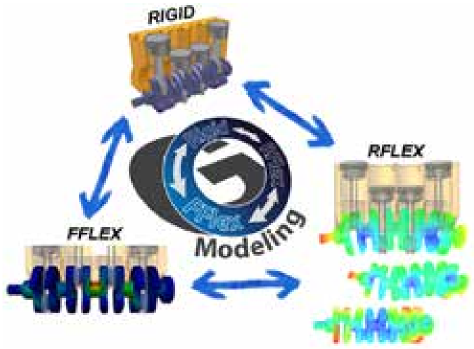

Figure 1

in which different representations of a component can be tested and compared, in order to finally choose the best option for each simulation purpose. Moreover, taking advantage of the G-Modeling technique, a single model can be used for multiple purposes by quickly converting bodies from one type to another. For example, a model can be created using only rigid bodies to test the overall system behavior with minimum computation time. Then one body can be converted into a flexible one so that the same model will calculate the stress history of the body and then predict its fatigue life.
RecurDyn contains a large number of powerful G-Modeling GUI tools to aid the analyst in modifying the model for various needs. The most remarkable is the G-Manager tool.

THE G-MANAGER TOOL

The G-Manager tool is a useful assistant in the conversion process of a body between rigid and flexible representation that centralizes and automates all the tasks required for the conversion. By using the G-Manager, Rigid, FFlex and RFlex bodies can be converted directly to any of these body types.

Figure 2

For example, the G-Manager can invoke RecurDyn's built-in Mesher or RecurDyn's RFlexGen (eigensolver) to convert bodies from rigid to flexible, automatically setting most of the options that are required to perform the conversions. A flexible body can be turned back to its rigid version as well with a simple rollback operation.
Moreover, by using the G-Manager, all the previously created features (e.g. Joints, Forces, Contacts, etc.) applied to a body will be preserved during its conversion process, thus avoiding any possible mistake in manual recreation of the features and allowing a massive time saving (up to 10x) in the modeling process. This makes G-Manager the most important tool to take advantage of the G-Modeling technique: the increase in versatility of a single system assembly model will definitely improve modeling efficiency and productivity of MFBD analyses.

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BODY TYPES IN RECURDYN	Rigid Body	Reduced-Flex (RFlex) Body	Full-Flex (FFlex) Body
WHAT IS IT?	ideal rigid representation	simplified flexible representation based on FE modal reduction	no-compromise flexible representation based on finite elements
A GOOD CHOICE WHEN...	- the deformation of the components is negligible - a fast simulation is required - the system overall behavior is the main interest - stress analysis is not a concern	- small deformations occur - material has linear properties - load points do not change - large FE model	- large deformations occur - material has nonlinear properties - contact and load points change - small/medium FE model
APPLICATION EXAMPLE	kinematic analysis of a complex mechanism	simulation of the control system of a flexible mechanism	analysis of a mechanism dynamics influenced by nonlinear flexibility

FunctionBay Annual Meeting and the European Success

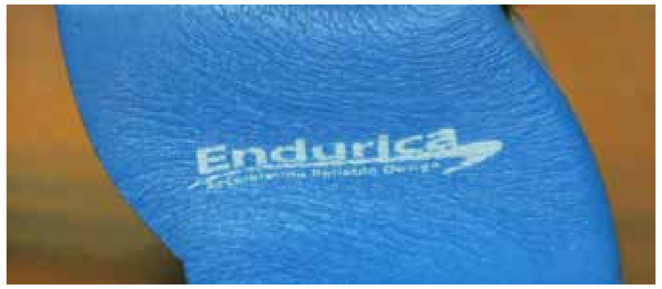
The 2017 FunctionBay Annual Meeting was held at Pangyo Seven Venture Valley auditorium from March 2 to March 3 in 2017. FunctionBay is holding the Annual Meeting in Korea, Japan, and Europe every year in order to share sales information and promote friendship between Korean headquarters, overseas business units and overseas RecurDyn dealers.

At 2017 Annual Meeting, the new functions of new version of RecurDyn, MBD for ANSYS and Particleworks were introduced. In addition, annual sales situation and success stories of FunctionBay headquarters, business units, and distributors were continued over the past year. Discussions were progressed more actively to identify market and technological trends around the world, and to develop appropriate sales strategies.

As every year, at the end of the meeting, the CEO of FunctionBay has awarded the best presentations given over the two days. The ceremony has become a nice tradition over the years through which the Headquarter highlights the great success that RecurDyn is getting wolrldwide. The "best presentation 2017" award has been given to the FunctionBay Germany team, which has presented to the community several challenging applications covered with the RecurDyn technology. Fabiano Maggio, from EnginSoft SpA, was kindly invited by our German partners for sharing this award. Indeed, in 2016, EnginSoft has contributed significantly to the success of RecurDyn in Europe.

At the very end of the ceremony, when everthing seemed to be over, EnginSoft SpA got an additional "Special Award" from prof. Jin Choi, CEO of FunctionBay. The reason behind this exceptional initiative is the excellent and passionate work that the System Dynamics Team of EnginSoft is doing on the Italian soil to promote RecurDyn and related technologies.
FunctionBay staff will take one step further toward the bigger goal.

Get Durability Right for Elastomers



Endurica LLC has just released version 2.50 of their Endurica CL fatigue solver for elastomers. The latest release features a brand-new interface for Ansys Workbench, as well as execution speed improvements and a new material model for problems involving self-heating. Endurica CL was purpose-developed for fatigue analysis to address the unique behaviors that elastomers exhibit: finite strain kinematics, nonlinear elasticity, strain crystallization, fatigue and creep crack growth, temperature dependence, ozone attack, etc. In addition to elastomer-specific damage models, the software features Critical Plane Analysis and Rainflow counting – enabling technologies that provide unrivaled accuracy in accounting for damage accumulation under multiaxial, variable amplitude operating loads.

Endurica is distributed by EnginSoft, for more information:
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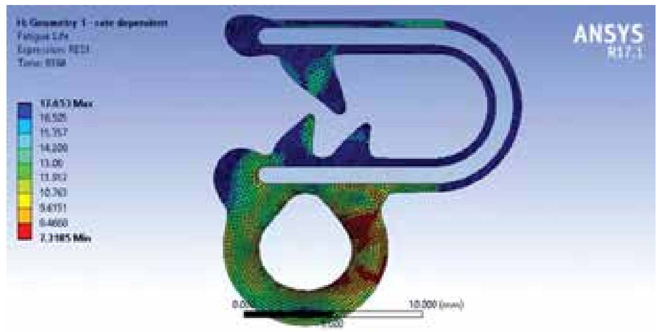


Figure 1. Screenshot showing Endurica fatigue analysis results (base 10 logarithm of life) for an automotive door seal simulation run in ANSYS. In this case, long life ($10^{7.3}$ = 20 million door open/close cycles) is predicted.

A powerful help on metal product development

FORGE® NxT 2.0

In January 2017, TRANSVALOR FORGE NxT 2.0 was released worldwide. FORGE NxT is the ultimate numerical tool for the simulation of many hot and cold forming processes such as closed-die forging, open-die forging, rolling, reducer rolling, cross wedge rolling, thread rolling, shape rolling, ring rolling, rotary forging, flow forming, hydroforming, incremental forging, orbital forging, friction welding, extrusion, fastening, wire drawing, deep drawing, shearing, sheet metal forming, piercing, glass forming, blanking cutting, superplastic forming, trimming and some additional non-conventional processes. FORGE NxT enables the possibility of simulating thermal treatments such as induction heating, quenching, carburizing and tempering.
This new release improves the experience with the new Workbench interface, introduced since NxT 1.0. Feedbacks collected from the customers' experience have been taken into account to develop new features and upgrades, in order to enrich the software's capabilities and ease of use.

FORGE NxT is the right investment in order to obtain:

- reduction on design phase, testing costs and material usage
- effective design of brand-new parts
- reduction on time to market
- optimization on current production processes
- extended equipment life
- increase and share of company know-how

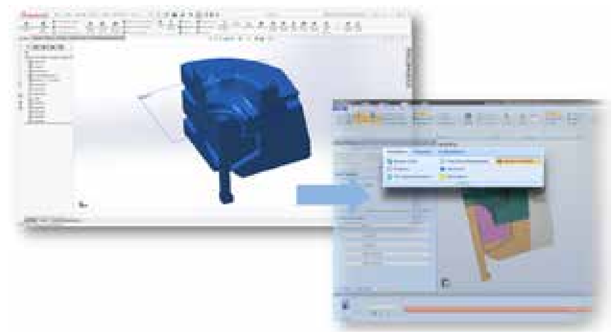
FORGE NxT provides a fast and holistic view of the product along the whole production process, being a advantageous partner of:

- product designers, who are interested on part feasibility and effect of manufacturing process on the final part properties
- process designers, who have to evaluate the best and cost-effective way to produce a component.

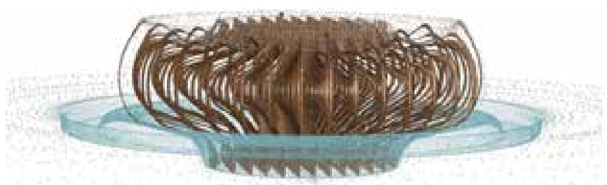
Let's take a look on the major upgrades provided by the new release!

More Efficiency in the Graphical User Interface

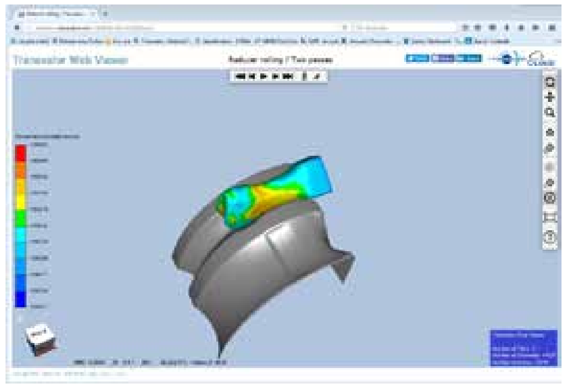
Automatic import of tooling assembly. Importing each component of an assembly one by one is time consuming and tedious. The Import Assembly functionality makes this task easier for users. After selecting your assembly file (.STEP, .STL, .x.t, ...) , the interface will ask for the type (workpiece or die) of each detected part to be selected and import it into the project.



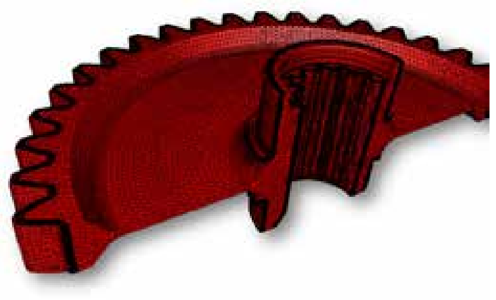
Marking grid & grain flow techniques. The generation of an under skin marking grid is essential for further analysis of possible folds caused by flow-through phenomena (e.g. at the base of rib). Thanks to a highly simplified definition, the use of under skin marking grids has become fast and efficient. Now, you can define markings as plane layers or fibers distributed through the volume to analyze the grain flow with a guaranteed 3D rendering.



One Click Sharing. Share your last simulations with a single click thanks to One Click Sharing. Your images or animations will be dropped on our servers in your personal user area. Your colleagues and partners will be able to visualize and manipulate these files in 3D via a web interface.



Initial Anisotropic Meshing. With the generation of an initial anisotropic mesh, you can create meshes that are especially adapted for heat treatment simulations with the necessary refinement in the depth of the workpiece's surface. Ideal for capturing gradients of temperature, of phase transformation or of carbon diffusion occurring on the extreme surface.



Metallurgical models

Phase transformation in titanium alloys. Due to the complexity of the transformations available in such kind of alloys, the necessity to predict phase transformations kinetics and α morphologies fraction, the implementation of the prediction of phases in titanium is a significant progress especially for deformation and heat treatment stages.

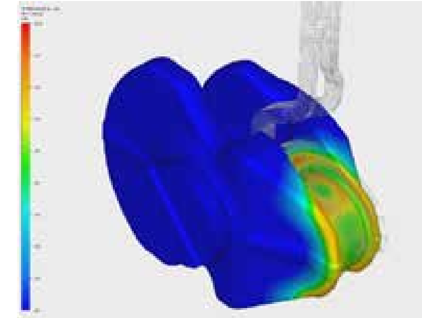
Implementation of the Li model. The heat treatment simulation of steels relies on the automatic generation of TTT diagrams and has been upgraded especially for high alloyed steels with the implementation of the model of Li which provides more precision in the prediction of phases.

Interface JMatPro – FORGE. JMatPro mechanical and thermos-physical properties are exported to FORGE material datafile as a result of long-lasting collaboration. FORGE NxT 2.0 now also supports phase transformation data leading to the use of TTT/CCT diagrams. Consequently, only one single datafile is needed to simulate operations of a different kind such as cold-warm-hot forming stages (preform, blocker, etc.) and any heat treatment operation (controlled cooling, quenching, tempering, etc.). It's so simple!

Induction heating simulation

Simplified meshing in the electromagnetic simulation. In order to simplify the meshing, a new functionality called Automatic Size has been implemented. The skin depth is automatically defined depending on the selected material and the parameters of the inductor.

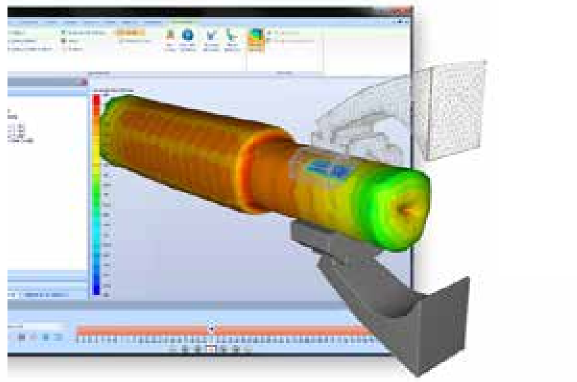
Integration of mobile inductors and concentrators. With the constant goal of achieving even more realistic simulations, it is now possible to simulate mobile inductors and concentrators or to simulate continuous induction heating in which the billet travels along the tunnel furnace.

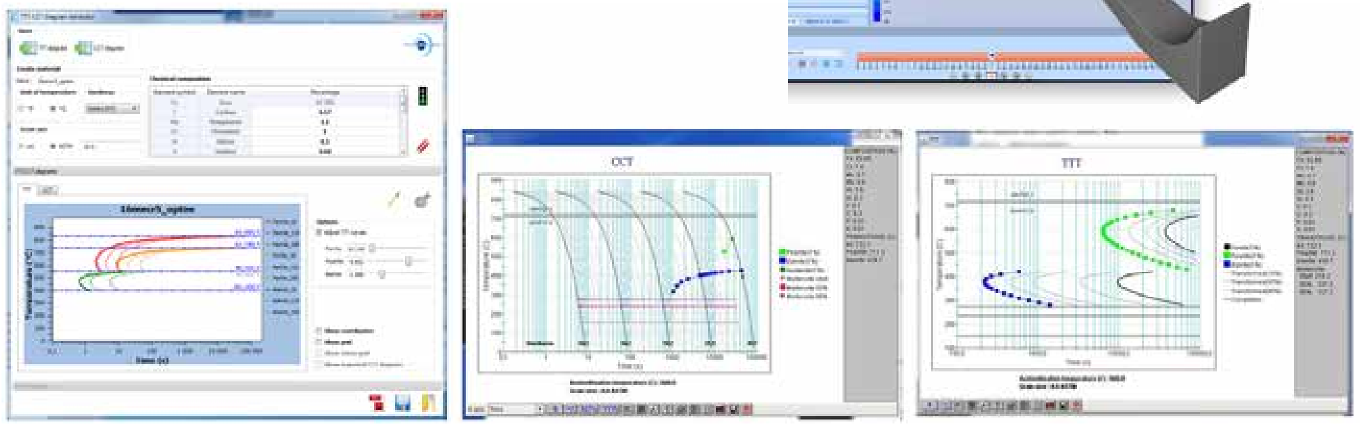


Power-driven mode for current generator. A power-driven piloting method has been implemented. This method makes it possible to modulate the current and its frequency, as your generator does, in order to keep a constant dissipated power in the part.

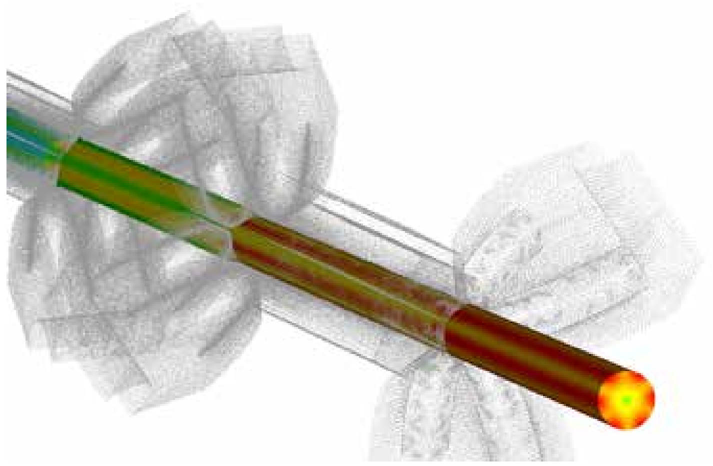
One Step Forward in Forging and Rolling

Use of 3D CAD models to define manipulators in Open Die Forging. For a more realistic rendering of contacts and thermal exchanges between a part and a manipulator, it is now possible to define a manipulator through a 3D model with a temperature and a thermal exchange coefficient.





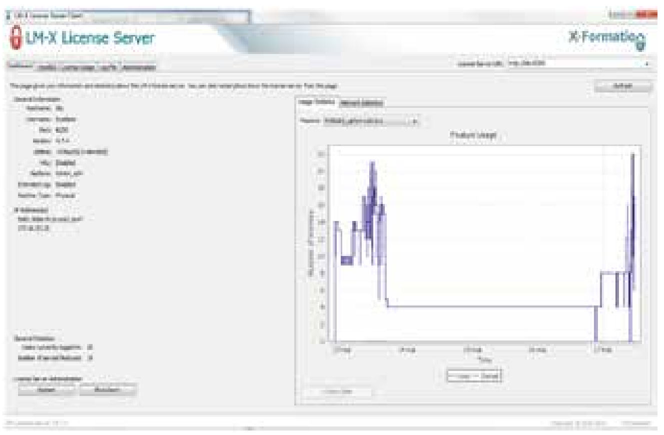
Computation with stationary method in Hot Rolling. The stationary method takes into consideration the stabilized flow during rolling with the use of one or several rolling mills. Compared to the incremental method, the stationary approach brings obvious advantages like the strong reduction of computation times and the capacity to naturally simulate the inter-stand tension. This method is suitable for long and flat products and compatible with mills of type Kocks.



New constitutive equations and damage criteria. With an always wider range of applications, FORGE NxT has been upgraded with new constitutive equations and damage criteria in order to simulate shape-memory alloys, hyper-elastic materials and high-speed processes.

New license management

Since this new release, license management will switch from lexNet Publisher (FlexLM) to LM-X (X-Formation). The main advantages of this new Web-based license manager are a higher security level and an easier monitoring of used license resources.



FORGE NxT is the result of continuous development work implemented by TRANSVALOR, in collaboration with research activities performed by CEMEF, excellence R&D center focused on deformation of metallic materials. Over 500 customers worldwide, including the major automotive, aeronautical and energy players as well as prestigious universities, trust TRANSVALOR and its software products, thereby guaranteeing their efficiency and reliability. The strong collaboration with users and distributors as EnginSoft leads to constant improvement of the tool, which grows and becomes more and more easy to use, robust, accurate and precise. The certified product maturity allows simple and rapid integration into any technical environment, to design products obtained by metal deformation and to optimize the relative production processes.

EnginSoft, exclusive FORGE distributor in Italy with specialized engineers with over 20 years of experience, can support your company on all the different steps, from the introduction into the design flow with dedicated training, to specific partnership along the product/process development, integration with other areas such as marketing, sales and quality, to discussion with your suppliers and customers.

For further information
Federico Fracasso, FORGE Product Manager
f.fracasso@enginsoft.it

EnginSoft "Metal Forming Team"

EnginSoft has been dealing with productive processes simulation for over 20 years with a group of engineers specifically specialized in metal deformation processes simulation. The activity carried out by this group ranges from the daily support to the over 70 Italian customers using Transvalor products Forge and ColdForm, to the training of those companies interested in undertaking simulation activities, to the performance of commissioned engineering works, up to the development of tailor-made models meeting customers' needs. The group competences extend from hot forging of steel and non-ferrous materials (brass, aluminum, titanium, …) for pieces of just few kilos, to open-die forging and circular lamination of steel for ingots of several tons, in addition to the simulation of cold rapid processes, such as bolts and screws and small parts forging.

The integrated approach provides the means to follow the material from the production phases of the billet/ingot (with the simulation of the continuous casting or of the ingot mould casting), to the heating, cutting, deformation, trimming and the heat treatment, carrying the stress accumulated in the part, as well as the porosity, the grain size and the related microstructural phases. The objective of all these activities is to support the achievement of the best possible value of the simulation, measuring its benefits on the real improvement of the process/product quality: considerable results can be obtain in the first weeks of simulation activities, with a ROI within a year, thanks to the method setting up along the years and with continuous assistance.

For further information and to understand the benefits applied to your specific requirements:
Marcello Gabrielli, EnginSoft - m.gabrielli@enginsoft.it

Ajei S. Gopal is the New ANSYS CEO

ANSYS, Inc. announced a leadership succession plan. James E. Cashman, who has served as ANSYS' Chief Executive Officer since 2000, will become Chairman of the Board of Directors effective January 1, 2017. Dr. Ajei S. Gopal, a technology industry veteran who has served as a member of the ANSYS Board since 2011, has been appointed President and Chief Operating Officer effective immediately and will continue to serve on the Board. Dr. Gopal will become Chief Executive Officer on January 1, 2017. Ronald W. Hovsepian, who currently serves as the Chairman of the ANSYS Board, will assume the role of Lead Independent Director as part of this transition.

Mr. Hovsepian said, "We are grateful to Jim for his remarkable leadership. He led ANSYS' transformation from a $50 million revenue company into the global market leader for simulation technology with nearly $1 billion in revenue, creating significant value for stockholders. On behalf of the entire Board, I thank Jim for his countless contributions and unwavering commitment to ANSYS. His decision to implement this leadership succession plan was made with much thought and consideration, and we appreciate him working with the entire Board to help identify his successor and facilitate a smooth transition. We all look forward to benefitting from his continued guidance, vision and expertise as Chairman."

Mr. Cashman said, "Over the past 20 years, we have grown ANSYS to become the world's leading engineering software provider thanks to our relentless focus on innovation and commitment to our customers. Today, ANSYS has the most talented employees in the industry, a best-in-class portfolio, more than 45,000 customers worldwide and a sound growth strategy to take us into the future. As we look to scale to $2 billion in revenues and beyond, I strongly believe that now is the right time to begin the transition to the next generation of leadership. Attracting Ajei, a technology industry veteran with an exceptional track record, is a huge win for ANSYS. I have come to know and admire Ajei as a fellow director, and I have no doubt that his outstanding leadership, unique perspective and appreciation for ANSYS' culture, people and organization make him the right choice to serve as our next leader during this exciting time."

Dr. Gopal is a 25-year industry veteran with extensive management and business development experience at large software and technology companies. He has held leadership roles at companies including Symantec, Hewlett-Packard, CA Technologies and IBM, and also brings start-up experience, having co-founded ReefEdge Networks. He joined Silver Lake in April 2013 as an operating partner.

Dr. Gopal's appointment as Mr. Cashman's successor follows an extensive search conducted by the ANSYS Board with the assistance of Heidrick & Struggles, a leading independent executive search firm. The search included a review of both internal and external candidates.

Mr. Hovsepian continued, "There is no better person than Ajei to lead ANSYS through this pivotal time in the Company's expansion. He brings a proven track record, expertise managing the scale and complexity of a global multi-billion dollar company and critical skills in software strategy, engineering, product management and development. Ajei has profound knowledge of our business and strategic direction, as well as significant financial discipline. We are excited to enter our next phase of growth under his leadership."

Dr. Gopal said, "I am honored by the opportunity to lead ANSYS. With an accelerating pace of innovation, ANSYS is on an exciting growth trajectory as it executes on its long-term plans. Jim's vision and tremendous leadership have set a high bar, and I am committed to building on our standard of excellence and pushing the boundaries of innovation to help customers solve their most complex design challenges. I look forward to working with Jim, the Board, our leadership team, employees and customers around the globe to continue our legacy and capture the vast market opportunity ahead to drive stockholder value."

Abouti Ajei Gopal

Dr. Gopal, 54, joined the ANSYS Board in February 2011. He has been an operating partner at Silver Lake since April 2013. In 2016, Dr. Gopal was seconded from Silver Lake to serve as interim president and COO at Symantec, leading the company through the acquisition of Blue Coat and the recruitment of a permanent CEO. Prior to Silver Lake, he was senior vice president and general manager at Hewlett-Packard from 2011. Earlier, Dr. Gopal was executive vice president at CA Technologies, which he joined in 2006. From 2004 to 2006, he served as executive vice president and chief technology officer of Symantec. Until 2004, Dr. Gopal was with ReefEdge Networks, a company he co-founded in 2000. Before that, he worked at IBM from 1991 to 2000, initially at IBM Research, and later in IBM's Software Group. He began his career as a member of the technical staff at Bell Communications Research. Dr. Gopal has 23 U.S. patents to his name and has a doctorate in computer science from Cornell University and a bachelor's degree from the Indian Institute of Technology in Bombay.

IRAN: a growing market open to advanced technologies

SAPCO seminar - 16th November in Teheran

A successful workshop on "Innovative application of High Pressure Die Casting process in the automotive sector" took place in Teheran on the16th November, 2016, thanks to the support of EnginSoft, MotulTech Baraldi, IDRA and IECI. The Italian delegation were invited by SAPCO, a subsidiary company of Iran Khodro group, to introduce state of the art advanced methods to design and control the full process.

Around 100 people participated in the workshop at SAPCO Auditorium in Teheran.

The HPDC seminar focused on the management and efficiency of the key equipment in the HPDC production line, with particular reference to the material injection process parameters and thermo-mechanical behavior of the die.
It is common knowledge that high casting quality and production efficiency are affected by the use of the equipment and by the optimization process, independently of furnace, machine or robot brands. The process knowledge and the methodology to design and optimize the process are essential to the proper use the existing (or innovative) technologies in the market.

EnginSoft (Nicola Gramegna) introduced the light alloy classification and their "castability" with reference to the HPDC, as well as the defects classification and correlation with process parameters.

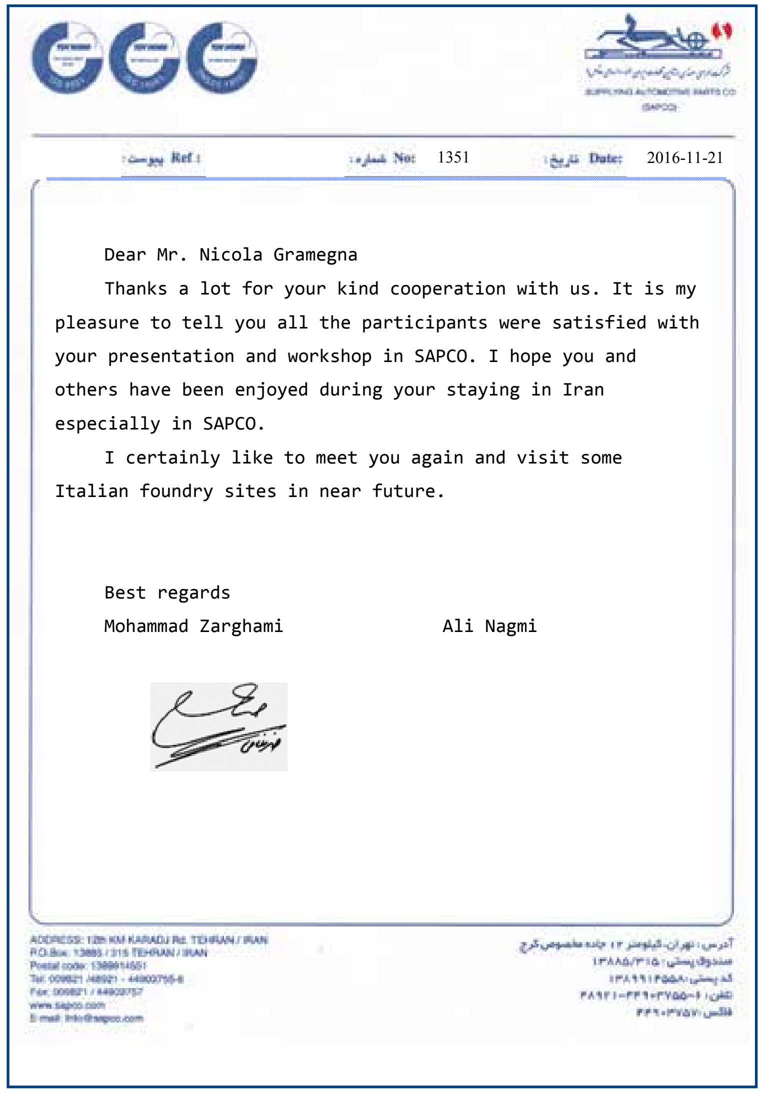
The use of the HPDC or SSR (Semi Solid Rheocasting) machine has described by IDRA (Paolo Romani) with a particular focus on the OLS machine and the innovative control panel 3.0, which represents the evolution of the technology, now available to take full advantage of the "Industry 4.0 new approach", concerning interconnectivity and data analysis fast management.

The end of the first session was referred to the design of the casting system and the optimization of HPDC process parameters, using the automatic optimization approach based on virtual simulation (EnginSoft).

The second part of the workshop provided the opportunity to introduce those factors contributing to the heat balance of a high pressure die-casting mold, as well as the impacts of the thermo regulation unit by IECI (Raniero Serana) and the lubrication phase by MotulTech Baraldi (Cosimo Raone). The use of TTV monitoring device was presented, paying attention also to the composition and application of release agents for HPDC, considering their effects on casts quality, thus reducing the occurrence of some defects. The relationship between lubrication phase and temperature distribution on the die surface was furthermore highlighted. As a consequence, it was underlined how the adoption of a system for temperature monitoring and control, like TOTAL THERMAL VISION, could meet these new needs and allows for the knowledge of the process to improve, as well as to develop specially designed die lubricants (CASTING TTV LINE).
IECI Thermo regulators explained the importance of a temperature control along the different stages of die-casting process. Special emphasis was given to the accurate temperature control of the shot-sleeve and the monitoring of the die-casting mold, to ensure a rapid and effective response to any change in process parameters. The IECI innovative control system was presented, since it's able to optimize the process parameters in an adaptive way. This ensures the greatest possible versatility with minimal waste of productive resources. An advanced global thermal control able to communicate in real-time with HPDCM and TTV monitoring was also examined.

The conclusions were summarized in the real-time Control of the HPDC process predicting the Quality at any shot, as results of the European co-founded project MUSIC. The reference papers and some copies of the books "The MUSIC guide to key-parameters in High Pressure Die Casting" and the "Smart Control and Cognitive System applied to the HPDC Foundry 4.0" were handed over.

The future business in Iran seems growing faster and faster with the support of key suppliers from Italy, recognized the leading country in casting process technologies for automotive components.



Ref.: No: 1351 Date: 2016-11-21

Dear Mr. Nicola Gramegna

Thanks a lot for your kind cooperation with us. It is my pleasure to tell you all the participants were satisfied with your presentation and workshop in SAPCO. I hope you and others have been enjoyed during your staying in Iran especially in SAPCO.

I certainly like to meet you again and visit some Italian foundry sites in near future.

Best regards

Mohammad Zarghami Ali Nagmi

Acknowledgments:
Mohammad Zarghami
Casting Processes Team Leader at SAPCO
and Ali Nagmi.

EnginSoft @ JEC Europe Composites Show Conference

Villepinte Exhibition Centre, Paris – March 14, 15, 16 2017

JEC world
International Composites Event
Paris, March 14·15·16·2017

EnginSoft – ANSYS Elite Channel Partner – participated at JEC Europe in Paris, the largest international gathering of composites professionals, on March 14th – 16th and hosted the Italian visitor at the ANSYS Booth (Hall 6 Booth S72).
ANSYS and EnginSoft talked with customers and attendees about composite simulation into the product development: pursuing the deep industry transformations and new market trends. The simulation of composites is no longer a separate solution, now it's fully integrated within the ANSYS comprehensive software suite vision. EnginSoft and ANSYS lead the companies to success in market competition through the use of engineering simulation to evaluate composite products and process performances, performing curing simulations and considering the interaction with embedded electronics devices.
The value of this collaboration is aimed to promote the use of ANSYS products for different engineering groups and to reach efficient and effective composite products with quicker time to market and reliable multiphysics performances.
For more information you can contact Eng. Marco Perillo who represented EnginSoft at the booth – m.perillo@enginsoft.com

EnginSoft CAE Tour 2017

The participation in the 2017's edition of the CAE Tour has been a great success for the presentation of the latest advances in numerical simulation solutions in the industrial field. The event, organized and promoted by EnginSoft, is an itinerant initiative that has reached 6 cities (Padua, Bologna, Bergamo, Turin, Rome and Mesagne) and has involved more than 250 analysts and designers globally.
The protagonist of this edition has been ANSYS 18 whose novelty and peculiar characteristics have been illustrated by EnginSoft engineers in two stages: in the classroom with presentations by discipline (Structural, fluid dynamics, electronics) and interactively through customized live demonstrations.
To complement the new release of the software house of Pittsburgh, some apps have been developed ad hoc by third parties, which increase so amazingly both the basic functionality and the specialization. Here the main ones are mentioned.
MDB for ANSYS is an extension of Workbench that allows to simulate the kinematics and dynamics of motion systems. Among the distinctive features, there is the ability to efficiently manage also complex contacts and flexible bodies.
Flownex is an environment for the simulation of a 1D System allowing the interaction with ANSYS, through dedicated API and to quickly and efficiently develop fluid-dynamic circuits.
GSAM is a topological optimizer integrated in ANSYS that allows to precisely optimize geometries and entire projects, in order to reduce weights or enhance structural characteristics. An application of the topological Optimization, generating a growing interest, is in the field of Rapid Manufacturing. Through the ability to generate forms and objects without morphological limits, normally dictated by traditional procedures, the modern equipment of Rapid Manufacturing allows to produce extremely efficient structures by altering the weight and the ability to withstand stresses. The presence of one of the most important suppliers of systems for Rapid Prototyping and Manufacturing at the CAE Tour, has offered the participants the opportunity to get to know and appreciate these technologies applied to an unconventional product development.
Last but not least, E4 Computer technicians have supported the Hardware best practices.

Next appointment with the CAE Tour will be in 2018.

33rd INTERNATIONAL CAE CONFERENCE AND EXHIBITION

2017

6 - 7 November

Vicenza Convention Centre
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Vicenza, Italy

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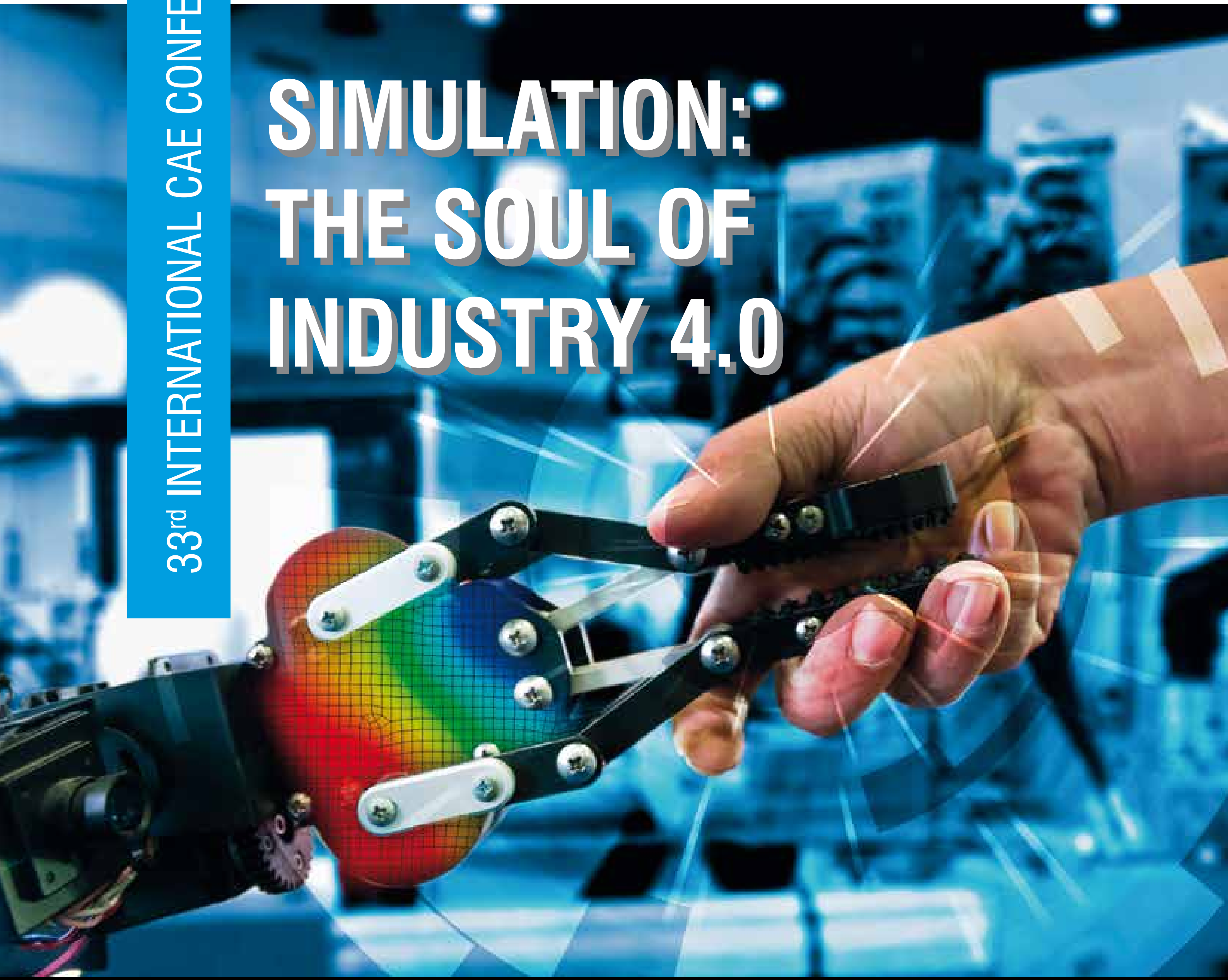

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