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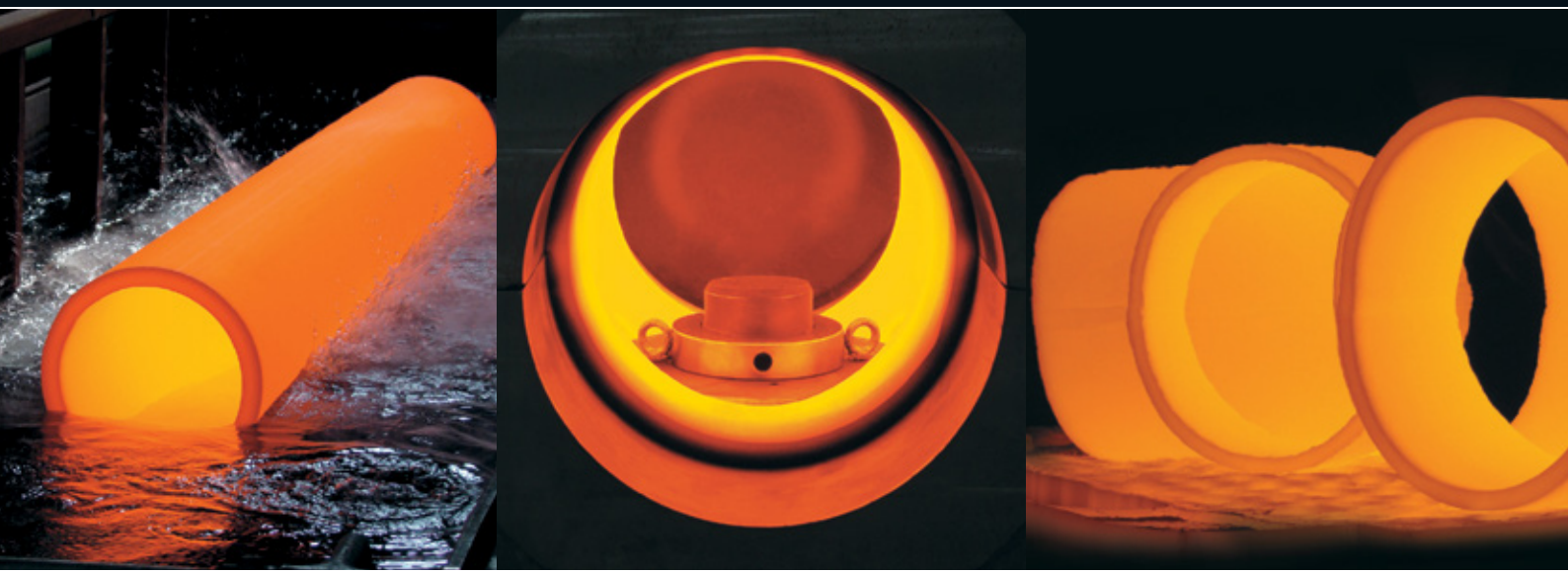

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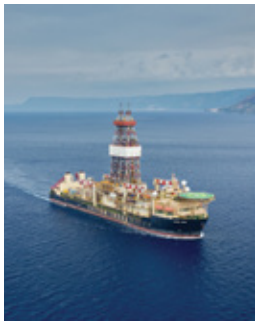

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Editorial

The restructured Italian Engineering and Contracting industry : ready for a come-back

Claudio Andrea Gemme
ANIMP President

Promoting growth, development, innovation and international industrial cooperation: these are the main goals of ANIMP, the association of Italian Engineering and Contracting companies, plant component suppliers and academia, which includes over 500 members, with the main focus on designing and building large industrial plants, worldwide. We have strived for more than 44 years to develop a world-class supply chain competitive in any global industrial plant market.

I am therefore proud to introduce also this year INDUSTRIAL PLANTS, our yearly publication for international audiences, which highlights some of our industry's recent achievements, projects currently under execution or recently completed, in international or domestic markets.

The last two years have been testing times: we have witnessed a collapse in oil and generally in energy prices, with a proportional decline in new investments in many industries. Our clients have rightly pressured us, general contractors and suppliers alike, to reduce our costs significantly and to improve the project delivery process, in order to accompany them in their quest to continue operating, to return to profitability and to grow in this 'new normal' market situation.

In addition, our industry inevitably faces numerous new challenges: a big shift and a convergence to new energy sources, the continuing and major geopolitical threats, many uncertainties regarding the implementation of new environmental and climate-change policies, to name just a few. At the same time, we see very welcome and often disruptive technology innovations, which are dramatically reshaping our industry.

Over these last two years the Italian industry has restructured and significantly improved its competitive position

Over these last two years the Italian industry has restructured extensively and significantly improved the competitive position of its supply chain. Firstly, by leveraging on the traditional resilience of our industrial system and particularly on the expertise in project management of our companies, many of

our players have implemented major turnaround programs. These efforts have not focused only on cutting costs and reducing the structural overcapacity in some industry sectors, although inevitably this had to be one of their first goals, but many have carried out much more comprehensive, all-encompassing strategic redevelopment programs.

Secondly, our industry has embraced new technologies and new market trends and needs, by starting to invest more and more in digitalization, automation and generally in new technologies development, and by repositioning the activities to new, more promising market segments.

We are pleased to see the first positive results of this streamlined and innovative effort, with the involvement in new, pivotal projects under way: for example, to produce gas from newly discovered, giant fields in East Mediterranean; to bring gas to Italy and through Italy to Europe from the so-called Southern Corridor; to foster decarbonization, via power production from wind, offshore, as well as from new solar plants positioned on old, decommissioned industrial sites; to produce ever cleaner fuels from bio-refineries; etc.

We are therefore ready for the next challenges and we look today at the future with more and better grounded optimism, in spite of inevitable and continuing competitive challenges and cyclic nature of our industry.

We see the first results of this innovative effort, with new, pivotal orders for major new projects

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Augmented Reality supporting revamping applications

How mobile and Augmented Reality technologies can help engineering teams in exchanging information in the revamping of a refinery

Michele Di Donato, *Amec Foster Wheeler*
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The revamping of a refinery is an intervention that, by means of a complex functional engineering activity, focuses on the optimization and/or recovery of existing plants. This kind of activity requires multiple engineering specialists to work together, i.e. it is a collaborative engineering task force. In order to start the activities, the customer (refinery) must provide the engineering specialists with the entire plant documentation they wish to revamp (Civil Drawings, Piping Layout, ISO, P & ID, Equipment Drawings etc.), and also provide the specialists detailed specifications. Combining the information provided by the customer with information taken by using laser scanning technology, which is a technology largely used to get geometrical information from the existing plant, the engineering team begins to work on the revamping activity. In case the engineering team is not equipped with any recent laser scanning technology, they must rely only on the documentation that the customer is able to provide.

Furthermore, when the team comes to the detailed engineering phase it may be that it is provided with documentation which does not necessarily reflect how the plant has been built, compared to how it was designed. So, the team might not know fundamental details such as the "routing" of an existing line, the position of existing supports (support points of the line), available measuring instruments on the line, or the position or size of the civil structures.

In these cases, it is necessary that members of the engineering team go to the plant site and verify the state of the plant, to collect the information necessary for the subsequent engineering activity. The site inspections are normally conducted with papers, pen, simple measuring systems and existing drawings. It may be that, during the site inspections, the engineering team needs to get in touch with other team members who are located in the technical offices in order to exchange information useful to the activity (for example, names of items or specific measurements).

In these cases, because of limited information that the two teams can exchange via phone calls, it is very complicated to instruct the team member who is on the site to get the right information.

For this purpose, we propose the use of a collaborative remote Augmented Reality (AR) application, which can help the two engineering teams collaborate to rapidly collect necessary and correct information.

This application was originally developed to support companies in their remote maintenance operations.

This application, which is based on a combinaton of mobile and augmented reality technologies, was initially designed as a support for industrial maintenance operations

It is based on a combination of augmented reality and mobile technologies. It enables several team members to exchange information by communicating with symbols, words or by sketching onto pictures taken in existing plants. Symbols, words, or sketches can be added to these pictures and the team at site can visualize this information superimposed onto the real environment, thanks to the use of augmented reality technology.

In our vision, the remote augmented reality application would help the two teams (the one on the plant and the one in the office) to interact by exchanging information in order to create a complete documentation of the site for subsequent interventions.

In the following, we describe the remote augmented reality application we developed for industrial maintenance operations, which might be used in such a situation to allow the team member at site to interact with those who are in the office and to better understand the demands made by the office team and to create the

missing documentation useful for the revamp activity. We will describe the original application and we will explain how this can be used in a typical revamp activity.

As an example, the team at site can request a list of the location of existing line supports, compared to the known fixed points (civil foundations or line notes) and the team in the office can indicate the information on the real site. This can reduce errors and speed up the collection of information.

Augmented Reality in industrial applications

Since the end of the twentieth century the research community has proposed the adoption of Augmented Reality (AR) as a support for industry. As an example, one of the steps of product lifecycle where Augmented Reality can be used with success, is that of commissioning. Here, all systems and components of a product must be installed and function as requested by the client. Georgel et al. [1] propose using AR to perform discrepancy checks following the construction of a powerplant. The idea is to find differences between a 3D CAD model and the constructed plant. Such discrepancies can arise from outdated building instructions, design incompatibilities or human errors. The proposed system aligns high-resolution images from the plant with the CAD model.

Allowing team members to communicate through text, symbols and free-hand sketches, this application was specifically built to work with low speed internet connections

Furthermore, since the beginning, AR has been recognised as being an interesting support in the industry for maintenance applications, assembly, and repair of machinery [2, 3]. For example, Feiner et al. in [4] describe KARMA, a prototype of an Augmented Reality system that presents a simple end-user laser printer maintenance application based on a see-through Head-Mounted Display. One of the main advantages of using an AR application compared to traditional documentation is that the operator can access the information necessary for performing the activities directly in the working area, without the need to refer to the traditional printed manual.

As described in [5] AR also is an effective training tool for maintenance and assembly that accelerates the technicians' acquisition of new skill on maintenance procedures. Haritos et al. [6] describe a mobile AR application for training in the field of aircraft maintenance, to replace traditional training practices, i.e. on-the-job training. The AR training system can be useful for job tasks training and for job tasks guidance for novice technicians in a real working environment. Regenbrecht et al. in [7] present some application examples, where AR is used in the automotive and aerospace industries.

In a previous paper [8] Bordegoni et al. described an application for remote maintenance based on the combination of mobile tools with AR technologies. The aim was to allow companies to perform remote maintenance activities on various industrial products, with no need of structured environments or high speed connections. Also, the application was designed to reduce the authoring time and was based on traditional input/output interfaces so that the skilled operator could use it for instructing the unskilled one. The application has been tested for years on industrial case studies and new functionalities have been introduced that can be useful in a remote collaborative maintenance task.

We propose the use of the same application for a collaborative design task for the revamping of a refinery.

Augmented Reality and mobile technology to exchange information

The architecture of the application is of type Client-Server, which well supports the connection of two or more remote team members, as illustrated in **Figure 1**. The engineers using the client application take some pictures of the real environment and send them to the server (office). These pictures are used for the client as a marker to correctly superimpose instructions on the real environment in augmented reality, and for the server to add information onto the real environment. Server and clients can exchange also text messages. Furthermore, the skilled operator can sketch on the picture.

The server can simultaneously communicate with one or more clients working on the same site.

The application has been developed so that it can be used with various hardware devices. Currently, the engineers in the office can use a personal computer, equipped with traditional input and output devices (keyboard, mouse and monitor), or a tablet or a mobile device equipped with the Android operating system or iOS.

The on-site engineers can use a tablet (which is also

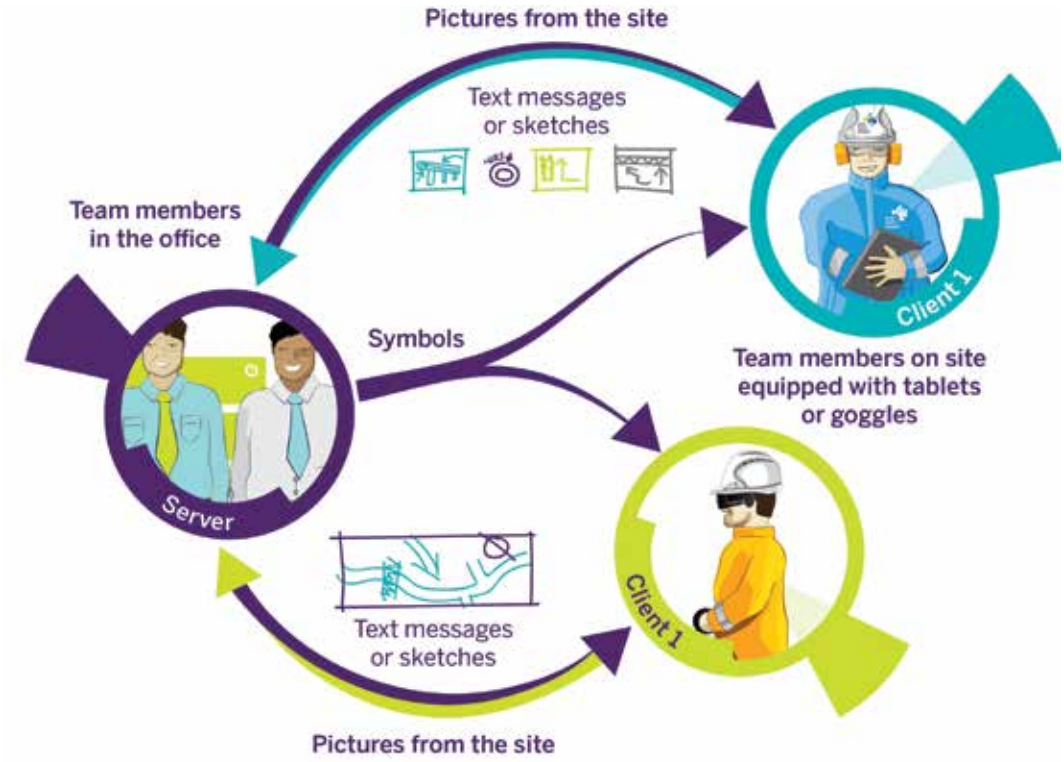

Fig. 1 System architecture: the team members can communicate thanks to a server/client system. On-site engineers send pictures of the real environment to the office engineers, who use them to locate instructions that will be sent back through symbols, sketches or text.

equipped with the Android operating system or iOS) through which they see a series of statements projected directly on the scene. Alternatively, they can wear helmets or any kind of AR goggles, which allow them to view the information simultaneously with the execution of the operation.

The application allows the user to decide whether to be server or client. On the server application (**Fig. 2**) the server user can choose what information symbol to display (e.g. unscrew, screw, location indication, warning, disassemble, assemble, etc.). Through the arrows, he can move the symbol to the correct location. Through the chat system he can also send text messages and, through the annotation system, he can sketch on the picture.

In the client part of the application (**Fig. 3**), the team member through the AR window sees the symbol the other team member chose and moved, superimposed onto the real environment in the correct location. In the top-right part of the screen are located the buttons to take a picture of the real environment. These pictures are used as markers. The button allowing to take a picture only appears if the program recognises the picture as a potentially good marker.

During the various phases, the client can update the image and send to the server, allowing the server to see the new scenario on which the client is operating.

In this way, the server and the client can exchange information, and during a revamp, they can get the information missing from the available documentation.

Discussion

In this work, we discussed how Augmented Reality can be effectively exploited for the revamp of a refinery. Our

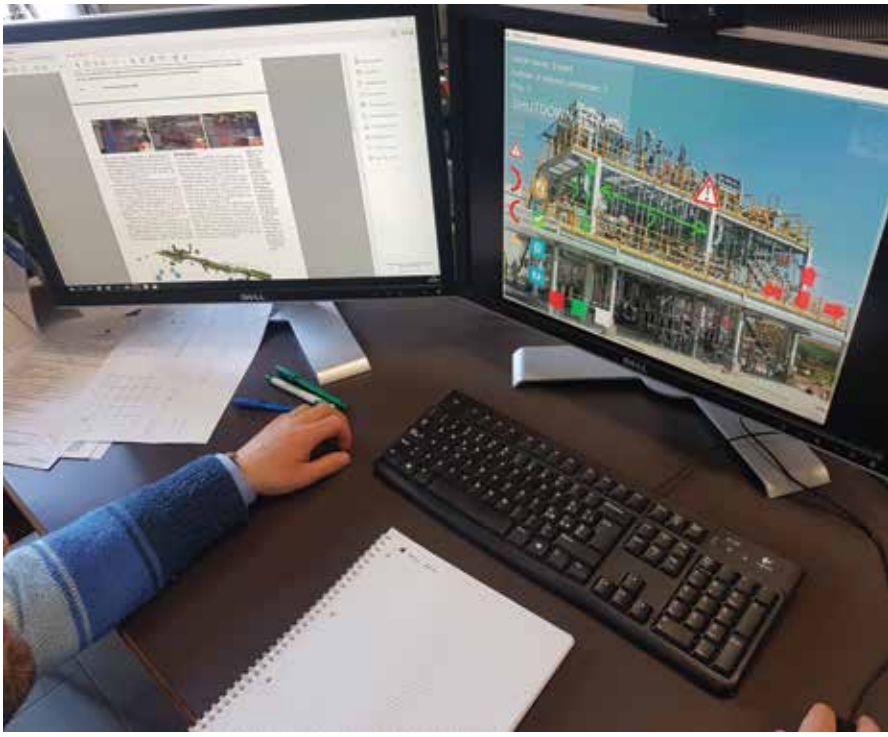

Fig. 2 The server application. The user, once they have received a picture from the client, can add text, symbols and sketch on it.

Fig. 3 The client application. The user sees what the server sent (text, symbols and sketches) superimposed onto the real environment.

idea is to use collaborative remote AR as an exchange channel between a team of experts (server application) in their offices, while technicians (client application) are on site at the refinery. The functioning of the application is very simple:

- the client sends relevant pictures of the site to the server;
- the server annotates each picture with useful information in the form of two-dimensional signs, text, freehand notes;
- the client watches annotations in place, even if the display device is moving;
- the client and the server can also communicate with a chat.

For a refinery revamp study, this application can be used to provide the team of experts with fundamental details such as the "routing" of an existing line, the position of existing supports, available measuring instruments on the line, position or size of the civil structures, and so on. The experts can use AR annotations to guide the technicians on the site to help them obtaining this information.

The main advantages in the use of this AR application for the revamping of a refinery are the following:

1. Communication from office to site improved: fewer misunderstandings due to the help of visual hints.
2. Reduced cost, using the local workforce, even if not skilled, to accomplish the tasks.

The proposed application is currently being improved to meet industry needs.

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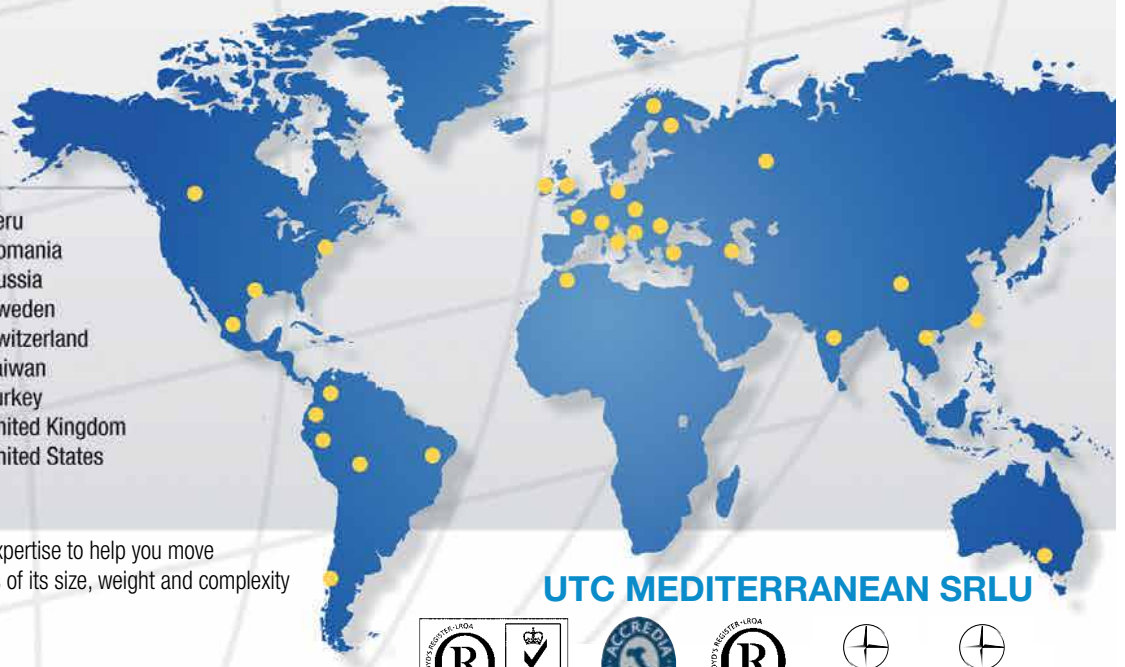

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Hybrid propulsion for small medium vessels assisted by energy storage systems

The hybrid propulsion is a combination of a mechanical propulsion and of an electric propulsion. The system can be assisted by an energy storage battery in order to smooth the power peaks, to reduce emissions and to increase the response time of the mechanical propulsion

Giordano Torri, CTO Fincantieri SI spa

The requirements for reducing the environmental pollution and emissions in port or in lakes or in protected waters has become an important issue around the world. This need implies new design approach for harbor tugs, ferries and in general for smaller vessels. These vessels have variable working cycles lasting for a short period of time that require engines running in a wide speed range, changing frequently speed and power too. It turns out that the efficiency is lowered and the fuel consumption gets higher and higher. In order to mitigate this effect and improve efficiency, the hybrid solutions have been provided for propulsion.

Basically, an hybrid propulsion system is a combination of a traditional internal combustion engines (ICE) and of a propulsion electric motors (PEM). They can work together, sharing the load or they can work separately, according to certain rules of managing the vessels. An important equipment introduced in hybrid propulsions is represented by the so-called electric energy storage systems (EES). Typically it is based on electrochemical batteries, acting as a tank of energy to be used according to the power demand. This method helps in increasing the overall efficiency of the propulsion system and it also provides a mean for getting a faster response time in terms of torque. In this paper a solution is presented and the key elements are described, along with an example applied to an harbor tug.

Required operational modes

Before entering in the technical details of the hybrid solution,some typical data of the operational modes of these vessels are shown in order to better understand the reasons why the hybrid solution is beneficial. The case of an harbor tug is quite representative due to its working cycle. An harbor tug requires a high propulsion power, normally used for a short period of time and a relative small power for auxiliary onboard equipment. The propulsion power can be in a range of 3.500 – 5.000 kW while the auxiliary engine is about 50 to 120 kW. Three main operational modes can be identified: idle, transit and working. In “idle” mode the tug is waiting for an operation and its consumption is basically due to the auxiliary equipment, since no propulsion is required. In “transit” mode the tug is navigating to the area of operation. The transit can be either at a speed lower than max (typically around50% of max speed) or close to its max speed. In “working” mode the full power is required because the tug must assist the ship. According to various experiences reported in many papers, the operational cycle of a tug (the combination of the three states said above) spans for a time about 3.000 to 4.000 h/year and it requires an average power of about 30-40% of its rated full power. The full power is then used for approx. 15% of the total time. As an example, a full cycle of about 2:30 hours is taken into consideration (transit and working) and the total time is divided in three zones as in **fig.1**: transit, working and transit again. Transit lasts for 1 hour (T0-T1 and T2-T3) while working for 30 minutes(T2-T3). Of course this simplification is not accurate, however it can be useful for explaining the hybrid concept and how to conceive the size of the various equipment and its usage. It must be noted that each harbor tug has its own operational mode and this

In this paper a solution is presented and the key elements are described, along with an example applied to an harbor tug

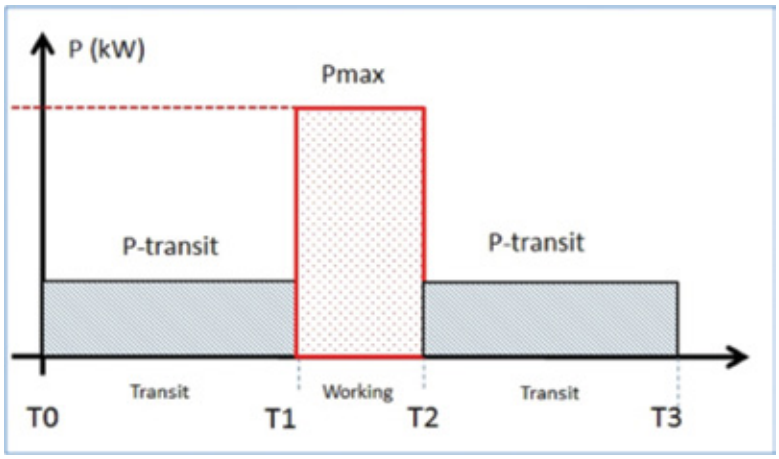
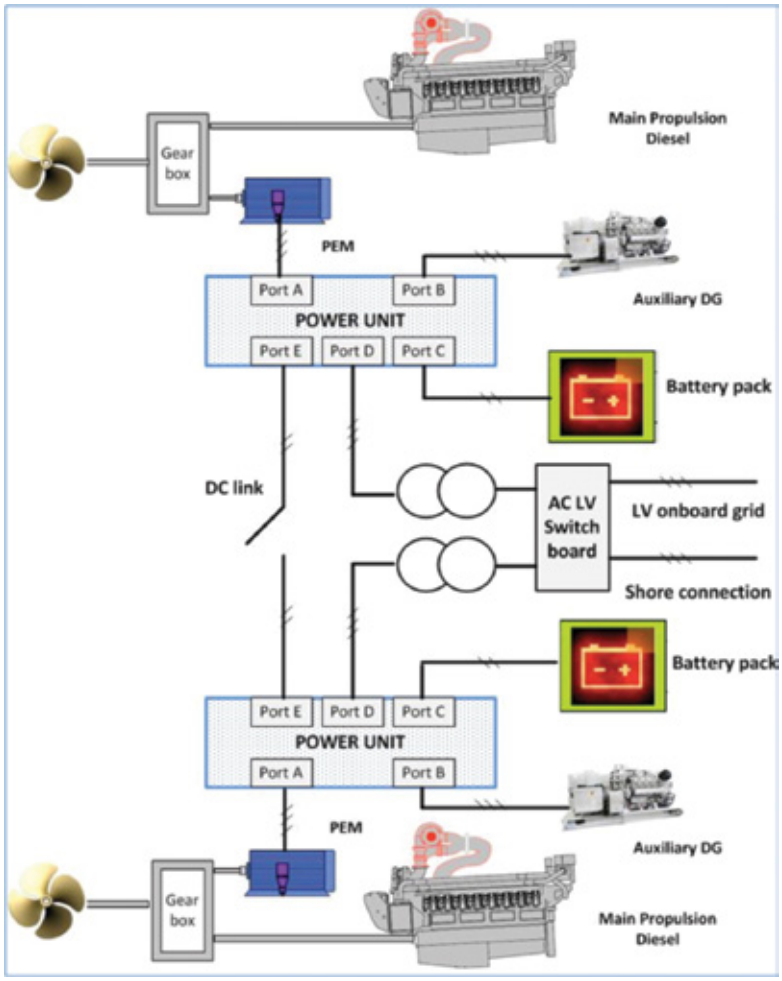


Fig. 1- Simplified load cycle for an harbor tug.

example can be taken and modified accordingly. Another important feature to take into account is the reaction time of the propulsion equipment when a sudden increase in power is requested for fast accelerations, in order to get the best maneuverability. The hybrid solution assisted by an energy storage equipment can satisfy the need of improving the efficiency and of getting a faster power response.

This power unit can be seen as a 4-power-port equipment, with the capability of adding a 5th power port for sharing its internal dc bus with the other power unit in order to offer redundancy

Fig. 2- Electric system for an hybrid harbor tug.



Hybrid propulsion assisted by energy storage system

The basic schematic of the electric system of an hybrid tug is shown in **fig.2**. The solution provides two shaft lines, driving the thrusters. Each shaft is driven by an ICE and a PEM is mounted on the same shaft or on the gearbox. The PEM can drive the propeller by itself or in parallel to the main diesel. For each shaft line an electric Power Unit is provided. The Power Unit performs the following tasks: i) controlling the charge and discharge cycles of the battery, ii) connecting and controlling the power given by the auxiliary generator, iii) providing energy at fixed voltage and frequency to the auxiliary onboard equipment, iv) driving the PEM in two modes, motor or generator according to the power flow required. This power unit can be seen as a "4-power-port"equipment, with the capability of adding a 5th power port for sharing its internal dc bus with the other power unit in order to offer redundancy.

The power unit

The design of the power unit is based on an HW solution that comes from the industrial world and known as a "common DC bus", multi-converter system. The simplified schematic is shown in **fig.3**. The internal structure shows a DC bus that connects four power converters, each one with a specific function and serving a dedicated power port. Each power converter is equipped with a dedicated control system. The DC/AC power inverter of port A is used for driving the PEM at variable voltage and frequency. It's a bidirectional three-phase inverter, with a vector motor control algorithm, that can run the PEM either in motor mode or in regenerating mode. The DC/AC power inverter of port B is used for controlling the power generated by the auxiliary generator. Here the active power flow is unidirectional. The inverter can provide reactive power to the auxiliary generator and it allows the usage of an induction generator instead of a synchronous rotating machine, with the advantage of a less expensive and simpler solution. The DC/DC power converter of port C connects the battery to the internal dc bus and can manage the power flow in both direction. It controls the current either in charging mode (step down) or in discharging mode (step up). The DC/AC power inverter of port D provides a fixed voltage and frequency to theonboard grid that feeds the auxiliary equipment. This inverter is reversible. When the vessel is at the quay, the shore connection can also be used in order to get energy

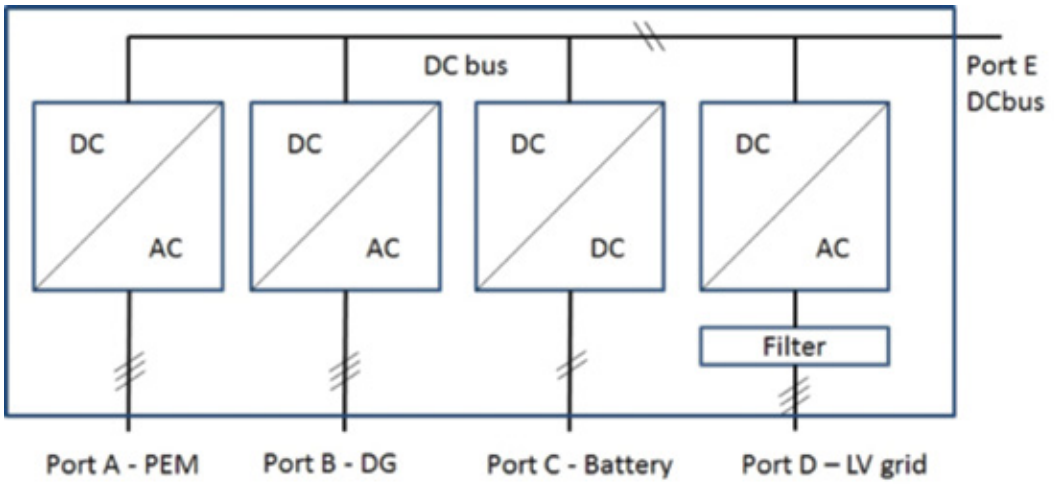


Fig. 3- Schematic of the power unit. A dc bus links three inverters and one dc/dc converter for the battery.

from the shore and switching off the on-board auxiliary generators. In such a case the inverter of port D takes the energy from the shore and feeds the internal dc bus, allowing a recharge of the battery from the shore. The last power port E is used for connecting the dc buses of the two systems. A disconnecting switch is also provided in between.

Electric motor

The PEM can be sized as a fraction of the main propulsion diesel with two scopes. First of all it can work as an helper in parallel to the main diesel at full power, for giving an extra power boost and for making a faster transient response either to sudden load increase or to sudden torque request from the lever. Second, the motor can drive the vessel at low speed without the need of keeping the main diesel running. This feature is desirable especially in transit, when the speed is less than 40-50% of the max speed and the power demand can go down to 20-30% of the max power. In such a case the main diesel would work in an non optimal way and its efficiency would be lowered. Using a PEM, whose rating is about 20-30% of the max power demand, the efficiency of the system is improved. Due to the intrinsic characteristic of an electric machine driven by an inverter, the PEM can be designed for a base speed of 50% of max speed. It will run in constant torque mode up to the base speed and in constant power mode over the base speed and up to 100% (**See fig. 4**). Of course, the PMS can also provide a command for running the PEM as a generator in order to recharge the battery and providing power to the LV network. If so, the mechanical power taken from the main diesel is converted into electrical power by the PEM.

Battery system

The capacity of the battery is determined by the duty requiredduring the full cycle. Assuming patterns as in fig. 1 for calculation, the first step is to identify when the battery is requested to provide energy to the loads and when the battery can be recharged. The main load for the battery is the PEM. In transit mode the PEM can be used for the electric propulsion, while in working mode it can be used as helper to the main diesel. In between, the recharging time must be identified. In order to provide the proper energy balance during the full cycle, the energy taken or given to the battery vs. time must be plotted over the power diagram of fig. 1, as shown in **fig. 5**. The simple diagram shows that the vessel can be started in electric propulsion only, up to approx. half speed. Then, before arriving to the working zone the main diesel is switched on and it provides power to the propeller as well as to the battery in order to restore the full charge of the battery.

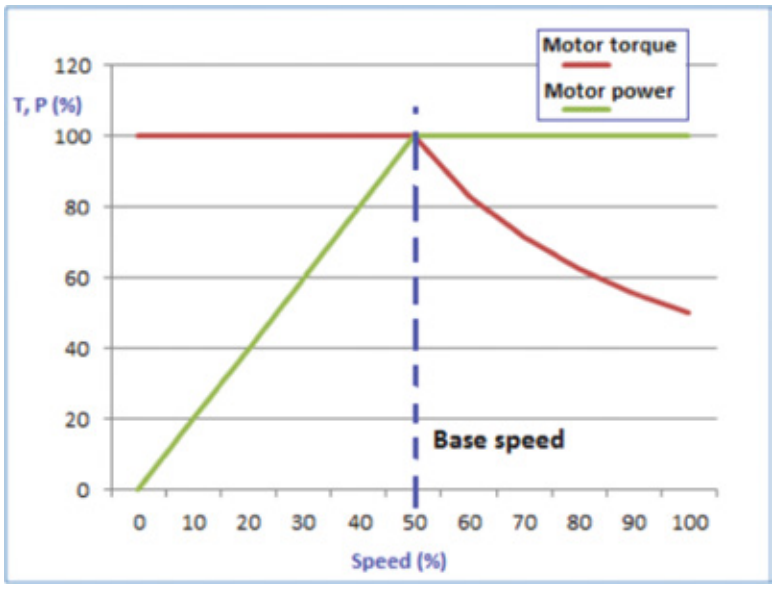


Fig. 4- Power and Torque as a function of speed for the PEM.

The capacity of the battery is determined by the duty required during the full cycle

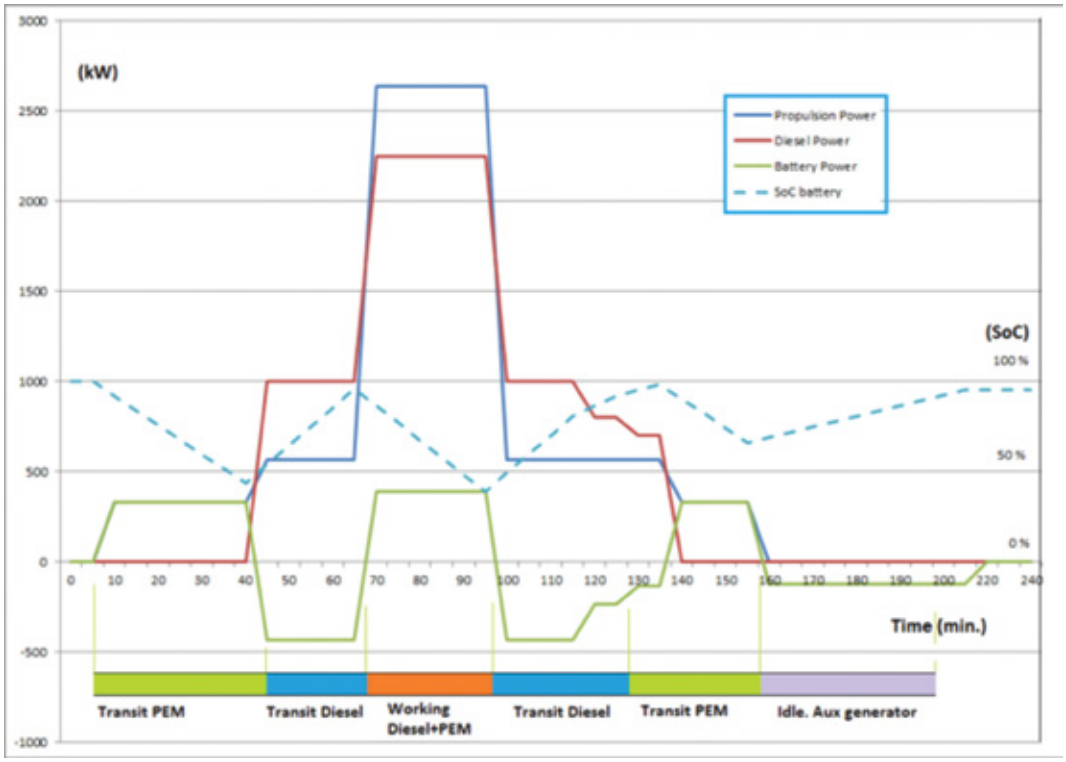


Fig. 5- Power vs. time and SoC of the battery during the tug's cycle. The usage of the PEM and of the diesel is shown.

The diesel works now at a power level approximately twice the power requested for the transit speed and the specific consumption improves. The time to start the main diesel is calculated according to the need of beginning the working phase with the battery fully charged. During the working phase, the battery can assist the main diesel either increasing the continuous power level or compensating the dynamic power response in order to make any maneuver faster. After the working phase, a transit phase follows during which, in the first part, the main propulsion diesel is kept on in order to restore the charge of the battery. In the second part of the transit the PEM can be turned on again and the main diesel can be switched off. Then, after the transit, when the tug is in idle, the charge of the battery can be completed by the auxiliary generator, providing its full power. Of course during the charging and discharging phases the current given or taken to/from the battery must be within its capability. Another important factor to be calculated is the number of cycles that a battery can sustain during its expected life time. In a power cycle as in fig 5 two/three charging and two/three discharging phases can be identified and the DoD could be around 40 to 60%. Taking into consideration the number of cycles per day it is easy to identify the requested number for its entire life. Typical values go up to 10.000 to 15.000 cycles. There are many types of batteries available on the market. However between them it is important to identify the most suitable for the so-called "power duty", that means batteries that react fast and can provide higher currents in excess of their amp/hour rating for short time. The Lithium based technology offers these performances. Another key issues is the required certification issued by the certification bodies, in order to provide safe and reliable solution for on board.

The integration of a PEM in parallel to the main diesel helps in reducing the fuel consumption and improves the response time of the propulsion system when in maneuvering

Power management system (PMS)

The system shown in fig. 2 needs a PMS in order to provide the proper sequences of operation and to coordinate the performances of each component. The target is to attain the maximum efficiency and the best performances for the vessel. The PMS can be configured as a system on top of the two propulsion lines and coordinates the equipment tied to the dc cabinet as well as the main diesel, the auxiliary diesel and the shore connection. Among the features provided, the monitoring of the SoC of the battery is essential, in order to define the right time of switching on and off the main diesel and the auxiliary diesel when in transit or in idle, in order to provide the best energy performances.

Case study

As an example, the data of a typical harbor tug are given. The main diesel is chosen with a power rating of 2250 kW @ 1800 rpm, as shown in **fig. 6**. The propeller curve is shown as well. Since the propeller requires

2650 kW @ 2.000 rpm, the PEM provides a boost to the diesel at max power/speed, as shown in fig.6. The PEM is capable of delivering 500 kW and it is connected in parallel to the diesel by means of the reduction gear. So, a max propulsion power of 2750 kW is met up to 2000 rpm, combining the 2250 kW of the diesel engine and the 500 kW of the PEM. A margin of 100kW is kept over the expected max propeller power. The base speed of the PEM is set at 1000 rpm where the 500 kW (the rated power) is given. Over 1000 rpm the PEM works in a constant power mode up to 2.000 rpm.

From zero speed up to 1000 rpm the propulsion can be provided by the PEM only. The electrical propulsion lasts as long as the battery charge remains over a certain value. During the transit the PMS monitors the SoC of the battery in real time and when the SoC goes too low the PMS switches on the diesel. The latter provides either the propulsion power or the energy for recharging the battery before the working area is reached by the tug. The fig. 5 shows the cycle described.

Considering the energy required by the PEM in the working mode, the battery must provide approx. for 30 minutes 230 kWh with a 60% of discharge. If so, the battery pack should be rated 380 kWh @ 2C with a minimum safety margin in SoC and energy. The battery has the same 2C rating either for charging or discharging.

When the working mode has ended, the tug begins another transit. During the first part of the transit the diesel provides either the propulsion power or the energy for recharging the battery, as infig. 5. When the battery is fully charged the PMS can switch off the diesel again and making the PEM provide the power for the remaining transit time. At the end of the cycle the battery has lost part of its charge again. In order to restore the full SoC the auxiliary generator is switched on. This generator is rated 150 kVA. The tug is in idle and its power need is quite low so the auxiliary generator con deliver about 70% of its power to the battery.

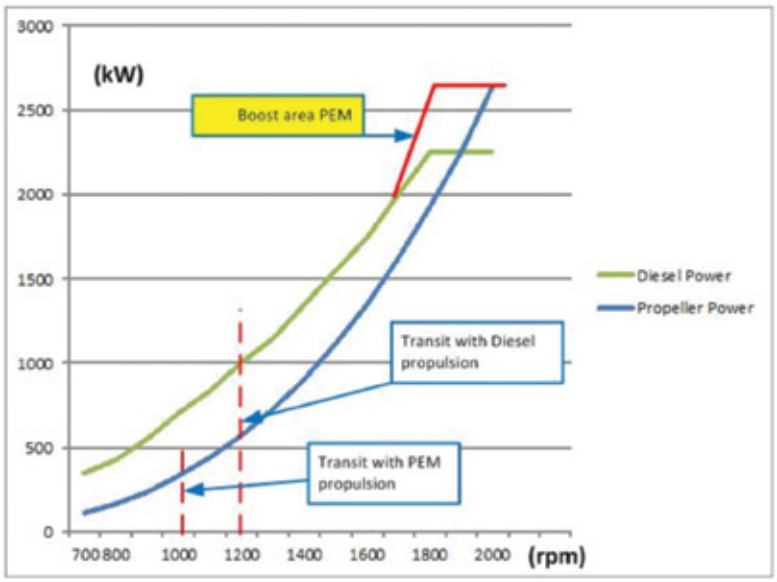


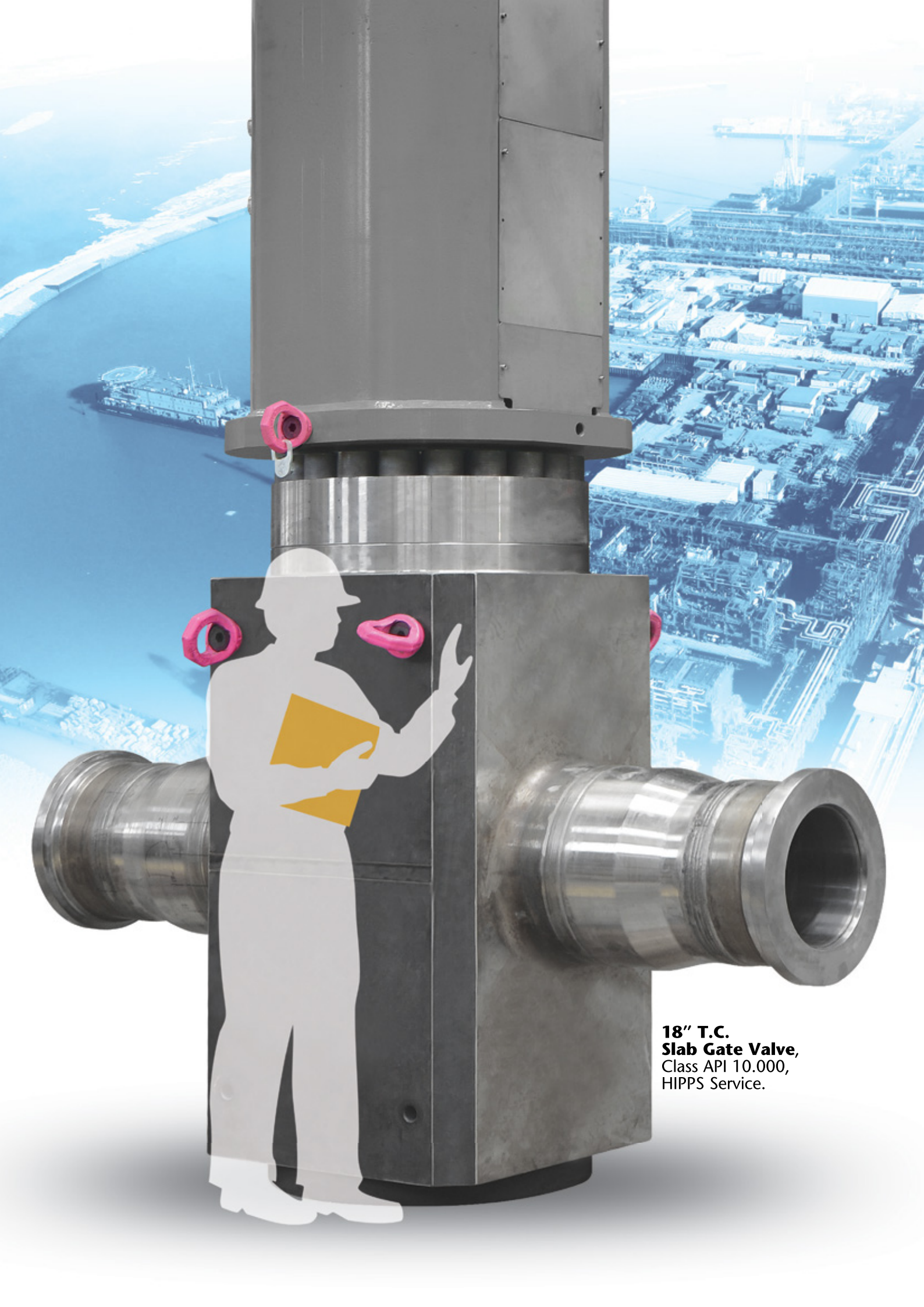
Fig. 6- Diesel and propeller power vs. speed. The transit speeds and powers are shown.

Conclusion

The paper shows some basic consideration for an hybrid system for vessels that work in a wide variable power range. The integration of a PEM in parallel to the main diesel helps in reducing the fuel consumption and improves the response time of the propulsion system when in maneuvering.

Giordano Torri

Giordano Torri was born in 1953. Degree in Electronic Telecom Engineering at Pavia University, 1977. At present, Chief Technology Officer at Fincantieri SI. In the past he covered the role of R&D and Engineering director at Ansaldo Sistemi Industriali. He devoted most of his activity to the development of solutions and products for the static conversion of the electric energy and for the electric power drive systems in industrial, transportation, energy production and energy distribution fields. Recently he was responsible for projects for Smart Micro Grid, Energy Storage, Renewable Energy and Hybrid Propulsion Systems.



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Successful design and construction of world largest H-Oil™ project

Challenges and achievements of a complex technology project under EPC LSTK Contract in a multicultural context.

Stefano Polimeni, *Technip Italy S.p.A., TechnipFMC*

In 2015 Technip Italy completed the construction, commissioned and supported the start-up and initial operations of the largest Vacuum Residue Hydrocracker based on Axens H-Oil™ technology ever built. The unit has been constructed in Bourgas on the Black Sea coast of Bulgaria for Lukoil Neftochim Bourgas (LNB), subsidiary of the Russian major oil operator Lukoil. The project results have been presented as a world class reference in workshops [1], [2]. This paper focuses on the challenges, the expectations, the achievements of LNB H-Oil™ project (HRPC) and of the key factors for the successful project execution.

The history of the HRPC project – objectives, process selection

On 1st January 2007 Bulgaria became a full member of the European Union. This fact became a key determinant factor in choosing the refinery development strategy. Harmonisation with the European requirements for fuels quality, environmental legislation, as well as the increased competition by European oil products producers in the area of the Balkans and south-east Europe, were Lukoil key factors to set new goals for the refinery:

- Improved refinery economic performance, including thorough increased production of light fuels with high added value and total increased conversion of up to 90%.
- Compliance with the long-term requirements of European and Bulgarian legislation regarding product quality through commissioning additional deep oil conversion processes.
- Reaching 1st -2nd quartiles of Solomon indices for Central and South-Eastern Europe
- Assurance of compliance with the long-term environmental requirements

This major undertaking was successfully completed due to a collaborative, 'win-win' approach from all parties throughout the entire project, with an EPC LSTK contract based on the Open Book Estimate developed during the FEED phase

To achieve these goals LNB executed a master plan considering several different refinery development scenarios. After completing economic and marketing analysis, the heavy residue hydrocracking process was considered the most attractive project.

The Complex Development Program was prepared providing for a heavy residue processing complex construction based on vacuum residue hydrocracking process H-Oil™ licensed by Axens.

The deep conversion units in the refinery

Deep conversion units in the refinery increase the conversion of the crude oil into more valuable products such as gasoline and diesel, and minimize the production of fuel oil by increasing the hydrogen to carbon ratio of the upgraded feedstock. The increase of the hydrogen to carbon ratio is achieved either rejecting carbon, using delayed coking technology or adding hydrogen. Table 1 compares major features of the two main technologies available in the market.

Delayed Coking	Residue Hydrocracking based on Ebullated Bed Technology
Delayed Coker is widely diffused for its maturity, flexibility and ability to handle all kind of feedstocks. It is a thermal cracking process that provides a complete rejection of metals and residual carbon as coke and provides high yields of distillates.	Residue hydrocracking is a catalytic cracking process that utilizes ebullated bed reactors to simultaneously achieve the metal and CCR removal, desulfurization and conversion reactions.
Main advantages ▪ Move towards zero fuel oil production. ▪ Lower capital investment	**Main advantages** ▪ Quality of distillates ▪ Marketable low sulfur fuel oil
Main disadvantages ▪ Coke storage and handling environmental issues ▪ Coke marketing (disposal)	**Main disadvantages** ▪ Hydrogen consumption ▪ Higher capital investment ▪ Sediment control
Installed base On a world-scale basis, presently approximately one-third of installed residue upgrading is by delayed coking	**Installed base** In last 25 years there were around 20 units built based on ebullated bed technology installed worldwide

Table 1 Residue upgrading technologies comparison

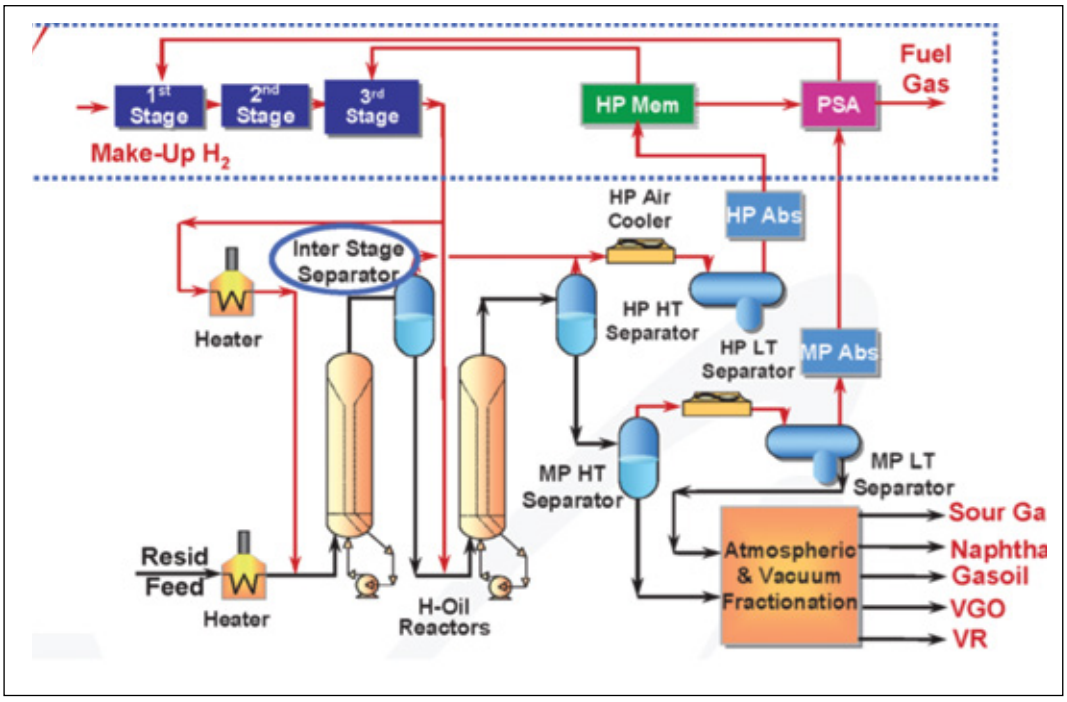

Figure 1 Axens H-Oil™ Residue Upgrading Process Scheme

Delayed Coking and Residue Hydrocracking have both supporters and detractors in the oil refining market.

Supporters of the Delayed Coking highlight the reduced capital investments and fuel oil production minimization and criticize hydrocracking for its high hydrogen consumption, large investment requirements and the challenging sedimentation control.

Factors supporting the choice of hydrocracking are the high quality of the obtained distillates and the low-sulfur fuel oil market prospects, opposing to the difficulties intrinsic in Delayed Coking process mainly due to environmental issues related with the coke production and storage and to the marketability of produced coke.

Both processes have significant technological and operating critical aspects that requires specific experience in design, construction, commissioning, operation and maintenance. But while delayed coker technology is widely diffused vacuum residue hydrocrackers are much less implemented in refineries and present serious challenges.

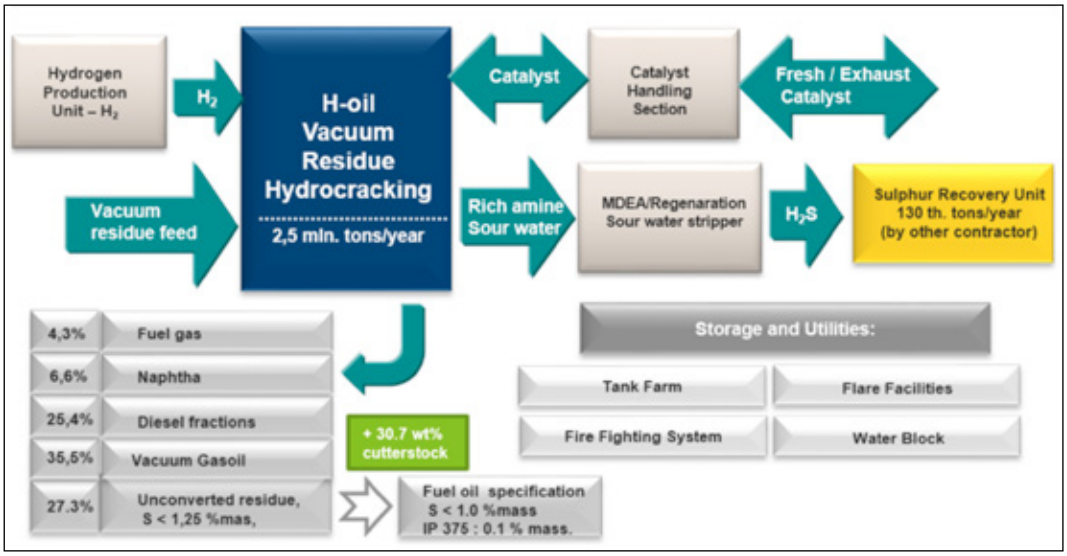

Figure 2 HRPC Project Scope

The specific nature of the capital investment for HRPC was an important factor on the selection of the project execution plan by LNB.

Lukoil Neftohim Bourgas Heavy Residue Hydrocracking Complex project

The main unit of the complex is the 7500 Tpsd Vacuum Residue Hydrocracker consisting of two-reactors with interstage separator. This configuration is designed to provide a conversion rate of 70% with the design crudes. The unit includes an atmospheric and vacuum distillation section, a recycle gas compression and purification section with membrane unit, a swing adsorption unit and a unit for catalyst handling.
In addition to the main hydrocracking unit the complex includes a hydrogen production unit, a MDEA regeneration unit with sour water stripper, two-train sulphur recovery unit, a tank farm, flare systems, fire-fighting system, a condensate/water unit and other auxiliary facilities.
With the exception of the SRU, which was built under another contract, all these units were contracted to TechnipFMC.

Few figures provide a brief highlight of the project size:

- 16 million construction man-hours
- 43000 cubic meters of concrete
- 13800 tons of steel structures
- 16500 tons of equipment or 490 items
- 2000 km of cables – Instrumentation, power and control, electrical tracing
- 220000 m2 of insulation
- 7000 Instruments
- 5 buildings
- 1250000 dia inches of welding

The complex processes 7500 Tpsd and 77000 Nm3 of H2 converting the feed in 4,3% of fuel gas, 6,6% - virgin naphtha, 25,4% - diesel fuel, 35,5% vacuum gasoil, 27,3% non-converted vacuum residue used to produce low-sulphur fuel oil.

Project phased execution

Lukoil is a major Russian oil & Gas operator that has over the years pursued a policy of internationalization of its investments. The project execution strategies often replicated the local market prevailing contracting schemes but recently and in special consideration of the technological complexity of the projects Lukoil has introduced alternative ways of contracting. The chart of **figure 3** shows how LNB introduced a new contracting strategy in its Bourgas refinery.

The important H-Oil™ project was sanctioned and approved by Lukoil board in progressive steps for a total investment of 1,5 Billion US$, resulting in the major refining project in Europe in the period.

After the master plan approval and the Process Design completion by the Licensor Axens the project started with the competitive bid for Front End Design finally awarded to Technip Italy.

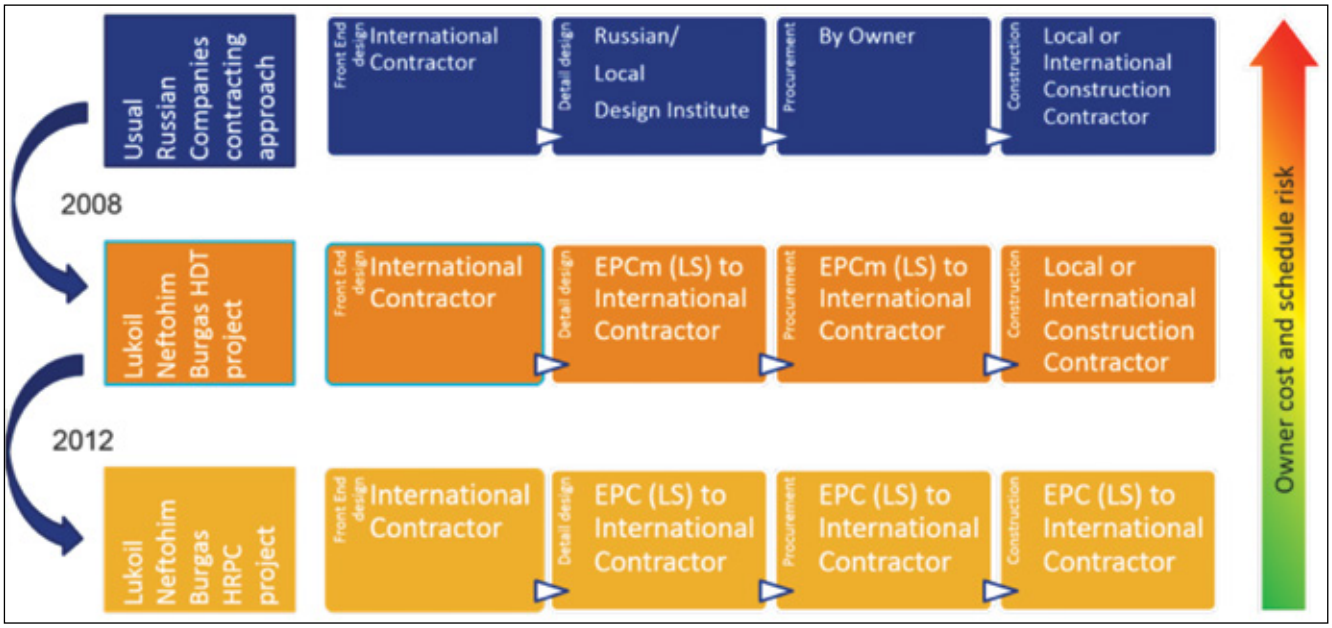

Figure 3 LNB Contracting strategy

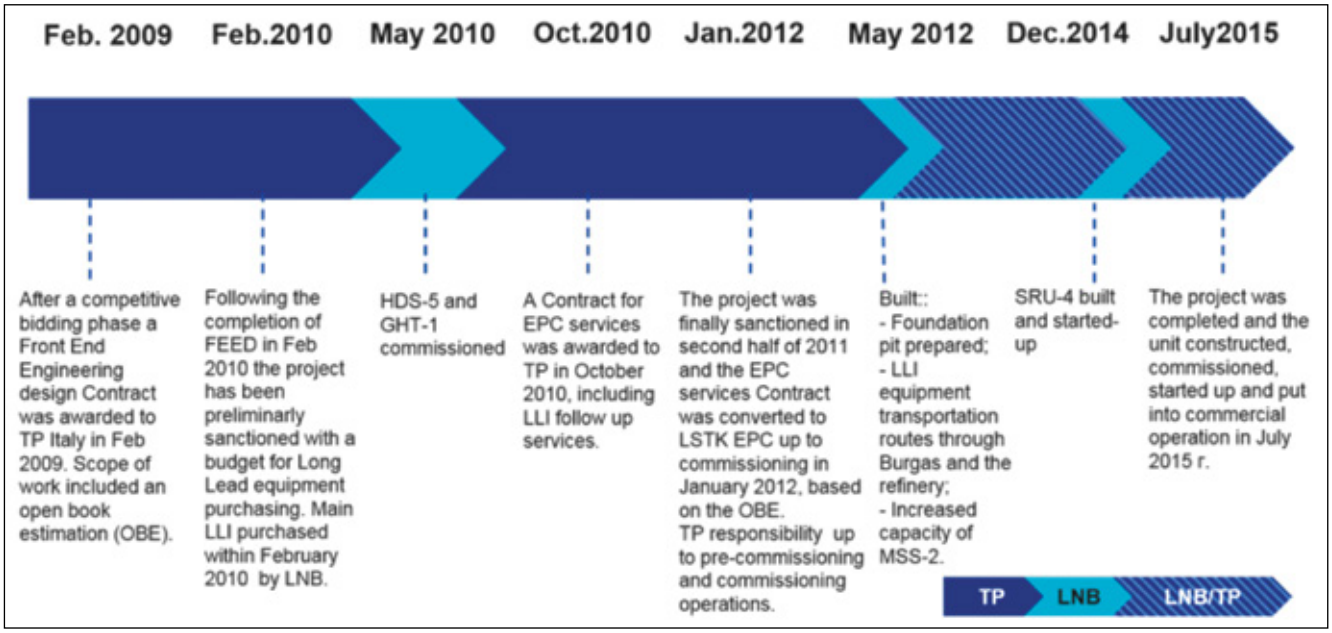

Figure 4 HRPC Project Phases

The project had a period of reduced pace from Feb 2010 to Jan 2012 waiting for the full sanctioning and clearance of permitting by Bulgarian authorities. In January 2012 an EPC LSTK Contract following the agreement of the Open Book Estimate was awarded to Technip Italy. The planned EPC time for completion was 36 months.

Project contractual scheme as a result of project risk assessment

General considerations

The project execution was based on a staged approach:

1. Master plan by LNB
2. Execution of Front End Engineering Design (FEED)
3. Purchase by LNB of Long Lead Items (LLI)
4. Preparation of Open Book Estimate (OBE)
5. Award of an EPC Contract based on LSTK Contract

Though during the FEED no pre-determined contractual scheme for the EPC was selected by LNB several driving forces supported a collaborative approach for the execution of HRPC project.

There are several factors that affect the possible execution scheme and contracting approach in a megaproject; the subject is very much debated in the academia [4] and in the industry [5] because globally

the capital efficiency in large projects is not fully satisfactory. Differences are wide in the public and private sector, in National Oil Companies (NOC) and joint stock companies, and among the field of activities [3].

In oil and gas projects two major contracting approaches are used:

1. The single source LS contract basis, after a phase of project shaping (Design and Build or EPC LS(TK))
2. The multiple source Design-Bid-Build or EPCm/ reimbursable style, in which engineering, procurement and construction are executed by different parties with only limited LS portions and interparties responsibility.

The main factors affecting the possible execution scheme are:

- Definition of project scope
- Owner skilled resource availability
- Technology maturity
- Project schedule
- Geographic area
- Contractors market situation
- Owner project risk management methods
- Local legislation requirement
- Local content requirement
- Project financing requirement

Naturally the legacy technical development and project execution background of each country affects significantly the selection.

Russian Oil&Gas companies' projects are largely executed on a design, bid, build scheme (EPCm/ EPs+Cm), though with some increasing trend in implementation of EPC LS(TK).

Overseas Oil & Gas companies project contracting scheme are more diverse but with a large predominance of EPC LS(TK), especially for megaprojects (>1 Billion US$)

The two main families of contracting approaches have some statistical difference in their outcomes. Usually

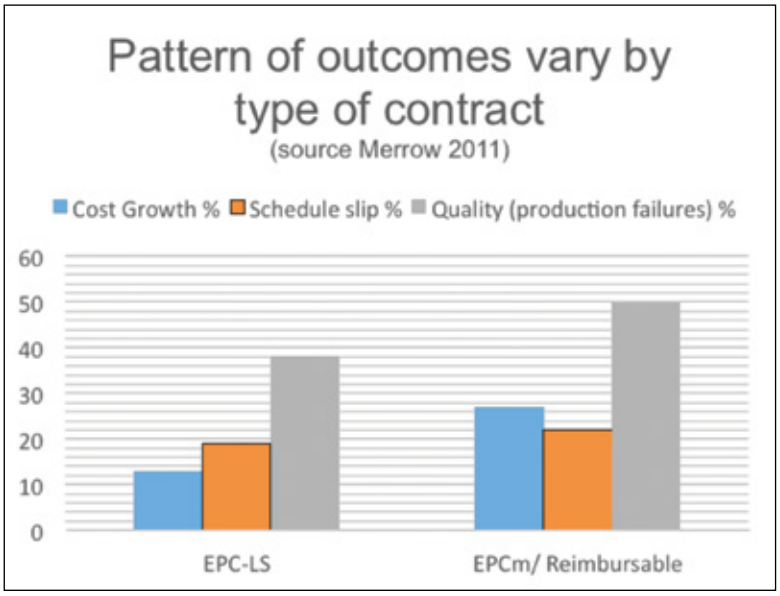

Figure 5 Alternative Contracting Schemes KPI

Notes:

Standard deviation is wide: there are very good and very bad projects in both categories

Russian oil and gas projects performances is worse than average (source IPA, 2012)

EPC LS performs better in what can be called "hard targets" (cost, schedule, quality/performance).

There is a solid background of this result though a warning shall be raised that this result has statistical significance but every project has its own background, history and peculiarity.

Actual performance of EPCm/Reimbursable contracts is somehow worse than EPC LS(TK) Contracts mainly for the following reasons:

- Improper/incomplete Front End Loading (actually EPC Contractors validate Front End during bidding phase and price relevant risk)
- Lower capability of Owners in managing project execution risks (Contractor organization is normally more project risk management conversant)
- Insufficient owner organization, not fully and

effectively backed up by Project Management Consulting (PMC).
- Ineffective reward/penalty scheme in EPCm/ reimbursable contracts.
- Implicit misrepresentation of project cost

So EPC LS(TK) is the key to successful projects? No or at least, not always. The focal point for the selection of a contracting strategy shall be the project risk profile evaluation and the risk management approach.

The correct identification of the project intrinsic risk profile in terms of:
- implemented technology;
- design technical maturity;
- available infrastructures;
- supply chain availability

and a rigorous assessment of the risk sharing opportunities among the different stakeholders are keys for the success but many times they are neglected and compromise the business case relying on the project implementation.

There is not an absolute best contracting scheme but the golden rule is that in each project the contract should assign the risks to who is more capable and in position of controlling such risks.

Practice in Russian projects

In order to understand the cultural environment in which the project execution strategy developed, it is worth to highlight that Lukoil is a Russian Company and that Bulgaria, among the countries in European Community, is the country that more keeps important relationships and a strong cultural connection with Russia.

Business and technical standards are affected by this important heritage though rapidly converging to European practices.

For HRPC project execution strategy definition it was important to understand the Russian project execution methods and performances.

EPC projects in Russia experience higher than average rate of unsatisfactory performances due to the many constraints pushing in different directions the project execution scheme:
- Rigid permitting procedure not allowing an easy implementation of concurrent E, P, C activities.
- Strong local content requirement but limited availability of qualified and experienced resources
- Sometimes opportunistic venturing between international contractors and Russian Design Institutes does not allow an effective mutual know how transfer.
- Sometimes adversarial approach by Design Institutes, EPCm Contractors, Construction Contractors, Owners
- Not fully available project/risk management competence in Owners organization.
- Insufficient awareness by international Contractors of Russian Projects specific conditions.

HRPC project environment could have been potentially affected by the above mentioned constraints and by the transition from the legacy soviet time legislation to the harmonized European legislation.

Burgas HRPC project risk profile

The HRPC risk profile assessment that pushed LNB and TechnipFMC to a collaborative approach as the best possible execution strategy was based on two main considerations:

1. The technological risk: Heavy Residue hydrocrackers are complex units, probably the most complex unit in the refinery. The unit operating conditions and the process technological features requiring a high degree of competence for its safe and effective implementation.
2. The project context requiring a reliable execution strategy in terms of resources and know how provided by fully experienced contractors.

The HRPC is based on a complex technology initially

developed in the USA in the sixties, but further improved with significant new challenges:

- Original design of heavy residue hydrocracker originated in the USA more than 50 years ago but number of implemented units is limited
- Though seven units were running, the most recent H-Oil™ was constructed more than 10 years before the award of the HRPC Project.
- Several process modifications were introduced by the Licensor with respect to the previous implementation.
- Burgas H-oil™ is the largest ever built and with a significant scale up with respect to the latest implementation

The operating conditions of the hydrocracker (160 barg, 430 DEGC), the feed characteristic (high asphaltenes, high metals and high sulfur content) and the environmental conditions (design temperature -20 DEGC) all required use of a wide range of exotic materials, complex equipment and special plant arrangement implying the sourcing from worldwide supply chain.

It was essential for HRPC to have access to the best practices in design, manufacturing and construction for such kind of unit.

In addition to the technological complexity some risks originating in the local context were present.

For several reasons not fully under LNB control the sanctioning of the project took more time than expected.

The risk of having committed huge amount of capital for the basic engineering and the long lead equipment procurement without getting the expected return of investment was high.

"Time to market" was considered to be an essential outcome of the project. This requirement implies two main aspects:

1. The efficiency in design, procurement and construction, considering the local condition of Bulgaria for permitting, skilled resources availability and construction safety and quality standards.
2. The smooth first time startup and assurance of "time to market" of products.

EPC Contract arrangement

Considering the HRPC project risk profile, it was finally negotiated and agreed by the Parties the Contract for the EPC phase on a LSTK basis. This arrangement was considered to be the most effective in order to achieve the main targets of the projects, i.e. the shortest possible completion time and the assurance of budget and quality.

The Contract was negotiated based on the Open Book Estimate developed during the FEED phase.

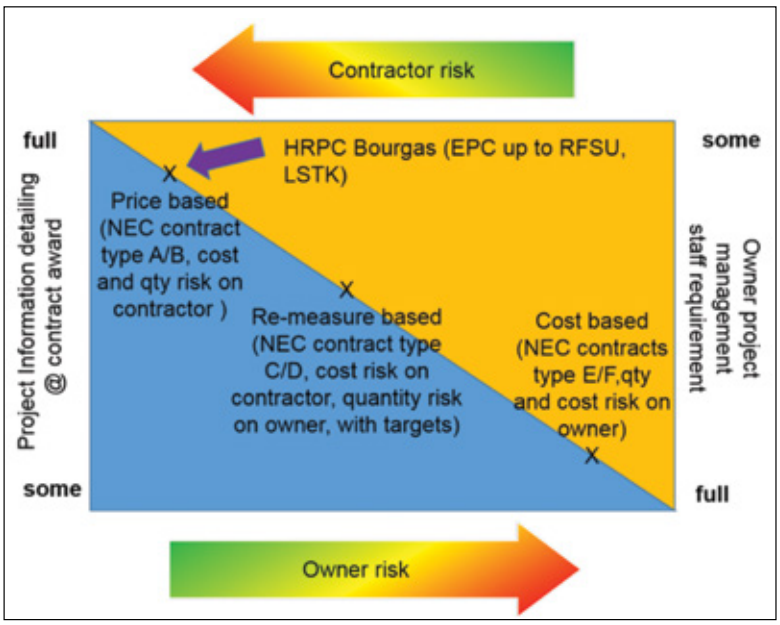

Figure 6 Typical Risk Sharing of Alternative Contracting schemes

It is worth to note that the final strategy developed mainly during the execution of early engineering works related to Long Lead Items purchasing by LNB after the FEED completion. It was in this phase that a full evaluation of the project execution risks was conducted and represented in a chart like the one in **figure 6**.

Most of the risks have been assumed by TechnipFMC in the EPC phase, with LNB being the leader in the startup, assisted by TechnipFMC.

Project Achievements

The project can be recorded as a common success for both TechnipFMC and LNB.

The following table displays the main achieved Key Performances Indexes:

The achievement was the result of an intense and proactive team working by both parties that took some time to build up.

Risk	Risk owner
Cost	TechnipFMC
Schedule	TechnipFMC
Defects	TechnipFMC until expires of warranty terms
Performance (yields)	LNB (by Axens)
Performance (throughput, utilities consumption)	TechnipFMC
Permit to build	TechnipFMC/LNB
Start-up	LNB
Permit to operate	LNB

Table 2 HRPC Risk Sharing between TechnipFMC and LNB

Considering the this was the first large project that Lukoil assigned to TechnipFMC a period of mutual knowledge and trust creation was necessary for the components of the project team.

It is important to recognize how the common project team created a workplace in which transparency and open mind was the rule. Problems occurred, as in all projects, but they were never hidden under the surface and both parties worked actively for their solution.

The project success was achieved overcoming some difficulties:

- The establishing of smooth and effective communication between the owner and contractor teams originating from the differences in standards of design and technical documentation preparation.
- Construction permits issue – due to lack of 100% synchronization between legacy Bulgarian and European standards.
- There were some differences between LNB and TP in defining contractual provisions regarding risk and management distribution under the EPC LS contract, that had to be agreed on during the project.
- Active owner's participation in the approval of technical solutions was largely based on Process Licensor's expert assessments, resulting in some misalignment of requirements to design solutions.

Corporate differences were a potential issue, but finally resulted in a very good opportunity of common growth and development.

The difficulties were overcome upon the gradual establishing of mutual trust and awareness of the necessity of a "win win" approach to the project execution beyond respective Contract obligations.

Growth through collaboration

The HRPC project success demonstrates it is possible to optimize capital expenditure efficiency and overall costs in project implementation by a collaborative approach to project execution.

The opportunities leading to a collaborative approach in project execution can be recognized considering that:

Target	Achievements
HSE	LTIF= 0,06, TRCF = 0,11 The safety results during construction were outstanding and far better than the average statistics in Eastern Europe area.
Quality	The challenging process conditions stretched design, material supplies, construction and operating procedures to unusual situations: some quality problems occurred but LNB and TechnipFMC succeeded in solving all of them. An invaluable bunch of lesson learnt is available to both parties for future HRPC implementation.
Schedule	H-Oil™ Construction ended up with a negligible delay. Commissioning and startup up to first commercial operation was performed in a record time for this kind of unit (3 months) allowing the fulfillment of "time to market" date for the products.
Budget	LNB budget was tightly maintained. Signed change orders were 1,3% of contract price. The Contract was closed out without reciprocal claims.
Performance	The initial operation period (about 6 months) required a deep and thorough observation of both reliability and yield performances to identify unit necessary tuning and optimization. TP, LNB and Axens collaborated in this phase to optimize unit performance. Valuable data and operation feedback are available to the Parties for potential optimization of design solutions.
Profitability	LNB pursued successfully the complex optimization of crude slates, downstream unit asset, cutterstock provision to maximize refinery profitability [1].

Table 3 HRPC Project Achievements

Soft Target	*Collaborative approach* (e.g. Feed+ obe+ EPC conversion)	*Arm's length approach* (e.g. Feed + bid EPC)	*Owner managing approach* (e.g. Feed+ bid EPsCm + bids P, C)
Owner involvement in performance	✓✓	✓	✓✓✓
Contractor incentive in performance	✓✓	✓✓✓	✓
Predictability of performance	✓✓✓	✓✓	✓
Know how capitalization	✓✓✓	✓	✓✓
Local content growth	✓✓	✓	✓✓✓
Asset value maximization	✓✓✓	✓	✓✓

Table 4 Soft targets index for alternative contracting schemes

- The market trends support a collaborative approach between the Owners and Contractors that have the know how to manage the increasing complexity of conflicting requirements.
- But it is not rare a reckless and opportunistic approach to risk management by market agents.
- While ultimately Owners need reliability and Contractors need early visibility of execution strategies

The table shows how the "soft" targets (long term assets not easily measureable but not less important of the main "hard" targets) benefits from a collaborative approach.
A collaborative approach pursues the optimization of the project execution, recognizing its intrinsic value beyond the specific contractual arrangement, that is a consequent detailed implementation of the intended agreement by the Parties of the Project Execution Strategy.

The collaborative approach values:
- joining the efforts and the know how in the right moment during the development of the project;
- assigning the risks fairly and rationally;
- rewarding the proactivity of the project teams.
With a long term vision of the ultimate project targets.

Conclusion

HRPC project success demonstrates that megaproject can be executed successfully in multicultural environment properly evaluating the risk profile and the possible execution strategies.
The main conclusions are:

- A rational approach to the project execution scheme, as the one used for Bourgas HRPC project, paves the way to a successful project.
- HRPC project was performed under a collaborative approach since the FEED and finally resulted in a success.
- While not advocating for any specific contracting scheme, we recognize that often the project context suggests, in a straightforward way, the optimal execution scheme and contractual arrangement.
- Early involvement and non-episodic collaboration between the Owner and the EPC Contractors creates the conditions for a common growth in project execution performance.

Stakeholders awareness and alignment on project ultimate targets is the pre-requisite for every successful project.

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Stefano Polimeni

Stefano Polimeni is a Project Director with more than 25 years of experience in the oil & gas project management. He holds a Msc degree in Electronic Engineering from University of Rome “La Sapienza”. His career developed fully in Technip Italy where after the first assignments as Automation Engineer he moved to the project management of large EPC contracts, mainly on LSTK basis, for major international clients like Lukoil, Saudi Aramco, ADNOC, SOCAR, ENI, MOH, ENOC.

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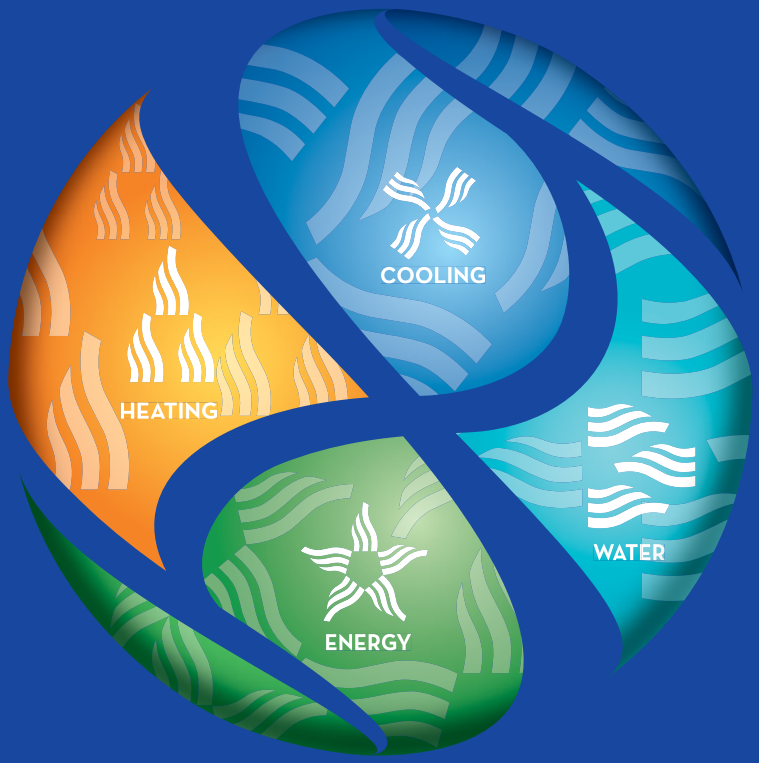

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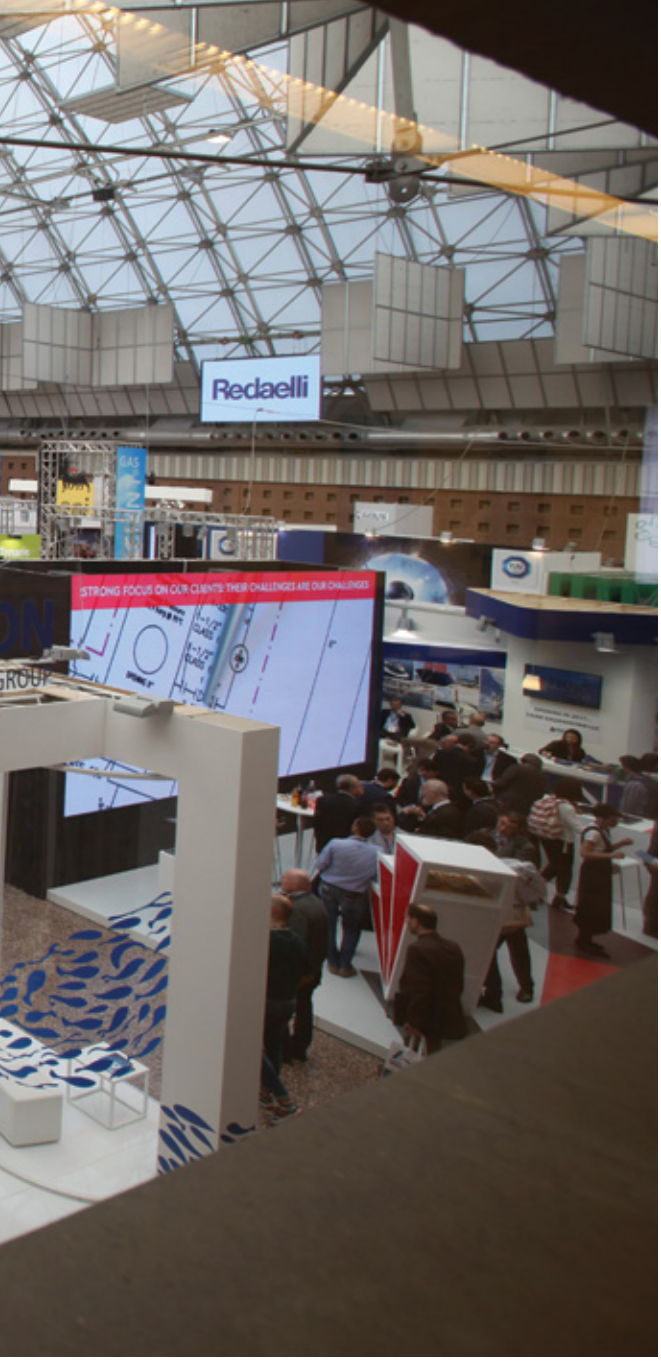
Transitioning to a sustainable energy mix, building a resilient industry

13th Offshore Mediterranean Conference and Exhibition
OMC – Ravenna, Italy

Enzo Titone, *Chairman OMC 2017*
Roberto Cimino, *Chairman of the Programme Committee OMC 2017*



The Offshore Mediterranean Conference & Exhibition is a biannual event taking place in Ravenna, northeast Italy, and is the largest oil&gas exhibition in Italy.

Started as a regional event in 1993, OMC has achieved through the years international status, becoming the major Oil & Gas event in the Mediterranean region.

Strategically positioned in the Mediterranean basin, Italy has developed the capabilities to act as a bridge between Northern and Southern Europe. Ravenna, where offshore activities started in the early Fifties, has grown to become the greatest centre for the offshore development in Italy, managing seismic surveys, drilling activities of hundreds of wells, construction and installation of several platforms in the Adriatic Sea.

Over the decades E&P activities have grown with no interferences alongside the traditional features of the region: agriculture, fishery, tourism, cultural heritage. Today the city is an example of sustainability and compatibility of different activities thanks to transparent cooperation with all the stakeholders.

The recently held 13th edition (29-31 March 2017) focused on the theme "Transition to a sustainable energy mix: the contribution of the Oil&Gas industry", has hosted a record 20,603 participants, 634 exhibiting companies from 30 nations, ministerial delegations and national oil and gas companies from Europe, Northern Africa, Middle East and Far East – offering to oil and gas professionals an ideal arena for discussion on research and development, technology achievements, future challenges in the energy sector and providing a unique networking opportunities.

Italy wants to act as a hub in an integrated gas market" (Ivan Scalfarotto, Undersecretary of the Ministry of Economic Development

Energy transition and the central role of Mediterranean as energy hub, bridging Europe and North Africa, have been discussed in the Opening Plenary Session of the conference.

The Undersecretary of the Ministry of Economic Development, Ivan Scalfarotto, has underlined how natural gas is a perfect fellow of the renewables, responding at the same time to the challenge of energy security: constructive dialogue at transnational level is necessary to put an integrated gas market in place, where Italy wants to act as a hub.

Natural gas has also a great potential to further contribute to the decarbonisation pathway agreed at COP-21, noted Remi Eriksen (CEO DNV GL), by

A new model for renewables: producing electricity by leveraging existing infrastructures, optimizing costs, reducing emissions, reducing gas consumption" (Claudio Descalzi, CEO Eni)

penetrating the transportation sector via LNG and displacing less climate-benign liquid fuels: the final goal is the greening of natural gas, by widely deploying Carbon Capture and Sequestration (CCS) technologies and exploiting the opportunities for biomethane production.

Claudio Descalzi (CEO Eni) presented the company blueprint for developing renewables in its activities, focusing on Eni's new model of leveraging existing infrastructures to produce renewable electricity in a cost effective way, with the triple aim of reducing emissions, optimizing costs, and reducing gas consumption in producing countries.

H.E. Tarek El-Molla, Egyptian Oil Minister (center), with Mr. Innocenzo Titone, Chariman of OMC2017 (left), visiting the ANIMP booth and Mr. Daslav Brkic , VP ANIMP and Executive Editor of 'Industrial Plants'

The reserves of Zohr, the giant Egyptian gas field discovered by Eni in 2015, and Nooros- noted Descalzi - open new possibilities for the Mediterranean area to become a gas hub satisfying at the same time Egypt's entire domestic production.

According to the Egyptian Oil minister, Tarek El-Molla, exports will start again in the form of LNG in 2019, pointing out that Zohr field discovery is a game changer after the difficulties that the country faced in the past years, ushering a new era. Egypt, underlined the minister, aims at establishing itself as the energy hub of the area, not only for gas but also for crude oil and oil products.

Gas export will start again in 2019 from Egypt in the form of LNG" (Tarek El-Molla, Egypt Minister for Oil)

Also for Marc Benayoun (CEO Edison), gas has a central role for the European gas market, which should become more and more efficient and competitive. As for the prospects of the energy transition, Benayoun believes that the trend will not be reverted, since public opinion is increasingly aware of the importance of sustainability.

The issue of natural gas has been debated in the Panel Discussion on "Mediterranean Basin: a new Gas Hub for Europe", where Luca Bertelli (Chief Officer Exploration, Eni) declared that exploration of the East Mediterranean has not finished: the discoveries made since 2009, Tamar, Leviathan, Aphrodite and Zohr fields, have risen the rank of East Mediterranean to a new emerging gas province of worldwide relevance.

The Mayor of Ravenna, Mr. de Pascale, inaugurating OMC2017, with H.E. Tarek El-Molla, Egyptian Oil Minister (left), and Messrs. Innocenzo Titone, Chairman (OMC2017) and Mr. Marc Benayoun, CEO Edison (both right)

Zohr was a game changer for Egypt: the Country wants to become the energy hub of the area" (Tarek El-Molla, Egypt Minister for Oil)

Using existing infrastructures such as LNG plants in the region can be a first step to start gas export together with the use of Arab gas pipeline. The construction of new long pipeline connections will require the political support of various states as well as material sources to justify the massive investment needed.

The cooperation among the countries involved will be the key for the development of the East Mediterranean

as a gas hub, and Tarek El-Molla confirmed that his country is looking strategically to integrate with neighbouring states, through talks with Cyprus, Israel, Lebanon and Jordan.

Cyprus, in particular, is focusing on export, as underlined by Yiorgos Lakkotrypis (Minister of Energy, Cyprus), since the Country has a very small domestic market and for this reason the reserves of Aphrodite

> Aphrodite reserves will be almost entirely earmarked for export" (Yiorgos Lakkatrypis, Minister of Energy, Cyprus)

will be almost entirely earmarked for export.

The issue of how the Oil & Gas industry can enhance its ability to withstand external shocks, such as the volatility of oil prices, has been discussed in the Panel "The resilient Oil & Gas industry: staying competitive at low oil prices".

Judson Jacobs (Senior Director Upstream, IHS Markit) has discussed the outlook of the industry in the years to come.

The sentiment, among experts and operators, is that oil prices will stay at the current level for a few years: for this reason a number of regions will be challenged, due to the cost of production higher than current market prices.

According to IHS Markit estimate, by 2030 30 million barrels of oil per day will have to be added to the current production: only the Middle East and Russia have now competitive cost of production compared to

> Exploration of the East Mediterranean has not finished: a lot has still to be found" (Luca Bertelli, Chief Officer Exploration, Eni)

today oil prices (50-60 $US/bbl).

Technology will have to play a key role to allow competition in a low price environment and E&P players are already adjusting technology priorities, focusing on facilities and especially on digitalization and automation: technology can drive capital efficiency gains upwards 10-20%.

Luigi Chiolini (Partner, Boston Consulting Group) has focused the role of technology in decreasing costs in upstream projects by changing relationships between companies and contractors.

The digitalization of the industry might allow the set up of collaborative design environments, avoiding reworks and compressing project schedules and overall costs.

Technology progress has, in this case, to go hand in hand with change in contractual frameworks: current lump sum turn key contracts should be replaced by new architectures allowing the exchange of data and a fair allocation of risks and rewards between sponsors and contractors.

Rita Marino (EVP Procurement, Eni), has focused on how Eni has faced the phase of market downturn by streamlining costs: in particular, the insourcing of engineering skills has allowed to cut contractors contingencies by internalizing design phases that in the past were included in the EPC contracts.

Standardization of design and design-to-cost have allowed additional substantial savings.

Antonio Careddu (Director Strategies, Innovation & ICT, Saipem) and Paolo Ruggeri (General Manager for Turbomachinery Solutions, GE Europe) have both highlighted the great potential of digitalization, collaborative environments and standardization in

Roberto Cimino, Chairman of the Programme Committee OMC2017 (left), Innocenzo Titone, Chairman OMC2017 (center), awarding the best stand design award to Marco Mosconi, CEO Pneumax (right)

Elizabeth Torstad, CEO of DNV GL Oil&Gas delivering a lecture leading to a panel discussion

Benayoun - El Molla - De Scalzi.

Paolo Ruggeri, GM GE Oil&Gas (left), Antonio Careddu, EVP Saipem (center) and Rita Marino EVP Eni (right) in one of the keynote panels

improving contractors productivity and decreasing overall project costs.

The perspectives of a low carbon economy and the contribution of the O&G industry have been addressed in the last of the three Panel discussions offered in the conference.

Elisabeth Tørstad (CEO DNV GL Oil&Gas) has pointed out, in her introduction, that sustainable development

> 30 million barrels of oil per day will have to be added by 2030, with the Middle East and Russia the gravitational pole of low cost producers" (Judson Jacobs, Senior Director HIS Markit)

of oil and gas resources will be essential in a low carbon economy, to reduce emissions via fuel shift (especially if gas will play a key role as a transportation fuel), increasing efficiency and integrating hydrocarbons with renewables.

For example, the potential reduction of GHG emissions in the Norwegian Continental Shelf is estimated to be 29% and the potential reductions for an energy efficient Greenfield are even more significant (34%).

The potential of natural gas, and especially LNG, to enter the transportation market has been also highlighted by Katia Valtorta (Principal, Arthur D. Little), with particular reference to ships, trucks and trains: hurdles include fueling infrastructure, cost advantage over competing transportation fuels, and environmental regulation.

Luca Cosentino (EVP Energy Solutions, Eni), has underlined the strengths that the O&G industry has to promote and even accelerate the diffusion of renewables: global industry presence and large portfolio of industrial assets, relationships and reputation in host countries, know-how in managing

> Oil and gas resources will be essential in a low carbon economy, and emissions can be further cut by 30% " (Elisabeth Tostad, CEO DNV GL Oil&Gas)

complex and hybrid projects are all assets that the O&G industry can claim.

Wilfried Maas (Technical Development Leader CCS, Shell), has advocated the importance of CCS in a low carbon economy, which will continue to use in the next future hydrocarbons: potentially such a technology – if widely implemented – might deliver 12% of the required GHG mitigation by 2050. Shell's experience in Quest Project, the largest demonstration CCS project to date, has proven to be viable, with over 1.5 million tonnes of CO2 injected in 16 months.

Finally, Robert C. Armstrong (Director, MIT Energy Initiative) has pointed out how much progress in terms of renewables deployment is being made: over the past decade wind and solar have accounted for more than 40% of new capacity additions.

Moreover, in the past five years the competitiveness of utility-scale PV in the US has improved dramatically with prices of power purchase agreements falling by 70% or more.

With increasing photovoltaics (PV) penetration of the market, challenges rise for grid operation, particularly regarding capacity and ramping, for this reason the future success of PV will be dependent on storage.

The future for very low-cost PV technologies lies with material systems that simultaneously reduce module and Balance of System costs, such as organic photovoltaics on which progress is being made at MIT.

In addition to Panel discussions, the conference has also offered a broad a comprehensive program, including 118 technical papers presented in 29 Sessions, 66 Digital posters and 13 workshops.

Next biannual edition will be held in Ravenna, 29-31 March 2019.

Saipem engaged in the Field Development Project for the "supergiant" Zohr gas field, located off the Egyptian coast in the Mediterranean sea

Located 200 km offshore at a water depth of approximately 1,700 m, the Egyptian Zhor supergiant field is the largest gas find ever made in the Mediterranean Sea. Since its discovery in 2015 by Eni, it has undergone an ambitious 3 phase development plan conceived and implemented for its exploitation

Giulio Fatica, *responsible of the Subsea Engineering of Saipem SA*
Piergiovanni Panico, *Project Manager for Engineering and Procurement activities of Zohr Development Project*

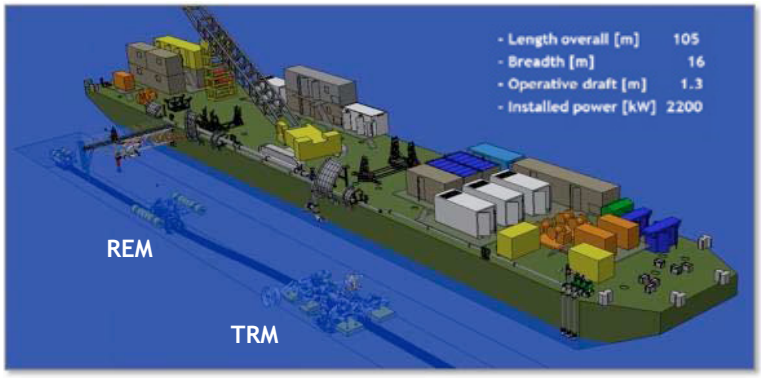
In April 2016 Saipem was awarded the contract for the Engineering, Procurement, Construction and Installation (EPCI) of the first and most challenging phase (Accelerated Start-Up) aimed at ensuring early production by the end of 2017 with the tie-in of the first 2 wells by September 2017.

To achieve such a challenging target, and to support the in-Country execution operations, Saipem is leveraging its outstanding experience in similar fast-track EPCI offshore projects, its long presence in Egypt and its knowledge of the Country's industrial capabilities.

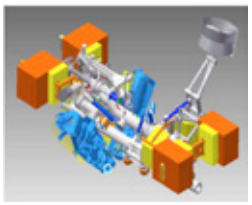
This first phase is characterised by a fast-track execution schedule and features a total of 6 producing wells, 30 km of infield rigid flowlines and related subsea termination structures, subsea jumpers and spools, two manifolds and 20 km of infield control umbilicals.

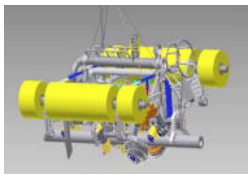
The subsea production system is remotely controlled from a platform via a 158 km main umbilical. A trunkline system consisting of a 218 km long 26" gas export subsea pipeline running parallel to a new 14" in-service and a new 8" MEG pipeline delivers the produced gas to the onshore Plant of El Gamil.

Saipem's world class offshore construction fleet allows for an effective combination of its most suitable vessels with Egyptian installation vessels to ensure the timely delivery of the Accelerated Phase. Saipem's flagship Castorone is currently laying the deepwater section of the trunkline system, together with the Castoro sei semisubmersible pipelay vessel for the medium water section and the PMS 12 pipelay vessel for the shallow water section. Landfall works, including cofferdam



PRODUCT	Pipeline from 6" to 28" (potentially up to 32")
WATER DEPTH	minimum WD 1.4m up to 20m
SOIL	UP to 350 kPa
TRENCH DEPTH	1.8m BOP Single Pass
	up to 3.2m BOP Double Pass
INSTALLED POWER	2200 kW
BACKFILLING	up to 80% cover by past experiences
SPREAD	TRM Trenching Machine
	REM Remedial Machine
	Back Filling equipment
	SB Sliding Buoys
	DT Dredging Tool


TRENCHING MACHINE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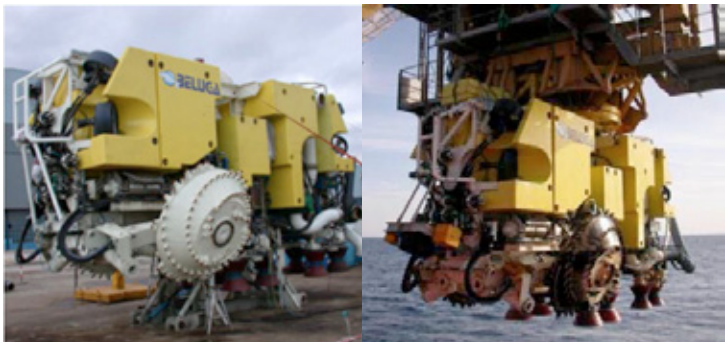

BELUGA TRENCHING MACHINE

Weight	In air: 14.5 Te - In water: neutral (free flying)
Water Depth Range	15 - 2250m
Trench Depth	1.4m (single pass) - 4m (multipass)
Max Slope	20 deg
Soil Range	Max compressive strength 30 MPa
Onboard Power:	280 kW x 2 motors, overall 560 kW

construction and pipeline shore pull operations, are being subcontracted to the Egyptian Contractor PMS. All the significant post trenching works required to protect and secure the trunkline system will be executed by a unique combination of Saipem owned spreads, including the shallow water trenching vessel and the Bautino subsea remotely controlled post trenching equipment; the post-trenching jet-sled operated by Castoro 10 vessel; the ploughing system PL3 and the Beluga subsea post trenching remotely controlled equipment for the localized sea bed corrections on hard soil sections.

The in-field subsea system will be installed by two other major Saipem vessels, FDS and S7000, for the rigid flowline, subsea structures and jumper installation. The 158 km long control umbilical, on the other hand, will be deployed by the subsea construction vessel Normand Maximus.

CASTORONE

State of the art DP3 Pipelaying Vessel

- LENGTH: 330 m excluding ramp/stinger
- PIPELAYING CAPACITY: Triple joint 12 m or double joint 18 m; pipe size up to 48" (60" including coating) – 3 off tensioners x 250 tons
- J-LAY TOWER Features for future installation of a fixed tower for pipelaying in J mode through the centre moon pool.

CASTORO SEI

Semi-submersible pipelay vessel

- HULL TYPE: Column stabilised semi-submersible
- PIPELAY EQUIPMENT: 3 off 130 tons pipe tensioners

CASTORO 10

Pipelay Vessel and Trench-lay Barge

- PIPELAY EQUIPMENT Fully enclosed production line for a 60" max. pipe diameter
- Trenching equipment; jetting sled

SAIPEM FDS

Field Development Ship

- FDS Field Development Ship - DP3 and self-propelled
- J-LAY TOWER FOR ULTRA DEEPWATER Laying quad-joints up to 52 m long
- Main crane of 600 tons.
- Capability to install flexibles and umbilicals

NORMAN MAXIMUS

Offshore subsea construction vessel

Normand Maximus is the result of innovative design philosophy aimed to combine SURF installation with field development activities in ultra-deep water.

LENGTH: 177.9 m
Main Deck: 2,500 sq.m. @ 15 t/m 2
Main Deck capacity: 12,000Te @ 5 m above deck
Station Keeping: DP3
Class: DNV
Ice class C & Winterized Basic
Vertical Lay System (VLS) with 2off x 275 Te vertical tensioner: Capable to install 50mm to 700mm OD products as well as up to 12" reeled rigid pipes
Basket / Caurosel: Up to 6,000Te under deck basket and capability for a 3,000Te carousel/basket above deck
Main Crane: 900Te AHC Lattice Boom Crane

SAIPEM 7000

Semi-submersible crane and pipelaying (J lay) vessel

- HULL TYPE: Self propelled dynamically positioned semisubmersible
- LIFTING FACILITIES: MAIN CRANE 2 twin Saipem 7000 model fully revolving bow mounted Amhoist cranes
- J-LAY SYSTEM: Pipe diameter range from 4" to 32"

Giulio Fatica

Giulio Fatica is responsible of the Subsea Engineering of Saipem SA, the French branch of Saipem group and one of its two main Centres for the Subsea. His career includes several assignments in onshore, offshore and infrastructure engineering for different groups in Italy and in France. He joined Saipem in 2001 where he has been working on major deepwater EPCI projects, covering different roles and responsibilities and maturing a significant experience in the subsea field development project execution.

He's graduated with honors in Structural Engineering at Politecnico di Milano and he's a chartered engineer. He is the author of several publications on stochastic dynamic, seismic insulation and subsea technologies."

Piergiovanni Panico

Piergiovanni is graduated in Mechanical engineering and he is a chartered engineer. He has 28 years' experience in the Oil and Gas industry.

He's currently working as Project Manager for Engineering and Procurement activities of Zohr Development Project. He was previously involved in EPCI projects for Shell, Total, Husky Oil and Burullus covering responsibility on project management, technical management and management of various major sub-contracts. He started his career in the sealine engineering department and then moved to roles of co-ordination.

He is certified Project manager at Eni Corporate University.

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It combines and compact two DBB's patterns into One Single Integral Body – one inlet with two outlets – each with B/N/B isolation.
A lighter and compact solution up to 10.000 psi rating.
Special Engineering in according to specific requirements is one of the best proof of our claimed flexibility.

TECHNICAL FEATURES

- Inlet : Flanged 2.1/16" API 10000
- Outlet : 2x 1/2" NPT-F
- Vent : 2x 1/4" NPT-F
- Design Code: ASME B16.34, B31.3, B1.20.1
- Temperature Range -46°C to +240°C

OPTIONALS

- Fire safe API 607 – ISO 10497
- Fugitive emission ISO 15818 Cl. A-B-C-D ; Part 1 & 2
- CU-TR Russia-Kazakhstan-Byelorussia
- CRN Alberta-New Foundland-Labrador-Ontario
- UA.TR.107.D Ukraine
- PED

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Digital transformation in Oil & Gas: an opportunity for the Italian value chain

Historically, Italian companies have been pioneering innovation and they are now well positioned to take advantage of Digital technologies. In fact, they have internal competences, a flexible approach, and availability of equipment, services and IT suppliers.
Recently there has been a global push towards digital, and the oil & gas industry has begun the journey in this direction, albeit at a slower pace than other industries

Roberto Nava, Riccardo Bertocco and Valeria Sterpos
Bain & Company

In this global context, how should Italian industrial companies address digital opportunities?

Although most oil and gas companies are closely focused on preserving margins to weather the low-price storm, many are also looking ahead and thinking about how digital technologies and data analytics will transform the industry.

Of course, analytics are not new to oil and gas. Unlike other industries, which have only recently leveraged data analytics and artificial intelligence, energy companies have long depended on massive amounts of data to improve reservoir and production modeling. Having said that, most companies have not reached full potential due to the lack of actionable insights or more effective decision making.

That will change as oil and gas companies upgrade their digital capabilities and improve the way they connect these insights to their operating model (see figure 1). We expect to see dramatic cost savings and significant improvements in productivity and revenue, as much as 10% to 12% earnings growth across the value chain, with most of the cost savings in upstream. For example, one integrated oil company managed to save about 10% on unit costs by digitizing a remote offshore operations center. Another one reduced operating costs per barrel by about 10% and improved recoverability of reserves by applying selective applications in intelligent oil fields through collective computing and sharing real-time information at all company levels.

In such context, the Italian value chain has started to adapt to the new digital era. Among EPCs, Saipem has declared to double budget for innovation in 2017 (from 30 M€ to 60 M€), while opening an "Innovation Factory" in Marghera and sealing a partnership with Siemens to cooperate on subsea control system technology.

Among Service and Equipment providers, ABB Italy – besides the wide application of its own digital technologies in its Italian factories – has enlarged its Smart Lab in Dalmine, unique structure where ABB tests and demonstrates a wide range of innovative solutions for the power and industrial sectors.

In the energy sector significant digital disruption coming from operators and service providers

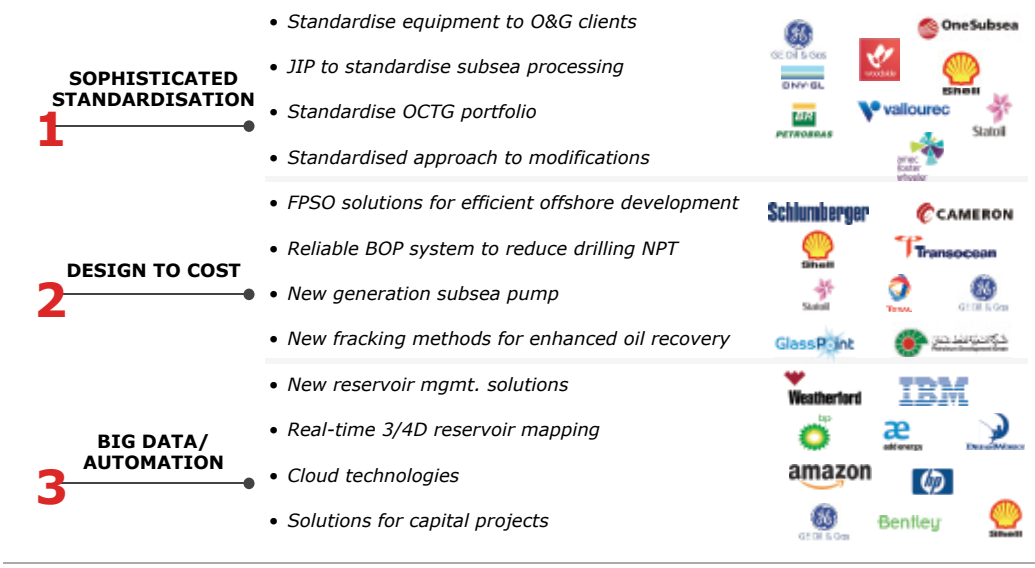

Figure 1: Digital addresses the main challenges and priorities the Energy industry is currently facing

Examples of these solutions are cybersecurity, digital simulation and remote control. General Electric has become a key player in the software industry, ranking #8 globally in terms of revenues (considering GE Digital Division). In Italy GE has made relevant investments and partnerships, for instance with Roboze, a startup from Puglia, which was selected to supply 3D printers (ONE +400) to produce and test components. Leonardo, a major technology player in the Aerospace & Defense, has developed remote controlled unmanned ground vehicles with a range of robotic arms with diverse applications, including Oil & gas. Finally, driven by large OEMs

and Equipment providers, suppliers of components and services are also developing their own digital solutions. For instance, CREL, a security company with automation capabilities, has developed a crane robot concept for in-line module installation in photovoltaics; Cozzani, an engineered valves supplier for reciprocating compressors has developed a flux control electromechanical system, remotely monitored and controlled.

Even so, few oil and gas companies have undertaken a structured and holistic approach to identifying which digital technologies can help create long-term sustainable advantage. Most of today's digital initiatives don't seek to disrupt operating or business models. Instead, they are improvements in technical or operational capabilities, things like predictive maintenance, well-completion analysis and using geological data from similar oilfields to build geophysical models and choose drilling patterns.

One reason for this incremental approach is that there is already a large, untapped potential in existing data, which companies can use to generate new insights with advanced analysis techniques. Another is that most companies aren't ready for a big transformation, because they lack the people, processes and capital required to make it happen.

Where digital efforts stumble

Given the challenging economics of today, oil and gas companies need to make their investments in digital where they can get the most bang for the buck. However, in our work, we frequently see companies making three common mistakes that are sure to limit their digital potential over the long term.

- **Lack of a multi-year digital strategy.** Many companies have ventured into digital investments without a clear understanding of where and when the transformation will bring the most benefit. Without a clear strategic, multi-year path, the risk is very high that companies could invest billions of dollars, but only capture a fraction of the benefits. For example: offshore drilling and production can benefit from advanced analytics based on reservoir and equipment data. These data can be analyzed to optimize maintenance of equipment and minimize disruption to operations. A single platform can produce terabytes of data per day, but current satellite network bandwidth is extremely limited to transfer speeds in the order of Kbps, making it impossible for subsurface and operations teams on the mainland to leverage available information in real time. In cases like this, the lack of an integrated digital strategy, encompassing both data transmission and data analysis leaves advanced analytics capabilities 'stranded' on the platform, as data can only be analyzed on-site.
- **Operating model.** Too often, companies fail to connect the information flows in ways that will actually improve how the organization operates. But if information doesn't follow structure, it gets lost. For example, a company might invest in visualizing a scheduling system with sophisticated routing capabilities, but then fail to connect it to the line management's scheduling decisions.
- **People.** People are the most important component of a winning digital strategy, yet failing to upgrade their capabilities is the most common pitfall in unsuccessful transformations. Executives should assess their current capabilities and develop a plan to manage change and improve technical expertise. This will involve a combination of recruiting fresh talent (including data scientists and other digitally savvy professionals) and teaching new skills to the operational staff. No one should assume that the front line will automatically embrace new processes and digital technologies. Change-management programs are needed to help them through the dramatic changes underway – for example, learning how and why to use an augmented-reality interface

The industry "future state" can be anticipated asset owners are working multiple future models

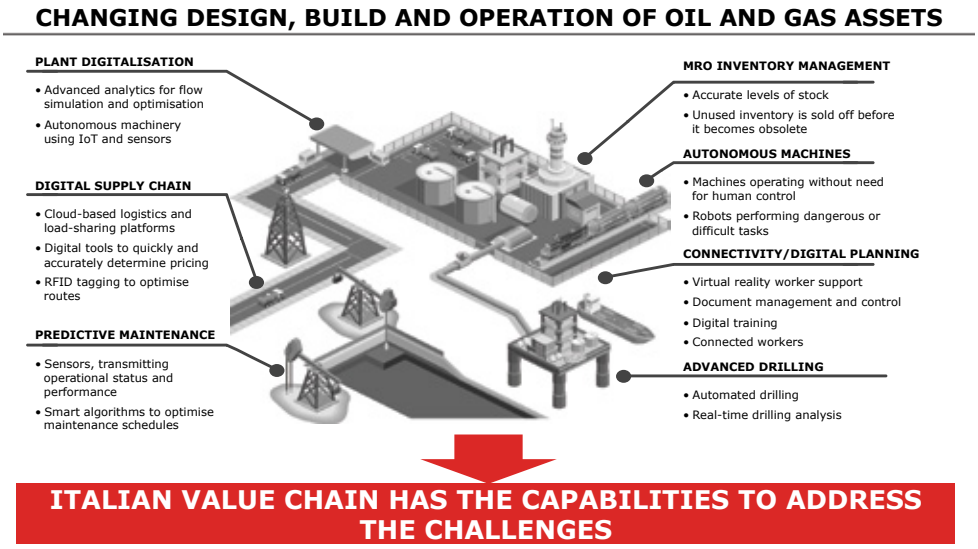

Figure 2: Digital themes in oil and gas.

rather than turning to their familiar, dog-eared manual, or exchanging data and communicating real-time with technical experts to evaluate corrosion issues on a pipeline.

Tapping the full potential of digital transformation

Greater changes will come over time, but today most companies are still preparing the groundwork for the larger and more disruptive transformations that will come as oil and gas companies implement a broader range of digital technologies (see Figure 2). As they put in place specific digital capabilities that can deliver fast results at reasonable costs, executives need to develop a strategic roadmap encompassing the digital strategy, operating model changes and, most importantly, people capabilities.

Approaches differ, of course, from one company to the next, depending on appetite for risk, potential gains from digital, and readiness for the transformation. But they typically include five key elements:

1. Identify the **areas of the value chain with the highest impact on financial and operating results**, and cross them with the opportunities to enhance delivery through digital technologies (see Figure 3).
2. **Monitor key industry and technology trends**, focusing on the identified value chain areas and

Opportunities along the O&G value chain

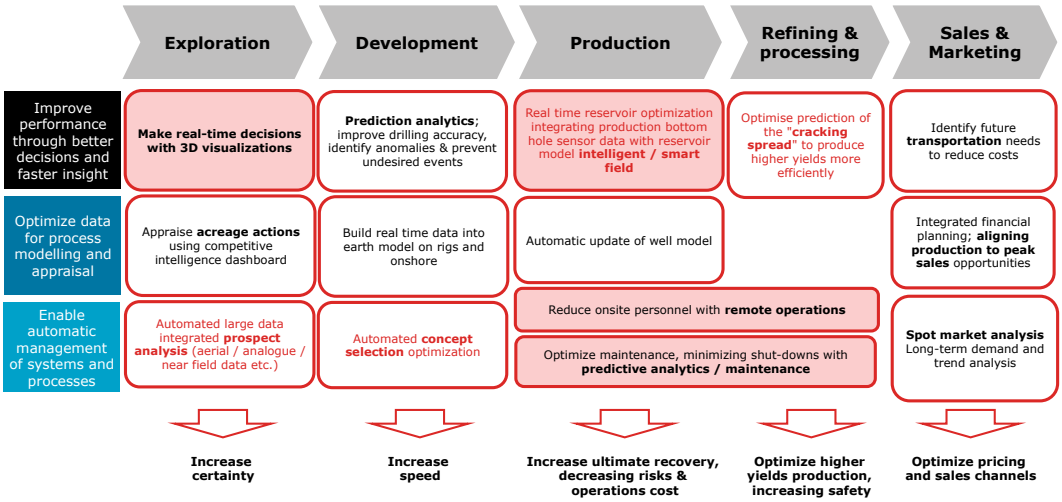

Figure 3. Although digital will affect the entire oil and gas value chain, four key application areas are already emerging

specific to the operations. Decide whether to lead the industry by innovating, or act as a fast follower by implementing tested technologies and processes.

3. Clearly define the **links between the company's most critical decisions and digital applications**, including showing how digital applications will improve decision making effectiveness. In addition, adjust the operating model to facilitate the sharing of key information, leveraging all available data sources
4. Evaluate the **investment necessary to digitize the key activities** of the company's value chain, and develop a multi-year budget and an overall roadmap balancing the capture of economic benefits with the financial burden on the cash flow.
5. **Assess current people capabilities** and develop a plan to address the gap. The talent upgrade plan needs to address gaps in technical expertise, as well as a comprehensive set of actions to promote change in the ways of working for people at the front line.

Every oil and gas company's digital journey will differ, depending on their industry position, ambitions and opportunities. Digital leadership is not always the best strategy – although it is usually the most expensive. But whether a leader or fast follower, every oil and gas company will need to develop a strategic plan for how they will use digital technology to gain competitive advantage over the next 3 to 5 years. All of these plans should include initiatives that offer short-term gains and build capabilities to develop long-term competitive advantage. Perhaps most importantly, they should all include details on how the flow of information necessitates changes to the operating model, and how each company plans to upgrade its talent and capabilities to make the most of the potential at hand.

In such context, the Italian industry is well positioned to seize the digital opportunity, having already started the transformation journey, across the entire value chain.

Roberto Nava

Roberto is a Partner with the Milan office of Bain and Company and is the Head of the Oil & Gas practice in Italy. In his over 20 years of experience, working across Europe, Asia, Latin America and Africa, he has led projects on strategy, performance improvement and organization, Capex Management with special focus on Oil & Gas (up-, mid- and down-stream), Petrochemicals, Oil Services and Engineering & Contracting.

He has a Degree in Business Administration from Bocconi University of Milan.

Riccardo Bertocco

Riccardo is a Partner with the Dallas office of Bain and Company. He joined Bain Milan in 1998 and transferred to the Dallas office in 2004.

While at Bain, Riccardo has led Oil and Gas projects in Europe and the Americas as well as large project management assignments involving Performance improvement and business unit strategy. His experience includes Purchasing programs for companies in Europe and the United States. He is also experienced in organizational re-design for Upstream Oil and Gas and Utilities merger and integration. Riccardo is currently a leader in the O&G practice. He earned his Business Administration degree from Bocconi University in Milan, and in 1995, an MBA from Wharton.

Valeria Sterpos

Valeria is a Manager with the Milan office of Bain and Company and a member of the Oil & Gas Practice.

She has more than 10 years of management consulting experience, and has participated and led projects in strategy, industrial planning, M&A and organizational restructuring for major Oil & Gas companies, service and component providers and engineering contractors, along the whole O&G value chain (upstream, midstream, downstream and distribution).

She has a degree in International Business and strategic relations from the Institut d'Etudes Politiques de Paris.

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Politecnico di Milano: a world-class technical university supporting the Italian EPC and manufacturing industries

Politecnico di Milano, one of the best technical universities in Europe, is unquestionably a cornerstone of Italian innovation and competitiveness in engineering and architecture

Ferruccio Resta, *Rector*
Daslav Brkic, *Visiting Professor*

Our *Politecnico di Milano*, founded in 1863 and now in its 154th academic year, is the largest Italian technical university for engineering, architecture and design, and it is one of the best scientific and technical universities in the world, according to numerous qualified rankings (see box).

To date it has graduated 185,000 architects and engineers, ranging from many founders of the Italian industry and architectural prowess as we know it today: to name just a few, Giuseppe Colombo, one of *Politecnico's* founders and the pioneer of electrical power in Italy, who built in Milan in 1882 the first power plant in Europe and later founded Edison, still today one of the leading European power utilities; Giovanni Battista Pirelli, the founder in 1872 of one of the world leading tire manufacturing companies, which still carries its name; the architect Gio' Ponti, who contributed in a unique way to the birth of Italian design after the second world war; Enrico Forlanini and later Luigi Dadda, pioneers in aviation and computerization; Giulio Natta, one of the fathers of the industrial synthesis of polymers and the Nobel Prize laureate in 1963 (see box); Renzo Piano, a world famous architect active today, who needs no introduction. And, today, numerous top managers from leading and most innovative Italian Companies are also graduates from the *Politecnico.*

More generally, Its over 10,000 yearly graduates in engineering, architecture and design, are most appreciated in Italy and internationally for their technical excellency and broad horizons. In fact, in addition to mere technical education, our *Politecnico* offers a broad training to prepare its graduates to manage the complexities and interdisciplinarities of today's world, to open the minds towards diversity, with attention to social issues and above all towards innovation. Post-graduate classes predominantly in the English language are just one of the many contributions to this long-term goal.

Today, *Politecnico di Milano* has 42,000 students in every engineering and architectural discipline.

The *Politecnico di Milano's* reputation has risen in recent years to be ranked as one of the top 10 European Universities for Engineering an Architecture

Measuring success

But how can one measure the success of such an university? We offer a few considerations:

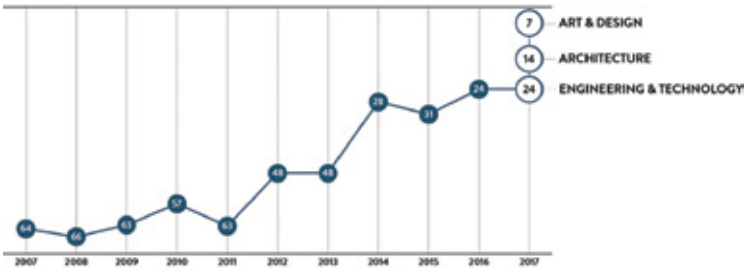
- 63.7 % of new graduates find a job within two months and 92.2% within 6 months of graduation (2014 data)
- The number of applications per available place

Politecnico di Milano in QS World University Rankings 2017

The March 2017 QS World University Ranking by Subject confirms the rapid progress in quality and global appreciation, by ranking *Politecnico di Milano* as:

- Generally, the first university in Italy
- 7th in Europe and 24th in the world for Engineering & Technology;
- 3rd in Europe and 7th in the world, for Art & Design;
- 6th in Europe and 14th in the world, for Architecture.

The QS World University Ranking system has been founded in 2004 and is considered one of the most authoritative voices in ranking universities internationally. Designed primarily for students who plan to study internationally, its rankings and opinions are published yearly on www.topuniversities.com. 4322 universities were considered and 916 were evaluated for the 2017 edition on the basis of academic reputation, employer reputation, citations per faculty, faculties and students, percentage of international students and teachers.
In particular, *Politecnico di Milano* has received excellent evaluations on the quality of its graduates ('Reputation with Employers') and teaching and research ('Academic Reputation').



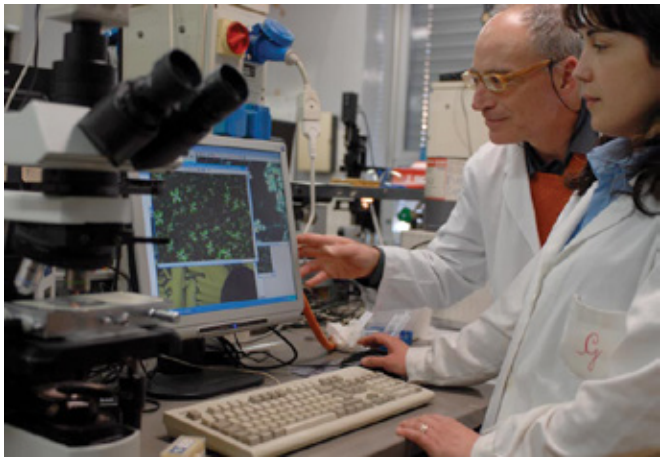
has consistently increased, from 1.7 in 2010 to 2.25 in 2016

- The number of international students entering the various Masters and other postgraduate programs has doubled over the last years, from 16 % in 2011 to 28 % in 2016
- According to most reputable university rankings (see box):
  - for Engineering & Technology the *Politecnico di Milano* is ranked 7th in Europe and 24th in the world;
  - for Architecture, 6th in Europe and 14th in the world;
  - for Art & Design, 3rd in Europe and 7th in the world;

Innovation

Since its earliest days, The *Politecnico di Milano* has emphasized fostering innovation:

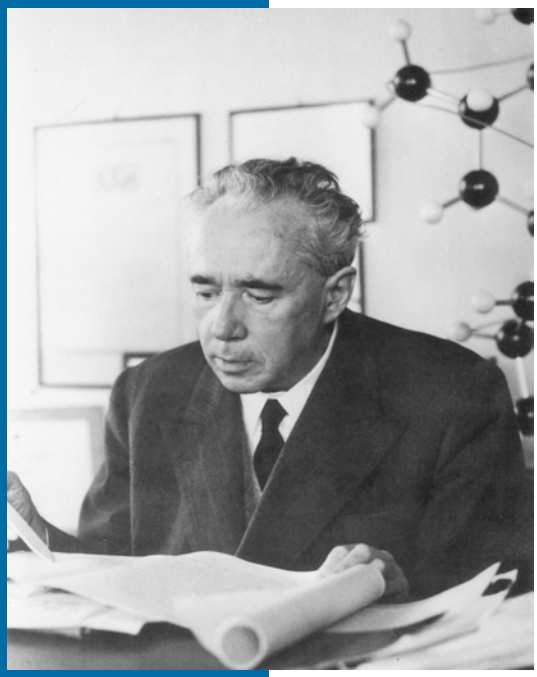
- 564 inventions and 1401 patents or patent applications, of which more than half have become industrial realities;
- 45 high tech spin-off companies, of which 8 in 2016;
- PoliHub, a high-tech research incubator founded in its present form in 2014, hosts today more than 100 companies. Since year 2000 it has given body to over 9000 ideas and has supported 390 start-up projects. According to the UBI Index, this is the second such incubator by size in Europe and the fifth one in the world;
- During the last decade, *Politecnico di Milano* has started working on 26 European Research Council Projects (FP7 and Horizon 2020), in 17 of which in the leading role as 'Principal Investigator'.



Joint Research Centers

In recent years, *Politecnico di Milano* has started cooperating with numerous companies on complex Research and Development projects. Several Joint Research Centers were so developed, after the pioneering agreement with the Eni group in 2005, in order to work jointly on new complex and strategic programs, to expand into select international target markets, and more broadly to connect the technology interests with industrial and university education policies.
To date, 25 Italian and international companies have formed such partnerships, including many companies from the energy plant engineering and construction fields: in addition to Eni and Enel, AnsaldoEnergia, MaireTecnimont and several others. Leonardo (ex-Finmeccanica) was the latest addition to this premier group of partners in 2016.
As an example, the JRC for Transportation has contributed significantly to the development and experimentation of FrecciaRossa 1000, the most modern Italian high-speed train.

Professor Giulio Natta, the 1963 Nobel prize laureate in Chemistry, one of the fathers of the modern polymer industry



Prof. Giulio Natta

While the *Politecnico di Milano* has seen no shortage of technology pioneers, Prof. Giulio Natta deserves a special mention here, particularly because of its impact on the chemical process technology industry.

As full professor of Industrial Chemistry and chairman of the homologous Institute, over more than 20 years Giulio Natta and his colleagues had carried out intensive research in the area of stereospecific polymerization, producing over 800 scientific publications and nearly 300 industrial patents.

This huge effort was crowned in 1954 with the discovery, together with Prof. Karl Ziegler of the Max Planck Institute in Muelheim, of titanium-based catalysts for the stereo-selective polymerization of alpha-olefins to produce polyethylene and later polypropylene. This new process, today known as "Ziegler-Natta Synthesis", allowed to obtain polymers with an extraordinarily regular structure and properties, giving birth to the modern polymer industry. The two scientists were awarded the Nobel Prize for Chemistry in 1963.

While the breakthrough was certainly due to Giulio Natta's genius, a combination of many positive factors contributed to the discovery: the open mentality of the university researchers both for fundamental R&D as well as for industrial applications, as has always been the tradition at the *Politecnico*; interdisciplinary research teams, which included experts in organic, industrial, organometallic and structural chemistry; advanced characterization techniques; major support by the Montecatini Company, then an international giant in the production of chemicals, both during research and subsequent commercialization.

This process technology and associate know-how are still today one of the stalwarts of the Italian industry on the global scale.

Prof. Giulio Natta's experimental apparatus, now in the Museum of Science and Technology

Internationalization

We have fully embraced today's needs for internationalization, in as much as it is – in our view – an essential facet of today's world. We are also pleased that 28% of our postgraduate students to our various Masters and other post-graduate programs come from overseas.

One of our many internationalization activities (see box for more details) is the IDEA LEAGUE, a strategic alliance among leading European technical universities, including also ETH in Zurich, TU in Delft, RWTH in Aachen and Chalmers University, UK, with the goal of strengthening the links between technology, science and society.

We have wholeheartedly embraced internationalization, via strategic alliances with leading world-class universities, increased enrollment of foreign students, classes in English and renewed academic programs

Another strategic alliance is Alliance4Tech, founded together with CentraleSupélec, Technische Universität Berlin and University College London, aiming at the creation of a European Campus without borders for students and faculties, with differences in culture and traditions but all united by a passion for technology and innovation. The GNP of the five metropolitan areas where these universities are located would be equivalent to the 10th largest economy in the world!

But perhaps the most daring example of internationalization is the developing partnership with Chinese universities: the new Innovation Hub, or campus, in Milan with the Tsinghua University of Beijing (see box), for which the Agreements have just been

The new Sino-Italian Campus in Milan

In February 2017, in front of the President of the People's Republic of China Mr. Xi Jinping and of the President of Italy Mr. Sergio Mattarella, Mr. Qiu Yong, the President of the Tsinghua University in Beijing, and Mr. Ferruccio Resta, the Rector of the *Politecnico di Milano*, have finalized their agreement to create within 2017 the Sino-Italian campus in Milan, at the site of *Politecnico*'s campus in Bovisa, Milan.

The main objective of this initiative is the development of a platform to attract Chinese investments in innovation, via the establishment of post-graduate and Executive Ph.D. courses and programs, as well as via the participation in numerous laboratories which the *Politecnico* has already developed in the area. The enterprises which will invest in this endeavor will have a privileged access to all these services, the possibility of establishing an R&D branch in the new campus and of interacting with PoliHub, Politecnico' s incubator of start-up companies (considered to be one of the top five such initiatives in the world and the second one in Europe), and with TUS STAR, the greatest university incubator in the world.

Therefore, the goal of the new campus will be to attract Chinese companies as well as numerous start-ups, thus enhancing the Bovisa Campus' reputation as one of the leading innovation clusters in Europe.

How it all started……

Northern Italy was always a place where engineering flourished. Let us recall that Leonardo da Vinci was – among others – a superb engineer, who designed the system of irrigation and navigation via canals in the plain of Lombardy, still in use today.

It was in a decree of Lodovico Sforza 'il Moro', the Duke of Milan (1480 – 1499), that engineers were mentioned in a formal way for the first time: a distinction was made between the *magistri fabrorum*, engineers and architects, and *aestimatores and surveyors*, establishing lower rates for the latter.

From the mid-sixteenth century onwards, the Government of Milan chartered the newly formed Board of Engineers with the task of "licensing" engineers. This corporate body was responsible for protecting the profession and verifying that the candidate possessed the necessary professional skills (gained through internships) and the birthright (a member of a socially distinct family) required to practice the profession.

With the arrival of Napoleon, the Board of Engineers was suppressed and engineers received their scientific training at universities. They were then required to perform an internship at the firm of a certified engineer.

The evolutionary ferment that swept across Lombardy in the 1830's caused intellectuals who were attentive to what was happening elsewhere in Europe to see intelligence as an economic factor on par with capital, labour and infrastructure. In addition to intellectuals and economists committed to promoting the country's modernization process, business owners - increasingly aware of the needs of modern agriculture and very interested in the growth of manufacturing activities - looked towards developing high quality technical and scientific education and referred to it as "one of the main sources of progress".

Upon its establishment, Politecnico became thus the hub of all educational and outreach initiatives in the technical and scientific world, the dynamic center of applied research and a place where businesses could turn to for third party experimentation and testing.

On November 29, 1863 – two years after the Unification if Italy - Francesco Brioschi, a politician, distinguished mathematician and hydraulic engineer, then secretary general of the Ministry of Public Education, Rector of the University of Pavia and Chairman of the board of the Scientific-Literary Academy, inaugurated the *Istituto Tecnico Superiore*, the first technical university in Italy. Brioschi remained its Rector until his death in 1897.

The *Istituto Tecnico Superiore* was based on the model of the German and Swiss polytechnic institutes and promoted a technical and scientific culture focused on specialization and on the ability to contribute to the country's development. Initially limited to three years of study (following a basic two-year program in Physical Sciences, Mathematics and Natural Sciences in other universities) and only two areas of specialization (in Civil and Industrial Engineering), in 1865, through the interaction with the Academy of Fine Arts of Brera, the institute was joined by the School of Architecture.

For the severity with which it was managed and its strict disciplinary provisions, the *Istituto Tecnico Superiore* was soon renamed by students the "Brioschi Asylum". Attendance was mandatory and absences had to be justified by parents or a doctor whose signature had to be authenticated by the mayor of their town of residence. Students were required to attend classes, which were held from Monday to Saturday afternoon, to participate in the laboratories, perform practical exercises, written tests, and to take "science journeys", educational trips to factories, industrial centres and civil constructions, in addition to attending international industrial exhibitions and cities of art. During these visits, students observed the most innovative production processes which were later discussed in class.

Graduation was accompanied by the custom of the portrait, and a group photograph of the year's graduates was first displayed in the windows of shops in the center of Milan.

There were only 25 first graduates at the end of the first program in 1865, but the attendance grew progressively in subsequent years, coinciding with the Italian industrialization process. A key factor of success was the collaboration and funding by numerous enterprises in Northern Italy. In many ways, *Politecnico* became one of the main focal points of technical know-how, education and experimentation of the emerging Italian industry.

signed by the two Rectors in front of respective country Presidents, Messrs. Xi Jinping and Sergio Mattarella; as well as the Innovation Hub under development with Xi'an Jiaotong University and other important analogous initiatives in Shanghai and Chengdu.

A look into the future

The world around us is evolving rapidly, even disruptively, so it is forcing us all to adapt and to change. Numerous social and geopolitical transformations are at play. Social and geopolitical

International partnerships

Politecnico di Milano is a strategic partner in many outstanding international networks:

IDEA League

It is a strategic alliance among leading European technical universities: ETH-Zurich, TU-Delft, RWTH Aachen, Chalmers University and Politecnico di Milano. The goal of the alliance is to strengthen the links between technology, science and society. IDEA League promotes programmes and projects for students, researchers, faculties and staff of the partner Universities in order to enhance their competences and skills.

www.idealeague.org

ALLIANCE 4 TECH

Alliance4Tech is a strategic alliance founded by CentraleSupélec, Politecnico di Milano, Technische Universität Berlin and University College London, aiming at the creation of a European Campus without borders for their students and faculties. Alliance4Tech connects four institutions of excellence, located in the economic heart of Europe, different in culture and traditions but united by a passion for technological innovation.

www.alliance4tech.eu

UNITECH International

UNITECH International Society is a non-profit association which brings together 8 outstanding technical European universities and 18 multinational companies. The aim of the association is to offer engineering students a study abroad experience in one of the partner universities and internships with a high technical and educational content in one of its partner companies.

www.unitech-international.org

T.I.M.E. Association

TOP INDUSTRIAL MANAGERS EUROPE

T.I.M.E. (Top Industrial Managers Europe) association brings together 53 leading European and international technical universities with the aim of providing double degree opportunities in engineering at Master of Science level, through bilateral agreements among members.

www.time-association.org

MEDes Master of European Design

MEDes is a network of 7 leading European Schools of design: Politecnico di Milano, Aalto University, Köln International School of Design, The Glasgow School of Art, Konstfack University College of Arts - Stockholm, ENSCI Les Ateliers, University of Aveiro. The goal of the network is to provide design students with a multidisciplinary education, based on the different cultural, professional and social contexts of the partner institutions.

www.masterofeuropeandesign.com

upheavals are modifying models of government, urban scenarios and mobility systems, together with changing relationships among people. We therefore need new policies and sustainable solutions to satisfy our needs for resources (food, energy, water), health and well-being, culture, education, professionalism.

We are also witnessing fast, even disruptive evolutions in technology development – just let us think of self-driving vehicles, drones, brain commands, oleographic technologies, 3D printing, cooperative robotics, energy from renewable sources….

A modern technical and scientific university in a multi-ethnic environment must have an international vision and fulfill at the same time its national technology and social missions. Therefore, for the next years, in addition to customary university teaching and technical development activities, we will strive also to Attract, Anticipate, Unite and Expand:

- **Attract** the best students, also by providing self-funded scholarships to all those who qualify: in 2017, 36% more scholarships for undergraduates, 40% more scholarships to Ph.D. students and hiring 50% more research fellows vs. the natural turnover;
- **Anticipate** the needs to train students in managing complexities and multidisciplinarity; promote

The Magalhães Association is a network of 35 major European and Latin American technical universities. It promotes the mobility of students of engineering and architecture between partner universities, through the signature of bilateral agreements.

www.magalhaesnetwork.org

It is a network of 20 partner universities in the field of aeronautics and space engineering. The aim of the association is to encourage international mobility among its members through Erasmus agreements. The network also promotes placements abroad, with a high technical and educational content, in aerospace companies.

www.pegasus-europe.org

Global Engineering Education Exchange (E3) is a consortium of 37 universities in the United States of America and 39 universities in the rest of the world, which provides an excellent study abroad experience for engineering students at universities members of the network.

www.iie.org/Programs/GlobalE3

Athens is an association of more than 20 outstanding European technical universities, which offers engineering students the opportunity to attend intensive technical and scientific courses offered by partner institutions to deepen their knowledge in specific areas or get closer to new ones.

www.athensprogramme.com

Politecnico di Milano School of Management

The School of Management was established formally in 2003 and groups together MIP (the Graduate School of Business, founded in 1979) and the Department of Management Engineering, established in 1990, bringing together all research and education operations in the field of management.
The School of Management delivers an end-to-end portfolio of services in research, education and high level consultancy within the fields of management, economics, and industrial engineering. Its mission is to create and share knowledge at the intersection between technology, management and policy, with the ultimate goal of educating responsible future leaders in both private and public sectors. It also aims at consolidating its role as a national champion in research and education at all levels with an end-to-end portfolio - including BSc, MSc, PhD, MBA and EMBA programmes, and executive and corporate education - alongside promoting and developing the School's international reputation.
Being part of the *Politecnico di Milano* influences our work on four levels. First, we focus strongly on innovation, change and the strategic advantage of technologies used in business; second, we transfer the attention for scientific rationality and quantitative methods typical of the engineering mindset to the area of management; third, we constantly pursue interdisciplinarity in both research and education, by making use of the wide array of technical expertise within the sixteen different schools belonging to Politecnico di Milano; and, fourth, we leverage being part of one of the regional engines of the economy in Europe: Milan and the Northern-Italy ecosystem.

Accreditations, Affiliations and Rankings

Throughout its history, the School of Management has always been known for the quality and excellence of its programs, and over the years, it has developed lasting contacts with leading national and international institutions for management training accreditation.
In 2007, the School of Management achieved the prestigious **EQUIS** accreditation (European Quality Improvement System) and joined the circle of 140 leading business schools accredited by **EFMD** (European Foundation for Management Development).
In 2009, the School was included for the first time in the **Financial Times' Rankings** of top European Business Schools.
In 2013, the School has received accreditation from the **Association of MBAs (AMBA)** for achieving he highest standard in Postgraduate Business Education for EMBA and MBA programmes. This accreditation establishes the School MBA programmes firmly amongst the best in the world and informs employers of the high standards of its graduates. AMBA's accreditation is internationally recognised as the global standard for all MBA and EMBA programmes.
From 2015, the School is a member of **AACSB International** - The Association to Advance Collegiate Schools of Business.

Academic portfolio

In addition to BSc, MSc, PhD, MBA and EMBA programmes, the School offers also master programs focused on specific topics (**Specialising Masters**), whose aim is to provide the students with high professional qualification in specialised fields of management, where the key to success comes from leading technical knowledge and mature managerial awareness and skills.
All Specialising Masters feature a solid base of knowledge on the fundamentals of general management. Building on this, each Master focuses on a specific field, industry or management area and provides up-to-date, in-depth knowhow and competencies in that area, through an appropriate mix of experiential learning, field experience, industry visits and insights, project work practice and traditional class training.

Masters held in English

In addition to numerous programs in Italian, the **International Master in Project Management (iMPM)** is targeted to recent graduates and those graduates already in the workplace, and offers a balanced programme of professional training at postgraduate level integrating the most recent research in Project Management with a cross sectorial and intercultural perspective that focus on managerial, behavioral and technical competencies developed shared over a 18-month full-time study period.
The **International Master in Industrial Management (IMIM)** is designed to provide students with primarily scientific or engineering based educational backgrounds with essential business and managerial skills, relevant to pursuing careers in internationally orientated manufacturing and servicing industries.
The **Global Executive Master in Operations and Supply Chain Management (GEMOS)** is a twelve-month long program taught on campus at two European schools, MIP Politecnico di Milano in Milan, Italy, and EADA Business School in Barcelona, Spain.
Supply chain and purchasing management is integral to the success of international businesses that are striving for competitive advantages at a global level. The key to this success is having the right skills and knowledge in order to plan and execute strategies that boost revenues and reduce costs through ideas and innovation. The **Master in Supply Chain and Purchasing Management (MSCPM)** has been created to give all the necessary skills to young graduates looking for a successful international career in supply chain and purchasing management.

The Alumni International Network

The Alumni network of the *Politecnico di Milano* counts over 155,000 graduates who have been awarded a degree between 1940 and today (94,000 engineers, 50,000 architects and 11,000 designers).

AlumniPolimi

Around 20,000 of them live and work outside Italy. They meet through local chapters and associations based all around the globe from Canada to Singapore. Groups in Europe and North America in particular are deeply rooted and engage hundreds of Alumni on a monthly basis, with targeted events and workshops (Paris Chapter alone counts over 300 members). They also provide valuable connections with local industries and institutions thanks to the professional networks they have created through the years.
Alumni abroad and are ambassadors of their Alma Mater and of the "made in Italy" way of thinking. *Politecnico di Milano* has among its goals to help them connect and share this mindset, an extraordinary force for innovation and a resource for Italy and the ecosystem we are in.

The *Politecnico's* Alumni are part of a network of colleagues that will last a lifetime. They can rely on a set of tools that help them keeping the network up and running and staying in touch with their Alma Mater:
An online **Polimi Alumni honor wall**, where they can look colleagues up and contact them wherever they are, ask for advice, seek collaboration or help younger colleagues www.alumni.polimi.it

- An annual **Convention**, the most important networking occasion for all Alumni, with over 1,000 participants attending every year and many more engaging in the conversation online
- The **PolimiRUN**, the biggest university run in the world, hosting 8,000 runners in the spring of 2017
- Targeted **networking events** spread throughout the year
- A **Facebook** page with over 25,000 followers and a **Linkedin** group with 23,000 members
- A monthly **newsletter** with updates on the university and other Alumni
- A **magazine** every 6 months with news and insights "Made in Polimi", the evolution of the *Politecnico*'s campuses, stories from Alumni throughout the world, interviews and much more
- A **dedicated team** helping Alumni to reconnect with people from Politecnico and with the university

integrated R&D in reply to complex technology and social challenges, e.g. invest in projects in 5 strategic areas: Industry 4.0, Smart Cities, Risks in 'fragile territories', protecting health and cultural heritage, maturing the needs for equity, diversity and inclusiveness;

- **Unite** with international university networks, with the enterprises and with the business world, with the institutions and the Alumni network; leverage on strategic partners;
- **Expand** to larger spaces for teaching, student and sport facilities, services, green areas, conceivably by expanding the Bovisa campus, in cooperation with other international universities (see box), and the old campus, by remodeling and enlarging the presence with new infrastructure and more green areas.

A dream? Often the dreams become reality, if we apply ourselves to them with persistence!

Ferruccio Resta

Prof. Resta has been recently elected Rector of the *Politecnico di Milano*, where he has spent most of his academic career.

Following his degree in Mechanical Engineering in 1992, he has been a full professor of Mechanics Applied to Machinery since 2004, head of the Department of Mechanics since 2007 and from 2009 member of the Academic Senate. Prof. Resta has also lead since 2011 the effort for the valorization of research and technology transfer. From 2013, he is the Member of the Scientific Committees of the Laboratory for Materials Testing and Construction Sciences and of PoliFab.

Currently, he is the member of the Teaching Staff of the Ph.D. programs for Mechanical Engineering and of the Leadership Committees for cooperation agreements between the *Politecnico di Milano* and Artsana, Biochemtex, ENI, Leonardo-Finmeccanica, Pirelli Tyres, Solvay Italy Spa, TCI Telecomunicazioni Italia, Veneranda Fabbrica del Duomo . He represents the *Politecnico di Milano* in PNIcube – Association of Incubators and in the Italian academic business plan competitions; he is also member of the Advisory Board of Polihub, the incubator of the *Politecnico di Milano*.

His research activities encompass the following areas:

- Dynamics and control of engines, engine systems, mechanical and electromechanical and structural systems;
- Automotive and railway mechanics;
- Wind engineering and interactions between structures and fluids;
- Vibrations control;
- "Energy harvesting" systems, MEMS (MicroElectroMechanicalSystem) and Smart material systems;
- Systems monitoring and diagnostics.

His research activity has led to more than 220 scientific papers. He holds 7 international patents.

In addition, he holds the following appointments:

- Member of the Leadership Committee for the Joint Research Center on Transportation, established by *Rete Ferroviaria Italiana*, Trenitalia, Bombardier, AnsaldoBreda, ABB, *Fondazione Politecnico* and *Politecnico di Milano*.
- Board Member of Italcertifer S.p.A.
- Member of the Executive Committee of the Cluster Trasporti Italia 2020.
- Founding Member of "T.I.Ve.T. – Innovative Technologies for Terrestrial Vehicles" and "E-CO", both spin-offs of the *Politecnico di Milano*.

Earlier, he was the leader or co-leader of research projects financed by the European Union, national authorities or by the Lombardy Region, and of research contracts between the *Politecnico di Milano* and, among others, Trenitalia, RFI, Italcertifer, Brembo, STMicroelectronics, Whirlpool, CIFA, ABB, LucchiniRS, Eni, GE, City Life, Ansaldo Breda, Expo 2015 S.p.A.

Daslav Brkic

Following decades of experience in international business, strategy, sales and technology development in the oil & gas, power, environmental and telecommunications industries, Dr. Brkic has recently founded his own consulting practice in marketing and strategic business development. In 2017 he is also a Visiting Professor at the School of Management and at the Graduate School of Business of the *Politecnico di Milano*.

After numerous assignments in R&D, international sales and specialty products development with UOP (today Honeywell), based in Chicago and in London, he has led Corporate Strategic Business Development for ABB Lummus and Key Account Management for the ABB Corporation, based in The Hague, the Netherlands. Subsequently, he has headed the International Division of Sirti, a telecommunications E&C company, based in Milan, Italy.

With Saipem, as Corporate Senior Vice President in the Milan headquarters, until mid-2016 he had been in charge of Business and Technology Development, which also included client communications, with particular emphasis on new strategic initiatives. He had joined Snamprogetti (later incorporated into Saipem) in 2002 as SVP Strategic Planning, Technology Development and Licensing.

He holds a Ph.D. in Chemical Engineering from the Technical Universities of Milan, Italy, and Erlangen-Nuremberg, Germany. He has attended the M.B.A. program at the University of Chicago as well as numerous top executive programs at Stanford GSB and at ABB and Eni Corporate Universities.

An active member of the Committees for Internationalization of Confindustria and Assolombarda, he is the Vice President of ANIMP and the Executive Editor of the magazines “Impiantistica italiana” and “Industrial Plants”. Earlier he was a Board Member of several International and Italian industry associations, such as the World Energy Council, Society of Petroleum Engineers, Assomineraria.

He is the author of more than 100 papers and conference speeches on energy, business, engineering & construction and technology issues.

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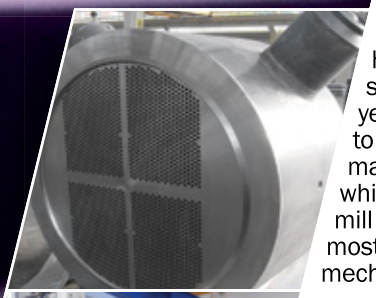

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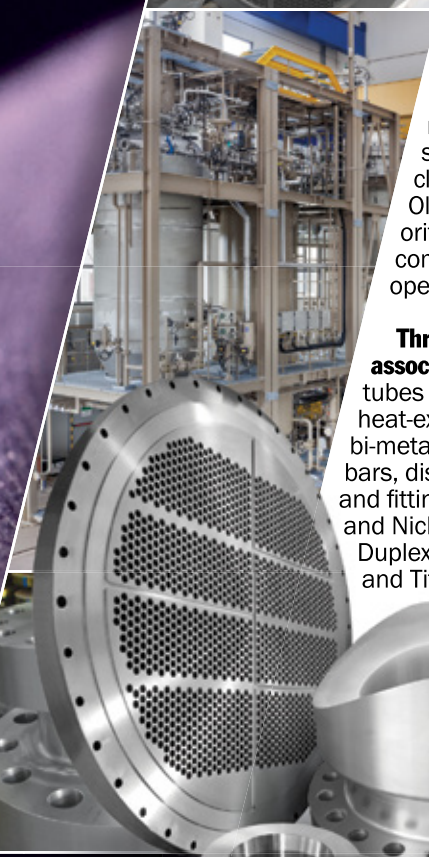

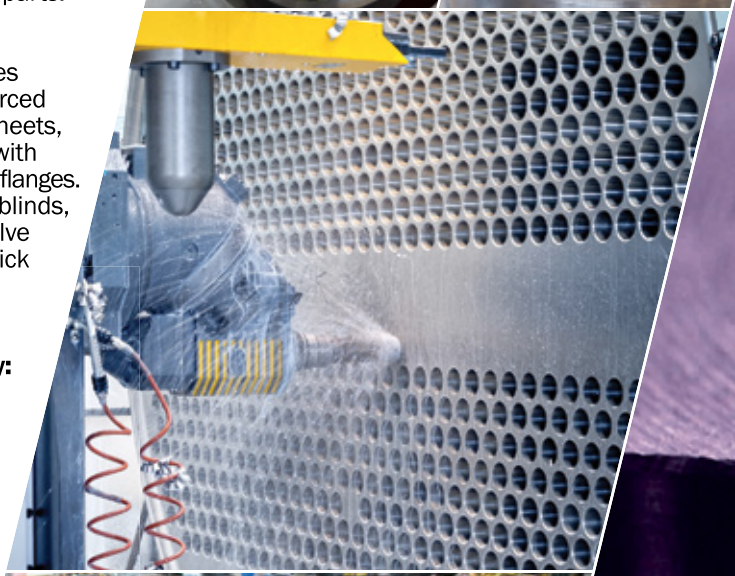

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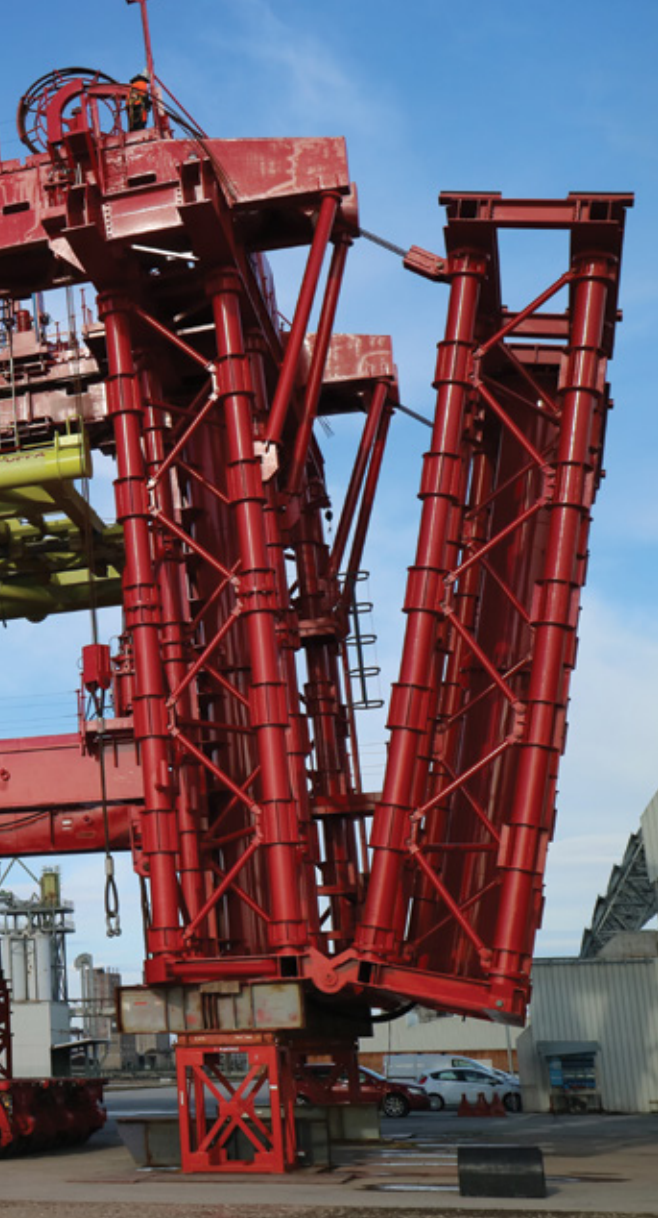
Pict. 1 - Fagioli gantry luanching system

Fagioli gantry launching system for the installation of gates at Malamocco, Venice (MO.S.E. project)

In 2012, Fagioli was contracted for the provision of heavy-lift services related to the transport, and installation of several sections and items for the MO.S.E. project.

Rudy Corbetta, *publicy officer Fagioli SPA*



MO.S.E. is the acronym of Modulo Sperimentale Elettromeccanico (**Experimental Electromechanical Module**). The project is an integrated **defense system** composed of mobile gates able to isolate the Venetian Lagoon from the Adriatic Sea when the tide reaches above an established level (110 cm) and up to a maximum of 3 m during heavy rains and announced flood. MO.S.E. project scope of work consists of the installation of a total of 78 gates which will constitute 4 barriers, positioned at the main entrances of the lagoon.

Each barrier (paratoia) is 20 m wide with a length varying from 18.5 to 29 m and (3.6 to 5 m thick) (pict. 02) The barriers are connected to 12,000 ton concrete caissons.

In normal condition tide, the barriers are full of water and rest in horizontal position inside the caissons. With high tide, compressed air is introduced into the gates to empty them from water, rotating around the axis of the hinges and rising up until they emerge above the water to stop the tide from entering the lagoon. In order to guarantee navigation in the Port of Venice when the mobile barriers are in operation, a main passage for navigation, is being constructed at the Malamocco inlet to allow the transit of large ships. At the Lido and Chioggia inlets there will be smaller locks to allow emergency vessels, fishing boats and pleasure craft to shelter and transit.

Fagioli between 2012 and 2014 was involved in the transport and installation of beams, weighing between 600 and 900 ton with a length of 57 m, for the syncrolyft structure (pict 03 a 03 b), a huge elevator device used to gently move the caissons into the water , ready to be dragged away and installed. The syncrolift was used at Malamocco port whilst at Lido and Chioggia ports, the caissons construction site were flooded with water allowing the caissons to be dragged away. Fagioli used a gantry lifting system to position the beams into the water in order to build up the syncrolift structure. Fagioli was also involved in the transport and installation of 12,000 ton concrete caissons, by means of a tailor made “catamaran” (pict.04) constructed by securing two 190 ton river barges (39,2m x 9,7m x 3,82m) with a pair of steel cross-head beams. The catamaran was provided with strand jacks used either for the pulling and lowering operations of the concrete items. After the final positioning of the caissons, Fagioli executed the transport, lifting and final lowering installation of the first No. 4 mobile gates by means of a tailor made gantry launching system positioned onto a barge and provided with strand jacks. (pict. 05)

The project is an integrated defense system composed of mobile gates able to isolate the Venetian Lagoon from the Adriatic Sea when the tide reaches above an established level and up to a maximum of 3 m during heavy rains and announced flood

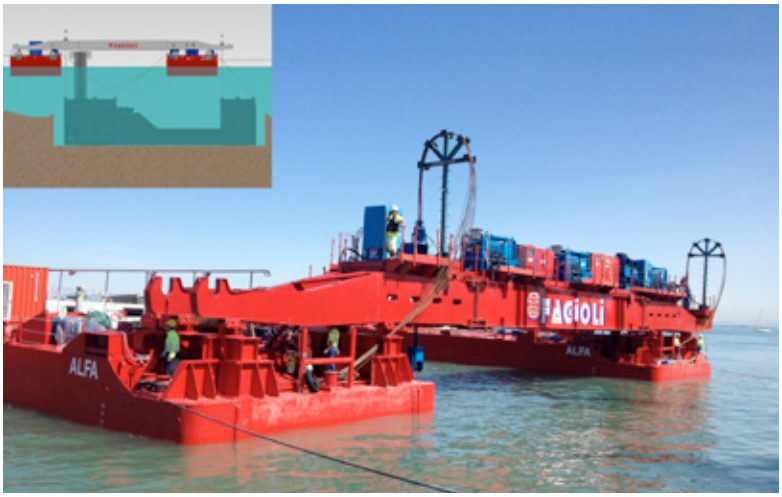
2016 -2017 Installation of no.19 mobile gates at malamocco

After the operations successfully executed of the first mobile gates, Fagioli engineering department came up with the idea to create a new gantry launching system for the installation of No. 19 mobile gates at Malamocco.

Pict. 2 - mobile crane

Pict. 3a - detail of the syncrolift beam

Pict. 3b - detail of the barge and beam approaching the gantry crane system



Pict. 4 - detail of Fagioli tailor made catamaran and final positioning of 12,000 ton caissons

(pict. 06) . The new structure was provided with a movable tower system able to rotate 180 degrees. (pict. 07).

Fagioli gantry lifting system

After detailed analysis and studies in order to create an efficient lifting / lowering system able to execute the No. 19 mobile gates' installation operations, Fagioli engineering department, after months of tests and 3d simulations, ended up with the construction of a reliable launching system with the following dimension: HEIGHT 33,650m; LENGTH 47,019 m; WIDTH 18,500 m. The lifting capacity was 690 ton with a loading capacity of 870 ton.

Assembly of the Gantry Launching system

Fagioli used Gantry lifting system, SPMTs and mobile cranes to assemble the sections of the Launching system. First, Fagioli assembled the Crosshead beams then the towers were assembled (pict. 8). Fagioli used SPMTs to mobilize the items and a 600 ton capacity gantry lifting system to lift the structure (pict 9). The crosshead beams, 47,019 m long, were provided on top with strand jacking system for the lowering / lifting operations of the mobile gates (pict 10). No. 4 x 300 ton capacity strand jacks were fixed on top of the crosshead beams. Then Fagioli completed the assembly of the lateral movable towers, able to open up for 180 degrees (pict 11). The towers were connected at the top and at the bottom with no. 2 beams called bottom and top frames. A middle frame is used to allow the rotation of the towers (see drawing 12). The drawing 17 shows a detail of the base frame which was connected to the caisson, under the water, once the gantry towers were opened. In order to execute the installation of the gates it was built a dedicated lifting system called «fishing beam». This lifting device was connected to the strand jacking system allowing the hooking of the gate for the lowering and final positioning into the water (pict. 13).

In order to guarantee navigation in the Port of Venice when the mobile barriers are in operation, a main passage for navigation, is being constructed at the Malamocco inlet to allow the transit of large ships

Auxiliary equipment

Fagioli built another tailor made structure called "transport beams" (pict. 14). This structure was provided with retractable beams used to lift the gantry

Pict. 5 - installation of the first No. 4 mobile gates

Pict. 6 - Fagioli new gantry launching system

Pict. 7 - movable tower system

Pict. 8 - assembly of crosshead beams

Pict. 9 - lifting of crosshead beams and towers

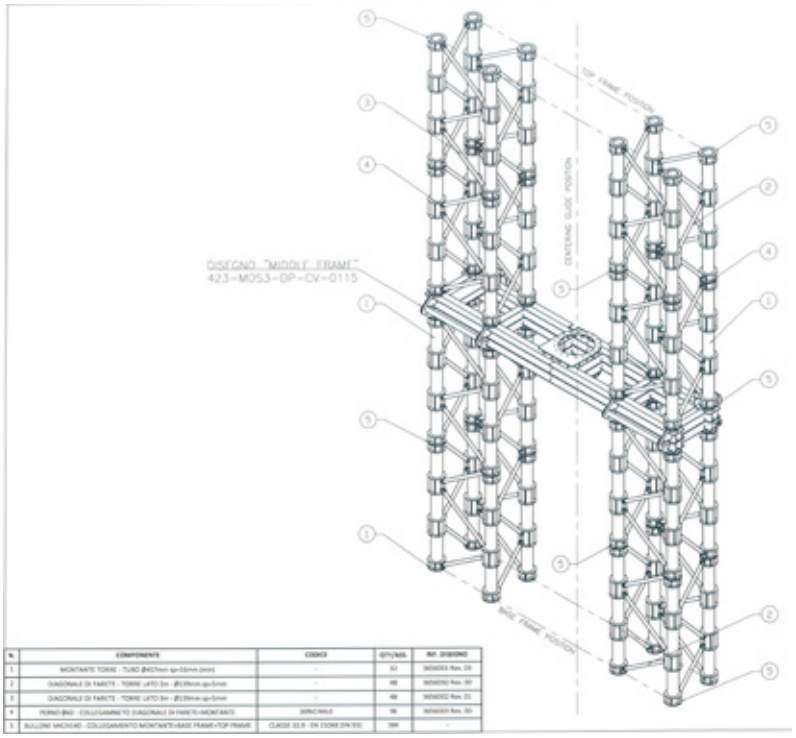
lifting system from the caissons and reposition it onto another caisson for the installation of the gates. The retractable beams equipped with No. 4 x 300 ton capacity each strand jacks and power packs for the skidding of the beams.

Moreover Fagioli used a total of 36 axle lines SPMT for the hauling of the sections during assembly operations, for the transport onto the barge of the gantry launching system and the mobile gates and finally for the mobilization of the transport beams onto the barge.

In order to complete the whole operation Fagioli

Pict. 10 - strand jack

Pict. 11 - lateral towers



Pict. 12 - middle frame

Pict. 13 - detail of the fishing beam

employed a dedicated barge for the transport of the gates and the lifting structure provided with winches positioned onto the barge for the mooring operations. Fagioli was also in charge of the ballasting operations.

Tests executed before the Operation activity

Fagioli executed several tests before the installation entered into the operational stage. At Marghera port the rotation of the movable towers of the gantry launching system were tested several times, taking into considering all the dynamic forces involved.(pict. 15). Another important test was executed offshore for the

> Fagioli used a gantry lifting system to position the beams into the water in order to build up the syncrolift structure

mooring connections between the barge the posts and the buoys. (drawing 16) It was extremely relevant to have a continuous stability of the barge considering the weights of the gates and structures involved at open sea. Last but not least, a loading test was performed before the actual operations were executed, checking with a remote computer the forces, eventual unforeseeable movements, weights and ballast procedures. (pict. 17).

Installation of the mobile barriers

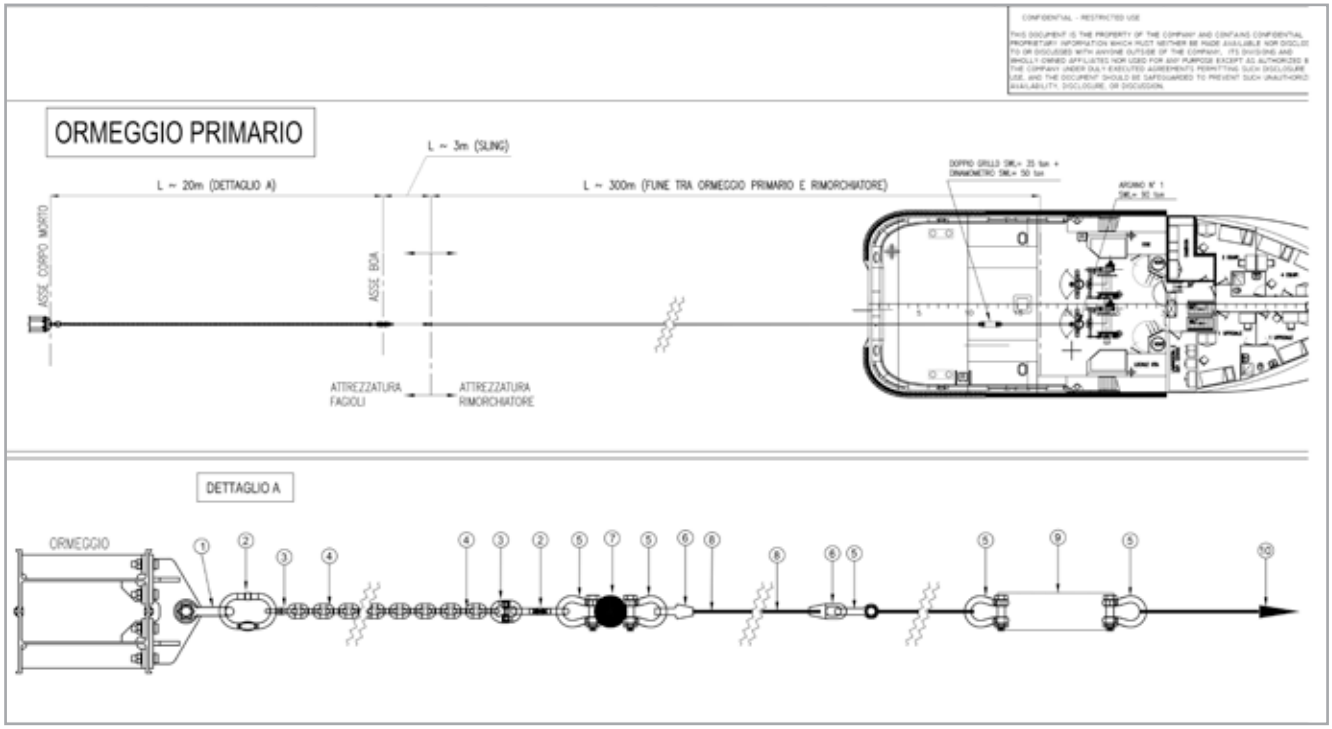
The first step for the installation of the mobile gates was the load out and sea transport of the gantry launching system which was executed by means of SPMTs onto the barge. After the ballast operations, Fagioli slowly proceeded with the transport of the structure onto the barge and the seafastening and securing operations (pict. 18). The barge was pushed

> The new structure was provided with a movable tower system able to rotate 180 degrees

by No. 2 tugboats towards its final destination at Malamocco. Once arrived at Malamocco, the barge loaded with the gantry lifting system was placed in position, over the 12,000 ton caissons (previously lowered into the water by Fagioli catamaran) on top of which the gate would be connected. The barge was moored and kept steady also by the tugboats. Once checked the correct position, the gantry launching

Pict. 14 - transport beam

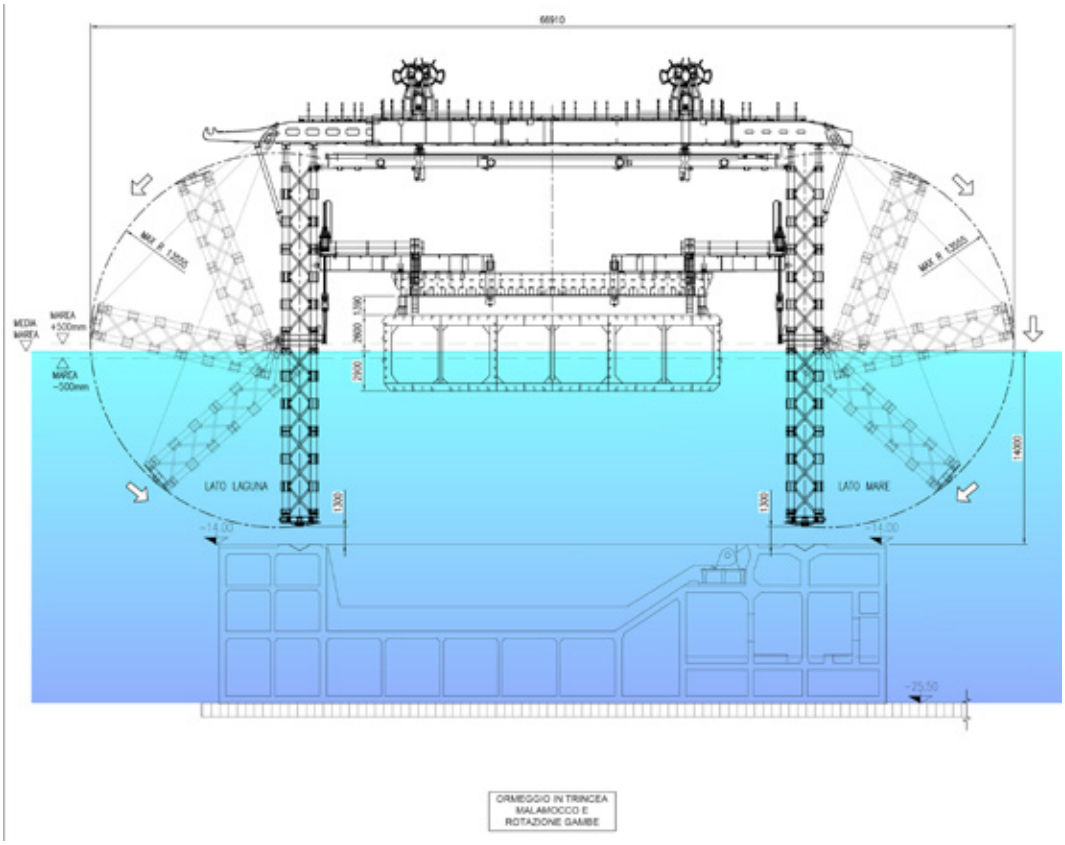
Pict. 15 - testing the movable towers



Pict. 16 - mooring test

Pict. 17 - loading test

Pict. 18 - load out of the launching system



Pict. 19 - rotation of towers

structure started opening the movable tower systems with a rotation of 180 degrees (drawing 19). The bottom towers, once complete the rotation, were joint together with the middle frame The drawing shows the complete rotation of the towers and the connection with the caissons under water. Once connected and checked the correct position of the launching system, the barge was unmoored and sailed away. The barge got to Pellestrina island where all the mobile gates were stored. Fagioli SPMTs, supported by their hydraulic system got underneath the gates and took the whole load. After securing the gates onto the SPMTs, Fagioli proceeded with the load out operation onto the barge (pict. 20). The barge then was pushed back to the

Fagioli used a total of 36 axle lines SPMT for the hauling of the sections during assembly operations, for the transport onto the barge of the gantry launching system and the mobile gates and finally for the mobilization of the transport beams onto the barge

Pict. 20 - load out gates

Pict. 21 - rotation

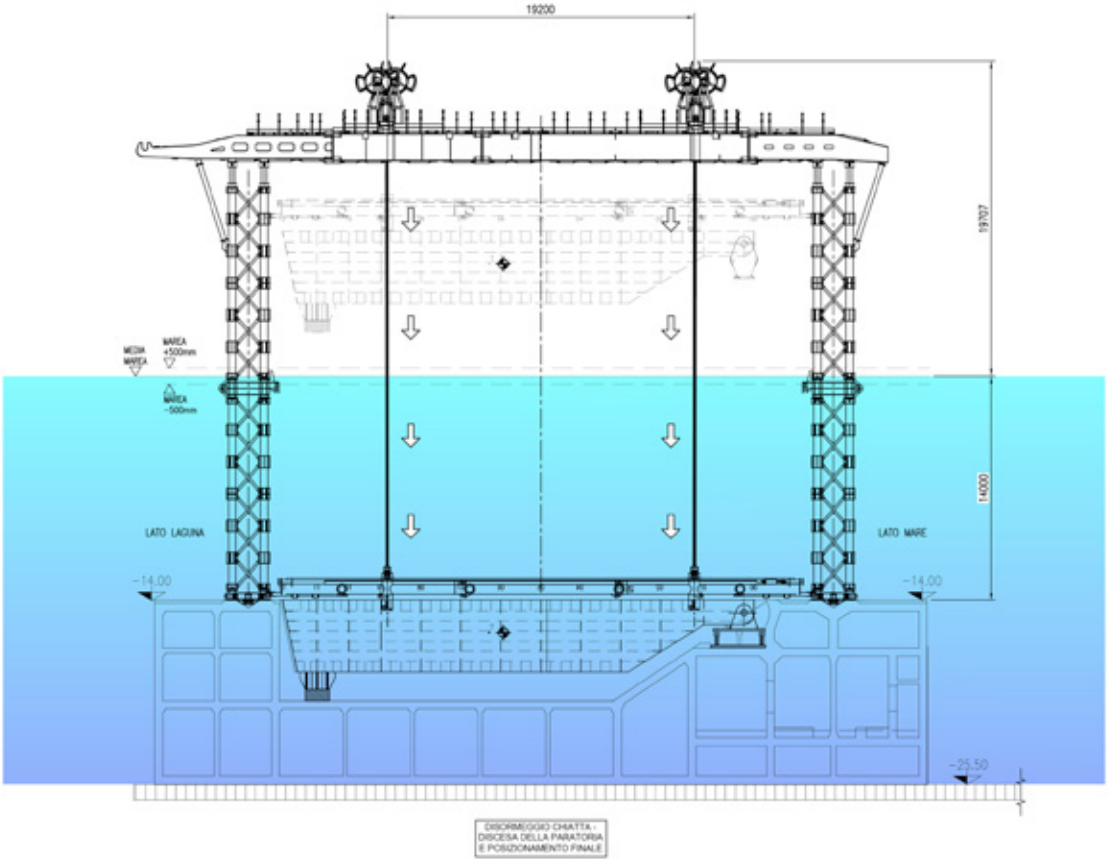
Pict. 22 - connection of gate and fishing beam

Pict. 23 - a lowering the gate

installation area by the tugboats. The barge was moored underneath the launching system previously laid onto the caissons. In order to reach for the correct positon for the connection of the mobile gate with the fishing beam (supported by the strand jacks on top of the launching system) it was necessary to execute a 180 degrees rotation. This operation was executed by the SPMTs (pict. 21), which were also used to get the mobile barrier underneath the fishing beam. During all the previous operations, the barge was ballasted in order to compensate the weights and movement of the structures. The fishing beam was gently lowered and eventually connected to the gate (pict. 22) . After connection, the gate was lifted by No. 4 strand jacks positioned on top of the lifting structure and the barge was sailed away. The mobile gate was lowered into the water by the strand jacks connected to the fishing beams (pict. 23-24) . The final operation was the connection of the gate with the caisson after checking the correct positioning (pict. 25). This last operation was extremely precise and checked by waterproof cameras. Once the connection was executed, the gate was automatically freed from the “fishing beam”. The fishing beam was lifted and taken into position ready for the following installations. As mentioned above, Fagioli prepared a “transport beam structure for the repositioning of the launching system. In order to execute the following installations, Fagioli used the transport beam (positioned onto the barge) to lift the gantry system and reposition it onto the following caissons. The transport beam was a retractable structure positioned onto SPMTs and provided with strand jacks. The transport beams were skidded to the outside to get in contact with the gantry lifting system (pict 26). The gantry lifting system was

> This operation will definitely represent another landmark in the history of naval engineering

Pict. 24 - lowering the gate



Pict. 25 - final position of gate

Pict. 26 - skidding of transport beam outside

Pict. 27 - connection of transport beam with gantry launching system

Pict. 28 - detail of launching system lifted by transport beam

Pict. 29 - detail of launching system lifted by transport beam

disconnected from the bottom base, and was connected to the transport beams (pict 27). The transport beams strand jacks lifted the launching system (pict. 28 and pict. 29) and the barge was unmoored ready to be pushed by the tugboats onto the following caissons.

Final considerations

Compared to the gantry launching system used back in 2012 and 2014, this new system allowed a save in terms of schedule time and costs, thanks to the movable towers. The new Fagioli launching system was easier to be removed and repositioned.

This operation will definitely represent another landmark in the history of naval engineering. Thanks to engineering and safety studies Fagioli managed to perform extremely precise operations in the sea with zero accident occurred.

Rudy Corbetta

Rudy Corbetta, degree in Foreign languages at the University of Bergamo. He has been working for Fagioli SPA since 1999 as publicity officer.

Umm Lulu platforms

Termomeccanica supplies water injection pumps for U.A.E. offshore fields

During the first months of the year, Termomeccanica started the delivery of the water injection pumps for Umm Lulu field to NTC, a joint venture between Technip Abu Dhabi and NPCC.
The supply consists of 4 groups aimed at pumping seawater into the Umm Lulu field for the development of its phase II, exploited by Abu Dhabi Marine Operation Company, a.k.a. ADMA-OPCO

Cesare Nardini
Termomeccanica Pompe's Project Manager

The four pumps are API 610 BB5 type multistage pumps made of super duplex stainless steel, characterised by 300 m³/h flow and 2,160 m head, and driven by a 3 MW motor rotating at 3000 RPM.

Each pump is equipped with a double seal, an 11/62 plan system and an API 614 lubrication system. An API 671 coupling is fitted onto the skid, which is installed on a 3-point base plate with gimbal-type ball joints. An API 661 air-oil heat exchanger will also be installed outside the skid.

The choice of super duplex A890 gr.5A for wet components was made in agreement with the EPC engineering team, considering the characteristics of the pumped fluid, i.e. seawater, so as to guarantee the best protection against corrosion.

One of the main features of these pumps, however, is the back-to-back impellers solution. This configuration combines the advantage of the balanced hydraulic thrusts derived from the back-to-back impellers with the reduced thicknesses of the castings of the BB5 barrel solution in comparison to the usual split case solution. The reduction of the castings thicknesses was particularly critical given that the type of pumped water and its pressure required the use of super duplex stainless steel for the pressure components.

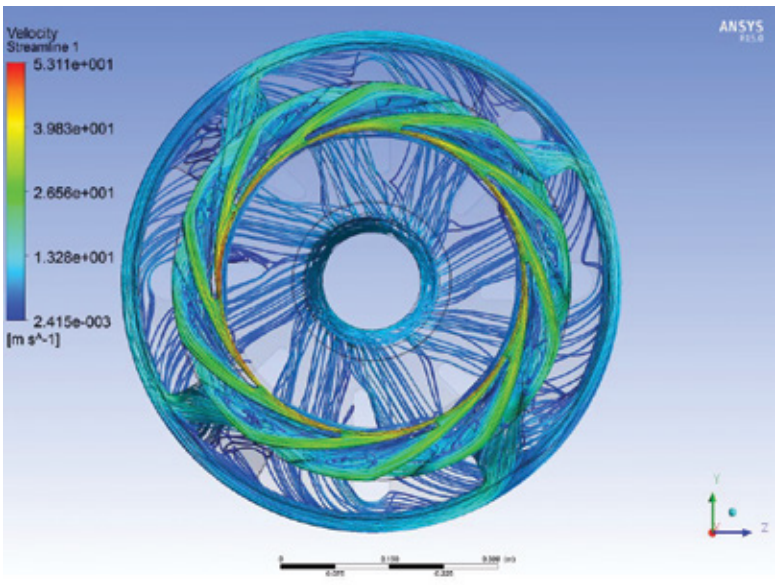
In fact, Termomeccanica had to reconcile the mechanical features of the pressure components, that pushed towards increasing thicknesses, with the metallurgic difficulties of super duplex production that grow in parallel to the increase of the material thicknesses.

The choice of super duplex A890 gr.5A for wet components was made in agreement with the EPC engineering team, considering the characteristics of the pumped fluid, i.e. seawater, so as to guarantee the best protection against corrosion

The first technical challenge was the development of a barrel casing with proper dimensions, without unnecessary layers of material and, most important of all, with regular and constant thickness along its entire length.

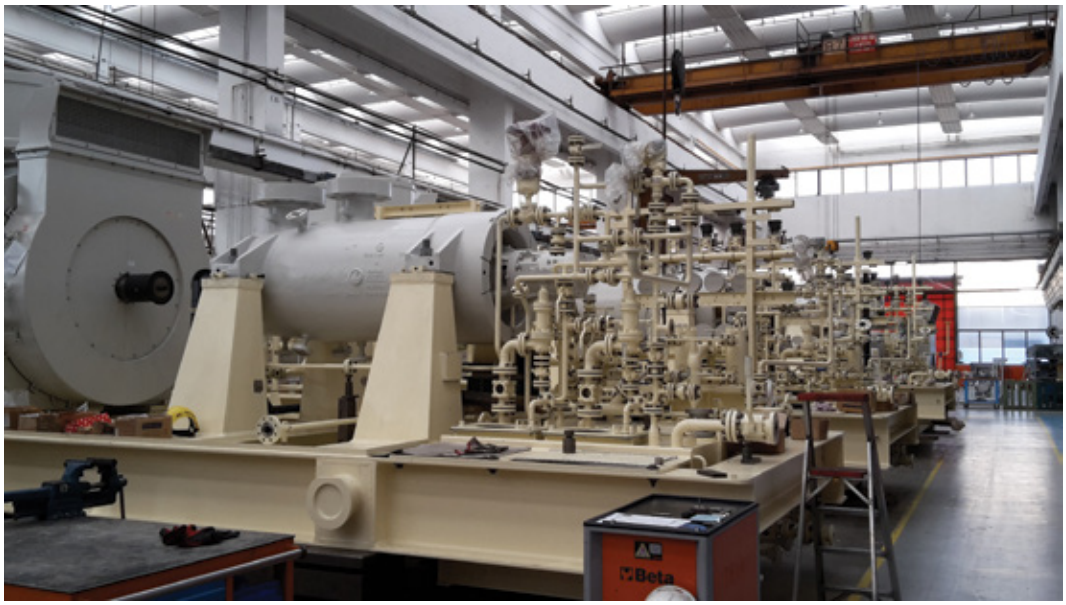
Once the design of the barrel casing was finalized, the second challenge consisted in adjusting it to make its casting feasible, i.e. respecting the restrictions related to the pouring of this type of material, finding the proper and most suitable process and the right size and position of risers and sprues to guarantee a successful outcome. For Super Duplex material, this part of the design is fundamental to prevent unwanted severe defects due to the formation of fragile phases and to achieve the proper final result in terms of mechanical properties.

The use of the most advanced computational tools and a close collaboration with not only foundries and pattern makers but also with NTC materials engineering experts allowed to perform a detailed analysis of this specific design and to define the most suitable heat



CFD simulation in pump crossover area 1

Umm Lulu water injection pumps in Termomeccanica's workshop - final assembly

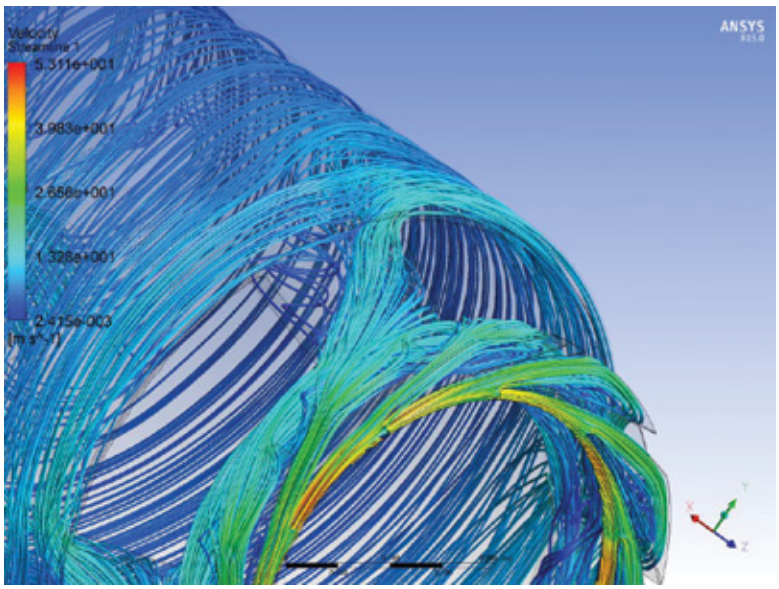


treatment cycle process.
A third engineering challenge was faced for the design of the crossover related to the back-to-back impeller configuration of the pumps. In fact, the pumps have 10 stages with the 5th impeller counter-posed to the 10th.

The aspect related to the reduced thicknesses of the castings was particularly critical given that the type of pump water and its pressure required the use of super duplex stainless steel for the pressure components

The crossover downstream the 5th stage is fed by 4 channels and the flow is then directed to the 6th stage impeller through a 7-chamber channel.
It was fundamental to engineer this crossover in order to guarantee the feeding of the downstream impellers without relevant pressure loss and to maintain the desired efficiency.
The design of the crossover was carried out through a large use of CFD analysis ((see pictures - CFD simulation in pump crossover area 1&2)), which allowed to detect possible complications, such as anomalous flows, performance and pressure loss between stages or pre-rotation phenomena. Based on the results of such analysis, various precautions were adopted to prevent the occurrence of the above-mentioned detrimental behaviors: improvement of channels section, addition of flow rectifier in specific directions, upgrade of the shape of deflectors and optimization of blades and inclination angles of borders.

CFD simulation in pump crossover area 2



Termomeccanica had to reconcile the mechanical features of the pressure components, that pushed towards increasing thicknesses, with the metallurgic difficulties of super duplex production that grow in parallel to the increase of the material thicknesses

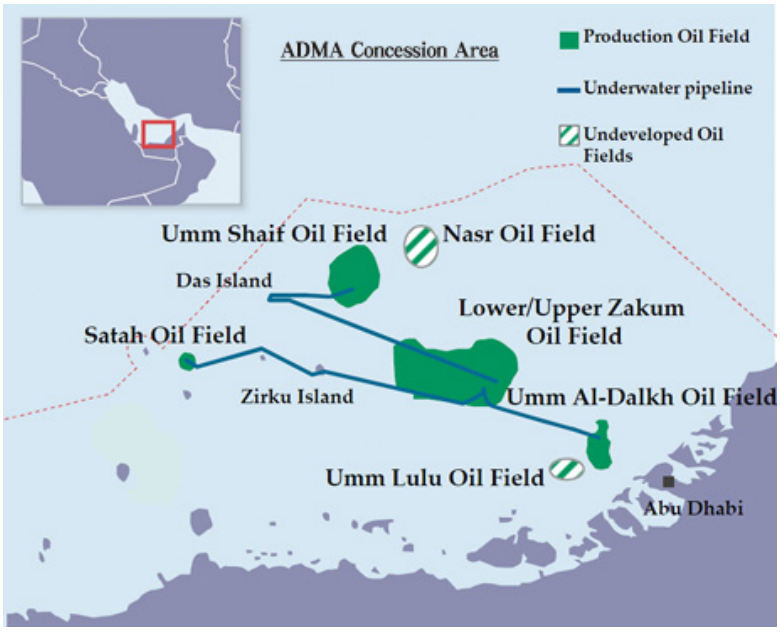
During the development of the project, FEM analysis also played a key role in assisting the design of the pumps.
For example, the Finite Element analysis was used for the design of the shear rings to verify the stress level for induced by the internal pressure in the test at 480 bar. FEM analysis was also used to optimize the design of the baseplate. Termomeccanica Pompe preferred to supply a 3-point baseplate installed on gimbals given that this solution, although somehow detrimental to the project efficiency due to extra costs, weight and complexity, allowed to overcome the difficulties created by the unavailability of precise data for the interface

Umm Lulu water injection pumps in Termomeccanica's warehouse - preparation for shipment

design incoming from the EPC. Such baseplate solution also allows to cope with unexpected behaviors from the interfacing deck.
As per TMP standard for this type of pumps, computational aiding tools were also used to perform torsional and lateral analysis.

The entire manufacturing of the pumps was carried out at Termomeccanica's main workshop located in La Spezia (Italy). During the machining and assembly phases, the material used (super duplex stainless steel) required particular care

The entire manufacturing of the pumps was carried out at Termomeccanica's main workshop located in La Spezia (Italy). During the machining and assembly phases, the material used (super duplex stainless steel) required particular care. Indeed, it was necessary to follow specific handling procedures in order to prevent contamination. Remarkable difficulties also had to be faced for the machining of the casings due to the intrinsic characteristics of the super duplex material (as well as to the particular geometric shape of the casing itself).
As it is usual for such complex projects, this supply is comprehensive of a complete string test for each pump, test to be performed at the supplier's facilities, i.e. in Termomeccanica Pompe's case, at its La Spezia



Adma Opco off-shore oil fields concessions including Umm Lulu

Termomeccanica to deliver water injection pumps for Abu Dhabi's Umm Lulu offshore oil field

In the second quarter of 2014, Termomeccanica Pompe (TMP) was awarded an important pump order for the development of Abu Dhabi's Umm Lulu off-shore oil field.
Such order epitomizes the company's strategic success in the international Oil &Gas market where, thanks to its century-old experience and constant R&D investments, it proposes customized API 610 pumps solutions in compliance with the most stringent demands of key services such as oil pipeline, liquefied natural gas, water injection and off-shore.

test center, recently renewed to increase testing capacity to 15 MW.
For this specific supply, all the pumps were tested with the noise hoods installed directly on their skids to guarantee the requested noise level.

Conclusion

Over the last few years, the leading players of the Oil & Gas market have been driven by the search for projects characterised by higher value-added, i.e. by higher complexity such as offshore and upstream projects in general. Termomeccanica Pompe has followed this market trend, implementing a specific investment program (involving engineering, R&D, manufacturing and testing facilities) geared towards serving the high value added Oil & Gas market segment. Such strategy has borne fruit and allowed the company to confirm its prominent role in this demanding market.

Cesare Nardini

After attending the University of Wollongong in Australia and Universitat Politecnica de Catalunya of Barcellona (Spain), Cesare Nardini completed his studies in 2000 at Politecnico di Milano obtaining a graduate degree in Management Engineering.
He started his work experience the same year at Alstom T&D in Montpellier (France) where he worked for 2 years on the development and installation of digital control system for electrical networks and substation, starting with product engineering development and then moving on to site- and project-management.
In 2002, he changed to the automotive industry and went to work as a project manager for Saira spa, a company of Gruppo Industriale Tosoni, which focuses on the railway market. He was first in charge of all projects related to foreign markets but later moved on to the domestic market, being also the project manager for the engineering and supply of the components for the ETR 600 / New Pendolino project, developed in co-design with Alstom Transport and Giugiaro Design.
He finally joined Termomeccanica Pompe's Project Manager team in 2008 with whom he has followed to date more than 50 projects in the power generation (including the nuclear sector) and oil & gas (including both the onshore and offshore sectors) markets.

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Holistic approach to innovation and optimization in Cooling Systems

Felice Meliti, *Executive Vice President & Chief Service Officer*
Marianna Caputo, *Marketing & Communication Manager*

repairs, to a broader service innovation concept with the ultimate goal to boost customer's business profitability. The firm has turned to a lifetime technological and innovative business partner by enhancing its value proposition. Nowadays our range of offerings include a wide and diversified portfolio of innovative service solutions, customized activities helping clients to maximize the value of their assets and returns on the initial investment. Moreover, pushing technology boundaries to boost performances of operating assets and increase customer's production, coupled with the commitment to develop advanced technical features,

Fig. 1 - Cooling Tower - Condition monitoring and optimization

Long-term reliability is a common challenge for all plant operators. In order to achieve the goal, it is necessary an approach that takes in due account a wide range of different factors and makes use of the most appropriate technology and skilled engineers as well as technicians. A flexible business model on service and maintenance is key to enable smooth operation and avoiding costly shutdown.

B&W SPIG approach is aimed at maintain, repair, optimize and monitoring cooling systems, saving the operators the costs associated with investments in new cooling equipment (**figure1**). The company also provides preventive maintenance for those older systems that might otherwise need to be replaced.

B&W SPIG philosophy is about the importance of continuous remote conditions monitoring on both newly installed machines and aged ones, to reduce degradation to a minimum and extend service life to avoid impact on the operational performances.

Service Evolution

In the last decade, B&W SPIG evolution has moved from traditional service provider, offering standard

A flexible business model on service and maintenance is key to enable smooth operation and avoiding costly shutdown

for both older and newer cooling equipment models and a prompt local response, are consistent to a smart service strategy.

Investing in new products development, specifically conceived for service purpose, is aimed at adding value through injection of new technology in the existing assets to enhance the overall production capacity. That

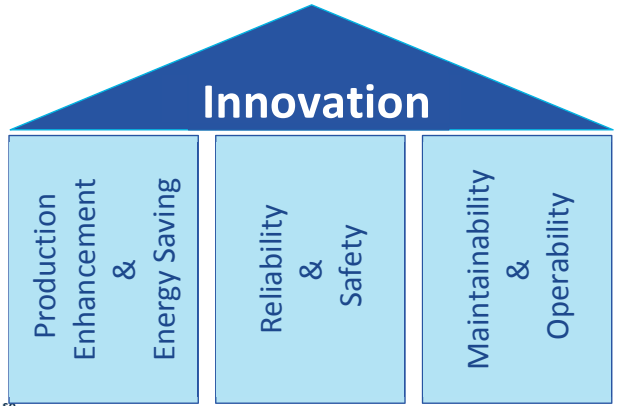

Fig. 2 – B&W SPIG Innovation House

means designing around the asset and layout, tailor made solutions that maximize ROI with a fast pay back.

B&W SPIG Service shapes the future of clients' plants through continuous innovations critical to solve increasing project complexity.

When it comes to innovation, production enhancement, energy saving, reliability and maintainability are considered outstanding improvements with the final aim to enhance the profitable uptime of our customer's assets (**figure 2**).

Fig. 4 – Continuous remote condition monitoring

Monitoring and Diagnostic

In order to minimize loss of revenue, it is essential to use online condition monitoring and diagnostics systems to receive information about the health of operating equipment.

By using predictive and preventive maintenance techniques, B&W SPIG can identify potential failures before they occur and take action to address them, helping to reduce downtime and optimize the yield for cooling systems worldwide.

Fig. 5 – Inspection &Testing

Fig. 3 – Monitoring & Diagnostic Service (M&D)

Monitoring the installed fleet of cooling systems enables us to provide diagnostics-based predictive performance maintenance; in short, we can see problems before they affect an equipment's performance and take preventative steps accordingly (**figure 3**). When monitoring a cooling equipment, data collected from other systems are also considered. This provides unique insight about how the equipment operates.

Monitoring and Diagnostic (M&D) is a system that allows continuous monitoring of Cooling Systems operating parameters through the acquisition of data collected from up to over one hundred sensors in each equipment. Information are analyzed and compared against the other Plant's Cooling Equipment and same type of global fleet.

In case deviations from standard, suspicious trends or path, or "not normal" conditions are found, alerts are generated in order to investigate and assess the situation, allowing detection of potential issue at an early stage. At the same time customer also has access to same data as B&W SPIG.

The B&W SPIG structured quality-orientated, lean six sigma problem-solving process is run from one central performance diagnostics center in Italy, and from local centers all over the world. It is equipped with a full range of precision data acquisition and analytical systems and collects data from customer sites worldwide twenty-four hours a day, seven days a week. With this capability, we offer a series of monitoring, diagnostic, advisory and tuning services to maximize machine performances, maintainability and safety, to help prevent unexpected failures.

> In order to minimize loss of revenue, it is essential to use online condition monitoring and diagnostics systems to receive information about the health of operating equipment

Customers may benefit from our knowledge and expertise acquired during our previous service or maintenance activities and information-based remote services, as well as our specialists' readiness to intervene with the suitable tools and equipment (**figure 4).**

As a consequence we are able to get in advance whatever is needed, thus minimizing lead time.

Fig. 6 and 7 – Increasing customer's uptime

Furthermore, by planning inspection visits during predicted low heat load conditions, we can help to optimize the equipment's profitability and capability (**figure 5).**

Smart Services

Customers' priority is to improve overall operational performances to drive revenues and reduce costs.
With this in mind, there are opportunities to develop and deliver new service solutions to address unmet needs within the client operation, thanks to consistent set of data that can be properly collected, evaluated and packaged to provide the necessary insight into customers' plants.

> In case deviations from standard, suspicious trends or path, or "not normal" conditions are found, alerts are generated in order to investigate and assess the situation, allowing detection of potential issue at an early stage

B&W SPIG is committed in maximizing customer uptime guaranteeing the cooling plant operation as a whole to generate profitable revenue. Increasing customer uptime involves improving customer operation to increase utilization & efficiency of customer's high value assets (**figure 6 and 7)**. In our consolidated experience this proactive approach allows the enhancement of total revenue generation (where capacity constrained) as well as the increase of cost efficiency (whether demand constrained or not).

> Customers' priority is to improve overall operational performances to drive revenues and reduce costs

It is of utmost importance to gain insight into our customers' unmet needs which, if addressed, would help them improve their operations and drive business performance. This means working for identifying potential "Knowledge Services" that could address customer's unmet requirements ("Smart Services").
Among the Knowledge Service already developed by B&W SPIG, we can mention the Vibration Condition Monitoring System (CMS).
The Vibration Condition Monitoring System (CMS) analyses how equipment is performing via a series of sensors. Customer will know early on if something is

One Global EHS&S identity

Since the acquisition of SPIG from Babcock & Wilcox, on July 1, 2016 we started a new journey by adopting the group's consistent global message and focus "Target zero each and every day" (**figure 8)**. We make safety our first priority and share our vision to "finish each and every day incident- and injury-free". We consider safety as a value and we have the mission to be the Best-in-class Environmental Health Safety & Security (EHS&S) performance and industry leader.
Our commitment to safety continues through the use and monitoring of our traditional safety measures.

not performing as expected and we can service and maintain the equipment before a problem becomes crucial and causes protracted down time. That way we will reduce unscheduled maintenance, improve availability, reduce repair costs, plan repair logistics more efficiently, and add value over the long-term.

The Vibration Condition Monitoring System (CMS) analyses how equipment is performing via a series of sensors

B&W SPIG has invested tireless efforts in developing Smart Services, leveraging on digital capabilities, e.g. creating apps available on customer's smart-phones and leveraging digital concepts to communication with clients. This win-win proactive approach results in: real-time fleet management, greater maintenance input, and better access to engineering and technical support for clients while for B&W SPIG means customer "stickiness", strong Service Agreements value, access to real-time status data and live link to customer input.

Service is definitively a flexible and high dynamic business requiring continuous investment in order to develop adding value solutions that meet customer needs and anticipate solutions for prospects' needs. At B&W SPIG we strongly believe that investing in Service means shaping today ours and our customers' future and create a key differentiator for positioning our company as an undisputed leader in the Cooling System's market in the years to come.
We continue to believe this approach will help us create value and maximize sustainable returns over the long term.

Felice Meliti

Felice Meliti is Executive Vice President and Chief Service Officer of SPIG S.p.A. He has over 15 years of experience in commercial and contract management and vast expertise in service businesses. Before joining SPIG, he worked as the Service Head of Business Development, Sales & Project Management for EMEA & Latin America within Vestas Wind System driving substantially revenue and margin growth new business development, product expansion and revenue enhancement strategies. Prior to this, Felice held various leadership roles in General Electric Oil & Gas where he spent 9 years, starting as Project Manager within Global Services for the Middle East region, moving in the Six Sigma quality team and, finally, assuming the responsibility of Senior Commercial Leader of Contractual Service Agreements for the EMEA, India & Americas regions.
Felice holds a master's degree in Aeronautical Engineering from the University of Pisa, Italy.

Marianna Caputo

Marianna Caputo graduated in Political Sciences at the University of Pavia in 2001 and in 2008 obtained a Marketing and Sales Management BtoB master diploma at SDA Bocconi, in Milano.
She started her professional career the same year at Marley Cooling Tower Europe S.p.A. as marketing assistant. In 2002 she joined SPIG FOREIGN MARKETS s.r.l./SPIG S.p.A. as marketing coordinator, supporting executives on projects directed at maximizing the company profits and developing sales strategies and marketing campaigns. In 2004 she became SPIG Marketing and Communication Manager responsible for Competitive & Market Intelligence, Public Relation, enhancing the company visibility and positioning, promoting its products and services on the global market.

Remote controlled monitors - a smart and reliable answer for a safer protection

Nico Zorzetto, Director Export e Marketing Sanco Spa

Safety is more than just being careful: it includes knowing what is unsafe and how to avoid the careless actions and inactions that can make an area unsafe.

Poor safety practices come from a lack of safety familiarity (need of trainings), while carelessness results from a disregard for that awareness. Both conditions can lead to catastrophe.

Yet, in some cases it may not always be possible to extinguish a fire, and, in such case, the fire should be controlled, and vulnerable equipment should be kept cool.

It is usual to provide a range of means for fighting and controlling fires, and fixed monitors are really useful tools required to provide cooling water spray or foam against radiation and/or to divert vapour clouds away from the source of ignition during fire operations or to deliver dry chemical powder for suppressing fires (for gas fires).

The adaptability of this kind of system is really noteworthy.

In fact, SANCO monitors can be used for the protection of many **fire risks**, such as

- jetty and harbours
- docks
- oil fuel and chemical storage tanks
- chemical plants
- oil refinery processing areas
- LNG cargos, jetty areas
- dyke areas (oil, fuel, chemical storage tanks)
- aircraft hangars
- helicopter loading paths
- offshore helidecks and platforms

Fire risks and extinguishing agents

There are different **types of extinguishing agents** according to each risk to protect, so it is essential to identify when to use one agent rather than another.

Series of remote controlled monitors employed for oil T-berth

For example, water is an extinguishing agent usually always available and it can be operated to cool surfaces exposed to radiation or affected by fire.

A water curtain can be useful to limit the thermal effect of radiation and, in some circumstances, it may be used also to extinguish a jet of burning gas. Water monitors are usually used to cool exposed items, such as equipment and gangways for escape. A water stream can also be used to cool metal supports and deck surfaces during a fire, to prevent weakening and buckling of structures. In the jetty situation, cooling has to be provided for the monitor poles/structures and the gangways between the ship and shore is important for escape.

On the other hand foam extinguishing agent suppresses fire by separating the flames from the fuel surface, retarding vapour release and cooling the surroundings, by excluding oxygen from the flammable vapours, reducing the rate of gas vapours cloud and, subsequently, flash fire or vapour cloud explosion.

In particular, when dealing with hydrocarbon products or flammable liquids, foam can be the most appropriate solution.

Several foam concentrates have been developed over the years, each with particular features.

On the market there are several foam concentrates that

can be according to their nature and they can be chosen according to the type of fire risk to protect, such as the following ones:

- Alcohol-Resistant (AR): as AFFF/AR and FFFP/AR
- Aqueous Film-Forming Foam (AFFF)
- Synthetic foam (S)
- Film-Forming Fluoroprotein Foam (FFFP)
- Fluoroprotein foam (FP)

However, foam concentrates can also be selected according to the expansion ratio (3% or/to 6%), that can be chosen according to the way the system has been designed: a 3% concentrate has a double concentration than a 6%, therefore it requires half the product to produce the same end result. Otherwise, it grants a double autonomy of the foam system.
Also foam is not the most suitable agent for extinguishing a fire coming from liquefied gas (LNG or LPG), while dry chemical powder is the most effective means for fire suppression, while water can be a suitable agent for a cooling effect on gas fires.

A major step forward in the world of fire fighting

The best way to predict the future is to invent it." Alan Kay (American computer scientist)

Technological developments in built-in fire protection measures are becoming familiar, with new extinguishing

Remote controlled monitors on towers

Local control panel (suitable to operate 2 RCM)

equipment and methods and alternative methodologies to emergency awareness.
The development of new products of buildings and relevant contents are creating changing and more challenging fire scenarios nowadays.
This has an effect on fire fighter tactics, protective clothing and equipment, tenability conditions, and it challenges some basic assumptions in the design of buildings for fire.
The resources that are available on site should be such to run an effective initial response to the fire in order to avoid possible uncontrolled catastrophic situations.

The increasing number of fires becoming much larger due to the late arrival of fire team and/or due to the complicated and inaccessible structures built today suggests the use of remote-controlled monitor systems (RCM), particularly recommended for fixed installations.
Fixed monitors may be of course manually operated, but they may be also designed in order to be remotely controlled by means of one or more remote control stations placed in a strategic area that allows a safe operation.
The fire team who is advancing to the fire can rapidly and safely intervene thanks to the help of remote-controlled monitors, that attack and control large fires from a relatively safe distance, such as from the control rooms placed in a safe area and/or from other auxiliary control points.
Remote controlled monitors can be stand alone or they can be part of a monitor network with multiple units controlled from one or more control panels.
The largest system with RCM monitors that I have personally ever been involved to design and manufacture includes an operation & control station (plus various local stations) that controls 36 monitors placed on

towers.

Monitors can be operated and moved thanks to:

- the valve for feeding the monitor, that opens/closes
- horizontal rotation movement (normally between 340° and 360°)
- vertical rotation movement (usually -75° + 80°)
- setting of stream control (in case of water nozzle the flow can be adjusted jet/fog, in case of foam barrel with the possibility to change the shape of the jet)

Moreover, water network valves can be opened/closed in order to activate the external cooling system for cooling poles and/or the safety escape ways (as above mentioned).

Remote-controlled monitors come in three main types:

A) electrically operated (the most employed)
B) electro-hydraulically operated (more utilized)
C) hydraulically operated (not used anymore due to the complicated and difficult maintenance that is required)

The above monitors can be supplied in several versions:
- for safe area
- for hazardous zone, explosion proof according to EXe or EXd or ATEX (for electrical equipment and for associated devices mounted with the monitor).

Moreover, the body can be made in stainless steel or marine bronze and, in some cases, they can be made of a special alloy suitable for very low temperatures (-35°C or even -40°C)
Monitors for fixed installation can be located on the top a pole or a platform with variable heights, usually between 6 and 25 meters, or they can even be placed on tower of ships.
At the base of the pole (or platform) a control panel can be installed, often in EXd execution, connected to a console placed in a safe area on which all signals and controls of other monitors of the same type (RCM) are collected and the valves used for controlling the water/foam line.
This kind of monitor is particularly suitable for fire risks such as docks and jetties.
In case of jetty protection, the fire appliance is not limited to RCM but it also includes:

- escape ways for personnel (with relevant spray nozzle net)
- hydrants, suitable to deliver water (for cooling, sometimes the hydrant can be foam type and it comes with relevant devices to product it)
- fire cabinets for hydrants (stainless steel or GRP made) complete with all accessories (hoses, nozzles, etc.)
- large size hose reels (1 ½" x 30 or 40 mt not kinkable hoses) able to spray water or foam thanks to a built-in foam concentrate tank (usually of 200 lt capacity)

Remote controlled fire monitor to be fixed on top of pole

In relation with electrically operated RCM the water feeding is made through a water pumping station, activated by the control panels and all the operations are controlled by the same main control panel.
This kind of system is really reliable, it quickly provides action thanks to electrical remote controlled devices. It does not need any particular maintenance.
The console can be installed also 250-300 meters away from the monitor, thus allowing the operator to interface by a local control panel or even by a master control panel and sometimes the monitors can be wireless controlled.
On the same pole both a foam monitor and a dry chemical monitor can be mounted, because they can be employed in a independent way on flammable

liquids (foam monitor) or flammable gases (dry chemical monitors) or event they can work simultaneously for both type of risks a twin agent system. Dry chemical is the fastest means for extinguishing the fire and foam AFFF or AFFF/AR seals permanently the fire, preventing the fire re-ignition. The most known dry chemical powders are Ultrex K, Monnex and Purple K.

These monitors can be also coupled with thermal imaging fire detection system in order to efficiently detect hot spots and extinguish fires in an automatic way.

An ideal fire control system would be able to properly identify the fire, activate a fire suppression system, and then turn itself off.
This may result in lower false alarms, it will provide enhanced detection, improve efficiencies, and use several sensing technologies.
Some examples of fire detection technologies called “trace” and VID (video) systems, that can be integrated with remote-controlled fire fighting monitors.
An important development is toward more specific products and more specialized systems for specific applications and niche markets.

We, SANCO, are available to supply customized protection schemes to provide a verified level of confidence, whenever and wherever needed.

Nico Zorzetto

Nico Zorzetto, Export & Marketing Director as well as shareholder of Sanco S.p.A., has been working in the fire fighting field for the last 40 years. Even if he graduated in Economics, he has always been dedicating its interest to technological innovation for “reliable products”.
He has been participating to the realization of several new products and systems; in particular he is co-creator of airmobile fire fighting systems (fixed type and rotating wing) for the fire fighting of bushfires. He has been publishing several articles – national and International - relevant to fire fighting subjects.
He operates also with national and International organizations for the Civil Protection Organizations, as well as with security matters, with jobs also with NATO.

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Fig. 1 - Modules Fabrication

Modularization affecting the Oil and Gas industry

The Italian Company APS SpA executed a Modular Plant Project for a licensed plant in Tarasovskoe field, the Russian Federation. The role of efficiency was fundamental in this successful project

Martina Marmotta, **Zivile Kriauciunaite**, **Massimo Paris**
APS S.p.A.

In the last few years APS SpA, the Italian Engineering and Design Global Contractor, signed a contract with a Company, which operates as a subsidiary of ROSNEFT Oil Company, for designing, production and supply of diesel hydrotreating block-module unit. Project investment was part of the Client's business targets to satisfy market needs for petroleum products through the development of advanced technologies with a special attention given to increase operational efficiency and modernization, in compliance with Russian Regulations. Tarasovskoye field (Yamal-Nenets Autonomous Region, the Russian Federation) was chosen as the location of the unit plant and considering also the harsh ambient conditions, the plant needed to be designed as a block modular supply to reduce drastically the installation complexity and time.

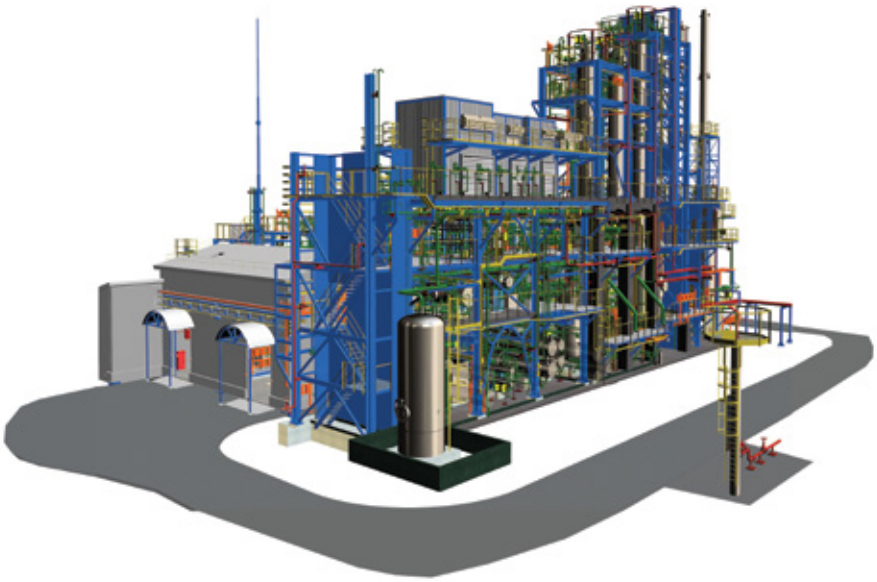
The decision of the Client to rely on APS was motivated by the Company's functional and technical skills in this sector, as well as the flexibility and the high expertise in Lump Sum Turn Key plants design and building. In order to perform the Contract, since APS operates in compliance with the regulations and laws, including those which govern the import and export operations, APS has obtained the mandatory Authorization from the Italian Public Authority named "Ministero dello Sviluppo Economico – MISE" dated January 20, 2015, in order to be entitled and allowed to export to Russian Federation the equipment inherent the Project.

In April 2017, APS has met once again all expectations bringing thus to fulfillment its mission. Modules, equipment and machinery have been modularized at the maximum possible level in order to save time and to reduce field labour during assemblage and installation in the construction area.

The Modules left the manufacturer's factory nearly complete and certified TR CU (Technical Regulation Custom Union), with most of its support structure, pipe, instrument stands, electrical wiring, grating, insulation and other components built-in and ready for operation, once connection is made to the plant's systems. The modules were transported to their final assembly site into easily portable skids.

The main factors that contributed to the success of this project have been the APS local presence in the Russian Federation with its Representative Office in Moscow, and the technical support of the State Unitary Enterprise GUP INKHP RB, for the examination of project and working documentation, including its conformity to the requirements of the Russian Federation standards. These local partners allowed APS to overcome a number of objective difficulties related to geographical distance, different institutional standards and language.

Fig. 2 –3D Modeling Project



Project highlights

The Diesel Hydrotreating Unit, based on American License, has a capacity of 15 m3 / h (2264 barrels / day); its aim is to reduce the amount of sulfur present in the gasoil within the limits defined by the Russian Technical Regulation approved on 27 February 2008. Placement of this modularized plant is planned at the

territory of the refining Complex in the District of Yamal-Nenets Autonomous Region, for this reason, the Licensor obtained permission from the U.S. Department of Commerce to export its own materials to the Russian Federation.

APS team designed 8 (eight) modules of a dimension compatible with railway and truck transportation. All modules have been totally prefabricated, in collaboration with Gruppo Antonini.

Of particular importance for its complexity and dimensions are:

Module 8 (13900x6300x6250 mm): The make-up hydrogen compressor unit is intended for maintaining permanent hydrogen concentration and circulation in the reactor unit, as in the process of the diesel fuel hydrotreatment a part of hydrogen undergoes various reactions and is removed together with hydrocarbon gases. All unit components are connected with each other by the pipes. The Hydrogen from module 8 will be mixed with gasoil coming from the Atmospheric distillation unit and feeding to reactors system. (**figures 3-4**)

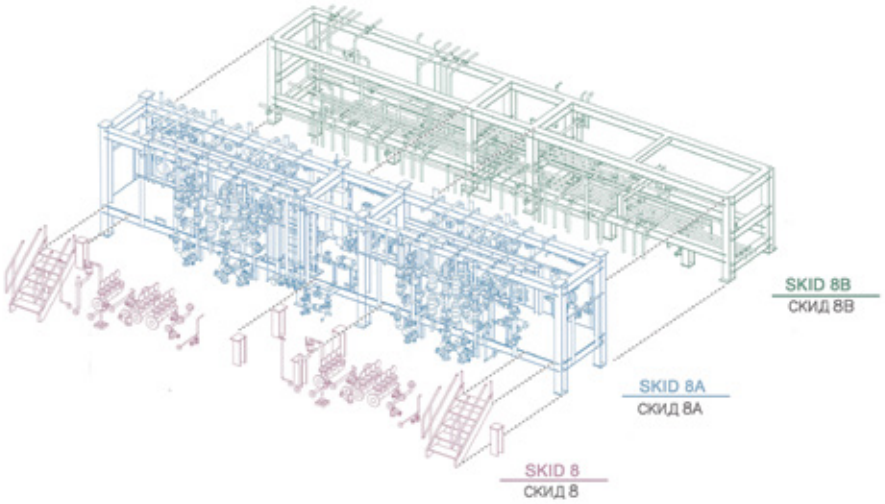


Fig. 3 – Assembly of Module 8

Fig.4 – Module 8

Module 2 (6050x6000x4800 mm): The reactor recycle pump module is used to provide the recirculation of diesel coming from the reactors and include two canned vertical pumps (licensed equipment) with two reciprocating pumps (licensed equipment) with maintenance sites and piping system components. The lubrification system of recycle pump is provided by the Module 7 (3750x2000x5141 mm) through the gasoil produced by DHU itself. (**figures 5-6**)

The design stage has great significance for the Modular construction process. The use of advanced 3D Modelling software is among the main factors contributing to an accurate review of accessibility for maintenance, operation and safety. Moreover, it is necessary to include design allowance in order to avoid any misalignment of components during the assembly. Once modelling is sufficiently progressed, the software allows a "walk-through review" of the modules simulating exactly the future configuration of the plant. The 3D modelling, (**figure 2**) skillfully used by APS Team, has allowed to solve, in design phase, any type of clash or physical inconsistencies thus avoiding costly and time consuming modifications during construction phase.

Modular plant solution

The economics of the downstream industries are under pressure due to the low cost of oil and natural gas and uncertainties regarding their future as the world economic situation is changing rapidly. Major capital projects are being re-evaluated in a market where supply, demand and pricing have suddenly become uncertain. In addition, developing countries are quickly building new plants and infrastructure to support a rapidly growing middle class that demands all the benefits of modern industrial production.

Modular construction is widely used in many fields and approaching this solution could help also the EPC sector to use it as a standard successful approach that can generate a lot of benefits. This highly efficient process may be a solution for projects located in remote regions where skilled labor is difficult to secure. It gives the possibility to reduce schedule and cost uncertainty and may help achieve a faster start-up (**figure 7**).

Modularization has become particularly prominent in the offshore oil and gas industry [*1*]. By fabricating key components in a controlled environment, it is possible to minimize risk, improve quality and increase overall safety. Units derived from fabrication workshops can be preassembled for shipping anywhere around the world and modular construction can be more easily executed with available on-site skills *[2]*.

Nevertheless, there is still low awareness level of both

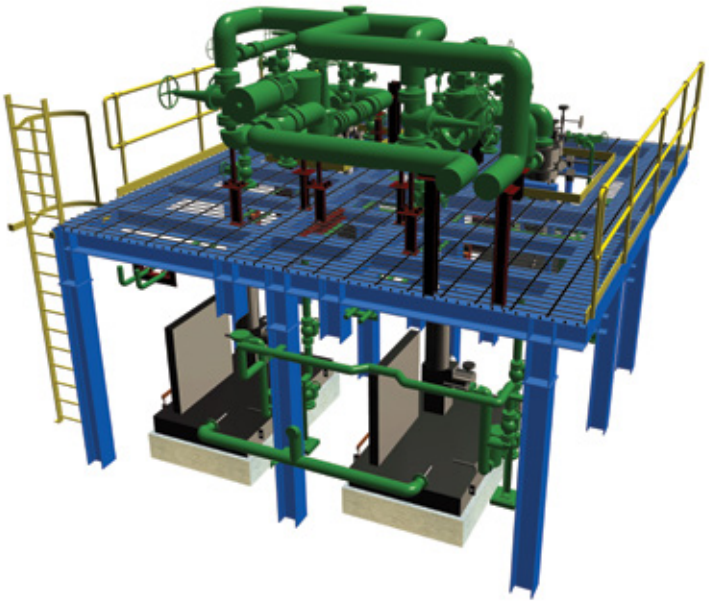


Fig. 5 –Module 2 Model

Fig. 6 – Module 2

EPC contractors and Clients on the results of modularization and this technique is quite recent in the Oil and Gas sector. However, the number of modular projects is increasing and more and more companies are interested in better understanding the potential of the modular execution mode *[3].*

Modular construction does not come without drawbacks.

One of the biggest challenges associated with prefabricating modules offsite is transportation.

of the modular project of APS, now nearing completion: "*Prefabricating modules is an increasingly popular strategy in today's competitive construction and upgrade market, which transformed the approach to building process systems and plants".*

He goes on to say:

"With regard to my project, APS prefabrication strategy has started with a thorough skills assessment. Certainly, transportation constraint was one of the biggest challenges. The systems had to be designed into

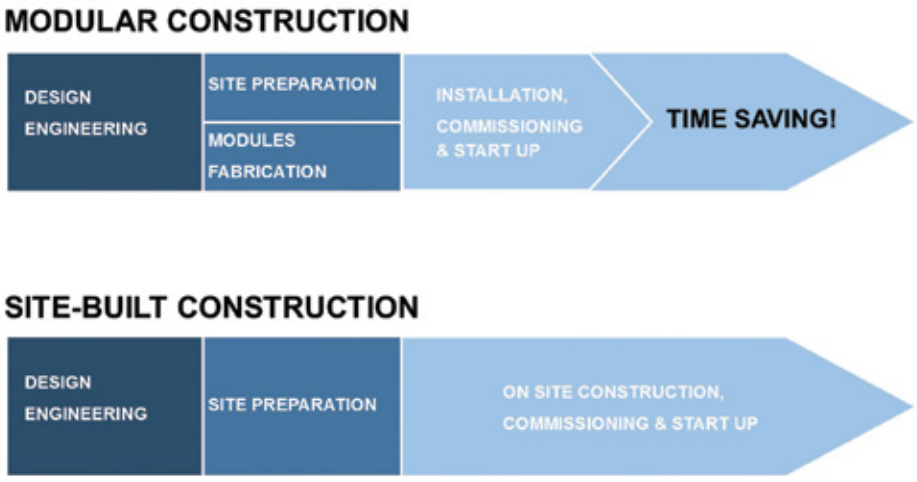


Fig. 7 – Typical scheme "Modular VS Site-built Construction"

Modules typically consist of multiple pieces of equipment ancillary piping, control systems and other components on a single skid, for this reason size and weight can be significant.

Shipping logistics and transportation form integral parts of modularization design and are influenced by the geographical location of the facility, the type of modularization, and the location of the module fabrication yard.

This issue is also highlighted by the personal experience of the Project Manager, Mr. Massimo Paris, responsible

portable skids in order to match the predefined cargo dimension of 12000x2700x2600 mm. In only a few months we succeeded in delivering by railway and truck the modules to site. It was an exciting experience and today's results show that APS has great potential".

Looking at the Russian market

Oil and gas are the primary assets of Russia in terms of the government revenue they generate and the stable economic growth and social development that the

industry support. Russia's economy in fact is highly dependent on its hydrocarbons, and oil and natural gas revenues account for more than 40% of the federal budget revenues. Most of Russia's oil and gas resources are located in West Siberia, and in the Urals-Volga region, extending into the Caspian Sea, so Russia's eastern fields may play a larger role *[4].* As a consequence, in the coming years, a number of Russian oil and gas Companies could announce plans for significant investments.

APS is well positioned in the Russian territory where it already has long-term presence and, in order to remain competitive in the eastern market, it also obtained the engineering license of SRO NP "Neftegaservices", applicable throughout the entire territory of the Russian Federation.

Company management sometimes means diversifying with the aim to improve efficiency. The usage of Modular as well as on-site Construction enables APS to be flexible and to have a complete kit of engineering solutions in order to manage successfully Oil and Gas Market demands and complexity and to make projects easier for the Costumers, regardless of the project size, scope or location.

Sources:

[1] Source: http://insights. globalspec.com/article/3002/modular-construction-in-the-oil-and-gas-industry

[2] Source: http://www.hydrocarbonprocessing.com/magazine/2016

[3] Source: "Supporting Decisions on Industrial Plant Modularization: A Case Study Approach in the Oil and Gas Sector" Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Kuala Lumpur, Malaysia, March 8-10, 2016"

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Martina Marmotta

Martina Marmotta is graduated degree in International Relations. Since 2013 she is registered in the Register of Italian National Journalist with her experience of reporting and writing on national newspapers. In APS she deals with quality system implementation, as well as support to the Commercial Business Unit.

Zivile Kriauciunaite

Zivile Kriauciunaite received a Master degree in People Strategy and after she specialized in Digital Marketing and Communication. She worked on several International projects, funded by European Union, as responsible for the development of communication strategies. In 2015, she joined APS where she works as Marketing Specialist and is responsible for promoting the Company's brand and services.

Massimo Paris

Massimo Paris is graduated degree in Managerial Engineering. In APS he has covered various positions like Instrument Engineer, Cost Control Engineer, Site Manager and Project Engineer. Currently is managing the Modular project for the construction of the Diesel Hydrotreating Unit.

New ideas to serve an industrial segment undergoing deep repositioning

Intergraph Engineering Environment Services SpA (IEES) supported Hitachi on challenging engineering activities for Saudi Aramco's Jazan mega-project, by taking advantage of Intergraph Smart™ 3D, the next generation, data-centric and rule-driven solution specifically designed to deliver mission-critical requirements by breaking through barriers imposed by traditional technologies, in order to enable a truly iterative design environment

Marco Radice – CEO, Intergraph Engineering Environment Services SpA
Guido Maglionico – Business Advisor to Intergraph Engineering Environment Services SpA

The times of turmoil and costs-cutting in the Oil&Gas industrial plants engineering segment have a "must": "competitiveness inside a quality and reliability frame" - three concepts including a business universe and the relevant approach to be turned into industrial reality.

A must in today's market: competitiveness inside a quality and reliability frame

This exactly was the aim of Intergraph Engineering Environment Services (henceforth IEES) when starting as an Italian registered stock company to approach the engineering market by implementing in Italy a HEXAGON international group (which owns IEES 100%) investment. Obviously no multinational group would decide such an important investment light heartedly, in a Country still under pressure from the heavy economical cycle and crisis unless the real profit potentials were clearly identifiable.

In fact the relevant IEES business plan not only highlighted the possible and profitable developments, but also stressed the short term achievements to pay back the investment and become profitable.

Such assumptions have been confirmed, among the others, by the following facts:

- IEES commercial results in its first year after its establishment early in 2015, through booking several SAIPEM's frame agreements out of the relevant Tenders, and repeatedly positioning itself as the first or one of the first, among the very best bidders;
- The cooperation and alliance relationship established with HITACHI, the works carried out together and those still under execution not only in Italy, but also in the Kingdom of Saudi Arabia;
- The very close cooperation established with AECOM, the environment drainage/ decontamination company, a world giant in a steady growing business;
- The flow of positively impacting enquiries from international markets, among them the Middle East, Africa, India, China, Korea, the Americas, induced by HEXAGON's (who owns the INTERGRAPH group) international subsidiaries network, including those in Europe, already

traditionally tendering on these markets.

Not to mention the paramount relationship established in a different, but currently growing, shipbuilding industry market segment with FINCANTIERI, again a giant world company and a leader, following the acquisition of a contract by INTERGRAPH.

IEES was in a position to overturn old solutions through its industrial group ties and the professional expertise available therein

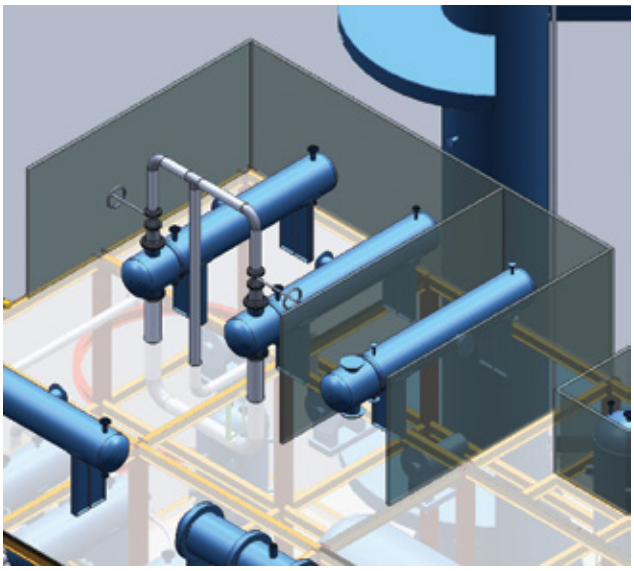
In order to better understand how such activities and relationships abide by the initially stressed "must", the definition of the relevant developing dynamics aimed at generating competitiveness for the whole industrial segment involved will help.

The initial "must" had to avoid the obsolete solutions linked to the mere "price dumping" to gain market share, since these solutions would not guarantee quality and reliability to customers.

At the same time IEES was in a position to overturn those old solutions through its company/industrial group ties and the professional expertise available therein.

In fact, the software house INTERGRAPH is the engineering SW world market leader by a distance: what better guarantee for IEES' customers than a company providing services based on the same group's SW products, those already well established on the market and those being developed inside the group's R&D department, a champion for investment granted by the group itself, when compared with other companies?

Once a new IEES project was clearly designed, planned and finally authorized and funded, the newly established company IEES made its upfront appearance on the engineering market to support the group's SW product for traditional customers and to carry on with a profitable business, while also transferring benefits and advantages to customers.



The above through applying basic but yet essential principles such as:

1. The immediately correct engineering benefits of far lower costs when not subject to repeated corrections and reworks due to unskillfulness, inefficiency, incapacity or missing proper training on the utilization of the IT means and SW products;
2. The immediately correct engineering eases the industrial plants construction and the shipbuilding industry, through highlighting in advance the possible difficulties, obstacles and drawbacks linked to the situations which might be developing at time of construction on project sites, either industrial or shipbuilding plants, also linked to the available instruments and components;
3. The ongoing maintenance operations benefit, through reducing costs dramatically, of the IT latest instruments and mainly of the SW latest products, which make available to the operators a virtual and/or augmented reality to ensure reduction of errors at the construction site, whether industrial or shipbuilding. The maintenance operations become more standard without the real need of complex readings of complicated manuals by personnel possibly not equipped at the highest standards, due to the locations, which in the O&G market segment are frequently remote;
4. Last but not least in our times of CSR – Company Social Responsibility and, luckily, of "frenzied" attention to industrial sustainability towards the environment, a correct environmental engineering made more accurate by the mentioned HEXAGON/ INTERGRAPH SW products, is more efficient, effective and less costly.

In other words the reaching of apparently diverging targets, but real and available for all with IEES.

What better guarantee for IEES customers than a company providing services based on the same group's SW products, already well established on the market, and on those being developed inside the group's R&D department?

Obviously in "a low margins" world, together with the technological offer a well-planned managerial offer had to go along in order to reduce the burden of fixed costs on day-to-day work loads.

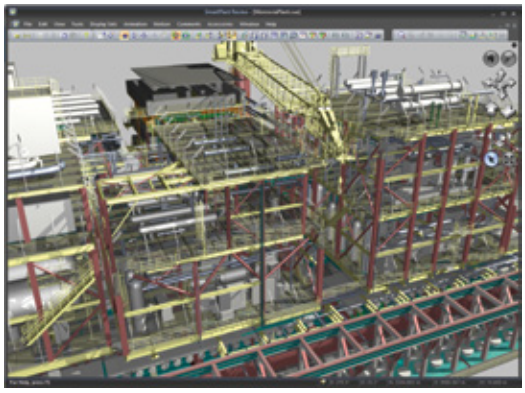
The company's organizational designs developed in a buoyant market, now obsolete, were not a proper answer to the new challenges.

Then came the idea to shape a very lean structure for IEES, which was possible due to:

1. The availability of group's Corporate functions to be managed as variable costs based on the actual day-to-day work loads;

2. Signing partnership agreements for the out-sourcing of the intellectual product, i.e. the engineering activity, with partner companies specialized in defined engineering fields, active and known on the market since decades, certified and approved (the so called IEES Competence Centers, already INTERGRAPH SW products users and as such constantly informed and properly trained);
3. Avoiding internal activities structured on internal divisions, which are instead replaced by the Competence Centers, implementing a IEES variable costs management based on the actual day-to-day work loads;
4. Last but not least, IEES chance of asking the group to appoint and staff specific Project Managers from the large number of them available inside the group itself, again based on the actual day-to-day IEES workloads.

Hence a flexible IEES structure to reduce customers' costs, by making them free from fixed costs normally reflected in the commercial offers.



The above still in a company environment based on Project Management, Quality, Reliability and Corporate Governance.

IEES achievements confirmed the company's project validity, as stated earlier, by allowing to reach diverging targets, such as: "competitiveness in a quality and reliability frame".

Marco Radice

Currently Marco is the CEO of Intergraph Engineering Environment Services SpA, whereas for Intergraph he follows the Energy & Oil & Gas markets as their Corporate Account & SE Europe Region Sales Manager, Marco has been focused in the Energy & Oil & Gas market for the last 29 years. He began his professional career in 1988 in Snamprogetti as Plant Designer. After about 3 years of technical training on the job, Marco was assigned to be the On-site Plant CAD Coordinator . Among the Marco's main roles at the time were: 3D CAD Manager, 3D modeling coordination activity, tender evaluation, planning, budget & milestone plant monitoring, Vendor selection, organization improvement based on technical and economic analysis, change management.

In 2000 Marco moved to Intergraph, where he continued his professional growth, following major Oil & Gas companies, as Technology Engineering Specialist. After 2 years he was appointed Intergraph Strategic Account Manager. Marco has specialized in Change Management, Business Strategy, Project Management, Conflict Management and NewCo Start-Up.

Today, Marco is part of Intergraph Management and his professional career is continuously inspired by the "Blue Ocean" methodology.

Guido Maglionico

A Lawyer, entrepreneur and LLC Sole Managing Director, Consultant to Boards of Directors of several companies on Company management, legal issues and sales strategies.

In ANIMP, the National Association of Italian Engineering and Plant Components Suppliers, he is the Member of the Management Board of the components group of companies; the Association's Legal Service Manager; the Company Management Area Manager and Professor in the Management Training Department.

He is also the Professor in Business Law at MIP – the School of Management of the Politecnico di Milano extended faculty.

Earlier he was the National Councilor of FEDERMANAGER – Italian Company's Executive Federation, an expert at CNEL – Economy and Labor National Council, a Company's Executive in the steel industry, the Board Member of FIASID – ILVA's Fund for the Executives Supplementary Health Assistance, a Jurist at European Union in Brussels.

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Nidec delivered.

Nidec ASI developed and supplied the equipment for the Quench Protection Circuit (QPC) required for the protection of the poloidal and toroidal field superconducting magnets of the JT-60SA project.

Nidec ASI scope of supply during commissioning

Yume dreams of a better world for all where clean, safe energy is in abundant supply and everything is in harmony with the universe.

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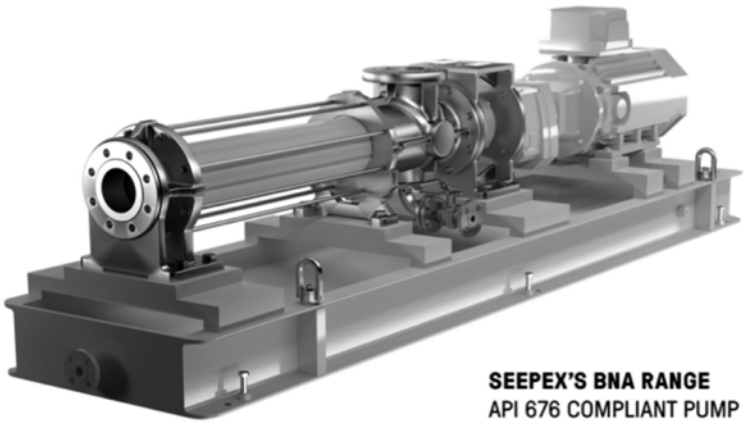
API 676 Compliance of Progressive Cavity Pumps

Owing to their operating principle and their roots in waste water treatment, Progressive Cavity Pumps (PCP) come with typical deviations against petrochemical standard API 676. Some of these deviations are inevitable, others can be healed. It is often headache and topic of discussion for project engineers to understand and identify which of these deviations are relevant, critical or acceptable for their project



SEEPEX'S BNA RANGE
API 676 COMPLIANT PUMP

Progressive cavity pumps also known as *Eccentric screw pumps* are positive displacement pumps that handle fluids gently and with minimal shear or agitation/turbulence/emulsifying. They manage fluids of highest viscosity and highest solids content, even abrasive or large particles. They can generate high pressure, 48 bar and more. They are suitable for high vapor pressure (low NPSH) as well as multiphase fluids. Due to linear performance curve and low pulsation they are suitable for dosing applications.

Flow direction can be reversed simply by reversing the motor rotation.

In the oil & gas industry PCP are often applied to convey sludge or oily water, or in situations where light hydrocarbons raise the vapor pressure to a level where other pump types would cavitate. A forte of PC pumps is vertical semi-submersed installation on a drum (closed drain, image below).

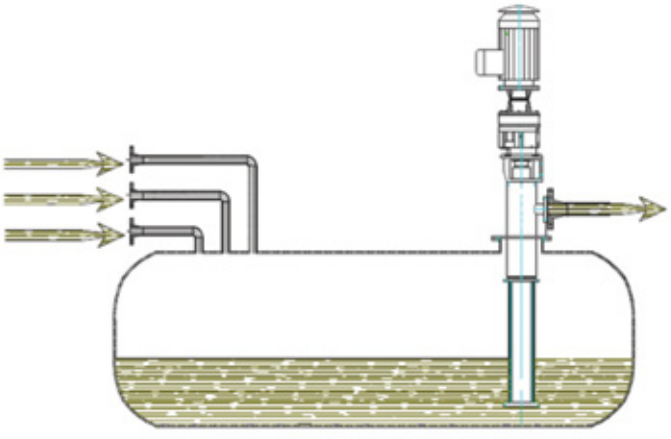
Open/closed drain drums or flare knock-out drums are a frequent application.

Historically PCP are rooted in municipal or industrial waste water treatment plants (WWTP) and manufacturers of PCP continue to supply the lion's share of their products into such applications. Naturally the design as well as production process of typical PCP are optimized for this market.

However, the requirements of petrochemical applications are quite different from waste water treatment and generally on a higher level. Furthermore, the petrochemical industry is largely based on US American standards while most PCP manufacturers are based in Europe.

The table compares some basic requirements of API 676 and petrochemical applications on the one hand, and typical waste water applications on the other hand. This demonstrates that a design optimized for waste water is unable to satisfy petrochemical requirements. Manufacturers of PCP regularly have to customize their basic designs in order to upgrade them for use in oil & gas, which dramatically increases cost and lead time.

Let us look at the two critical issues that give rise to most discussion and customization.

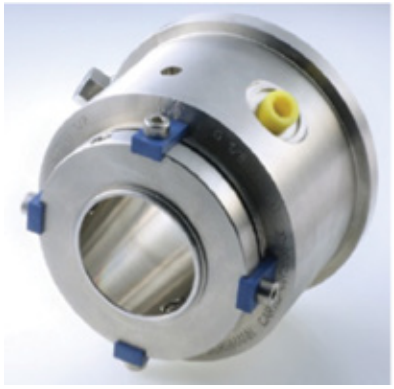


Feature	Waste Water Treatment	Petrochemical / API 676
Operating pressure	max 6 bar, rarely higher	12 to 24 bar, often higher
Design pressure	10 to 16 bar (DIN PN16)	class 150 (19 bar) or class 300 (49 bar)
Flange norm	EN 1092, DIN 2501	ASME B16.5
Shaft sealing	packing gland, component mechanical seal	cartridge machanical seal API 682
Material of construction	grey cast iron, carbon steel, EN and ISO standards	316L stainless steel, Duplex stainless steel, ASTM standards
Material traceability	not required	at least material certificate 3.1
Casing Drain	not required	flanged casing drain
Drive	integral geared motor	gear and motor separated
Explosion protection	rarely	always
Base plate	simple U-beam	Skid: welded frame with full-length drip pan and lifting lugs
Integration of accessories	rarely	often (API 682 seal plans)
Corrosion protection	low requirements	Highly corrosive environment: ISO 12944 Kat. C4 (Onshore) to C5-M (Offshore)

1. Casing design

PCP vendors typically use cast casing designs optimized for waste water treatment. These do not cover the following requirements:

- design pressure (MACP) exceeding 16 bar, in line with ASME flange ratings or to achieve higher containment pressure for safety in upset conditions
- operating pressure exceeding 12 bar, if the pumps operates clockwise
- suction region and discharge region to be designed for same MACP (API 676 para 6.3.3.2)
- fully ASME compliant flanges (API 676 para 6.6)
- nozzle loads as per API 676 (para 6.7.1) or higher, which simplifies piping layout
- flanged casing drain (API 676 para 6.4.2)
- corrosion resistance exceeding 316 stainless steel
- NORSOK qualification of raw materials
- Bespoke welded constructions with their associated high effort of engineering, procedure approval, fabrication, non-destructive examination, inspection and documentation are needed to meet such requirements.



2. Shaft Seal

PCP typically have rotor joints with cardanic articulation to allow for the eccentric rotor movement. A rotor with such joints comes with assembly restrictions that are not compatible with installation of an API 682 mechanical seal which is bolted to the pump casing. PCP design typically clamps the seal housing between the pump casing and a lantern. As a result, the mechanical seal cannot be fully API 682 compliant; it can be a heavily engineered seal in spirit of API 682 at best.

Most PCP vendors use bespoke universal cartridge seals tailored to the needs and dimensional restrictions of the pump type. [ILLU Burgmann Cartex left vs. APItex right]

Other deviations and exceptions are rooted in the PCP principle itself and cannot – or need not – be avoided. Again we look at reasons and consequences:

3. First and foremost, the progressive cavity principle is based on permanent tight contact (clamping) of a steel rotor and elastomer stator. There is no gap.

- Elastomer can never be fabricated with the same precision as steel; this results in performance tolerance exceeding the limits of API 676 (para 8.6.3) which is +3/-0% of characteristic capacity; a PCP can typically manage +10/-5%; tolerance is even higher for small pumps or high pressure. The only standard that correctly takes into account the characteristics of a PCP is the ancient German VDMA 24284 which is why PCP vendors still refer to it for test tolerance.

- A consequence of the clamping contact is that the stator is a wear part, to be exchanged at regular intervals that depend entirely on the application and are hard to predict. Non-stop operation over three years as required by API 676 (para 6.1) is not something a PCP can guarantee.

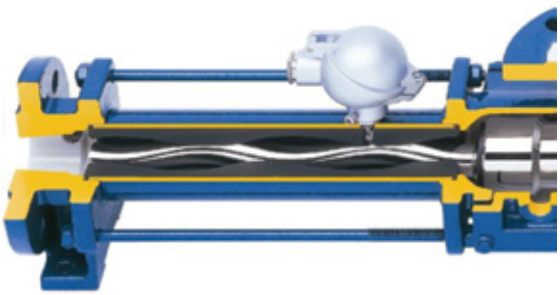
4. There is the eccentric kinematic of the rotor and its impact on vibration:

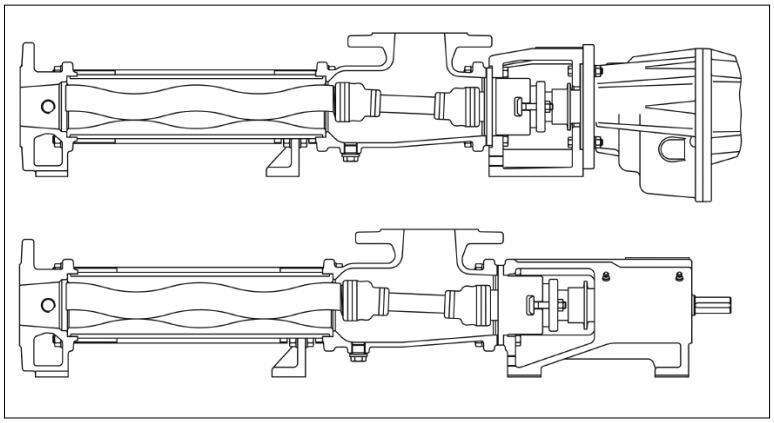
- For a given capacity, vibration levels of a PCP are necessarily higher than other API 676 pump types based on concentric motion. A standard PCP may exceed the limit of 3.8 mm/s (para 6.11).
- This low frequency vibration is inherent in the design and not a sign of trouble, thus vibration monitoring makes little sense.
- Vibration is a critical issue and limiting factor only for vertical semi-submersed PC pumps, where the shaft can become several meters long.

5. PCPs typically operate at slow speed 100 - 300 rpm, about 10-20% of a centrifugal pump. Thus:

- There is no motive for precise alignment or balancing. PCP baseplates are typically not designed with precision machined pads and jacking screws that facilitate alignment.
- Shaft bearings are grease lubricated and typically sealed / lubricated for life. Elaborate oil lubrication systems with associated monitoring and cooling function are not needed but nevertheless specified by API 676 / API 614 and present in the mind of project engineers familiar with other pump types.
- It is common practice for PC pump design to omit dedicated shaft bearings altogether and use the gearbox bearings to support the shaft – this is called “block pump” and it can omit also the coupling.
- Shaft seals do not generate much heat by friction, therefore, seal cooling is rarely needed and standard seal plans offered by PCP vendors may minimize or omit the cooler, as a deviation from API 682.

Finally, there are those exceptions that are related to sourcing and US standards. API standards usually





cross-reference other API standards or US manufacturing standards.

6. Gearbox and bearings

- API 676 references AGMA and ABMA standards and requires gearboxes > 18 kW (25 HP) to conform with AGMA 6010, or even API 677.
- API 677 gears are generally not available for the typical power ratings and drive configuration of PCP. Please refrain from specifying API 677; pump vendors could not comply even if they wanted to.
- Outside the Americas the AGMA and ABMA standards are not used. European gear manufacturers will design and calculate according to DIN 3990 or ISO 6336. American and European gear standards are not compatible because they are based on different physical models and basic assumptions. It is also not possible for the vendor to demonstrate that a gearbox designed to DIN/ISO is ‘equal or better’ to an AGMA design, which is a frequent requirement of project engineers trying to circumvent the issue. Sometimes this leads to a hot debate of almost religious dimensions without practical result. Comparative papers by gear specialists can be found on the web. However, it is absolutely safe to assume that a gearbox following European standards will perform just as well.

7. IEC/IEEE

API 676 requires motors to follow IEEE 841.

- However, most international projects outside the Americas prefer IEC motor standard. IEEE 841 motors are only produced in the Americas; import by European pump vendors raises the price and lead time.

8. Welding

- API 676 references ASME BPVC IX for welding of pressurized parts and AWS D1.1 for structural welding.
- While ASME IX is customary in Oil&Gas applications, most European workshops are basing their fabrication on ISO standards which

result in a quality level at least equal to ASME IX. Welders may be additionally qualified to ASME IX but if you make that a firm requirement you may raise the price tag without benefit. The economical decision is to leave this choice to the Vendor.

- Welding to AWS D1.1 is unusual in Europe and hardly available. Welding of non-pressure or structural parts according to ISO welding standards should be allowed or tolerated.

Project engineers preparing or evaluating a bid typically spend many hours in discussion with pump vendors to identify which of these points are relevant for the actual project, which can be accepted to cut cost, and which are viewed critically by the client so that a concession request becomes necessary, adding to the time.

SEEPEX BNA pump range of API 676 compliant pumps

To provide project engineers with smooth sailing and purchasers with favorable price and lead time, manufacturer SEEPEX introduced a new range of horizontal PC pumps that are designed based on API 676 requirements – the BNA pump range – with built-in conformity to the key points outlined under 1) and 2) and avoiding welding completely. Main features are:

- heavy-duty cast casing with design pressure 50 bar
- flanges class 300
- standard flanged casing drain
- high nozzle loads
- full uncompromised compliance to API 682 Cat. 2 / API 610 for shaft seals
- materials suitable for corrosive or harsh environment and for fluids including Chloride and H2S

[ILLU BNA design]

An Example

In 2016 ENI SpA had to retrofit their Val D'Agri plant and quickly install additional pumps in order to restart the plant. The pumps were specified as API 676 and NACE MR-0175 compliant including double-acting seals API 682 Cat. 2 with seal plan 53B. The fluid was produced water and oily foam (gas fraction) with H2S. Required discharge pressure was 16 bar, high vapor pressure leading to NPSH < 1 m. SEEPEX delivered complete API 676 pump skids with BNA pumps within 11 weeks after award, to the surprise of the ENI engineers who were accustomed to lead times of 20 weeks and more.

API standard - Guideline or Law?

From the vendor's point of view, unfortunately many EPC Contractors and Clients do not use the API standards as the guideline they were intended to be, but tend to view them as a law book, so that any deviation creates friction and is considered undesirable even if actually there is no problem. PC pumps with their particular characteristics are not well represented in API 676, thus we keep discussing the same inevitable topics.

We hope this editorial helps you understand the specific situation of progressive cavity pumps and organize your work most efficiently.

If there is anything SEEPEX can do for you, please let us know.

AVEVA's Digital Asset Approach helps transform decision making at every phase of the asset life cycle, naturally supporting BIM throughout your projects

At AVEVA, we have a long and proud history of pioneering data-driven, collaborative engineering, design and information management systems. In fact, many of the principles at the heart of BIM were central to AVEVA long before BIM was introduced. So, it's no surprise we wholeheartedly support its aims and values - and have a range of technologies that can add value to your BIM projects

BIM and AVEVA: made for each other

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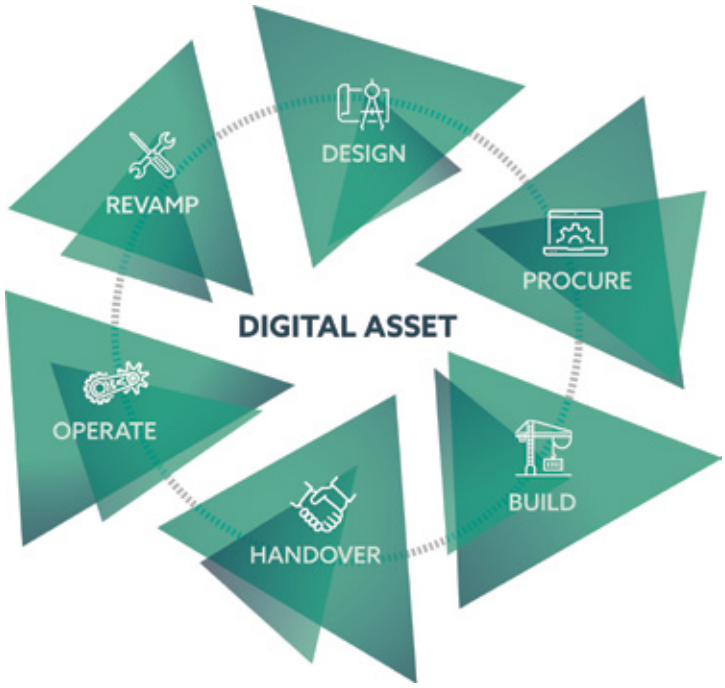
Digital Asset Innovators

As early pioneers of employing a BIM strategy within a number of industry sectors, we have transformed decision making by encouraging a dynamic digital counterpart to every physical asset, true collaborative working and lean principles. What we call the Digital Asset Approach.

For AVEVA, BIM is all about defining, building and validating an information model that digitally describes a physical asset.

AVEVA's BIM Approach

We appreciate BIM isn't just software and some vendors are to blame for perpetuating that myth. BIM is instead a business process which AVEVA aims to support through the use of our technology, technology that has been tried and tested in capital intensive markets. AVEVA has a refreshing approach to BIM, we believe in taking a true data centric solution rather than a 3D or document centric approach to BIM projects. To look at AVEVA's approach in more detail let's break it down in to 3 key principles...



AVEVA's 3 Key Principles of BIM

1. *Get control of your asset information standard*

Data requirements, and the resulting data management must be driven from the information standard. Asset information requirements can be complex and can change over the lifecycle of the asset which begs the question; if you don't have control of the information standard or as the energy industry describe, a class library, how can you control the information? People often talk about the validation and quality auditing of information, however if the information standard to which you validate is not fully designed and

communicated then how can this realistically be achieved?

AVEVA Information Standards Manager™ (AVEVA ISM™)

AVEVA ISM allows you to create and manage standards/class libraries in an intuitive web interface. If a project is adhering to BIM, then there will be an Employers Information Register (EIR) in place.
The information requirements in the EIR will form the basis of the project class library built in AVEVA ISM. Which in turn allows you to develop a registry of key classes, or asset types and the data that defines it.

BUSINESS BENEFITS

- Clear definition, control and communication of mandated information standards.
- Improved data quality at handover, streamlining the process.
- Reduced errors, delays and project overruns resulting from delays in finding accurate information.
- Collaborate more easily with project partners, subcontractors and suppliers.

2. Multi discipline data needs to be managed in a dedicated tool

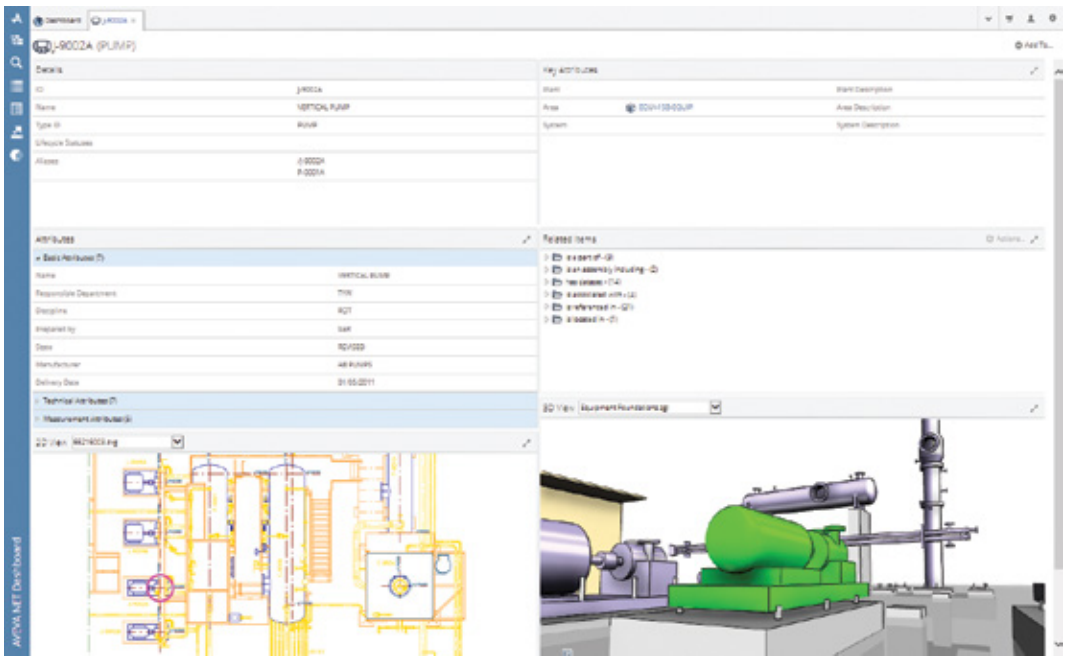
Multi discipline data must be properly controlled in dedicated tools. Some people choose to use their 3D systems to manage vast amounts of data which is often not what they were originally intended for. This means different disciplines and contractors need access to the 3D model to add information making it a headache to manage access and control. Spreadsheets are commonly used to manage this data, however they can easily be copied, emailed etc. resulting in multiple versions being changed by many people. And again these manage the files that contain the data. Not the objects that appear in the physical facility.

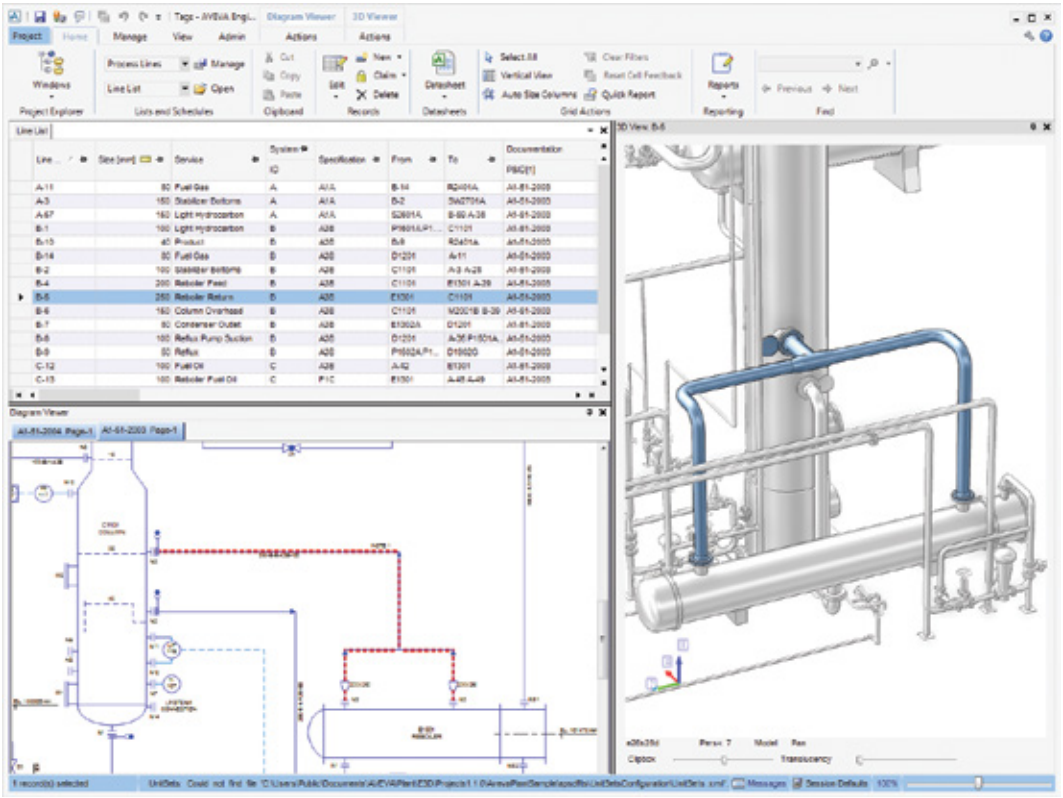
AVEVA Engineering™

AVEVA Engineering gets data out of disconnected spread sheets, 3D models and other uncontrolled sources and into a dedicated data management solution driven directly from the information standard. Enabling multi-discipline engineering teams and contractors to work and communicate concurrently regardless of their location. It provides efficient and controlled development of engineering items and their attributes whilst at the same time each discipline retains full control of their own data while being able to access and reference data from other disciplines.

BUSINESS BENEFITS

- Puts engineering data into a common project database where it can be more effectively managed, controlled and used.
- Enables effective multi-discipline collaboration.
- Fewer errors from uncontrolled handover of data between disciplines.
- Enables efficient multi-site collaboration on a wider range of engineering data.





3. Published information to a single secure web-based location

All published project information should be integrated and available in a single, secure, web-based portal – no matter where or what it was originally authored in. Information is the lifeblood of any engineering project. The efficient flow of quality information is essential for effective project control. It is vital for the health of the project that the right information flows to the right people at the right time, to ensure properly informed design and project decisions can be made.

AVEVA NET™

AVEVA NET provides a fast and efficient Information Management system for engineering and operations. It provides users with complete control of their project and asset information throughout the entire asset life cycle. Its powerful information management hub complements and integrates with your existing design toolset.

Which is then used to control, link, evaluate and deliver all types of data and documents in a secure environment, regardless of application and format. AVEVA NET also provides a mechanism to transition from a Project Information Model, with the focus on project delivery to an Asset Information model.

BUSINESS BENEFITS

- Better-informed decision making.
- Improved information standardisation.
- Effective search, navigation and visualisation of project and asset information.
- More efficient and effective information access.
- The ability to enhance data quality and integrity.
- Reduced software licensing costs.

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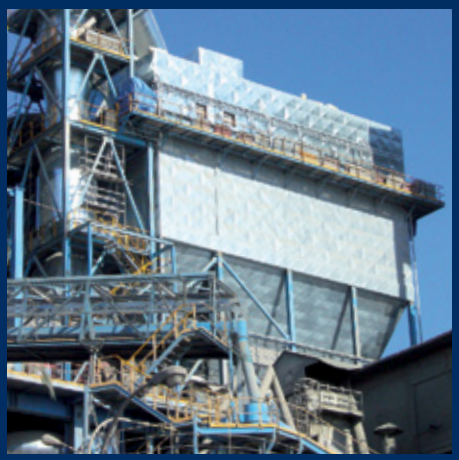

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Boldrocchi Project for Dangote Refinery in Nigeria

In 2016 Boldrocchi Group has been awarded by GE Oil & Gas an Order for the supply of eight Diverter Damper Systems for GE Fr 6 gas turbines, due to be installed in Dangote Refinery, Nigeria

Despite their apparent simplicity, the importance of Dampers become clear when they fail in operation. As evidenced by experience, Users often take dampers for granted, therefore contracting inexperienced Companies to supply inexpensive dampers: this often lead to operation failures, unplanned shutdowns and production losses. It highlights that there is no replacement for specific experience.

Boldrocchi Group offers a wide range of dampers, including on/off, modulating and zero leakage type:

- Heavy duty dampers
- Guillotine dampers
- Diverter dampers
- By-pass dampers
- Stack dampers
- Gas distributors
- Multi-louvre dampers

Our team uses mechanical design & computational fluid dynamic (CFD) studies to highlight the internal flow distribution & minimize vortex/vibration stress. Noise impact studies are also carried-out in relation to internal and external noise sources.

We tailor-make dampers of any size (over 7m x 7m (23' x 23')), any shape (square, rectangular, round, etc.), with different actuation systems (manual, electrical, hydraulic or pneumatic) & for any amount of gas tightness or flow required.

The Dangote Project

The scope of supply comprises eight electrically operated diverter damper systems each fitted with a guillotine and sealing-air fan skid.

The system is entirely designed in Boldrocchi's Italian headquarter (located in Biassono near Milan), fully respecting all the Customer's specifications and leveraging on Group's capability in combining customization level with the high technology content, consolidated over decades of experience in the sector.

This project reaffirms the strength of Boldrocchi products. In particular the zero leakage sealing technology and the actuator systems have been tested in Boldrocchi Labs with a back-pressure which exceeded 3x the customer requested specification. Consequently the wear of elastic parts could be reducted and operational life extended.

In order to test for proper functioning of individual components and to ensure prompt on-site erection, all units are fully assembled and tested in the presence of customer inspectors at Boldrocchi's new testing facility in compliance with strict product control procedures and standards.

The opportunity to use Company's owned manufacturing and testing facilities is a great point of strength in developing demanding Projects.

From the early stages of conceptual design attention has been paid to the optimization of transport and the reduction of assembly work on-site.

For this reason, all components are designed with a high degree of prefabrication. As shipment of exceptionally large items, such as some heavy duty dampers, via road is troublesome due to the need of transit permits, the products are disassembled after functional testing into key components and reassembled on site under our supervision, with minimal impact on resources and time spent before actual shipping.

Boldrocchi, with over 100 years of experience, has successfully executed more than 88.000 worldwide projects. The Group is manufacturing in accordance with Project-specific and International Standards full dedication to Quality in Engineering, manufacture and Project Management.

All these aspects have allowed Boldrocchi to build a strong and reliable relationship with its customers.

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//FROM STOCK // FROM PRODUCTION

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_ Superduplex
_ Superaustenitics
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Production and distribution of piping materials worldwide

By combining the expertise of a producer with the flexibility of a stockholder, Raccortubi Group is able to promptly respond to customers' requests and efficiently meet their expectations

Manufacturer, **stockholder** and **supplier**, Raccortubi Group is providing customers with **pipes**, **tubes**, **fittings** and **flanges** in **stainless steel**, **duplex**, **superduplex**, **6Mo, nickel alloys** and **titanium** from strategic locations around the world. It supplies piping packages for **critical applications**, such as chemical and petrochemical plants, oil installations, power plants, shipyards, fertiliser plants and offshore platforms.

Global Distribution Network

Along with its massive warehouse in Italy, in 2013 Raccortubi Group established three stockholding subsidiaries in Brazil, Dubai and Singapore, in the aim of extending the Group's distribution network. In line with this, the opening of a branch office in London and the acquisition of Raccortubi Norsk in Aberdeen, Scotland in 2015 further strengthened the company's structure, with the first providing EPC contractors, fabricators and blue chip companies with a dedicated service for complex order management and project handling.

Raccortubi Group made the most of its latest global developments and now acts as a single point of contact, which can meet requirements both from stock and from production in the provision of complete packages, as well as single item necessities, to short timescales. In fact, it is able to supply pipes, fittings and flanges, for both projects and maintenance operations, quickly and efficiently, to customers all over the world.

Manufacturing Capabilities

With the acquisition of Petrol Raccord at the end of 2014, Raccortubi Group has extended its butt weld fittings' manufacturing, which traditionally ranged from ½" to 16", to reach 56", almost without wall thickness limitations. In addition, an increasing part of production is dedicated to **special/customised fittings**, which are produced in accordance with customer drawings. Thanks to its integrated production facilities, Raccortubi Group is able to guarantee not only the quality of the final product, but also short lead times resulting from adaptive planning and flexibility.

Synergy between Stock & Production

Complete range of pipes, tubes, fittings and flanges

Within Raccortubi Group, pipes from stock are used as raw material in the manufacturing of butt weld fittings. Raccortubi stocks are then constantly replenished by the Group's integrated mills, giving them a consistent supply of fittings from which to fulfil customer orders immediately. The combination of **stockholding** and **manufacturing** activities allows for quick, cost-effective, comprehensive solutions for the most demanding fields of application.

Efficiency in Handling Quality Certifications

Hot-formed tees

Quality checks are implemented throughout the entire production process in order to achieve the highest standards and **fully-certified products** in accordance with the most stringent market requirements are available off-the-shelf. Moreover, an integrated software guarantees the real-time availability of all the products' quality certifications for any placed order, allowing customers to review all the required documentation online, even before the goods effectively arrive at their premises.

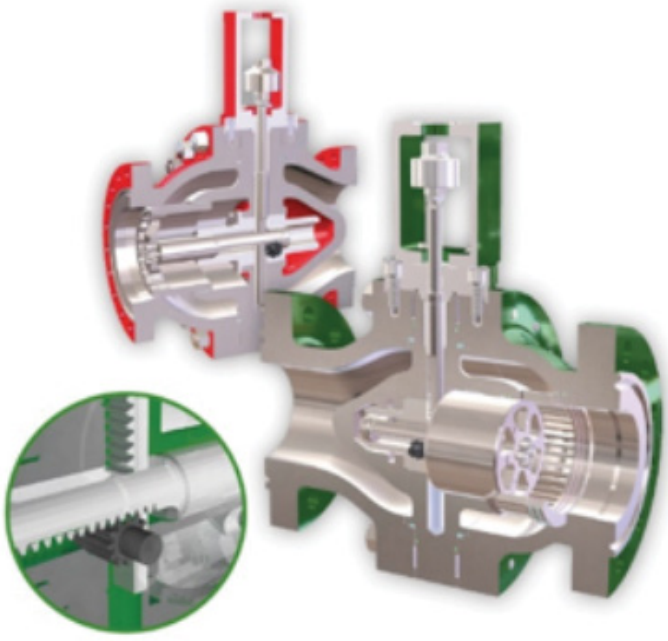
The expertise of being a producer and the flexibility of being a stockholder, combined with the presence worldwide and the striving for the highest quality standards in all the phases of its supply chain, enable Raccortubi Group to offer its customers added value and have to be considered real benefits when evaluating the corporate services as a whole.

Goodwin International launches new range of Axial Isolation & Control Valves

British engineering company Goodwin International, with a track record of supply of some 35 years, is a global brand for the design, manufacture and supply of Dual Plate and Axial Flow Check Valves, to all aspects of the hydrocarbon, energy and process industries - upstream, midstream, downstream. In the past 10 years, the company has enjoyed sales of over 750 million USD.

Goodwin is exceptionally pleased to introduce to the valve user market its brand new range of Axial Isolation and Axial Control Valves. Founded on the same exceptional design and quality principles as its check valve products the new Isolation and Control Valve ranges have been developed to meet or exceed today's stringent end-user specifications. Designed around the same platform to ensure as much similarity and compatibility across components without any compromise on performance, both designs employ several innovative features for some of which Goodwin has international patents lodged: Key features include:

- A **3 piece split body design** which allows simpler manufacturing processes to be adopted, reducing defect rates and difficult weld repairs whilst also permitting a higher level of access for non destructive examination techniques. The 3 piece body also permits the use of forged or cast base material for the pressure envelope components, which can be adapted according to the end use application.
- Unique **rack-pinion-rack gear train** with distinct advantages over alternative mechanisms.
- **Fully pressure balance design** which significantly reduces actuation forces required for operation.



The new range of valves is designed, manufactured and tested using Goodwin's, in-house resources. By offering economical engineering solutions for flow control, high pressure drop, noise attenuation and severe service applications, the Goodwin axial isolation and axial control valve represent a straight forward choice for a cost conscious hydrocarbon industry that needs competitive deliveries and pricing.

The importance of E&I equipments Revamping in a Scientific research Institute

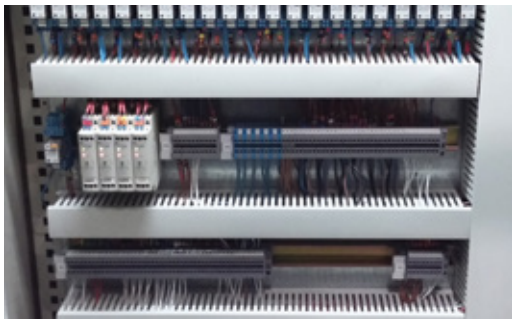
Costruzioni Elettrotecniche Cear highlights its experience on revampings

In a scientific research institute a lot of technological equipment are installed with high level of performance and availability required for their scope of use. Even if a long lasting term of use is foreseen, usually they need maintenance over the years and, sometimes, according to the new requirements related the update of the plant, they need to be modified.
This means for the Scientific research institute a big investment but also a challenge where should be foreseen a minimum risk of failure or inconvenience related the above modification or maintenance.
For this reason, teams of engineers and technicians are involved in a very tight schedule where everything is planned in order to avoid any mistake or unforeseen event.
Costruzioni Elettrotecniche Cear has been involved in the past two years in many projects of revamping for some E&I equipments related technological units of an important European Scientific Research Institute.

The involvement of Cear has started in 2015 for the Revamping and update of existing Control System of 3 cooling and ventilation group of an important section of laboratories.
Each of this cooling and ventilation group control system was composed by a Motor Control Center for feeding the machineries and was composed by a PLC control panel that was communicating with a SCADA through a serial communication.
Cear's involvement has started with doing a site visit done at the very beginning in the bidding stage, in order to collect all the relevant information, pictures and datas necessary to be matched with the technical dossier received by the customer.
After this preliminary stage and order awarding, the job have been done in several stages that where defined by a specific project schedule that foresees that the job has to be partially done in factory and partially done with installation and modification on site .

The importance of site survey

At a first step was very important to collect during the site visit pictures and notes related the part of each power and control system that has to be modified; so that the technician, that would have been involved in the project, collected information regarding a PLC control panel, SCADA system, Motor Control Center and all field existing electrical and instrumentation connection. This was necessary to develop the new engineering documents, that have to integrate and complete the old ones given by the customer, as for example the design of the updated equipments and technical documentation necessary to buy and manufacture new parts of the control system.



All of these documents, needed to be checked and approved by the customer and once this activity was completed, the design phase could start in order to develop the modification of the E&I control System and start manufacturing some hardware parts, in our workshop, to be installed during installation phase.

The main hardware modification developed on PLC Control panel for the three control systems was to manufacture a new backplane, that have to substitute the old one, fitted with all equipment required for the proper handling of the process. The backplanes shall be designed following technical prescriptions related Electrical and process standards issued by the laboratories.
These backplanes shall be dimensioned for a nominal current of 25 A and a maximum short circuit current of 10 kA (Ik1) with a power supply is 1P+N+PE; they should have had installed newest models of PN/DP PLC and the I/O cards and some additional cable connection and feeders necessary for the modification of the control system, as for example temperature switch for ventilation system or flow switches for each pump to digital PLC inputs; all of these requirements where related to the upgrade of the new control systems.

The activities on field

The installation phase have been very intensive and has considered the following activities for each of the three sections of the cooling and ventilation system:

- The modification of the cubicles: related the PLC control panel, MCC cubicles and PC SCADA cubicles, in order to re-adapt the system to new requirements
- The removal and installation of new backplanes for PLC control panel, with all related cable connections
- Cabling, including supply and installation of new cables; the main requirement was about the removal of the existing communication cable to the Trane UPCM PLC located in the control cubicle and Pulling an Ethernet cable between the Ethernet switch installed in the control cubicle and the main Ethernet socket installed in the PC cubicle.
- In addition it was very important to do a checking of all electrical and instrumental connection for the feeding and feedback of instruments on field and their interconnection with the PLC cubicles. Finally, this activity required to do a complete survey of cabling and connections of the existing installation, with integration of the acquired information in the electrical drawings.
- Supply and electrical and mechanical installation of additional instruments. Each section of the cooling and ventilation system had different needs regarding instrumentation, but the main instruments provided and installed with all the electrical interconnections were:
  - temperature sensors, that were replacing the oldest one that were no more compatible with new technologies,
  - additional flow meters to be connected to the existing circuit,
  - differential pressure transmittal to be connected to the existing circuit,
  - water counter, on the filling circuit following the modification of the pipeline
- Installation of missing ID labels on the existing installation, as per new requirement
- Test and commissioning: the completion of activities on site foresee that this new section of plant have to be tested following a specific procedure with a dedicated test report to be issued.

The customer , after completion of this activity required also Cear's technician presence for pre-commissioning and assistance during the overall commissioning of the system to execute the I/O tests on the equipment that has not been replaced and the new equipment installed.

A final completion of technical documents, after the latest commissioning activity have been produced in order to give updated documents with the last modification done on field during final stage, with the delivery of the so called "as build" drawings.

Conclusion

To resume, Cear for this revamping project have done the following main activities, in time, following the strict schedule submitted by customer:

- Engineering document modification
- Supply of The control system including PLC, I/O modules and Power Supply;
- Modification of the control cubicle including the supply of new equipped backplanes;
- Modification of the field cabling including supply and installation of new cables;
- Supply and installation of new process instrumentation;
- Pre-commissioning and commissioning activities
- Supply of as-built electrical drawings

Nowadays revamping projects are becoming even more important type of jobs required by customers, in order to save money and in some case to update technological systems that need to give better performances. The opportunity to express Cear capabilities for a research institute, that has very strict protocol of quality procedure, is a successful result of our activity also in this field, where old and new equipment need to be matched together.

Alessandra Ranno

Alessandra has studied Languages and Communication, then graduated in Marketing & Communication at the University of Milan. She's in Cear since 2010 and she's in charge as Sales and Marketing Manager for coordinating marketing activities, sales team and implement international markets.

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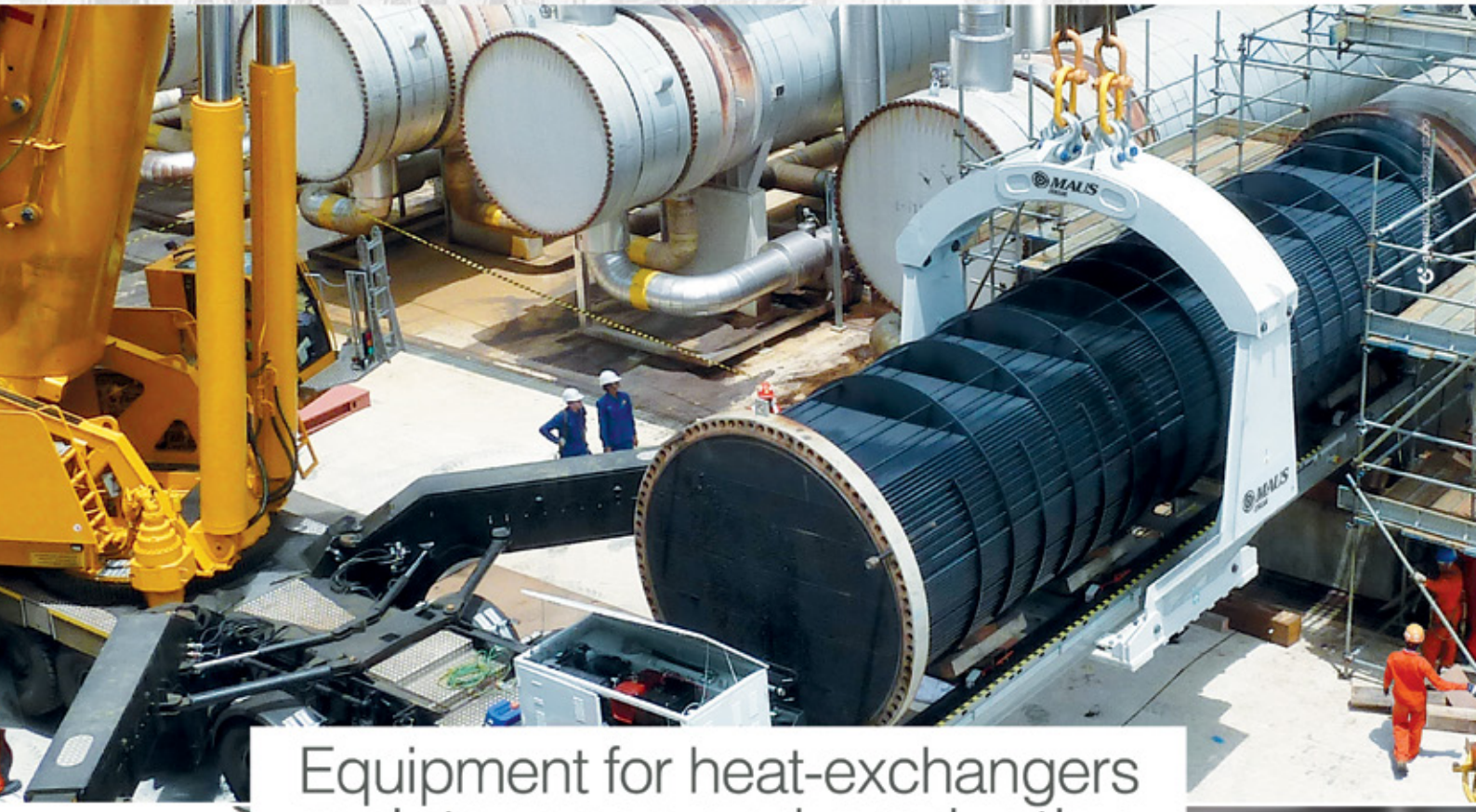
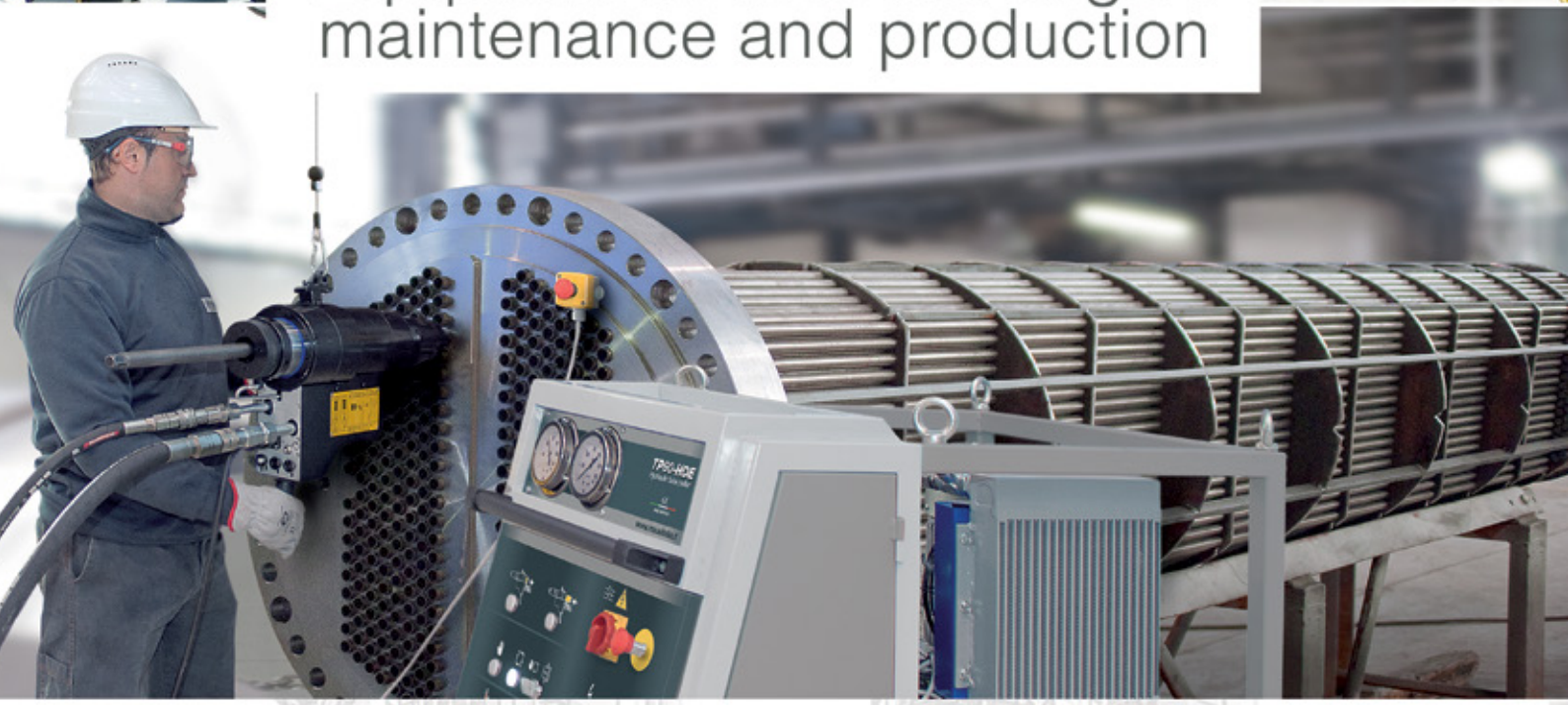


Equipment for heat-exchangers maintenance and production



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Techint Engineering & Construction built the largest LNG Terminal in Europe

The Dunkerque LNG terminal will have an annual regasification capacity of 12 billion m^3 of gas, representing around 20 per cent of France and Belgium's annual natural gas consumption

Finished in September 2016, the Dunkirk LNG Terminal, which Techint Engineering & Construction built along with Sener for *Électricité de France* (EDF), has a regasification capacity of 12 billion m^3 per year, sufficient to meet the demand of 9 million households.

"It is an exceptional terminal," says **Carlos Bacher**, the company's CEO, as he looks back at the four and a half years that the project took. "It has a capacity that accounts for roughly 3 percent of Europe's entire energy needs and 20 percent of France and Belgium's natural gas consumption."

The scope of this €1 billion project included the design, engineering, procurement, construction, commissioning, start-up and project management services, requiring more than 11 million hours worked by 8,500 people.

The terminal comprises a reception station; one LNG unloading system; three cryogenic tanks with a storage capacity of 190,000 m^3 each; one regasification unit that extracts LNG from the tanks and vaporizes it by heat exchange in open-rack vaporizers; one sea water inlet intended for the heating of LNG; and one network connection for supplying the natural gas to the French and Belgian networks once reverted to a gaseous state.

"This was a very big project with constant challenges to face", says **Giuseppe Viggiani**, the project's site manager since September 2015. "We had to build a really complex structure, meeting very strict standards and requirements, in a huge surface," he adds.

In addition, climate conditions did not make things easier. The area in which the terminal is based registers 60 km per hour winds that impacted on most of the lifting operations. On the other hand, managing 8,500 people, including around 20 subcontractors, was quite challenging too. It required a very thorough planning and follow-up of all tasks in order to secure the progress of the project. For instance, a key decision was to create a task force made of people TS LNG and mechanical subcontractor teams for the preparation and execution of pressure tests of the pipelines, a critical activity in this type of systems.

The construction of the plant also involved a great coordinated effort among different areas of Techint E&C, including their engineering centers in Buenos Aires, Milan and Mumbai. There had to be a rapid integration among people from different nationalities, something very characteristic of the Techint Group, which is constantly recruiting talent from all over the globe.

The kick off

"This is a historic day for Europe, for France and for our companies," said Carlos Bacher, as he watched the 285-meter-long Madrid Spirit tanker docking after sailing 9,000 kilometers during 16 days from Bonny, Nigeria. It was a cloudy Friday morning on July 8, 2016, and, over the following 10 days, this tanker built in 2004 discharged the first 130,000 m^3 of natural gas at the Dunkerque plant in northern France near the border with Belgium. "We are all very proud of the team that did this," said Bacher. It was the official kick off.

The Hispania Spirit was the second tanker with liquefied natural gas to dock in Dunkerque on September 15. It brought 140,500 m^3 of natural gas from Peru.

Finally, the third cargo of liquefied natural gas arrived on November 22, on board of the Maran Gas Asclepius and hailing from Qatar. With it, the commissioning of the plant entered the final sprint before the keys to the project are handed over to the client EdF.

For Techint E&C, having Dunquerke in the portfolio means consolidating Techint E&C's leadership in the regasification terminal business: apart from Gate in the Netherland, there is Polskie LNG in Poland, Costa Azul in Mexico.

LNG is slowly gaining ground in the continent's natural gas matrix, and it now represents around 10 percent of the total imports. The gas comes in large vessels like the Madrid Spirit, mostly from Qatar, Algeria and Nigeria. Some 25 LNG terminals were built in the continent over the last two decades. Dunkerque now joins that league.

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plug in

Oman turns to WEG to enhance gas recovery in major depletion project

Achieving maximum productivity from oil and gas fields is the prime goal for the petrochemical industry but the extraction process becomes more difficult as fields become depleted.With this in mind, leading global manufacturer of motor and drive technology,WEG,has developed bespoke variable speed drive systems to help with extraction from some of Oman's older oil fields where the natural pressure is beginning to fade

Boosting extraction from depleting reserves is part of a US$33 billion project which aims to enhance Oman's hydrocarbon production capabilities and help the country broaden its economic base.It is expected that Oman will unlock about one trillion cubic metres of natural gas over the next 25 years, representing a long term sustainable competitive feedstock for its petrochemical industry. Plans are also afoot to develop downstream industries such as the production of Ethylene Dichloride (EDC), Caustic Soda and other chemicals.

As part of this major effort, the PDO SaihRawl Field Depletion Project, Phase 2, will see US$550 million invested on developing a daily gas production capacity of 30 million cubic metres, which will be fed to the existing SaihRawl central processing facility. Extra compressors will be installed to increase the pressure so that gas continues to flow, enabling the field to feed the liquefied natural gas (LNG) industry while offering a back-up when other plants are shut down for maintenance.

Electric motors willplay a key role in ensuring that such compressors runefficiently, smoothly and reliably, as they will be responsible for driving their suction and discharge cooler fans. Bearing in mind that electric motor-driven systems (EMDS) are the largest individual source of energy use, accounting for 45% of the world's electricity consumption, and over half of this energy demand originates from motors used in fans and compressors,[1]Indian company Larsen & Toubro decided to partner with WEGto equip the main gas

compressorwith an efficient drive system, which could endure the most demanding applications.

To meet such needs, WEG has developed a bespoke solution comprising48 30kW variable speed drives and motors and 32 15kW drives and motors,which have been supplied as systems and mounted in control cabinets, and also includea high capacity circuit breaker for emergency cut outs and a by-pass system for DOL (direct on line) starting. Additionally, WEG has fitted its equipment with a passive input harmonic filter to reduce problems relating to mains borne corruption of the power supply, while an output filter will be used to protect the drive.

WEG'svariable speed drive systems have been tested at its manufacturing facility in Brazil in the presence of inspectors from PDO and Larsen & Toubro to simulate

the harsh environmental and operating conditions that may occur in the field. WEG is also conducting performance tests of the motors at the fan manufacturer's plant in Korea and has organised training sessions for PDO staff in the Brazilian factory.

Thanks to its vertical manufacturing process, WEG has also been able to supply Larsen & Toubro with all of the overloads, switchgear, relays and pushbuttons used within the drive cabinets,thus ensuring component compatibility and trouble free system building and commissioning as well as efficient ordering and delivery. Other elements in the cabinet include a control power transformer and auxiliary contactors and circuit breakers. Additionally, a door mounted control panel incorporates a backlit LCD keypad, while a redundant serial link (2 channels Modbus-RTU over RS485) provides communication to the wider control system. Finally, the control cabinets include space heaters, which are essential to withstand the extreme temperature differentials between day and night in the Oman desert, which can cause potentially damaging condensation.

"We have exceptional experience of developing complete drive solutions for oil & gas applications – both upstream and downstream – and our involvement in such a major project as the PDO SaihRawl Field is a fine example of our commitment to help the oil & gas industry operate more efficiently and reliably," comments Colin Cox, Managing Director, WEG Middle East.

WEG offers one of the broadest ranges of energy-efficient explosion-proof motors currently available with rated power from 0.12 kW to 5.6 MW and frame sizes from IEC 71 to 800. For example, the W22Xd IE4 Super Premium motor- the most energy efficient flameproof motor available on the market - combines explosion protection with IE4 efficiency levels andoffers a long service life and low maintenance costs, helping businesses in the process industry increase productivity, improve reliability and cut costs by up to 40% compared to conventional models.

WEG's drives minimise voltage surges by carefully regulating the time between the pulses of their IGBTs (integrated gate bipolar transistors). This decreases the possible surge magnitude and also allows longer cable runs without detrimentally affecting motor insulation.

Its patented flux optimising technologyreduces input current by up to 50% of the motor rated speed, which decreases motor temperature rise by as much as 11%. Insulation life, and therefore motor life is extendedbecause it is doubled for every 10° C decrease in its operating temperature. Alternatively, output torque can be increased by 50% of the motor rated speed to suit more demanding applications.

"Thanks to this high performance drive and motor architecture, WEG products are the perfect solution for the most arduous industrial applications, such as those that are likely to be foundin Oman's PDO SaihRawl Field Depletion Project," concludes Colin. "WEG can provide the ideal explosion-proof motor for virtually every application, even with extreme operating conditions such as ambient temperatures from -55°C to +80°C and altitudes up to 5,000 m".

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Automation Instrumentation Summit (5 - 6 July 2017)

With the global hydrocarbon industry facing discontinuities due to the relevant drop of oil prices, the plant engineering supply chain is being increasingly targeted as a strategic tool to spawn greater value and ensure a sustainable growth for the whole sector

Castello di Belgioioso, the historic venue where the Summit will be held

In this view, the first Italian AUTOMATION INSTRUMENTATION SUMMIT® aims at summing up what the industry has achieved so far, as well as identifying the best strategies for long term improvements. The Summit will take place in Castello Belgioioso near Milano, Italy, on July 5-6, 2017, bringing together the Italian segment composed by engineering companies, system integrators, manufacturers and showing it to customers all over the world.

The two day-conference will in fact provide an excellent opportunity for all the players engaged in the supply chain to participate in discussions on automation, instrumentation, analyzers, communication, control systems, SCADA, safety, fire and gas, integration and cyber security. The manufacturing companies will have the opportunity to showcase their products and solutions at the stands of the exhibition area whereas the speakers will present their papers based on case histories and share common experience with all the other experts during the event.
Key topics to be addressed at the summit:

- **ADVANCES IN CONTROL SYSTEMS**
- **CONTROL AND PLANT COMMUNICATION**
- **THE INDUSTRIAL INTERNET OF THINGS, 4.0, CYBERSECURITY**
- **INSTRUMENTATION AND ANALYZERS TECHNOLOGY EVOLUTION**
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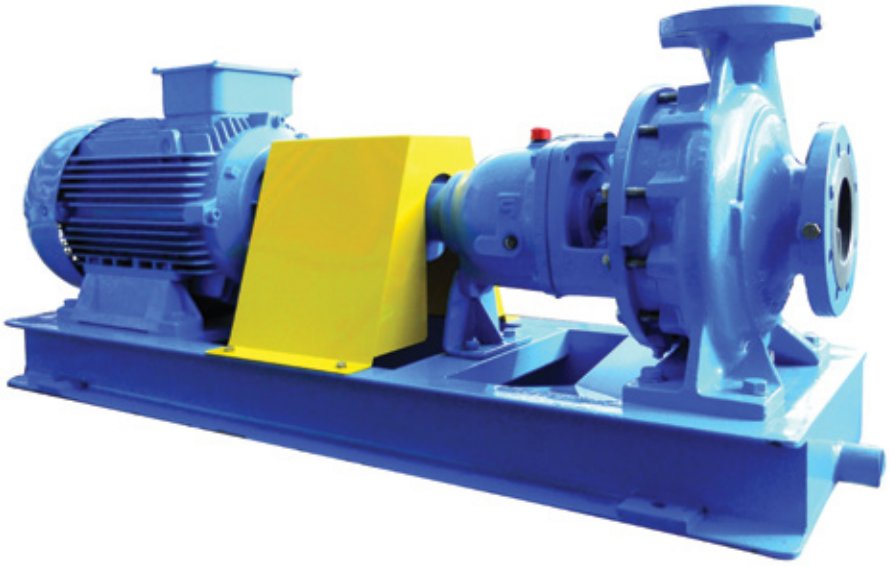
The industrial orders of Garbarino

+39% in 2016 compare to 2015 thanks to Egypt

Garbarino, manufacturer since 1932 of centrifugal and positive displacement pumps for marine&offshore, navy and industry in 2016 received from Egypt most of the orders in the industrial sector:

- With Veolia Water Technologies in Egypt more than 60 chemical pumps (CN) and vertically suspended line-shaft pumps (MU-VS and MCA-VS) for the South Helwan power plant owned by Upper Egypt Electricity Production Company.
- With Orascom Construction several chemical (CN) and vertical multistage (GV) pumps for the Burullus combined cycle power plant.
- With AC Boilers several vertical in line (MU-L), side channel (BT) and chemical (CN) pumps for the South Helwan thermal power plant owned by Upper Egypt Electricity Production Company.
- Again with Orascom Construction several chemical pumps (CN) for the New Assiut Combined Cycle Power Plant in Egypt.
- Always with Orascom Construction 16 vertically suspended line-shaft pumps (MU-VS) for the Burullus combined cycle power plant.
- Besides Egypt Garbarino wants to underline the cooperation with the European Organization for Nuclear Research (CERN) located in Geneva (Switzerland): Garbarino won the tender for the award of a contract concerning the supply of centrifugal water pumps. The contract is valid for five years.



The Essence of Energy Efficiency

MCE - Mostra convegno Expocomfort 2018: Integration is the key to our future

Milan, March 2017 – With one year left to go, the 41st MCE - MOSTRA CONVEGNO EXPOCOMFORT – the world's leading exhibition dedicated to residential and industrial installations, scheduled for 13/16 March 2018 at Fiera Milano - is offering an exhaustive overview of best-in-class products spanning the four macro-areas: Heating, Cooling, Water and Energy.

Cutting-edge systems and solutions showcased by the major national and international players in the heating, air-conditioning, refrigeration, valves, hardware, sanitary technology, water treatment, and renewable energy as well as domotics and building automation, reign once again as the undisputed protagonists of MCE 2018. So far MCE has recorded an attendance figure of over 1,000 exhibitors, 37% of whom coming from 53 countries worldwide, occupying more than 70% of its exhibition space.

Bolstered by the success of the 2016 edition (2,018 exhibiting companies, 912 of whom from abroad, and 155,332 trade visitors, 39,140 of whom from 146 countries), MCE reaffirms its leading position within an industry segment that is one of the most technologically advanced on the market, and increasingly strategic in the current economic scenario, ensuring a constant stream of innovative and integrated products, systems and solutions, as well as economic benefits and employment opportunities arising from energy efficiency. The concept behind MCE 2018 is actually the high-grade integration between systems and solutions, electric and thermal world, to implement intelligent management system, to reduce energy use, to grant high performances, optimize costs and preserve our natural resources.

"The high number of exhibitors who have already signed up to MCE 2018, indicate positive trend in the manufacturing world represented by ANIMA, Federation of Italian Associations of Mechanical and Engineering Industries – declared Massimiliano Pierini, Managing Director of Reed Exhibitions Italia –. Our mission is to organise a unique event, a concrete platform for better matching supply and demand, building relationships, and networking to proactively generate new business opportunities. An exhibition provides an invaluable tool for us and Reed Exhibitions Group to which we belong, that helps fulfill the needs of our customers be they visitors or exhibitors, becoming a major driver of market evolution at one with trends and changes. MCE is perfect for an in-depth interaction between exhibitors and visitors, to meet each other's needs. I'm fully convinced that MCE will meet the expectations of all who take part in."

MCE - Mostra Convegno Expocomfort

Mostra Convegno Expocomfort is the biennial international exhibition dedicated to residential and industrial installations: heating, air-conditioning, refrigeration, hardware, valves, sanitary technology, bathroom, water treatment, tools, renewable energies and services. Established in 1960 as Italy's first trade exhibition, MCE has been a leader in the sector for more than 50 years thanks to its proven ability to follow the evolution across the reference markets, creating opportunities for technical, educational and political exchange and discussion. Mostra Convegno Expocomfort is a trademark of Reed Exhibitions, the world's leading organiser of trade and consumer exhibitions, conferences and meetings, whose current portfolio includes over 500 events in 30 countries with an overall attendance figures of more than 7 million participants in 2016. Reed Exhibitions has 38 branches worldwide serving 43 industry sectors. Reed Exhibitions is part of RELX Group plc, the leading provider of professional information and workflow solutions in the business sector.

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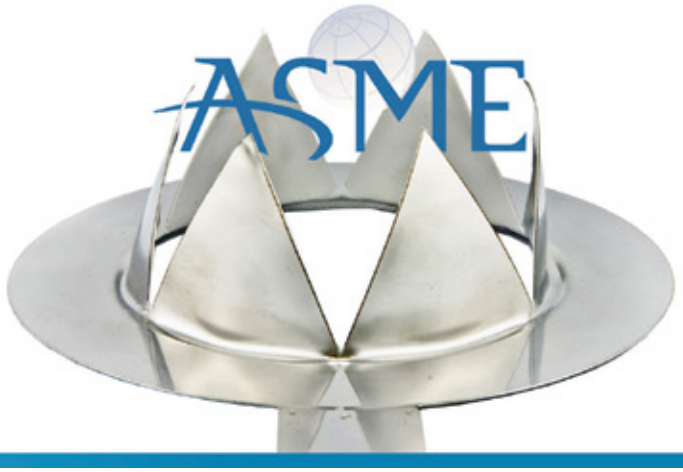

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