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How to digitalize an equipment for operational excellence and eco-conception

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Abstract – There are two possible approaches to the digitalization: one top-down, the other bottom-up. While the top-down approach seems reserved to operators because requiring a global overview of the digitalization, the Original Equipment Manufacturers (OEMs) and Manufacturers can bring part of the digitalization solution with a bottom-up approach. By digitalizing their equipment, OEMs and Manufacturers can not only reach higher operational excellence but also reduce the carbon footprint of project and operations.
The purpose of this article is to present a method and an example on how to digitalize your equipment.
The first part will explain the logic and the pitfalls of the digitalization. The second part will be dedicated to detail the process for a successful digitalization. The last part will high light the theory with a practical case : the connected agitator, benefits and specifications.

Index Terms — PCIC Europe Paper Format, Writing instructions, Style requirements.

I. INTRODUCTION

More half of all the spendings of Operators of the Oil & Gas industry dedicated to innovation, are focusing on digital technologies. For an industry known for its risk averse approach to innovation, the Operators are now looking to embrace the use of new technologies with quite some logic.

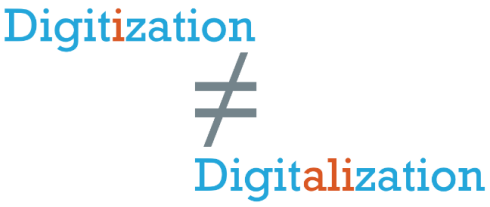
By nature, the complexity of projects in Oil & Gas industry may be the highest one amount all the sectors of the global economy. From filed EOR, to deep offshore drilling, or north pole production, the petroleum industry has been prompted to succeed against the harshest challenges. And this is no surprise if Oil & Gas projects all require a huge engineering effort to be executed, hiring the largest EPC companies worldwide. It is all because of the complexity of this industry.

And this the perfect playground to use the digital technologies. New technologies can go beyond oneself understanding and solve problematics larger than the human mind could do. Not to replace the knowledge of people but to become the tool solving problematic too complex for human capacities.

In this white paper we will try to explain the idea, the process, the execution of a digitalization we made of an equipment to solve two problematics : better operations for the Operators; and a better design to save time/cost/energy.

II. LOGIC AND PITFALL OF THE DIGITALIZATION

The first need when talking about digitalization is to clearly set the boundaries of the concept, and even more not to create a confusion between digitization and digitalization.



Digitization is the conversion of any type of information from an analog format (text, sound, picture, video, etc.) to a digital format. Once digitized, the information is available to be proceeded or stored by electronic devices. For example, a scanner digitizes documents.
Digitalization is for an entity the use of digital technology to proceed tasks. Organizations digitalize their activities to develop new services and become more productive. For example, emailing is the digitalization of the mail service.

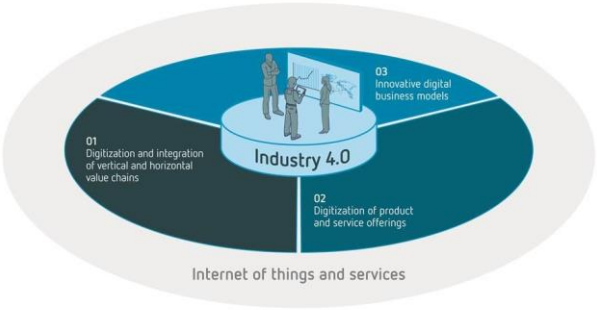
In this paper, we will only treat of the subject of Digitalization, considering the Digitization already made in preliminary steps.

A. Logic of the Digitalization

Digitalization concept is to use the service of new technologies for innovation. Among the new technologies we can quote the most interesting one such as Big Data, Artificial Intelligence, Augmented Reality, Cloud hosting. Being innovation by themselves, these technologies are not innovation in the Oil & Gas, but their applications and good use is. Thus is the idea of the concept Industrie 4.0 : applying new technologies to revolution the industry .

In fact, the goal and main logic of the digitalization is to use the new technologies to carry on the Oil & Gas industry activities in a more efficient way. The final aim is to use digital technologies as a driver of innovation in the petroleum industry to, for example, save energy, reduce costs, design faster, etc. Not to carry on different activities but to do these activities differently for the best.

Digitalization is broad concept with many possibilities to impact our industry, but we can define 3 large scopes of application, in link to Industry 4.0 :



1. Digitalization and Integration of vertical and horizontal value Chain

   The first use of the digitalization is often to improve internal processes in a company, but once this is made, the next step is to integrate the processes of its value chain. By integrating part of its supply chain or value chain, companies have more control on their activities because it is a way to consider the company environment into the optimization process of its internal activities.

   This integration of our supply chain can appear as far fetch but it is in reality a daily practice for most of the actors of the oil & gas. For example, integrating the delivery time of your suppliers into your production system, merging the specification papers of a part to your equipment spec, All the projects, all the production system in Oil & Gas is the result of an integration of skills and expertise from many companies. Now the digitalization comes a mean to smooth these interfaces and deepen the relationship between entities.

   If we reuse the digital technologies on the examples above. We can easily create through the cloud an interface between the ERP of different suppliers and your company. So, when making a production plan, your internal software can go check the capacities from all the different suppliers and thus propose different scenarios based on the price, the quality, the delivery. Letting you decide about the best configuration to put in place. This example is already live with a german electrical cabinet manufacturer able to probe all the distributor parts available in order to design the cabinet with the minimum time of procurement

   Same goes for merging the specifications of your suppliers' components with the ones of your equipment. It has been a paperwork for decade, but thanks to digitalization and 3D Digital Twin, it is now feasible to transfer and aggregate all these data digitally and pass them more efficiently to engineering and operators.

   Once again, the relationships between all the layers of a supply chain and value chain are no news, but the digitalization is really deepening the possibilities of these partnerships. To the extend, where the concept of Extended Enterprise has been created to specify this new kind of relationship where companies do not work as a "chain" anymore but as a "network".

2. Digitalization of product and services offering

   The digitalization of a product or a service is usually the most natural application of the new technologies in our field, or it is a least the simplest to represent. In this case the digitalization main objective can be to add a digital layer on top of a product or a service, and can be to create a fully digital product or service.

   To illustrate these two possibilities, we can refer for the first one to the example later explain in this paper of the agitator digitalization. The aim of this project of agitator Digital Ready is its internal capacity to capture data about its operations and about its environment in order to participate actively in the Digital Twin of the Operator. By acquiring these, data from the agitator, the Operator is able to optimize operations, decrease downtimes and failure, simulate production, trace the quality of the actions, etc. In this case the digitalization is overpowering the functionality of the product in order to create more value for the users in operations thanks to this digital layer.

   A common example for a fully digital service created by the digitalization is the service of maintenance predictive proposed by many solution providers. Most f the time, these applications are proposed to operator as an add-on to plug on their scada system to detect deviation in assets running data to alert upfront the Operator on risk of failure. Over the last years, these solutions have proved their efficiency and have become a must have for smooth operations. This type of offering and service was enabled by the use of Artificial Intelligence for the digitalization f the industry.

3. Innovative Digital business models

   Last in the order of this paper because the last of the Digital Transition step, is the emergency of new innovative Digital Business model. Linked to the establishment of the first two categories innovation which will generate new value, part of this value will of course need to be monetize. The monetization and the capture of this new stream of value will be done via the existing business relations between actors of the oil & gas industry, but part of this emerging innovation will require the creation of new business models.

   There not so many examples we can quote from the oil & gas itself, but this is the case on other industries. Just on the example of the airline industry where motors OEM sells their assets by a subscription to the number of running hours, and not at a fix rate. This business model integrates a sort of lending of the asset but also the maintenance of it. For the manufacturer it enables a long-term business model and give them the maintenance responsibility. For the airline, it ensures the motivation of the maintenance to make the airplane as ready to fly as possible and thus limit the number of flight delays.

   In more theoretical point of view, the digital transition is enabling companies to pass from reactive business model to pro-active ones. In our industry the reactive business model would be : the production line is down, operator call its service company, the service company pays a visit, the disruption is solved. In a pro-active business model where data are connected: auto-detection of an anomaly, service company pays an early visit, problem is solved before shutdown.

Digitalization has been tagged as the fourth industrial revolution not only because of the technical possibilities enabled by the new technologies, but also for the evolution of revolution it will generate in terms of people, business and legal organization between companies.

B. Pitfall of the Digitalization

Digitalization is an ocean full of opportunities as much as it is of pitfalls and traps.
We all know many examples of large failure when it comes to digital transformation where the results never matched the investments and efforts. Like any other innovation, the success of digitalization is never guarantee.

Digitalization needs to avoid 3 common mistakes which are preventing organizations, especially large, to create value. All of these mistakes are usually made at the beginning of projects, and when found later are impossible to turn around. These 3 common pitfalls are:

1. Approach Digitalization for its technology purpose

   As we explain on the previous party, the aim of digitalization is to use new technologies as an enabler of innovation. But unfortunately, we too often see popping up initiatives where the technology is put at the center of the work. From day 1, the digitalization is in peril because teams are sometime trying to push technology for its own sake and not to create value. With the wrong aim, these initiatives have the highest chance of failure

   Those situations are often created by top management answering to the shareholder of trendy topics. Lately, the last topic in all the focus of C-level is the blockchain. Even if blockchain is a great technology, no real profitable use case has been proven. Yet many companies have launched programs to create their own blockchain for the sake of communicating about this technology inside their company.

   This pattern of failure is today on Blockchain, was yesterday with Virtual Reality, and will emerge with a new technology tomorrow. Even if those technologies created value in few cases, it clearly never matched with the money and time invested. The main reason behind those failure was the wrong aim from the beginning to push a technology for the only sake of its own innovation, and not to create value. New technologies need to remain tools in the toolbox and go beyond the hype they create, to be used only when they are required. If not, digitalization will remain unproductive and ineffective, missing on the long term is opportunities.

   To be successful, the digitalization has to be approach like any innovation and aim to create value by solving pain points, increasing efficiency, or creating new services.

2. Approach Digitalization only globally

   In the first paragraph we explained how the digitalization was connecting the value chain and how its impact was global. Yet its implementation may not follow the same path. Many large companies have created large programs for digitalization with new business units in charge of pushing the digital in the entire company. Even if it is mandatory to gives a corporate framework to the digitalization, to make sure the work done does not deviate from the global aim, it is important not to push the digitalization only from the top of the corporate ladder. Digitalization, like any other innovation have to emerge from the pain point and in our industry from the operations or projects.

   Too often companies commit this pitfall to push the digitalization from the top with its global vision and global objective. Because, later on this vison is pushed to the operations who are asked to adapt based on this new dynamic. But the operations hardly adapt to innovator wish if the added value is not tangible for their daily emergencies or daily delivery. This is the reason why, most of the “Top-Down” digitalizations ended badly: the concept and idea were good, but the execution failed because of low support. The same schematic happens in the 90’ when companies were trying to push “quality” policies through the top management by creating “quality control” positions. It only really created value when organizations stated quality was part of everyone job.

   In our case of Digitalization, the pattern is sensibly the same. The digital transition will impact everything and every position of a company. It is thus important to take the matter from the birth of the company reason. Meaning the digitalization has to begin in the core operations. In this case, any paint point can become a Use Case of Digitalization with a clear added value. This approach often referred as “Bottom-Up” offers a good way to create value from your Digitlaization and achieve step by step a larger scope of digital transition. These small or medium initiatives are also productive on the global scope because thanks to the global framework initially put in place, you can be sure, the developments can be repeated or scaled up.

   Thus, the digitalization to be successful has to start small and grow inside a company from its core operations to create value and create momentum.

3. Approach only the technology of Digitalization

   The use of new technologies is at the heart of the Digitalization, as an enabler to create value. The new technologies are far beyond in advance of the problematics of our industries. Yet many projects of digitalization fails even if the technology seems ready. In this case the pitfall organizations

commit is to think only the technology will matter in the success of their digital transition. In fact, for few years now, new technologies are more than ready and mature to be applicated on our use cases. Unfortunately, in most of the case the failure is not technological. Failure comes from the environment of the company or of its partners.

An easy example of this type of pitfall is link to big data initiatives, especially those where companies try to have predictive maintenance. The algorithms in charge of the machine learning are all available and easy to implement. What is not easy at the opposite is the access to the rough data the algorithms will crunch. Accessing databases, or joining databases is not so much a technical challenge, yet many entities are struggling to do it because of legal and governance questions. It is important to realize in a context of oil & gas project, the operator is not the owner of all the data generated by the assets. In the same way, you can buy a car, but you are not the owner of the data generated by the vehicular. Operators are not the sole owner of the data generated in their projects, so when it comes to using these data for a predictive maintenance use case, Operators have to agree with partners on the data governance and the business model to create value for each one of them. In this case, the technicality of the digitalization is not a problem, the challenge comes from the partners organization and agreement.

In too many cases, the legal and business aspects of digitalization are forgotten or underestimated to focus on the technology itself. At the opposite, the digitalization to be successful has to start by setting the legal and business boarders to insure the compliance and the value creation of their later technology solution.

III. PROVEN PROCESS OF DIGITALIZATION

As explained through the beginning of this paper, Digitalization is a broad concept able to take different pathways to achieve its goal. In this part of the paper, we will present a path among others which has been proven in several occasions to be successful.

A. Value creation

Before jumping on the road to digitalization, it is quite important to set the goals of it, and as such define what is a successful digitalization.
Once again, many expectations can flow form a digitalization project impacting all the step of a project lifecycle. Yet from a general point of view, a successful digitalization projects is a project which has created value for its actors. If a project has failed to create and show it has created value for its stakeholders, then the digitalization cannot be considered as successful.

In a project, value can be created by different means :

1. Saving time
   Of course time is money, but digitalization may have to benefit from being more tangible than this maxim. To give some context, digitalization can in some cases accelerate a project or operations. A clear example of such acceleration is the use of the 3D Digital Twin of plant during its construction to assemble the different design and find the layout. By using such a Digital Twin, engineerings and contractors are able to scenarize the global design of the plant and chose the quickest one to build.
   In this particular case, using the same resources at the construction stage, contractors will build the plant faster. Thus saving time, and pushing the project for an earlier first day of operation.
   The value created by saving time can be easily calculated via the Return Of Interest (ROI).

2. Saving money
   On this aspect, the gain is quite clear on how saving money is a value creation. A penny not spent is the best source of value.
   An easy example of it comes with the more and more common usage of predictive maintenance tools. Imagine using such a digital solution on a MV motors running on a compressor. The predictive maintenance tool is able to detect early sign of rupture in the bearing of the motors and such send a warning.
   Without such a solution, the motor will have most likely turned until bearing explosion, causing damage to the motor rotor. Avoiding some expensive damages, this predictive warning transformed a rotor maintenance and reparation into a bearing replacement.
   The savings in this kind of operations are direct and happens quite often, representing a large pool of value to be created.

3. Increase performances
   In a sector like ours of process and operations running 24/7, the performances have a direct impact on the profitability.
   More and more, Operators use digital technologies to optimize their performances, as the process digital twin is trying. It is the use of running data to analyze and optimize the operations of a real-world process over time. The model represents the key characteristics of the selected physical process, to find the best suitable configuration of production. Thus, production configuration can be adapted in real time to reduce the cost, maximize production, or increase margin.
   All those means to of course generate more value from the same operations.

4. Reduce downtimes
   Downtimes are for sure the nightmare of every operators and a large source of extra cost. Extra costs occur by the cost to repair the cause of downtime, as well as costs appears by the losses of non-production.
   A daily use case is the installation of a new equipment. In same case, this installation will require a stop in the production to switch equipment. Thanks to the 3D digital twin, operators are able to perform a spatial analysis on the plant. Considering the perceivable architectural elements with their boundary, the solution is able to stress the feasibility of an

installation and run its simulation. So later in action, operators are more efficient in their manipulations.
The value created by restarting production earlier is easy to calculate and value for operating companies.

Once this value created, it is of course mandatory to measure it. Without the measure of the value created, it will be impossible to prove or estimate the value of a project and thus impossible to motivate the investment to initiate the process.
A successful digitalization is a transformation enabling to create value and able to measure the value created.

B. Team and Business Model

Once the value creation and its measurement identified, it is important for the leader of a digitalization process to build a robust team and draw a first business model.

It is quite clear today that one single actor is not able to have all the solutions and all the opportunities of digitalization. As such, the digital transformation will happen across all the supply chain of our industry.
For a leader, it is important to build up a strong team to approach the complexity of digital topics. A strong partner in a project will be a company with a strong technological background ready to innovate, and also a company you can trust to share knowledge with. Digital projects will always require the exchange of data and information, which will require a commitment stronger than legal NDAs.
Finding the right partners is not enough, it also important to pay attention to the way the puzzle will be assembled.

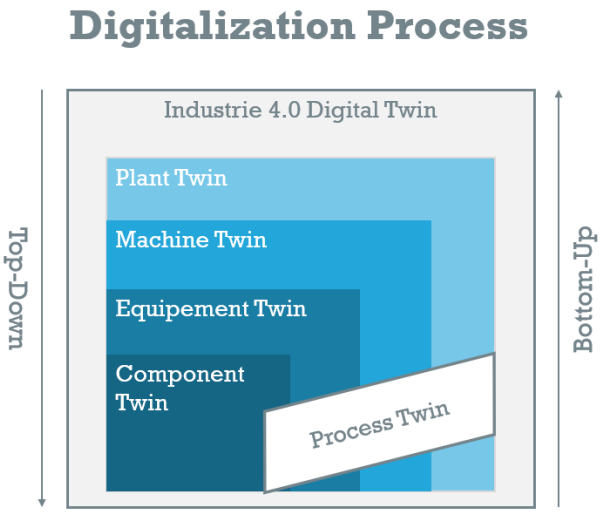
The best way to organize the collaborative team is to put in place the correct business model.
A good business model is able to measure the value created by digitalization and transfer part of the value created to the digitalization team. In this sense, Digitalization may require the use of new business models not so common in the energy industry, but which are at use in others.
A good business model will help bring the different partners around the table to start the project, but a correct one will also be able to retain the partners around it.
As such the correct business model is thus the one able to capture part of the value created at the client, but also model the relationships between partners.

New business models could be explored in the future years, such as leasing of equipment, contract per running hours, etc.
But one thing is sure, once the value identified, the team settled and the business model in place, the technical aspects of the digitalization can start.

C. Top-Down of Bottom-Up

Depending on where you stand in the value chain of the process industry, you may choose between two different approaches of the digitalization, the Top-Down or the Bottom-up to tackle the technological aspect of the digitalization.

Both approaches present their pros and cons, but it is important for any of them to keep an agile method and scenarize the different technological resolutions of the initiatives.
Some solutions may be more complete but too expensive, some can be lighter but good enough, etc.



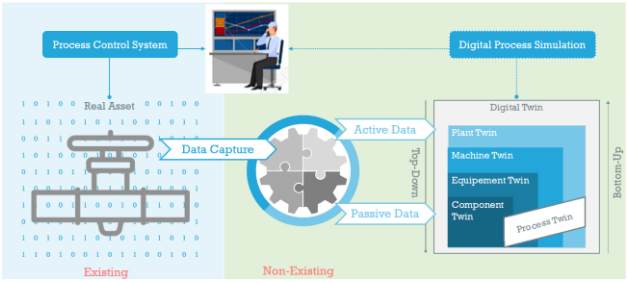
In that respect, the Top-Down approach is dedicated to the End Users and requires investments at the scale of these facilities. This Top-Down approach fits perfectly on new projects, especially in offshore or harsh environment. In these cases, Industrie 4.0 digital technologies can provide End Users with step change in Capex and Opex.

In opposite way, the Bottom-up approach may please all the players of the value chain from the bolt manufacturers to the End User.
It begins with the digitalization of components or small equipment. Then, it escalates to machines, to the process and on last stage at the whole plant. This approach is easy to implement especially on existing facilities. There, it brings quick wins at small risks with great pedagogical value in organizations.

At the end, the purpose of the Top-Down and Bottom-up approaches is to build the digital process loop by one way or another.

D. The Digital Process Loop

As previously said, the digitalization is not the target by itself, it is a mean to create value. The best way to ensure you digitalization process will generate value for the example of operations is to integrate the operator vision of a Digital Process Loop.
In the picture below, we illustrate how to build the digital process loop in parallel to the usual process control system loop.



Compared with the existing conventional process control loop, the digital process loop provides End Users with three key major benefits.
First, it offers far shorter response time, then it guides the operator straight to the root cause, finally it allows to model scenarios for resolution. These capabilities change the game in running large and complex operations.

In the picture above, the idea is to capture most relevant data from the installed base. Then, after a first treatment the purpose is to produce passive data and active data.
The passive data are related to the components and the equipment while the active data translate the process status. The passive data helps to build the Digital Twin of the components and the equipment, then the combination of passive data and active data contributes to build the Digital Twin of the process and the whole plant.

Anyway, collecting these data and treating them to build up the digital loop require multiple competences. Some of them belong to the End User, but most of them standing in its supply chain.
Therefore, creating value from the digital process loop is the results of collaborative process involving key players, in the right business model with the right approach.

IV. ECO-CONCEPTION & DIGITAL READY

This part of the white paper is now going to present a practical example of digitalization. Under the example of an agitator, we will present how Mixel digitalized their equipment.

A. Context and scope of the digitalization

Agitation is a complex step in any process because it requires to master all the different disciplines of mechanic, hydraulic, viscosity, electricity, and automation; to realize the expected agitation and produce the right quality of output product.

In this sense agitation is quite a paradox because it is present in almost all the processes such as water treatment, chemical, food; and it is an operation quite crucial for the process; but yet so little do we know about this knowhow.
In fact, the knowledge about agitation is very much concentrated in few OEMs concentrating the vast majority of the market. And those companies acquired their expertise from decades of experience in design and in operations of their assets. The theoretical models and comprehension of agitation processes is not quite there yet. Or at least not precise enough to match with the current expertise of those OEMs.
Agitators being complex by nature, at the heart of the process, with an high criticality and a lack of theoretical understanding; made it the perfect candidate for a digitalization.

In our example, the digitalization was balanced into two projects running one after the other to serve two different purposes.
The first project named “Eco-Conception” is an R&D approach to optimize the design of agitators and reduce the need for resources by avoiding over quality.
The second project named “Digital Ready” targets to connect the agitator and capture more data from this critical operation to be used by the operator.

In term of team, Mixel partnered with 2B1st Consulting and Vibratec for the execution of the project. One expert of the digitalization, the other expert of instrumentation and signal analysis.
Concerning the Business model to be adopted by the collaborative team, 2B1st and Vibratec were hired to execute a prestation and would not claim any Intellectual Property from the innovation created by the project.
As such, Mixel is consequently the sole owner of the Intellectual Property generated by the Eco-conception project and will also be the sole partner involved in the commercialization on Digital Ready agitators.

In this example, the digitalization project was aiming to learn more about the agitation equipment for one part. And for the other to create a digital twin shell to be proposed as a service to the agitator customers.
As our project was centralized around the equipment, we were by nature in a bottom-up approach. Coming from the below layers of the supply chain to propose a digital solution to operators and engineerings.

The aim was double. First learn more about the operational characteristics of agitators and their dynamic mechanical behaviors to later optimize their design. Second, proposing a digital twin solution to operators to integrate the Digital Process Loop at its roots by capturing more Passive and Active Data.

B. Eco-conception

This project took its essence from field feedbacks.
An agitator is composed of different parts: Electrical motor, gear box, shaft, and propeller. Along the years most of the maintenance requirements were on the gears box and the electrical motor. In fact, the shaft and the propeller never break despite operators using the agitator in conditions way beyond their window of design with viscosity double the supposed one.
This early deterioration of the gear box could be avoided if the shaft was more flexible and thus transmitting less efforts to the gear box and motor.
In term of maintenance cost, it would be better for the shaft to be more flexible and preserve the bearings. Even if the shaft would come to a rupture, it would be better to break the shaft than the gear box.

In order to acquire more flexibility, the goal of the project was to measure the real flexibility and efforts applicated to

the agitator during a process test and compare those numbers with the theoretical numbers estimated by the design.
By comparing both, it would later be used to optimize the models of design in order to reduce the stiffness and increase the flexibility, and consequently durability.

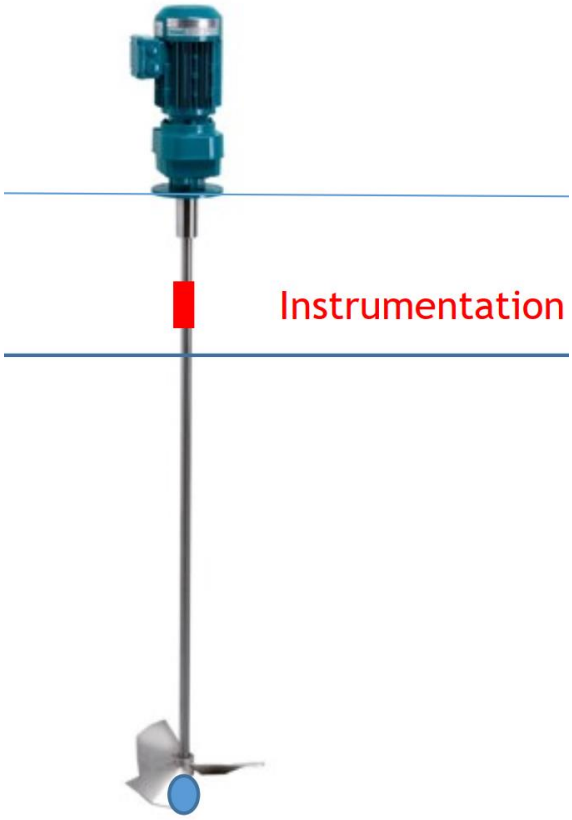


Fig. 1 Instrumentation of the agitator

It was decided to equip the agitator with different types of instrumentations:
-In red above the water, 3 strain gauges in order to capture all the efforts applied to the shaft. Those efforts are the flexion, traction, compression, torsion.
-In the red above the water, a rev counter to measure the rotation speed, and torque
-In blue below the water, 2 accelerometers to capture the turning position of the propeller and by calculation obtain the shaft deformation
-On the motor, 2 vibration captors in 3 axes.
-On the electrical drives, tension and intensity were monitored

A serie of tests was programmed to vary the propeller, shaft diameter, rotation speed, and analyze their impacts on efforts and deformation. In the table following and the picture, you will be able to see the different type of test conducted.

Fig. 2 Different set of propellers to be used

TABLE I
Agitator test configuration

Test Id	Parameters		
	Propeller diameter (mm) Propeller type	Shaft (mm) Shaft height	Rotation speed (rpm)
1	1200 TTA	73 3 m	30 / 45 / 55
2	1200 TTA	73 4 m	30 / 45 / 55
3	1200 TTPA	73 3 m	50 / 65 / 80
4	1200 TTPA	73 4 m	50 / 65 / 80
5	1200 T3P45	73 3 m	40 / 50 / 60
6	1200 T3P45	73 4 m	40 / 50 / 60
7	1700 TTA	73 3 m	20 / 30 / 40
8	1700 TTPA	73 3 m	25 / 40 / 55
9	1700 T3P45	73 3 m	25 / 35 / 40
10	900 TTA	60 3 m	40 / 60 / 80
11	900 TTA	60 4 m	40 / 60 / 80
12	900 T3P45	60 3 m	60 / 80 / 95
13	900 T3P45	60 4 m	60 / 80 / 95
14	900 TTPA	60 3 m	80 / 100 / 120
15	900 TTPA	60 4 m	80 / 100 / 120

To push the tests to the limit, it was also decided to add 2 stress tests aiming to go to the rupture of the shaft in

order to find the elastic limit of the agitators. These tests were performed by increasing the speed rotation of the agitator way beyond their operational limits and ended up by the rupture of the steel shaft.

All tests carried on, have been successful in showing a margin between the estimations given by the design simulations and the field values measured during tests. The difference between both family of figures had little variation in ratio. Meaning modelization figures of effort were quite aligned with their tests results. In general, the ratio between simulated value and measured were about a third.
This ratio being quite constant between the different tests, tend to show the quality of the models used for design. In fact the models only needed to a calibration to fit perfectly on the reality of agitator operations.

Beyond the learnings done on the mechanical aspects of the agitator through efforts and deformations, it was also the occasion to link those variables to the electrical/vibration ones.
In fact, the second goal of this eco conception was to detect and evaluate the patterns of deformation/efforts through the other type of data collected. The aim of this pattern recognition was not directly done for the eco conception project, but for the following one Digital Ready.

C. Digital Ready

The essence of the Digital Ready project is to enable operators to use the digital twin of their agitators to better operations and maintenance. To do so Operators needs to be able to detect early signs of maintenance needs as well as acquire warnings of failure which today is not possible for agitators.
In term of functionalities, those needs translated into the aim to enable the agitator to capture data and share those with operators, in addition to a brick of knowledge. The knowledge brick being the expertise for operators to translate data into information. In our case the information could be deviation due to maintenance need or warning about product quality in the process of agitation.

Of course, with all the instrumentation used during the Eco Conception tests, any type of deviations could have been easily detected, but in the field it was not realistic to propose such a complex and expensive solution for operators.
Usually, agitators on the field are not equipped with any instrumentation, we thus needed to propose a solution affordable for capturing the data and transmitting them to the operator. The effort was to limit the instrumentation as well as bringing a simple connectivity solution.

In plants, variations in electrical intensity or vibrations are easy to measure and a specific analysis of those signals must make it possible to detect malfunctions. During the Eco-Conception tests, we aggregated several physical quantities measured in a synchronized way to be able to determine during the development of the Digital Ready project the pattern through each variables measured.

Given good results of malfunction identification through each type of variable we decided to concentrated our efforts on the vibrations and electrical intensity, to be captured and transmitted to operators.

Using only two pieces of instrumentation, we could transfer to operators the vibration and the intensity. These two variables are enabling operators and software to analyze two direct values but also its combination. Using those 3 channels of information, we were able to identify all the malfunction of the equipment and problem in the process.

At this point, the challenge was to propose an integrated solution available to be sold in a package with the agitator and which could be added to any operator digital environment.
The decision was thus to integrate the intensity and vibration captors directly in the motor and gear box group. Those captors will be standardized to fit all the portfolio of agitator. The captors will be linked to a gateway attached on the equipment as well. The gateway being adapted to the client in order to fit to its communication infrastructure (Bluetooth, LoRa, wifi).

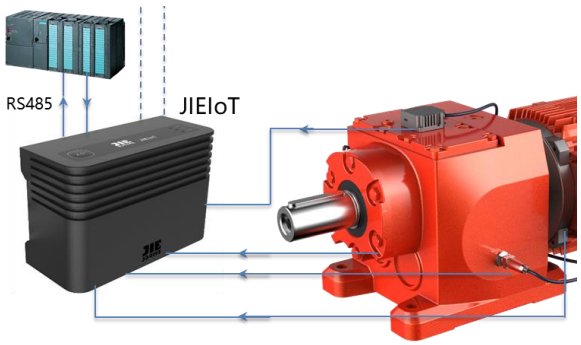


Fig. 3 Captors and gateway installed on Agitator

The arbitrage was decided to adopt a simple solution to put in place and use for operators to service 99% of their needs regarding agitators.

The solution created for the Digital Ready project was of course perfectly suited for brand new agitators sold to customer but could also be installed in retrofit for existing plants. To go beyond, the solution was neither brand specific and could service all the type of agitators, given the knowledge acquired by the Digital Ready project into identifying patterns of deviation.

The first feedback from field is positive in term of installation and integration for operator into their digital environment. Now gaining some experience, the set-up has already caught its first deviations and served its purpose to alert operators to optimize the plant process.

II. CONCLUSIONS

In this article we have tried to present the theoretical as well as the practical aspects of the digitalization of an equipment for the Energy industry.

Looking back at 2014 when new technologies were trying to find their usages in the industry, we now have a more practical vision of the impacts and benefits for our operations. The intention of this white paper was also to

go beyond the hype of some technologies and to share some good practices. From years of digitalization projects and their challenge, our goal is also to enable other actors to follow the path and bring more digital technologies to the service of our sector.

The example of the agitator Eco Conception and Digital Ready are of course transposable to any type of equipment and should be used as such.

The capture of more data being at the core of the digitalization need, equipments, because of their proximity with the process, are of course the first brick to be implemented on the path to Industrie 4.0 plants. But the digitalization of agitators even if creating a lot of value by itself, is not enough. We need to replicate this example to all the types of equipment, being mechanical, electrical or automation to optimize our operations globally and carrying on doing better at delivering energy.

III. ACKNOWLEDGEMENTS

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