

AIMM

STORK MAGAZINE 2019

THE ROBOT REVOLUTION

- > Working at heights
- > Robotics@Stork
- > Innovation in practice

STORK

A Fluor Company



05 | THE ROBOT REVOLUTION

Stefano Stramiglioli, professor of advanced robotics, University of Twente sharing his thoughts with us:

“Game-changing opportunities ROBOTICS can provide in the Inspection & Maintenance Industry”

18 |

8 WAVES OF CHANGE

Working at heights.

12 THE ROBOT, A FRIEND TO EVERYONE

exoskeleton, laser cladding and drones; robots are deployed in Stork.

14 COOPERHEAT, A STORK BRAND

Innovators in thermal technology since 1958.

17 iFACTOR

Innovation in practice; digitalization, robotics, and sustainability.

18 FIRST FEMALE NORTH SEA SCAFFOLDER OFFSHORE

Vicky Welch is proud to lead the way as first female scaffolder.

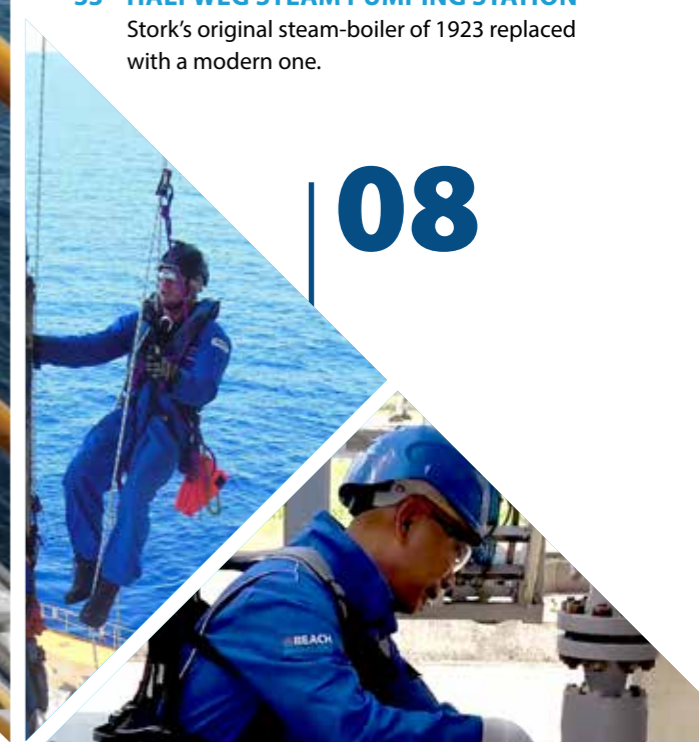
20 ADDRESSING AN AGE-OLD INDUSTRY CHALLENGE

Maintenance of offshore facilities with surface preparation and coatings repair.

23 APPIICATION

Digital applications improve the efficiency, transparency, and predictability of work activities.

08 |



33 |



12 |

26 REMOTE CONTROLLED DEMOLITION
How a robot provided a safe, efficient solution to wall demolition.

28 GOLDEN AGE FOR HARD WORKERS
Maintaining a reliable energy supply demands the utmost from Stork's employees.

30 REFURBISHMENT FOR BIOMCN METHANOL PLANTS
Massive refurbishment project, with short lead time- for BioMCN Methanol plant, successfully started up again within 2-years.

33 HALFWEG STEAM PUMPING STATION
Stork's original steam-boiler of 1923 replaced with a modern one.

GAME CHANGERS

Dear Reader,

Game-changing innovations usually seem impossible or unfeasible before their introduction; after which you think, "Of course!"

Flashes of inspiration come from new connections, a willingness to experiment, and perseverance to find a better way. Triggered by technology, collaboration, or just a healthy dose of curiosity, new ways of thinking about a product or service create the new reality.

This drives our vision at Stork. Creating better ways across the globe – such as testing new technologies with the research arms of client companies like Ecopetrol, collaborating with knowledge institutions and industry partners in Digital Innovation Hubs, and integrated delivery with colleagues in the wider Fluor family from Papua, to Colombia, to the North Sea and the Netherlands.

In this issue of Stork AIM, we feature Robotics, an exciting field for our industry and a key Stork focus area along with Artificial Intelligence, Big Data and Digitalization. Stefano Stramigioli, Professor of Advanced Robotics and Chair of the Robotics and Mechatronics Group at a leading Dutch University (UT), shares his thoughts about the impact of robotics on inspection and maintenance. He predicts that it is not a matter of whether, but of when robotics will revolutionize the industry.

I am pleased to say that the revolution has already taken off at Stork. This 2019 issue demonstrates how robotics is being embraced in the field for safer, faster, higher quality, and more cost-effective solutions. And I am particularly proud when we enhance health and safety. The more we do, the more ideas we get. Our heritage of technology and hands-on care is providing the basis for intelligent hands-off solutions.

Stork strives to be the industry reference, every day and everywhere. The application of science and technology gives this ambition wings. Ultimately, it's the mindset of our people, supported by the company, which drives finding better ways. They are the pioneers and game-changers. I hope that you will feel inspired by their ingenuity and join in revolutionizing what can be accomplished together.

Taco de Haan,
President Stork



“ I believe that it's the mindset of our people, supported by the company, which drives continuous improvement and innovation. ”

PREPARING FOR THE ROBOT REVOLUTION

It's not a question of whether robotics will change the face of inspection and maintenance. It's a question of when. And, according to **Stefano Stramigioli**, professor of Advanced Robotics and Chair of the Robotics and Mechatronics Group at the University of Twente, the companies that pioneer research into industrial robots today, will be the market leaders of tomorrow.



WHAT GAME-CHANGING OPPORTUNITIES CAN ROBOTICS PROVIDE IN THE INSPECTION AND MAINTENANCE INDUSTRY?

There are so many ways that Robotics will soon improve production and performance. But in maintenance and inspection, there are a number of specific benefits. Robots can reach locations that are difficult – or impossible – for humans to reach. But they can also operate in conditions too hazardous for human workers. The impact on safety can be significant.

What's more, robots can precisely and swiftly localize problems in industry equipment, and make maintenance much more efficient and cost-effective. Instead of regularly scheduled maintenance managed by humans, the robots can move around large structures and alert human teams to real-time issues that will soon require intervention. They can predict failures and confirm safety. Which in turn can decrease shutdown time and reduce maintenance activities to only those that are truly necessary. Use of robots creates significant cost-savings over the current model, and an increase in operation time.



WHAT ARE YOU WORKING ON NOW THAT CAN REVOLUTIONIZE OUR INDUSTRY IN THE NEAR FUTURE?

One of the very exciting developments is a robot that can be deployed to inspect pipes from the inside. No human can crawl inside those pipes, but we're developing a robot that can scan and inspect pipes for abnormalities and identify weaknesses. When we talk technology, everyone thinks about AI and data. But they forget the physics and the physical world with which they need to interact to get that data. The Robotics we're working on are meant to be applied in the physical reality of the industry, and help make real advancement.

Also, many enterprises are using drones to achieve better, faster and more accurate inspections. But currently, drones can only provide an image, a visual representation. We are able to add sensors to the drones, so that they both fly and touch; take measurements and provide real-time data about the area they are inspecting. That will again change the game for companies who have the knowledge to put it to work.

WITH ALL THE TECHNOLOGY CURRENTLY AVAILABLE, WHAT ARE THE KEY SUCCESS FACTORS FOR ACTUALLY IMPLEMENTING ROBOTICS IN THE INDUSTRY, AND USING THEM TO THEIR FULL POTENTIAL?

The technology is there, but what we need now is intensive Research and Development into how to get the robots to do the right thing at the right time. Robots will change the world – this we know for sure. But the only way to ensure that they're utilized to their full potential is to experiment now. The enterprises that are willing to invest in Robotics development now will almost certainly be market leaders when Robotics becomes commonplace in the industry.

The research we are doing now will benefit the entire industry. It's about creating reliable, robust robots that act and behave in the ways we need them to. That requires step-by-step deployment in non-critical segments, so that we can test the technology in real circumstances. The pioneering companies who make these advancements possible and help create reliable robots will surely be the most successful when the technology is fully mature. After all, they'll have a head start on how it all works.

WHAT ARE SOME OF THE BARRIERS TO IMPLEMENTING ROBOTICS IN INSPECTION AND MAINTENANCE?

There are quite a few, to be honest. As usual, it will take some time for legislation to catch up with technological advancement. In particular, the petrochemical industry faces some regulatory barriers when it comes to using Robotics in areas with flammable or explosive materials. But here again, the more we test and use Robotics in safe environments to optimize their performance and make them entirely reliable, the sooner we'll be able to prove their safe use in dangerous environments.

There are human barriers as well. Of course, many people feel that implementing Robotics will eliminate the need for human workers, but that's simply not true. I predict that for the next 30 to 50 years, there will be very little – if any – loss of jobs for humans. The implementation of robots will simply allow humans to transfer to another job. Robots will allow humans to take safer, more technical jobs, like that of an operator. By the time robots are so prolific that they can entirely replace humans, we'll be in an entirely new socio-economic structure and politics needs to see and adapt on time. It won't just be production that changes, but everything. Still, that's a long way off. I don't see that happening in my lifetime.

WHAT ABOUT INDUSTRY PLAYERS WHO WANT TO GET INVOLVED IN ROBOTICS, BUT DON'T KNOW WHERE TO START?

This is the most important reason why we have Digital Innovation Hubs that bring together engineers, developers, service providers and end-user enterprises. Everyone brings something to the table. If we don't connect with the industry and the service providers, who will actually implement and use the technology, it ends up dying in the lab, and no one wants that. But when knowledge institutes, like University of Twente, partner with service providers like Stork and their customers, great advancements can happen.

Without industry partners willing to take the risk, try and test these technologies, no true industry advancements can happen. We need people who can tell us what the specific needs in the industry are, and what the specific challenges

are. And together, we can build and test the solutions. We know this because in industries where robots are being used more regularly, we got there because the end users were closely involved in development.

Take the medical industry, for example. We couldn't create surgical robots without in-depth involvement from surgeons.

WHAT IS YOUR VISION FOR THE FUTURE?

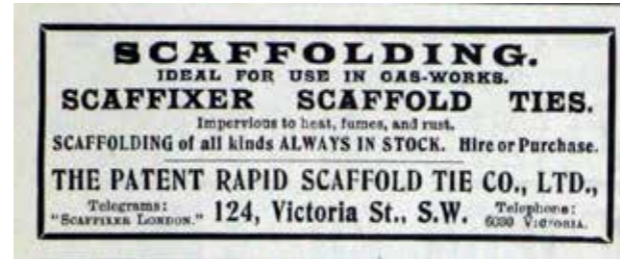
I often say, "Physics can predict the future, but Robotics will make it." The sooner the industry realizes that Robots are on their way, the better prepared they will be when they arrive. It's not a question of whether or not Robotics will be part of the Maintenance and Inspection landscape. It is merely a question of whether companies will get on board now and be leaders of the future, or whether they will hesitate, and potentially get left behind.

Stefano Stramigioli is professor of Advanced Robotics and Chair of the Robotics and Mechatronics Group at the University of Twente (NL). He received an M.Sc. with honors (cum laude) and a PhD. with honors (cum laude) in 1998. He is an IEEE Fellow, ERC Advance Grant Recipient and was recently nominated as a member of the Dutch Academy of Science (KHMW). He is serving a second term as Vice President of Research at euRobotics. He was Editor-in-Chief of the IEEE Robotics and Automation magazine, an AdCom member of the IEEE Robotics and Automation Society, and recipient of – among others, the IEEE-RAS Distinguished Service award and the euRobotics 2016 Tech Transfer award. Among his many areas of interest and applications, he specializes in robotics application in Maintenance and Inspection, as well as the multiple award-winning robotic bird, 'Robird'.



WORKING AT HEIGHTS

FROM BAMBOO TO ROPE TO DRONES...



Scaffolding has been around forever, right? Well, yes and no. Yes, because people in prehistoric times were already using a scaffold made of bamboo or wood to work at heights. It was only in 1913 that "Scaffixer" was patented; a coupling device that was far more robust than rope.

SCAFFOLDING TODAY

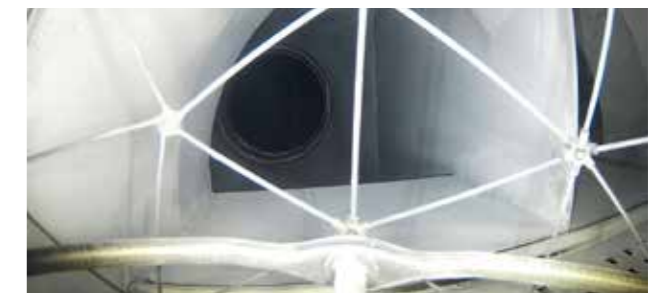
It was only in the mid-1950s that lightweight tubing entered the scene, creating scaffolding as we know it today. Continuous improvement hasn't stopped though; think system scaffolding, think even lighter aluminum tubes. So Stork continues to push the envelope with, e.g. composite scaffolding (Podium Step!), magnetic supports, and specialized tools.

ROPE ACCESS

However, on the whole, scaffolding is still a quite labor-intensive activity, and it isn't surprising that people started to look for radically different alternatives. One of those alternatives is rope access, a technique that also existed for millennia, but only in the 1980s started to be applied industrially on oil & gas platforms in the North Sea (with Stork being a pioneer). While certainly not a replacement for all scaffolding work, it can radically reduce preparation time and the total number of people working at heights. Despite its apparent advantages, it is 'interesting' to see how relatively slow the uptake is onshore.

ROBOTICS

Another radically different alternative is robotics: as you can see in this AIM magazine, these can be flying (drones), crawling (attached via vacuum or magnetic), or swimming (ROV, remotely operated vehicle). These efforts are still quite in its infancy, often because the facility was never designed to be maintained with robots: ladders and platforms, stiffening rings, clearances; none of these were placed with robotic maintenance in mind. Similarly, if you think of rope access: how many pad eyes to facilitate rope access are even installed during initial construction?



Drone recording in a confined space



THE FACILITY OF THE FUTURE

The real promise of robotics (and rope access) lies in the combination of robotics with the facility-of-the-future. With the wave of acquisitions (e.g. Fluor and Stork) in the industry, the race is on. The question now is: which owner company is willing to invest in that facility-of-the-future, where no one is working at heights or in confined spaces? Some owner companies have taken up the challenge.... Exciting times lie ahead!

Take a step back; what we see are 'waves of change':

- First, there was scaffolding, present for millennia and rapidly maturing in the last century;
- Then there was rope access, present for millennia and rapidly maturing in the last decades;
- Now there is robotics, only recently available, but rapidly maturing in recent years.

So if there have been three waves of change - and these waves are ever more rapidly maturing - what will the fourth wave be? Maybe the facility-of-the-future will consist of containerized modules that get stacked on top of each other with quick connectors; and when maintenance is required, the individual containers are decoupled and brought to grade level for maintenance...

... Indeed, exciting times lie ahead!



STORK IMPROVES WELDING OPERATIONS

Certified by The American Society of Mechanical Engineers and The National Board Inspection Code.

For more than 35 years, Stork has been offering services to the oil & gas sector in Colombia, South America, primarily in Construction, Operations and Maintenance. Stork offers welding services for fabrication, rebuilding, maintenance and repair of facilities, components, and mining equipment.

Specifically, Stork provides welding services like piping fabrication (shop and field), installation and maintenance of piping, vessels, equipment and structures, and turnaround maintenance in the Colombia Refineries (Barrancabermeja and Cartagena). Stork has



plenty of experience and expertise with SMAW, GTAW, GMAW, and FCAW welding processes.

Last year, Stork was to manufacture and assemble power boilers (Stamp S), manufacture pressure vessels (Stamp U), and execute metallic repairs and alterations, all at field location.

CONTINUOUS IMPROVEMENT

Despite all of the certifications and recognitions already obtained, Stork worked every day to improve and learn from the execution of our projects. Some months ago, in the welding operations of an Ecopetrol contract in the Barrancabermeja Refinery, we experienced rejection rates higher than 5%.

With the support of Mike Lang, Director of Fluor Construction Welding Services, we defined several actions to improve our KPI and quality indicators. These actions included:

- More training in welding processes, better storage of the filler metal, enhanced Welding Procedure Specifications (WPS) and Welder Performance Qualification (WPQ).
- Quality control inspector certification in Visual Inspection (VT).



- Introduction of best practices from Fluor, such as ID root inspections.
- Flow and leak inspection in shielding gas equipment and hoses.
- Assurance of proper use of portable and stationary ovens.
- Implementation of the first version of Fluor's Welding Manual in Spanish.

As additional measures, Stork implemented stricter guidelines for the monitoring and retraining of welders in the event of rejections, and incorporated TIG flex head torches and gas lenses. Stork also strengthened the requirements for the interpretation of radiographic films.

After implementation of these actions, the rejection rate decreased 4.3% (from 5% to nearly 0.7%). During the implementation, strong collaboration with multiple parties – including QA/QC, supervisors, welders, and staff – was required.

Everyone contributed to achieving the goal. All of these actions have been a great support to our operations in the field, improving Stork's welding processes, indicators, and positioning with clients.



PIPELINE MAINTENANCE IN COLOMBIA

Stork was awarded a 5-year maintenance contract by Ecopetrol's wholly owned subsidiary, Cenit Transportation, and Logistics, in Colombia. Stork will provide maintenance services for Ecopetrol's hydrocarbon transportation network in Colombia.

Stork and Mecanicos Asociados, a Stork company, formed a consortium to provide maintenance services for Ecopetrol's extensive pipeline network in southeastern Colombia which transports liquid hydrocarbons. This contract expands Stork's collaboration with Cenit, which includes maintenance for pump stations throughout Colombia.



THE ROBOT: A FRIEND TO EVERYONE

Need a hand in the warehouse or help with maintenance work? Robots can do it all. From simple tasks to complex undertakings, robots are deployed within Stork to help perform work more safely, easily, and efficiently. For example, we use drones to support us in the inspection of inaccessible sites, employees can safely 'laser clad' with robots, and exoskeletons gives its users extra backing. Those who approach these possibilities with the appropriate amount of respect will find a friend for life in robots.

ROBOTS FOR LASER CLADDING

One great example can be found at Stork Laser Cladding in Rotterdam (NL). Laser cladding is a technique in which a material (a powder) is welded to another material via laser welding. As this process creates a so-called metallic connection, the layer is impossible to release. The technique is applied in order to provide new products with a layer that holds unique properties, for example one that is extremely wear-resistant, corrosion-resistant, or erosion-resistant. For existing products, it creates a solution to compensate for the effects of wear and tear, helping to extend the service life of gearboxes, valves, and shafts, for example.

As laser cladding is only possible with 'heavy lasers' - usually of laser class 4 - manual performance of this work is not permitted. One small misstep could lead to lifelong blindness or other serious injuries.

Since its inception, Stork Laser Cladding has been using three robots. This includes two smaller mobile robots (an ABB and a Fanuc) and one larger, stationary ABB robot. The latter is positioned permanently in a cabin of 12 x 7 m. These robots are not only concerned with safety, but they also have an eye

for quality. There are no cases of the Monday morning blues or "pre-weekend elation". There is always consistently high quality with similar repeat accuracy.

The team is continuing to innovate to maximize the deployability of the robots. The programmers have even surprised the supplier with what is possible. Connections between robots and tools in-house have also been redesigned and manufactured using 3D printing. This has led to savings in weight of 80%, allowing the same robot to work at higher speeds.



The impact that robots are having in professional spheres such as maintenance is growing. On the one hand, this is due to technical developments in areas such as IT, materials science, and production technology. On the other hand, people are becoming increasingly more creative and can do more and more with these programmable machines - because that is truly all they really are!



ONE WITH THE ROBOT

In the laser cladding example, the robot represents a separation between man and process in the name of safety. In the case of the so-called exoskeleton, there is a conscious connection. An exoskeleton is, in fact, a wearable skeleton that supports human movement where necessary. For example, it supports the arms and shoulders when overhead work needs to be carried out for a long time. Or to support back and legs while lifting and when placing heavier loads in a warehouse. Of course, this is not a real robot. It is not a machine, and it functions primarily based on the use of mechanical springs rather than software. Nevertheless, it does feel a bit as if it were a robot, as specific movements seem to run automatically.

Stork is currently testing the Suit-X exoskeleton in the Netherlands and in the USA. This exoskeleton is a modular solution whereby the user can choose which parts of the body are to be supported, such as the shoulders, back, or legs. The suit has been tested out by a number of different people at various locations. And it has been well-received. Within under a minute of slipping into the suit, even the most skeptical of employees were convinced of its added value. They were able to work more safely and efficiently with a lower risk of injury. And it certainly applies to those who already suffer from a range of physical issues. These positive reactions were also expressed by the subcontractors who tested out the suit on a special subcontractor day. They were impressed by the ergonomic benefits for both the user as well as for the employer, which would reduce absenteeism and related costs.

NO LIMITS FOR DRONES

Safe working conditions is certainly one good reason to use drones in inspection work. Not only when conducting periodic inspections in hard-to-reach or dangerous locations, but especially when troubleshooting under essential time constraints. With drones, the many hours of preparation required to build scaffolding can be eliminated, and there is no need to send qualified people, equipment, and materials out on a risky mission. A drone only requires a qualified pilot and, if flown outside, good weather conditions.

Stork often uses drones for indoor and confined-space applications. For example, to inspect a bent pipeline, a duct, boiler, tank, or silo. Extending the eyes with real-time camera images, the pilot directs the drone through the confined spaces, searching for defects.

All the while the drone documents everything via video, which can be turned into 3D-models.



Ball drone in confined space

COOPERHEAT: INNOVATORS IN THERMAL TECHNOLOGY SINCE 1958

**HEAT TREATMENT DESIGN | CONSULTANCY
ONSITE SERVICES | PROJECT MANAGEMENT
EQUIPMENT RENTAL | MANUFACTURING OF BESPOKE
FURNACES AND OVENS | TRAINING**

The heat treatment of metal has been practiced in many forms for centuries. Initially, heat treatment was used to enhance the properties of raw iron for tools and weapons. The process produced an excellent combination of toughness and flexibility in blades. In addition, it could provide a very hard cutting edge using the most basic of forges, if operated by highly experienced craftsmen.

Today, heat treatment is a method of altering the physical and sometimes chemical properties of a metal. Essentially it can be defined as the controlled heating and cooling of a metal or metal alloy, in its solid-state, to produce certain changes in its properties. Heat treatment is generally designed to result in the metal being free from harmful, unevenly distributed internal stresses, while leaving it hard and tough enough to be serviceable. It removes the external brittle microstructures that follow quenching and restores toughness and ductility, depending on the temperatures and durations applied.

LONG STANDING, RICH HERITAGE

Much like the heat treatment method itself, Cooperheat has stood the test of time. Established in 1958, the Cooperheat service and product offering quickly became known within the industry as the 'go to' leading expert in thermal technology. Decades on, Cooperheat's reputation and portfolio continued to expand with Stork acquiring the company in 1999. Henceforth, Cooperheat was branded as Stork and it continued thriving on an international scale

being in demand by many different sectors; from oil and gas, nuclear, chemical, and power, to heavy fabrication and automotive industries.

COOPERHEAT HAS EVOLVED

The Cooperheat brand has evolved over the years as an integral part of Stork, however its historical identity continues to resonate with its clients, providing the reassurance that they are in safe, capable hands.

For this reason, the next generation of Stork's heat treatment business line will be reinvigorated through the reintroduction of the Cooperheat name throughout our global operations. It will be business as normal, under the refreshed banner of Cooperheat.

THE HOME OF HEAT TREATMENT

Cooperheat's experienced team of designers and engineers are dedicated to solving thermal technology challenges anywhere in the world; whether it be through its unique product designs, the manufacturing of bespoke ovens and furnaces or onsite services and project management. Its experts work to the highest standards of quality and technology to ensure that problems are solved and challenges overcome safely and cost-effectively.

Visit the online Cooperheat Equipment Shop to receive your tailored quotation and to contact its technical experts:

www.stork.com/Cooperheat.

*Stork offers its full range of Cooperheat branded products to all international markets with the exception of the USA, for which the products offered are specifically Stork branded. Both the Cooperheat and Stork branded products are identical in all respects other than the naming plates (if fitted) and this is purely a compliance and regulatory requirement. Please engage with your local Stork contact if you have any specific queries regarding this.



ADDRESSING ECOPETROL'S NEEDS IN COLOMBIA

Since 2007, Stork has been providing pipeline maintenance services to Ecopetrol, the largest and primary petroleum company in Colombia. Recently, Stork extended its current pipeline maintenance contract with Cenit, the transport and logistics subsidiary of Ecopetrol by 60 months. Additionally, Stork obtained a 42-month station maintenance contract. Stork will expand to four new cities in Colombia, and added several new services that specifically address Ecopetrol/Cenit's needs.

Along with the new departments of Antioquia, Caldas, Risaralda, and Valle del Cauca, Stork addressed Cenit's request for the application of technologies that would aid in efficiency improvement, cost reduction, increased safety, and enhanced productivity for the client.

A CLEAR ADDED VALUE

Through teamwork and collaboration, Stork Colombia was able to offer the client services that specifically address its core needs. The value Stork can add comes directly from experience, expertise, and access to resources.

Stork is currently running more than 35 projects in Colombia alone, which makes us experts in the region and knowledgeable about the region's specific needs and challenges. Our presence throughout the country means that a Stork expert is never far away, and so can directly address the client's needs in person.

Through support and expertise from the global Group office, in Colombia, Stork can enhance its knowledge with solutions and services from other Stork operations, thereby leveraging the power of Stork's global reach to address local challenges.

Lastly, and perhaps most importantly, Stork has a strong local presence in Colombia, and a history of working closely with

communities and stakeholders to achieve ideal solutions with minimal disruption. Through Community Management programs and the use of local suppliers, Stork ensures that as many Colombians as possible benefit from our presence there.





STORK AND SAFERAD

Cooperheat, a Stork brand, offers SafeRad RT services in Saudi Arabia to all the major owner entities in the region.

SafeRad is an innovative system that offers a world-leading close-proximity radiography solution. This patented system from SafeRad UK dramatically reduces the evacuation zones needed for traditional IR192 isotope-based radiography. This allows continued activity by the other maintenance and construction teams on the same project.

Several Stork inspection crews are working in the same project area, without having to evacuate all other site personnel at, amongst others, the following projects:

- Saudi Aramco Jizan Project.
- The Fadhili Gas Plant Sulphur Recovery Facility Project.



WHY SAFERAD RADIOGRAPHY?

The SafeRad system effectively avoids evacuation of other working personnel in the project area. While a traditional evacuation area had a diameter of 50-200 meters (165-656 feet), the SafeRad evacuation zone can be as little as 2 meters (6.5 feet).

This drastically reduces the need to perform RT at night, or allocate time windows for RT. Both of these cases require the evacuation of all other working personnel from the site, which results in a massive loss in work hours. With SafeRad, evacuations are minimal, and more RT crews can work within the same area – thereby increasing production. At the same time, other site personnel can also continue with their work, resulting in no loss of work hours.

BENEFITS

- Saferad is safer for the radiographers in confined spaces/elevated locations like platforms, where they are forced to stay nearer to the radioactive source. Using SafeRad they get reduced dosages.
- As the control area diameter is very small, it can be easily monitored – preventing accidental exposure to those who inadvertently cross into it.
- More RT crews can be used within the same work site location – resulting in higher production.
- Prevents full site evacuation – resulting in high workforce utilization and no loss of man-hours.

* Radiographic Testing (RT) is a nondestructive examination (NDE) technique that involves the use of either x-rays or gamma rays to detect flaws in welds.

iFACTOR INNOVATION IN PRACTICE



To be a leader in the industry – Be the Industry Reference! – innovation is key. Innovations allow Stork to deliver unique solutions that save on costs and improve customer performance. There are three central areas of innovation initiatives within Stork: Digitalization, Robotics, and Sustainability.

DIGITALIZATION	ROBOTICS	SUSTAINABILITY
Examples include the use of data from assets for predictive maintenance or the use of apps for streamlining work.	The use of robots for carrying out inspections and for being able to work without scaffolding or in a confined space.	This could translate into reducing CO ₂ emissions and energy consumption, but also into relieving heavy workloads for the benefit of sustainable employability of workers.

In addition to central innovation, knowledge sharing between the Stork regions and companies, and creating innovations together with chain partners, innovation in practice is also an important pillar. To stimulate innovation, Stork conceived the “iFactor” innovation competition in the Regional Business Line Europe. With ‘iFactor’ we are looking for the best innovative ideas from practical experience.

50 entries were submitted for the first edition of iFactor. A jury of experts selected 3 winners from the entries; one in each of the three categories:

- **Digitalization:** Wim Kluitier - Advanced 3D scanning.
- **Robotics:** Multidisciplinary Drone community - Drone roadmap 2020.

- **Sustainability:** Sebastiaan Niessen and Quinten Hoven - Emission reduction with flange management.

Those who submitted these winning ideas will work together as a team to further develop the concepts and ultimately implement them. This will help ensure that the innovations remain grounded in practice. The specific applications will remain confidential for the time being, but we will soon be actively using them to impress our customers.

And at the end of this year, a new edition of the iFactor will hopefully kick start even more promising ideas.



FIRST FEMALE NORTH SEA SCAFFOLDER GOES OFFSHORE WITH STORK

In the offshore Oil & Gas sector, demographics typically paint a picture of gender imbalance, particularly in disciplines like scaffolding. One of Stork's newest scaffolding recruits, Vicky Welch, is proud to lead the way as the first female scaffolder in the North Sea. Vicky shares her thoughts and experience.

Vicky, age 29, is one of six qualified female scaffolders in the UK. She started her career in the onshore scaffolding industry in 2009 as an apprentice in the North East. The apprenticeship came about by chance after Vicky was offered a couple of days' work on a construction site. Less than 2 years later, Vicky became qualified in system scaffolding. Vicky enjoyed the job but, after a few years on the tools, she moved into roles that were more corporate and office-based. She completed a BTEC Level 3 in Construction and a Built Environment qualification while undertaking a trainee Quality Services role. While Vicky enjoyed successes in these roles, she came to realize she preferred a more 'hands on' position and a different career path. So she returned to the tools, working with tube and fittings in London.

GOING OFFSHORE

Never one to shy away from a challenge, and with 10 years' experience in the construction industry, fully qualified Part 2 scaffolder Vicky saw the demand for scaffolding skills in the offshore Oil & Gas industry. As the working environment on an offshore installation poses different hazards than the construction sector, Vicky had to undertake her Basic Offshore Safety Induction and Emergency Training (BOSIET) and Minimum Industry Safety Training (MIST). At first, Vicky was apprehensive about the helicopter escape and sea survival components of the training course, given her fear of being submerged in water. The task required her to use every bit of her resilience and mental stamina.

Vicky commented: "Although I was fearful of the water elements of the training, I understood how important the training was and knew it would be worthwhile since it would keep me safe offshore. I actually enjoyed the course in the end and successfully passed all mandatory training in early 2019. If training is the only obstacle, I would encourage anyone to just go for it; it's all about mind over matter."

JOINING THE MIX

With all the relevant certification and offshore training, Stork was delighted to welcome Vicky as our first female scaffolder, setting a new precedent for other females to follow. Vicky has now completed her first trip offshore on CNOOC International's Scott platform and has already been mobilized on her next scope to the company's Buzzard asset.

Vicky explained her thoughts on her first trip: "I was nervous as to how I would be accepted in the offshore environment. I worried that people might change their behavior around me. As the only female scaffolder offshore, I knew people might be intrigued about my skills and experience, but I am no different than any other scaffolder. Nobody I worked with made my gender an issue. I proved I am capable of carrying out the job, so they treated me the same as every other scaffolder on board. You will always have people with more

technical knowledge, others with more physical strength, but the industry itself is a mix of different people, and I just felt like part of the mix, regardless of my gender."

BREAKING BARRIERS

While on her first trip offshore, Vicky was pleased and encouraged to encounter other females on board, undertaking such roles as geologists, chemists, and stewardesses. The offshore industry is changing, and Vicky is an excellent example that gender does not dictate position.

Going forward, Vicky is passionate about obtaining and developing knowledge of the offshore assets that she visits and how each component works. As scaffolders often work so close to all the main equipment offshore, she would like to learn more about the working environment, so that she can easily identify hazards or issues that may occur. Safety is very important to Vicky, and her goal is to become a Safety Representative offshore and focus on mental health first aid. She wants to encourage an open-door policy for counseling, and create a platform for supporting her offshore colleagues with health issues. Those issues are typically challenging to address, especially for the younger generation. She hopes to break down barriers and address the stigma associated with mental health issues.

Vicky truly believes gender is irrelevant, and that it is about the right person for the job: "I would only recommend a male or female to join the offshore industry if they are the right type of person. You have to be used to working in a harsh environment where the weather can change quickly and you can be working in confined and restricted spaces. The job is demanding but very rewarding, and I would encourage anyone right for the job to choose a career in scaffolding offshore."



ADDRESSING AN AGE-OLD INDUSTRY CHALLENGE

Maintenance of offshore facilities, specifically surface preparation and coatings repair, remains integral to safe and sustainable operations. But in times of lower oil prices maintenance is often discounted on offshore installations. Many major Oil & Gas operators with aging assets are pressured to maintain production levels, reduce costs and stall non-essential maintenance. Delays to maintenance work provide immediate relief, but can seriously affect the long-term integrity of equipment, levels of production, and the safety of the personnel on board. But Robotics can also offer a solution here

AN AGE-OLD CHALLENGE

Offshore assets face some of the harshest weather conditions, which are extremely destructive to their protective coatings. Large portions of the exposed surfaces on an offshore asset are made from carbon steel. Therefore, they are highly vulnerable to corrosion. This costs the global Oil & Gas industry an estimated \$1.372 billion per year (Source - NACE International website). The corrosive nature of the material, combined with the harsh environment, limited access, and safety challenges of surface preparation and repairs, makes for challenging operations.

Operators are now recognizing that many of their assets are working beyond their expected life span, and see the benefits of effectively maintaining them. Maintenance plans involving innovative, best-in-class preservation activities can keep their assets operating for longer. This results in the highest yield from the deployment of safe, multi-disciplined personnel and state-of-the-art equipment.

A NEW-AGE SOLUTION

With this in mind, Stork continues to monitor the market for innovative surface preparation products and methods to ensure we are at the forefront of emerging technology. This not only exceeds our clients' aging asset requirements but also improves the safety of our people. What's more, it minimizes the environmental impact and enables Stork to remain competitive in a low oil price market.

The Spiderjet® 3000 robotic surface preparation system, designed by Hammelmann, is one such innovative product. It offers a safer and more efficient alternative to traditional hand jetting methods and forms part of our comprehensive range

of jetting equipment for the maintenance and repairs of an asset.

Spiderjet® 3000 provides precise and efficient stripping of vertical, inclined and horizontal surfaces using ultra-high-pressure water, making it ideal for storage tank maintenance projects, helidecks, large deck areas, laydown areas, and bulkheads.

The system attaches to the work surface by vacuum, which also contains the removed waste material and wastewater. It is remotely operated and offers maximum maneuverability via two individually, pneumatically driven wheels. This enables the jetting system to complete projects vertically and horizontally, on flat and curved surfaces. It can also be operated overhead and can remove existing coatings at a rate of up to 70m²/hr (753ft²/hr).

IN PRACTICE

Work scope: Stork's Environmental and Decontamination division was tasked with the completion of coatings removal, surface preparation, and a full recoat of wellhead jacket decks and supports. The work scope was to be completed within a limited timeframe (21 days), on a North Sea installation. The area of work, measured at 925m² (9,957ft²), would have traditionally required conventional open-nozzle blasting and deck scrubbing to remove the extensive corrosion scale and defective deck coatings before the application of a remedial coating.

Solution: Stork suggested to use the the Spiderjet® 3000 for most of the work. After liaising with the client, a demonstration of the Spiderjet® 3000 was conducted at Stork's facilities. This

provided the client with the confidence that the tool was fit for purpose and capable of completing the work scope within the desired 21-day timeframe.

RESULTS & BENEFITS

The system offered a safer and more efficient alternative to traditional hand jetting methods with reduced scaffolding, sheeting and containment requirements and increased removal rates. The Spiderjet® 3000 technology offers many efficiency benefits such as:

- Removes areas of corrosion efficiently; blasting speed twice as fast than conventional methods.
- Eliminates encapsulation required.
- Minimizes waste direct to containers.
- Eliminates fire and gas inhibition requirements.
- Reduces personnel on board and flight seating requirements.
- Eliminates the need to clean up spent abrasive, scale, or coatings.
- Does not require flogging of the decks prior to blasting operations.
- Does not require wash down prior to surface preparation.
- Offers uninterrupted working in harsh weather conditions.
- Provides Ultra-High Pressure (UHP) heating of the steel prior to coating application.

HSE BENEFITS

- No dust.
- No hand and arm vibration recording required (HAVS).
- Very little noise; no requirement for double hearing protection.
- Reduced barrier requirements, which increases simultaneous working operations.
- No blast suit, blasting gauntlets or blast hood requirements.
- Minimizes the need to build scaffold or use rope access on a vertical slope.

With these combined benefits, the Spiderjet® 3000 reduced manpower efforts by 52% and delivered a 40% cost saving. The Spiderjet's surface preparation capabilities combined with Stork's multi-skilled technicians form a formidable solution to address age-old challenges in a new and better way.

STORK MOBILE LABORATORY: FIRST IN COLOMBIA WITH ONAC ACCREDITATION

At Stork, we work every day for the continuous improvement of our value offer. The National Accreditation Organization (ONAC) extended the accreditation for our Mobile Calibration Laboratory, becoming the first accredited laboratory of its type in the country.

WHY IS THIS ACCREDITATION IMPORTANT?

The laboratory began as an HSEQ initiative more than 10 years ago, consolidated now as a new business that provides a comprehensive outsourcing service, managing the metrological assurance of our clients. The integrity and performance of the assets of our clients rely on accurate calibration and validation of their measuring and metering equipment.

HOW DO WE ADD VALUE?

Our calibration business line allows us to guarantee that our customers reach the highest quality in their safety processes as we will enable them to operate with totally reliable equipment.

Our technical staff is highly qualified to offer a flexible approach and a wide range of tools and equipment, ready to maintain our client production facilities and measuring principles at any required level. And with supplier-independent process reliability.



STORK AND ECOPETROL TEST NEW TECHNOLOGY

REMOVING ASPHALTENES FROM OIL WITH ECODESF®

Ecopetrol S.A. and Stork signed a Special Cooperation Agreement on Science and Technology. The agreement was made to carry out the scaling test of the ECODESF® crude asphalt removal technology. Ecopetrol S.A, Colombia's state oil company, selected Stork as a strategic partner after an internal evaluation based on multiple criteria.

These criteria included extensive experience in integrated operation and maintenance services in the Oil & Gas sector, operation of petrochemical process plants or oil fields, refinery turnarounds, and presence in the area of influence of the project.

REDUCING VISCOSITY

The ECODESF® technology was developed at the Colombian Petroleum Institute (ICP). It allows a reduction in viscosity of heavy and extra-heavy oils (called 'oil upgrading'). Removing asphaltenes from the oil facilitates its transport through oil pipelines and decreases the use of diluents, such as naphtha. Laboratory tests obtained satisfactory results, and after a pilot test, ECODESF® technology was deployed on an operation plant at the ICP facilities.

KEY PARTNERSHIPS

Stork performed most of the activities executed in this project, working very closely with Ecopetrol S.A.

The activities include:

- Plant operation and experimental test implementation, using both primary and secondary variables in critical and complementary equipment.
- Laboratory work, including the analysis of samples which characterize the process.
- Operational and engineering intervention that allows the correct and adequate operation of the plant.

The application of science and technology allows Stork to go beyond current knowledge barriers, permitting us to solve various identified problems and challenges more efficiently every day.

Our challenge is always to find a better and more efficient solution to keep our clients' assets safe and running, allowing them to work in the most efficient and innovative way.



APPIFICATION

WITH APPS MORE EFFICIENT, FASTER, AND WITH ADDED TRANSPARENCY

'Apps' are not only used for private purposes. Digital applications also improve the efficiency, transparency, and predictability of work activities for projects, maintenance, turnarounds, and internal processes. A few practical examples include ...

PRINCE

Easier work package compiling, improved project documentation viewing, and faster (real-time) insight into the progress of a turnaround (TA) or project. These are a few of the essential benefits of the app that is linked with Prince, work preparation and the planning system for TAs, pre-fab, and projects. For example, when planning work in the field, a work planner can add photos and observations to the work packages instantly. During a TA, the individual performing the work can report progress in real-time, can take pictures of the welding work for QA/QC, or immediately report any issues during work operations. This could include damaged flange surfaces or missing gaskets. Work preparation would then receive an instant notification, allowing them to quickly take any action deemed necessary, for example, adjusting the schedule or ordering any missing materials.

REGULAR MAINTENANCE WORK

At the Delfzijl Chemical Park, an app is used for the regular maintenance work performed at client locations during activities for inspections and lubrication work. This allows inspections to be performed much faster, requiring much less paperwork and all of the information is recorded instantly.

The app saves the engineers a lot of time on written documentation; an attached photo says much more than a thousand words. Of course, all of this is done using special explosion-proof ATEX-certified tablets or telephones.

HANDS-ON-TOOL-TIME

Working more effectively with the people you already have is an important topic, partly due to the shortage of well-trained technical personnel. A higher Hands-on-Tool-Time (HoTT) ensures that the deployment of available technical staff is optimized as much as possible. Our HoTT-app enables data accumulation of the activities on site. These numbers can be benchmarked and recommendations can be made on possible improvements.

These are just a few examples of how apps are being used by our clients and for the benefit of our clients. And we are not the only enthusiastic fans of this higher work efficiency and effectiveness - our clients' users, such as TAQA, Borealis and OneGas, are also in full support.

For more information; view videos and articles on our website: www.stork.com/en/solutions.



ORDER FOR OFFSHORE WIND FARM IN DENMARK



An EQIN team recently traveled to Esbjerg in Denmark to deliver and install equipment on board the Brave Tern and the Blue Tern (formerly Seafox 5). Both ships are used for the offshore installation of wind turbines for the new Hohe See wind farm in the North Sea. The supply of EQIN equipment in Esbjerg is now also in full swing.

The team was on board the Brave Tern for two weeks to install cables, cable ducts and distribution boxes. The power supply was already on board. On board the Blue Tern, the power supply has been installed with three remote readable 150 kVA generators in load sharing, distribution boxes, transformers and 270 meters of cable ducting.

Initially, it was the intention that most of the work would take place when the two ships were alternately docked in Eemshaven. But the EQIN-team and all equipment were hastily transported to Esbjerg, due to changes in the planning of the client, Fred. Olsen Windcarrier.



NICE COMPLIMENT FROM AN ENTHUSIASTIC CLIENT

A client in Rotterdam Botlek has given the EQIN team a wonderful compliment for its performance during a major Turnaround. Together with eight other contractors, EQIN was voted best contractor in the field of safety, quality, efficiency and cooperation.

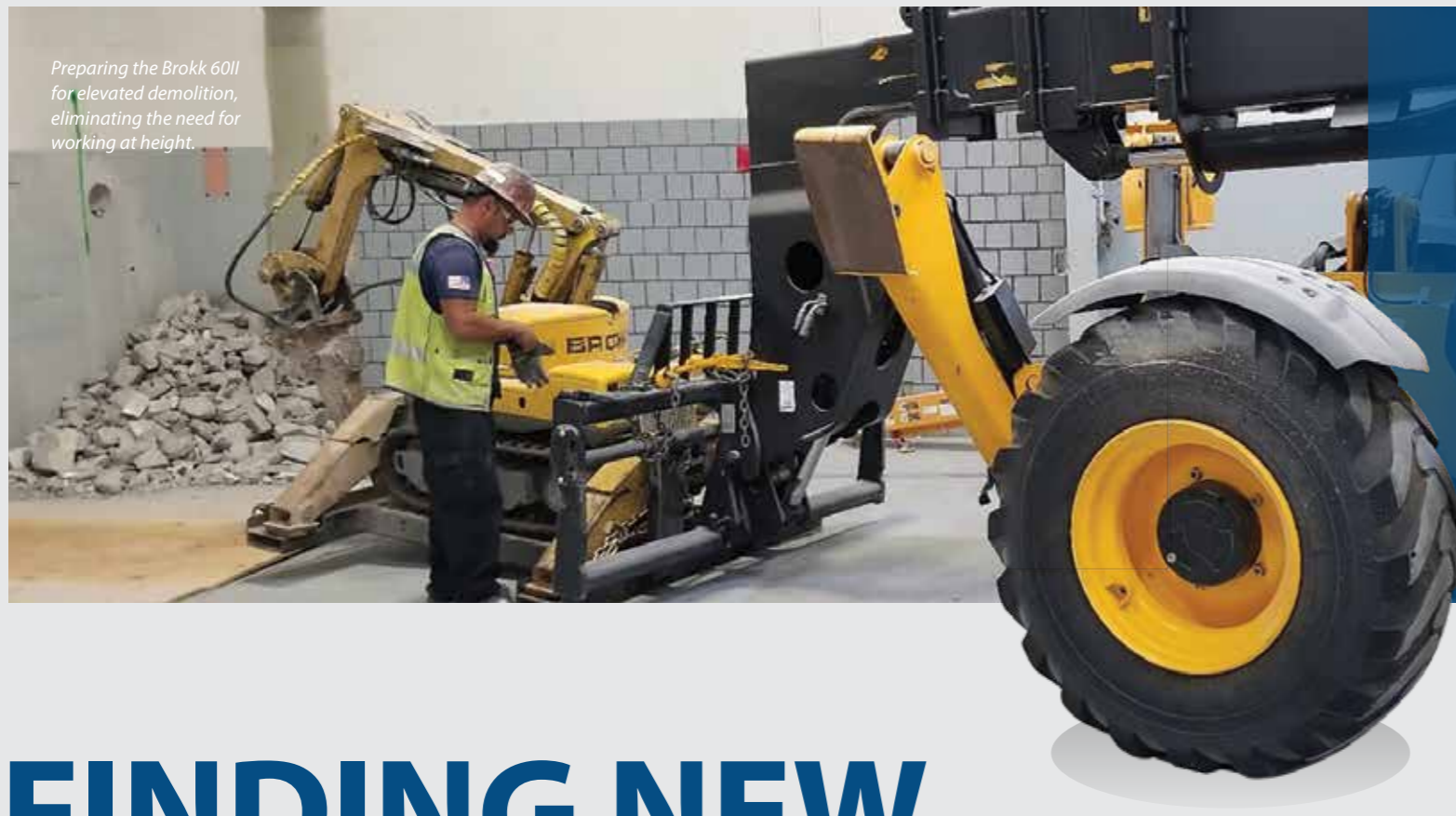


To reach its verdict, the client listed the performance of all the contractors involved in the Turnaround and selected the best ones.

A delegation from the team was present to receive the award. The EQIN team, which has previously already won 8 silver and 3 gold awards for its safety performance during the Turnaround, received an A-award from the client.



Preparing the Brokk 60II for elevated demolition, eliminating the need for working at height.



CHALLENGE

Safe demolition of a 40-foot by 70-foot brick wall within 10 feet of client operating lines

SOLUTION

Utilization of the Brokk 60II remote-controlled demolition machine

BENEFITS

- Provided a safer approach and remote operation
- Reduced labor compared to manual demolition
- Shortened total demolition time
- Eliminated double handling of waste materials

SAVINGS

- Saved the client an estimated \$25,000 in construction labor and equipment rental

FINDING NEW WAYS TO TEAR DOWN OLD WALLS

How a robot provided a safe, efficient solution to wall demolition.

In the course of providing O&M and construction work at Procter & Gamble's (P&G) consumer product goods manufacturing facility in Oxnard, California, the Stork North America team was responsible for the demolition of a 40-foot high, 70-foot wide block wall that came within 10 feet of a P&G operating line. The usual course of action would be to manually demolish the wall by engaging teams of workers operating rented scissor lifts and breaking through the wall with hand-held jackhammers. This scenario presented multiple safety risks, such as working at height for long periods, physical fatigue from extensive hammering, and flying/falling cement debris close to the workers. In addition to the increased safety risks, the manual demolition would be labor-intensive, with at least two to three operators per scissor lift and ground watch. The team and site manager,

Marc Borbas, began to wonder - Is there a better way to perform the demolition?

BETTER SOLUTIONS

The Stork team searched for a way to provide a safer, more efficient demolition at the P&G facility. After careful research and planning, the team discovered the Brokk 60II remote-controlled demolition machine. It quickly became apparent that by subcontracting the use of this robot, the client would see substantial savings in labor and equipment rental as compared to typical manual demolition. And - most significantly - the robot removed the risk of operators and workers working at heights near hazardous flying debris. What initially would have been a labor-intensive scenario with numerous safety implications became an example of how

robots can be effectively used to innovatively save money for clients and decrease risks for all those involved. A licensed, authorized operator controlled the Brokk 60II, while adequately secured and bound to lifting equipment per manufacturer's specifications. The subcontractor's safety personnel oversaw all the operations. The Stork team performed job safety analyses (JSAs), the work method was authorized, and the demolition frequently monitored and audited. Instead of the multi-worker crews, the scope was limited to the robot operator and one worker who handled the silica dust mitigation, along with respective safety personnel. The demolition was completed in two days with the Brokk, as opposed to more than a week with a traditional demolition crew.

// *We are constantly looking at ways to improve our construction processes. This innovative approach to use the Brokk 60II machine allowed us to perform the work more safely and efficiently. The result was a win-win - benefitting our customer as well as protecting our workforce.* //

Marc Borbas Stork Site Manager

P&G Manufacturing Facility, Oxnard, California

SIGNIFICANT SAVINGS

By continually asking if there are better ways to perform tasks, the Stork team saved the client an estimated \$25,000 in labor and equipment rentals, and significantly reduced the duration and impact of the demolition. Finding ways to innovate often means coming together to brainstorm and ask questions, looking inside and outside of the organization for solutions, tailoring the solutions to overcome site-specific challenges, and then sharing successes so others can benefit from the experience. The Stork team will continue to look for ways to apply the Brokk 60II to future demolitions, as well as continually rethink how they perform their tasks - is there a better way?



The Brokk 60II demolishing the wall under the direction of a remote operator, keeping workers away from flying and falling debris.

A GOLDEN AGE FOR HARD WORKERS

Situated in the high mountains of Papua (Indonesia) is the Grasberg gold and copper mine. To ensure the mine stays operational, Stork manages and maintains the power plant that supplies its energy. This includes a coal-fired power station that produces electrical energy about 100 km away and transports it via high-voltage power lines to the mine high in the mountains. About 50 diesel generators are also in place as backup.

CHALLENGING ENVIRONMENT

Maintaining a reliable energy supply demands the utmost from the five permanently stationed expats and the more than 100 local employees. First of all, they have to deal with extreme climatic conditions. A lot of rain can fall on the Indonesian island in a very short time, which can cause the soil and equipment to easily wash away. The local conditions also place a heavy burden on all devices and machines; everything is dirty, full of dust, and subject to wear and tear.

CONDITION-BASED MAINTENANCE

Despite the challenges, the employees of the power plant manage to meet the - sometimes sharply fluctuating - demand for energy with incredible reliability. An important role in this lies in carrying out daily maintenance and accurately planning the annual shutdown for major maintenance. By working on the basis of an in-house developed condition-based maintenance concept called 'Wharf to Wire', this is done at the lowest possible cost.

Furthermore, Stork is currently involved in the expansion of the energy supply that is linked to a planned expansion of the mine. A strong move by the project team. This means that future maintenance is directly taken into account in the engineering process, which positively influences the Total Cost of Ownership (TCO). The knowledge and experience of people who have been working on site for years are worth their weight in gold.



WHARF-TO-WIRE METHOD

Stork's in-house developed 'Wharf-to-Wire' method is used to map the current condition and performance of an installation. The method is specifically intended for assets for which relatively little information is available, for example because it concerns older equipment that Stork has to work with when starting a project in a new location. It is also used to analyze the more straightforward installations where no (online) monitoring is applied and therefore no data is available digitally.

Having this type of data is important in order to properly plan the long-term maintenance. This, in turn, is key in guaranteeing the availability, reliability, safety, and productivity of the installations. Good planning means more than the ability to control costs.

WHARF-TO-WIRE WORKSHOP

In order to identify missing data, so-called 'Wharf-to-Wire' workshops are organized periodically. Participants include operators, maintenance engineers and supervisors, as well as plant managers and other experts who know more about a specific installation (or parts thereof). During the workshop they share all knowledge and experience about the condition and performance of a specific installation. Permanent

operators, for example, know that exceeding a certain pressure causes problems and, for reasons of caution, stay below that threshold. Maintenance people indicate that specific bearings need to be replaced every three months.

Every characteristic of the installation that is determined on the basis of these observations is then analyzed. It is then determined what the impact of this is on, for example, the safety for people, machines, and the environment, the customers themselves, and financial matters. This creates a so-called 'risk overview'. On the basis of this overview, a plan is drawn up with measures with regard to maintenance, modification or replacement. For example, it may not be necessary to replace the bearings every three months when the machine is re-aligned. Or a pressure limiter may need to be installed to prevent problems when another operator is hired.

By organizing the workshops periodically and using checklists, there is little chance that issues will be overlooked. The method has therefore been successfully in use for some time now. All the more reason for Stork to further develop and automate this method within the framework of user-friendliness.



REFURBISHMENT PROJECT AT BIOMCN

“ACTUALLY, THERE ARE TWELVE SHUTDOWNS AT THE SAME TIME”

In the northernmost tip of the Netherlands, you will find the company BioMCN. In 2006, BioMCN acquired two methanol plants (not in operation) from AkzoNobel. Because of the unfavorable methanol price at the time, it was decided to keep one factory open - the M1 - and leave the other for what it was. After 12 years of stagnation, the market for methanol picked up, and it became profitable to invest in the M2 plant, which dates back to the 1970s. Stork was contracted to take on this massive refurbishment project, in which a short lead time suddenly became essential. A lead time that was met. Within 2 years, the factory was successfully started up again.

The refurbishment project allowed Stork to present itself across the full spectrum. Practically all disciplines have played some part in the project, which started with a thorough preparation, followed by inspecting, replacing, repairing, overhauling, and upgrading all relevant assets. Also, many activities have been assigned to so-called projects. Stork Thermeq, for example, looked into issues with the old reactor. It was showing a lot of cracking but, with a great sense of passion and expertise, has been rebuilt into a modern, safe and productive main component of the factory. Departments such as Mechanical, E&I, Valves, Rotating, Turbo Services, and EQIN have also used their knowledge and experience in cooperation with many - mainly local - subcontractors.

In terms of contractors, Mammoet (cranes, transportation), BIS (scaffolding, coating), and GFI (insulation work) were key partners.

CORROSION UNDERNEATH INSULATION

On the whole, the project went according to plan. In 2017, a feasibility study was started, which resulted in a budget indication. This was approved in August of the same year and paved the way for the detailed mapping of all activities. A setback was the pipework. The hours that had been budgeted turned out to be far too short because corrosion had formed in many more places underneath the insulation that had previously been estimated. This meant that the scope of the project had to be extended by about 4 months due to the many extra pipes that needed replacing.

2500 I/Os

But that was the only hold-up, and the schedule was closely followed. In the end, more than 1.8 million work hours were invested, with over 800 people working at the height of the project. Just let the corresponding numbers speak for themselves, like 12,500 welds, 25 miles of cabling, 2500 I/Os, and more than 15 miles of pipeline.

Furthermore, with the help of the Flange Management System, all flanges were removed, labeled, made asbestos-free, mounted, and checked for leak-tightness. In addition to replacement and repair, significant work has also been done to ensure that the installations comply with current legislation and regulations. For example, all kinds of controls and certainties have been built in to guarantee safety for people, machines, and the environment. As a result, mechanical, electrical, and control engineering specialists consistently worked intensively together.

SAFETY

And all this without any noteworthy safety incidents. We can't deny that there have been cases where employees got a cut or a near miss, but Stork's safety policy has also been extremely fruitful in this project. Unsafe working is not an option. Neither for the company's own people nor for the (sub)contractors.

EXITING PROJECT

The plant is now in full operation and produces green methanol based on green gas. The project team can look back with satisfaction at an exciting and challenging project that no one would have wanted to miss. It's exciting because refurbishment projects are different from new construction or maintenance. After all, the scope is not entirely clear in advance, and many unexpected issues needed to be taken into account. But when the atmosphere in the team remains good, and people keep communicating openly and honestly, it will always be 'fun and exciting', and the project books can be closed with a good feeling.



Jan Lowies, Refurbish Manager BioMCN

SAFETY – FIRST PRIORITY

Regardless of the time pressure being so high with this type of projects, the targeted end date will never take precedence over working safely at Stork. Safety is a core value, and everyone fully comprehends this both our own people as well as all subcontractors. In addition to the fact that all employees are adequately trained and educated for their specific task, there is also a positive safety culture. This includes performing regular work inspection rounds, encouraging people to call each other to account for unsafe behavior, and ensuring that communication is given the highest priority. Toolbox meetings are also organized regularly to emphasize specific safety topics

Jan Lowies is Refurbishment manager of BioMCN:

“Only when you deal with safety as effectively as Stork can you manage to achieve one and a half million man-hours and 52 sub-projects without any major accidents. Unsafe working is not an option. Three to four people work full time on safety every day. Moreover, Hazop studies were carried out in advance, as well as risk analyses of the plant, and so on. The various projects are based on these analyses, which once again demonstrates that safety is given the utmost attention across the board. Not only for our own people during the execution of the project, but also for the people who are currently working in the plant.”

“Working unsafely is simply not an option”

GENERATION ROBOTICS 2.0 A NEW WAVE OF TECHNOLOGY

This year, Stork hosted an interactive morning at its Kwinana Operations facility, in Western Australia. The session featured demonstrations of the latest Remote Digital Video Inspection (RDVI) technology. Jason De Silveira, founder of Nexxis (a technology partner of Stork), delivered a presentation on the impact of constant and rapid advancements in this technology. In particular, the area of RDVI and Non-Destructive Testing (NDT). Jason compared how technology was used in the past and present to the impact of imminent and long-term future developments.

TANGIBLE SUCCESS

The presentation was followed by a hands-on demonstration session, in which the clients were able to get their hands on the equipment in an interactive environment and ask questions about the suitability of the many examples of robotic inspection-gear on display.

The demonstration day was well attended by Stork's clients, including Tier 1 asset owners in the Oil & Gas, Power, Mining, Industrial Chemical sectors, along with clients in the construction and engineering space. Positive feedback about the session has been pouring in, and so Stork aims to host similar sessions on a regular basis moving forwards. With strong and close partnerships with companies like Nexxis, Stork aims to



become the Industry Reference, every day, everywhere in robotic inspection technologies, and continue to push towards 'Generation Robotics 2.0'. You can find more information on Stork's Remote Digital Visual Inspection capabilities on www.stork.com.

UGANDAN DELEGATION VISITS WASTE-TO-ENERGY PLANT

A delegation from MBale, Uganda, visited Stork Thermeq (NL) and the Waste-to-Energy plant of waste processor Twence. The Ugandan city is struggling with a major waste problem, but it aims to make MBale the cleanest city in Uganda; a Waste-to-Energy installation can make a major contribution to this.

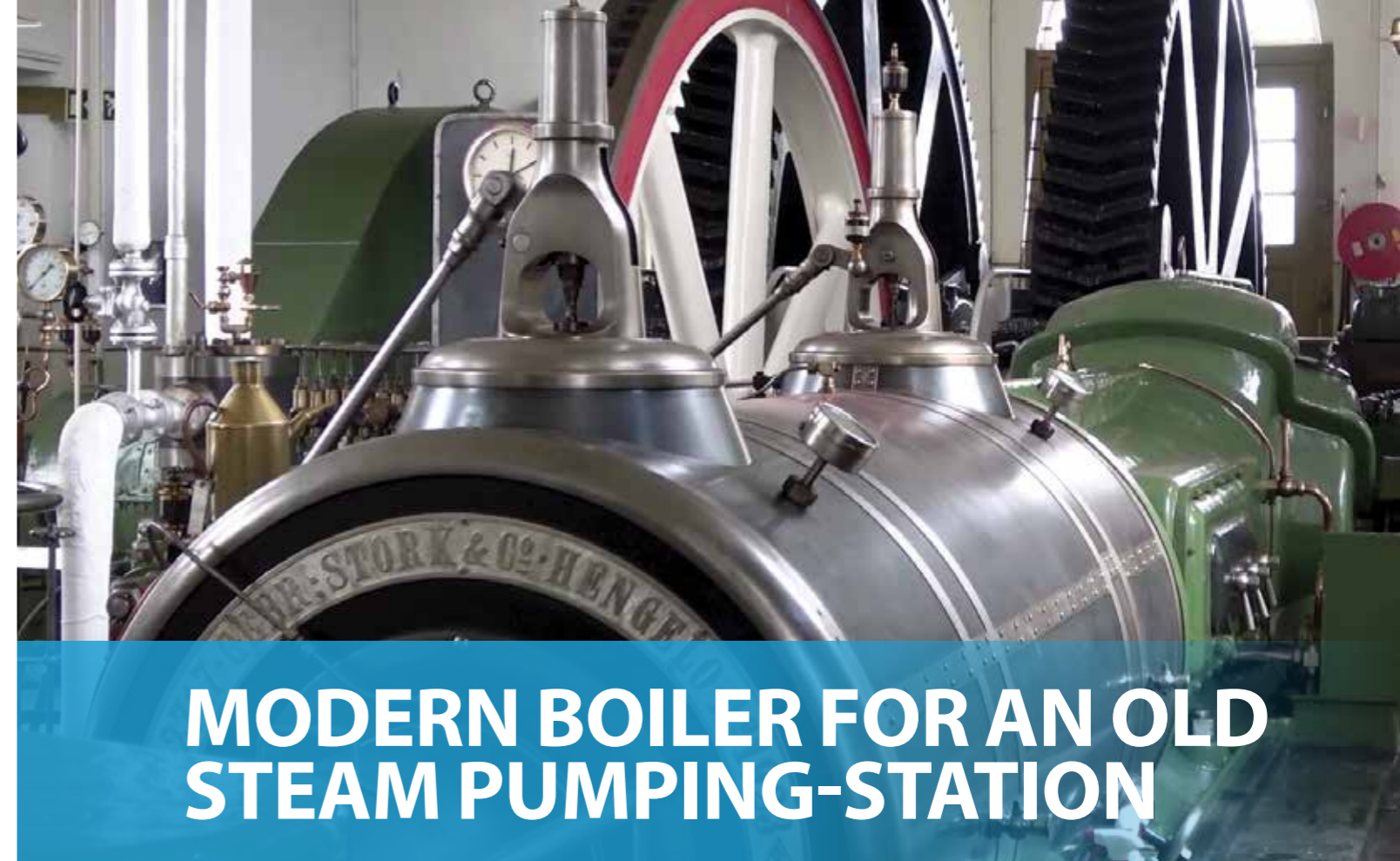
MBale was once one of the cleanest cities in Africa but is currently faced with a major waste problem. There is no proper structure for the collection of household waste and the waste is dumped in a few rapidly growing landfills. By setting up a waste incineration plant where the domestic waste is converted into electricity with the associated collection structure, a contribution can be made to a solution.

The delegation from Uganda, including the mayor of MBale and representatives from other Ugandan cities, was welcomed at Stork Thermeq by the mayor of Hengelo, Sander Schelberg. The delegates were also introduced to the waste collection services in this region and how they are organized by Twente Milieu, the company that manages the waste flows of eight Twente municipalities. The next stop was at waste processor Twence. Here, the technical aspects for the future Ugandan waste incineration plant were discussed and the delegates received a demonstration of how a waste-to-energy plant works in practice.



WHAT IS WASTE-TO-ENERGY?

Incinerating waste and simultaneously generating energy shows that residual waste can be put to good use as a source of energy. Around two-thirds of all household waste falls under the biomass category and can be recovered as CO₂-neutral energy. It is a valuable alternative to reduce CO₂ emissions and thus reduce our dependence on fossil fuels. This sustainable generation of energy is already happening in the Twence Waste-to-Energy Power Station, which was built by Stork.



MODERN BOILER FOR AN OLD STEAM PUMPING-STATION

Last year, both the 'Museum Stoomgemaal Halfweg' and Stork celebrated an anniversary. The museum celebrated its 40th anniversary, and Stork its 150th. Was it a coincidence that they bumped into each other again last year? It must have been fate because in exactly this jubilee year, just before the museum wanted to open a commemorative exhibition, the original steam boiler of the pumping station, which had been delivered by Stork back in 1923, failed the tests.

The Halfweg steam pumping-station dated from 1852 and was in danger of being demolished in 1977 following the construction of a new, electrically powered pumping station. The mayor put a stop to this by turning it into a state museum and, to this very day, a large team of enthusiastic volunteers still runs it. They regularly let the two-times-three scoop wheels of the storage basin pumping station turn by firing up the steam boiler and starting the steam engine as a drive.

In 2018, an inspection of the rivet joints revealed that the boiler could no longer be safely used due to small hairline cracks. It was rejected, and the museum sent out price requests to several boiler builders to investigate the possibilities for a new boiler. To no avail. Until an employee of Stork Thermeq happened to see the museum's predicament on television. The wheels in his head immediately started

turning. He couldn't just sit by and let 'their' boiler, after 95 years of loyal service, simply be dumped and left to rust...?

Contact was quickly made and the 150th anniversary of Stork was all the more reason to deliver a new boiler at cost price. A boiler that still has the old type plate from 1923 but is produced using modern techniques. Not round bending but roll bending. Not riveted but welded. And pressure testing at a pressure of 34 instead of 24 bar. The many volunteers of the museum pulled the old boiler apart, lifted it through the roof and were ready to help Stork hoist the renewed boiler inside, connect it all again and check all the piping.

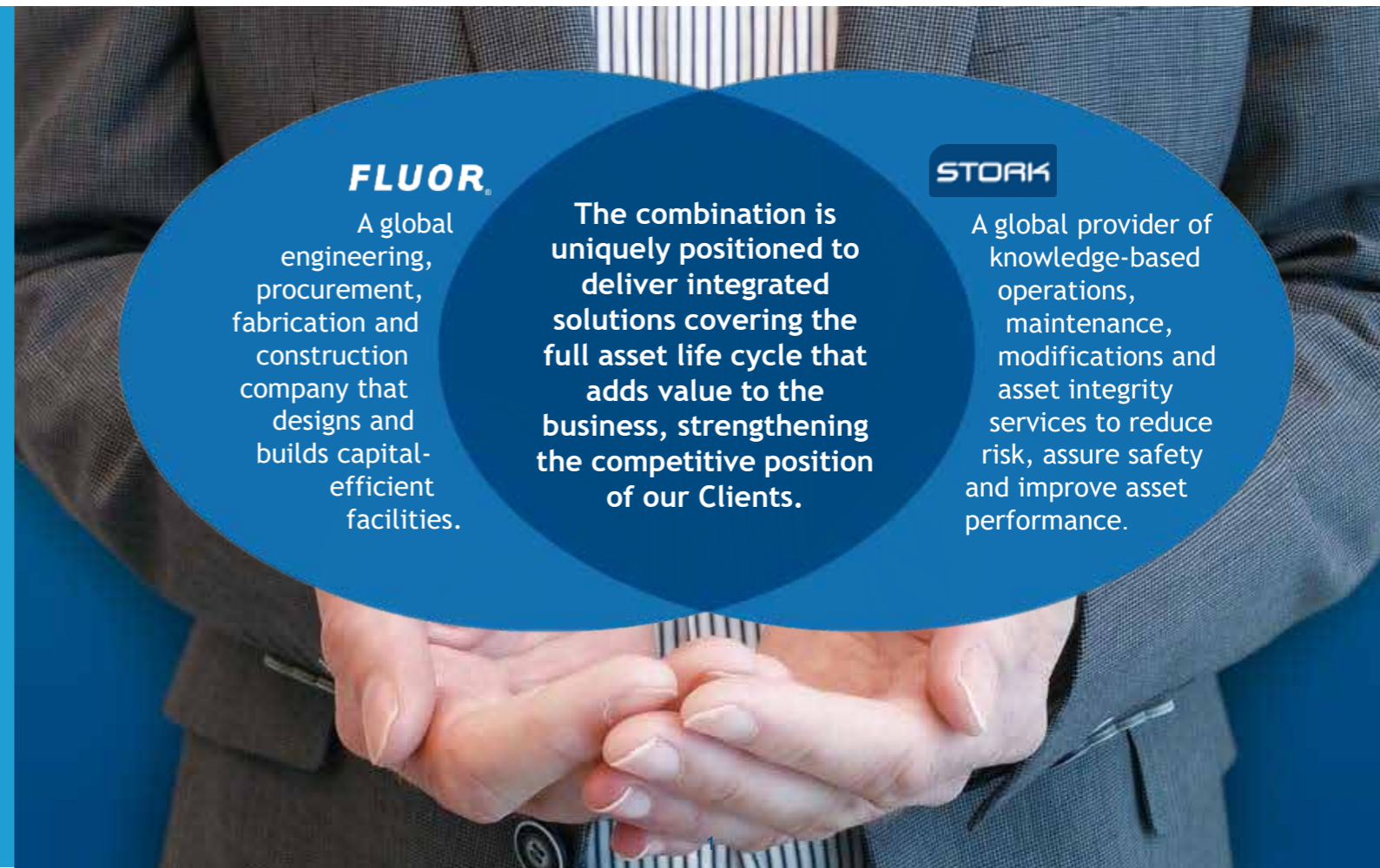
The steam pumping station in Halfweg (NL) was finally recommissioned in May 2019 by the mayor of the municipality of Haarlemmermeer. A fantastic project and an extremely engaging collaboration between two parties who have known each other since the old days and have the same passion for technology.



AN INTEGRATED APPROACH FOR 'SMALL CAPEX' WITH FLUOR AND STORK

ONE TEAM FOR MORE EFFICIENCY AND SHORTER LEAD TIMES

With our clients, we often see that small capex projects and opex portfolios struggle to meet objectives when it comes to planning and budgets. There are a wide variety of causes for this, such as limited availability of qualified employees, the pressure to continue production operations, and conflicting interests between contracted parties. In close coordination with its customers, Stork and Fluor have developed a joint proposition that addresses many of the issues that have been identified as well as their underlying causes: an integrated approach for small capex. With this ONE TEAM approach of Fluor and Stork, the overall ownership enhances significantly, resulting in a drive for a flawless design and its flawless execution, which improves the overall predictability of schedule and costs.



FLUOR

A global engineering, procurement, fabrication and construction company that designs and builds capital-efficient facilities.

STORK

A global provider of knowledge-based operations, maintenance, modifications and asset integrity services to reduce risk, assure safety and improve asset performance.

The combination is uniquely positioned to deliver integrated solutions covering the full asset life cycle that adds value to the business, strengthening the competitive position of our Clients.

CONCEPT

The basic concept behind this approach is that these small capex projects, or a portfolio of opex projects, are placed in the hands of one party that has competencies in design, purchasing, and construction. In a conventional approach, a distinction is made between the design and the construction phases - generally with a tender process in between - that can easily take 6 to 8 weeks. This period is eliminated with the "small capex approach", resulting in a significant reduction in lead time. Construction experts have a seat at the engineers' table right from the beginning, allowing for input to be made regarding constructability and maintainability. And vice versa, someone from engineering is always present during the construction phase to be able to quickly make any adjustments or clarifications that are deemed necessary.

ONE TEAM

This "small capex approach" not only results in reduced lead time but also in decreasing costs and workload on the customer side. Partly this is because we work as one integrated team, whereas there would generally be three teams in a conventional approach: one at the customer, one at the design agency, and one at the construction company. This leads to considerable savings in the project management staff. Also, there is less risk of having to 'rework', or of having additional work and conflicts afterward, as there is no interruption between design and construction. There is **one** responsible entity, with **one** general contact for **one** team, working at **one** work location, toward **one** common goal:

implementing the process efficiency and achieving a rapid (re)start of production.

You cannot achieve all these synergy benefits simply by ad-hoc putting two teams together in one building. We have analyzed and compared our design and construction processes extensively, those at Fluor as well as those at Stork. And we have asked questions such as 'is this step necessary if we are in one team?', 'who is best equipped to perform this step?' and 'what is the added value if the other party is (already/remains) involved?'. This has allowed us to optimize the way our processes are aligned. We also applied this analysis method to our supporting systems, which has helped us prevent any unnecessary overlap and to allow systems to exchange information seamlessly. And of course, we have also examined the best ways to form the team itself, selecting colleagues with experience on the other side of the fence in crucial areas.

BENEFITS

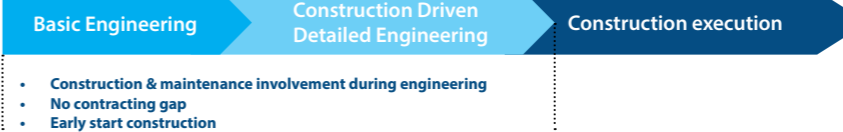
In this "small capex approach", market functions such as requests for tenders in construction have been eliminated. The use of benchmarking can partially offset the loss of this review for determining the correct market price. We are convinced that the benefits in efficiency far outweigh this uncertainty with regard to pricing, even without taking into account the benefits of a faster start to production. And we have not even yet touched upon the benefits when it comes to maintenance. By having Stork and Fluor teams permanent-

CONVENTIONAL VERSUS INTEGRATED MODEL

CONVENTIONAL MODEL



INTEGRATED MODEL



ly sitting in the same area, maintenance-thinking gets infused in the design-process, which can greatly reduce maintenance costs.

For example, we share space at Chemelot, the chemical industrial site in Geleen (NL), a location used by Fluor engineers and Stork project and maintenance experts for work on both separate and joint projects.

An example of comprehensive cooperation is the conversion of a diesel-driven pump installation into an electric drive for the Defense Pipeline Organization. Here, Fluor and Stork

jointly delivered the entire process for Engineering, Procurement & Construction, and Stork is now also responsible for Maintenance.

CONCLUSION

For our clients, this joint Fluor and Stork approach achieves reduced TCO (Total Cost of Ownership) by a compressed schedule, reduction in overlapping positions, and bringing in the right expertise, at the right time.

A high-angle, low-light photograph looking down into a large, circular industrial vessel. A worker in a blue protective suit and helmet is visible in the lower center, working on a component. The vessel's interior is dark, with several circular openings and bolts visible along the walls. A bright light source is visible in the background, creating a strong glow and casting long shadows. The overall atmosphere is industrial and focused.

STORK

A Fluor Company

STORK
Van Deventerlaan 121
3528 AG Utrecht
The Netherlands

WWW.STORK.COM

© 2019 Stork, A Fluor Company. All Rights Reserved.