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DOWNSTREAM US MARKET OUTLOOK, 2021 & BEYOND

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CHAPTER 1:

COVID-19 Productivity Losses in CAPEX related Projects

We are close to 18 months of dealing with COVID-19, the pandemic has been major challenge to all Construction related organizations around the world.

COVID-19 has seen close to 200 million confirmed cases & close to 3 million deaths around the world. (Some commenters believe this number could be closer to 7 million, due to poor record keeping in some less developed countries). More than 600,000 + deaths in USA attributed to the virus.

COVID has created significant problems to the Global Construction sector, compelling many organizations to substantially modify, shut down or severely slow down ongoing construction activities. The pandemic has negatively impacted the economies and construction sectors of more than 180 of the world's 200 countries. Some counties have successfully navigated around the pandemic, while many countries have significantly struggled with the virus.

In the USA over 70% of Contractors have experienced project delays & disruptions in last 12 months, more than 80% of Contractors have suffered delays in obtaining domestic & international construction components, and over 75% of construction related companies have suffered project cancellations, suspensions or major delays.

Key construction materials (structural steel, rebar, copper, timber & plywood) are experiencing spiraling price increases, shortages & delivery to site delays brought on for the most part by COVID relate pent up demand, the US housing boom and the Suez Canal closure, these issues are causing increased construction cost & a rise in inflation across the world.

There are some shortages of qualified workers in some countries (Welders / Instrument fitters etc.) In the US, the Covid crisis appears to be weakening, however COVID mitigation at site is still a major challenge, unfortunately COVID-19 will be with us for the next year or two, it might be smart to keep your masks.

The 2nd half of 2021 is forecast to be a challenging period for the Global Construction Industry. COVID-19 has disrupted the Construction Capital Industry (CAPEX), some of the main issues include the following items.

- Construction productivity on Oil & Gas Capital Projects has been negatively impacted by between 10% and 30% due to the COVID-19 pandemic.
- Owner and construction related companies have initiated travel constraints, limited face to face meetings, compelled staff to work-from-home were possible, instigated new safety rules / social distancing and other practices to protect employees.
- Construction materials, supply chain interruptions have in some situations have had a significant cost and schedule impact, some of Compass International's clients have experienced holdups in obtaining long lead process equipment (Compressors, Heat Exchangers, Fabricated Piping), construction work has also experienced delays due to the COVID-19 pandemic.
- Construction Materials / Major Equipment have experienced longer delivery times.
- Construction In-Directs (Supervision / Plant Hire, Site Establishment) have experienced significant cost increases.
- Construction sites have been utilizing social distancing 2 meter / 6 foot policies.
- Construction staff & workers are required to wear masks, in some cases gloves & goggles.
- Extensive cleaning measures / protocols required by Owners, some Owners are calling for dedicated COVID cleaning crews.
- Additional hiring of COVID mitigation/ testing site staff, requested by Owner.
- Increased field in-directs (Site Offices / Lunch – Change Areas & additional support labor are now required).

- Smaller, spread out work crews, dictated by Owner.
- Required cool down breaks in morning & afternoon due to the permanent wearing of masks, gloves & safety glasses in high temperature locations.
- Provision of hand sanitizers & refills on a daily basis.
- The possible need for 14 day quarantine periods for certain construction workers coming from different states or countries.
- Additional site buses / drivers, needed for social distancing in transporting construction workers to work areas from parking areas.
- COVID-19 temperature testing each day at the site entrance & providing new masks.
- Many Construction Projects have taken longer to complete due to COVID issues.

These delays have resulted in increased costs, claims & change orders. The 2nd half of 2021 is forecast to be a challenging period for the Global Construction Industry.

COVID-19 Construction Productivity Changes:
Reuters Events partnered with Compass International who have been having conversations and conducted a survey with approx. 30 + Construction Managers, Site Superintendent's, Trade Foremen, Planners, & Estimators in the last couple of months regarding the loss of productivity on specific trades (Carpenters, Pipefitters, Electricians etc.) due to COVID-19 on Industrial Construction projects currently being constructed in the USA & Canada.

This is the feedback we are getting:
The majority of Refinery, Gas, Power, Manufacturing and Pharmaceutical Owner companies are including clauses / contractual language in their construction contracts / Requests for Proposal (RFP's) focused on minimizing the spread of COVID-19 within their existing production sites / manufacturing hubs, most of these contractual requirements impact construction productivity, they include.

- Employing social distancing 2 meter / 6 foot regulations on construction sites and offsite fabrication facilities.
- Construction staff & workers are required to continually wear masks, in some cases gloves & goggles are mandated.
- Employment of COVID mitigation/ testing site staff.
- Extensive cleaning measures / protocols of materials delivered to site & stored in clean COVID free warehouses.
- Some Owners are calling for dedicated COVID cleaning crews.
- The possible need for 14 day quarantine periods for certain construction workers from different states or countries (these individuals need accommodation, meals & related travel expenses).
- Required 15 minute cool down breaks in morning & afternoon due to the permanent wearing of masks, gloves & safety glasses in high temperature locations.
- Expanded field in-directs (Site Offices / Lunch – Worker Change Room, additional site logistics, warehouses and support labor).
- Smaller, spread out work crews dictated by Owners.
- Provision of hand sanitizers & refills on a daily basis.
- Additional site buses / drivers, needed for social distancing in transporting construction workers to work areas from parking locations.
- COVID-19 temperature testing each day at the site entrance & providing new masks each day.

The following table indicates the productivity changes that have taken place since the onset of COVID-19 and the results of the feedback & our research.

	TRADE / SKILL / WORK DESCRIPTION	PRE - COVID PRODUCTIVITY (a task that would take 100 hours to perform)	POST – COVID PRODUCTIVITY (impacted by COVID-19)
01	Site Clearance / Earthworks / Roads / incoming utilities	100 hours	105 to 110 hours
02	Concrete work (rebar, formwork & concrete installation	100 hours	110 to 125 hours
03	Major Equipment Installation (Towers, Compressors, Heat Exchanges, Pumps) Setting Equipment & Alignment	100 hours	110 to 125 hours
04	Masonry / Brickwork / Wall Systems / Siding / External Envelope	100 hours	110 to 120 hours
05	Structural Steel / Pipe Racks / Platforms / Ladders / Railings	100 hours	110 to 120 hours
06	Architectural Finishes (Walls, Ceilings, Flooring, Painting)	100 hours	110 to 130 hours
07	Field Fabricated & Erected Piping (Utility & Process)	100 hours	115 to 135 hours
08	Offsite Fab Shop Piping (Utility & Process)	100 hours	105 to 110 hours
09	Electrical & Instrumentation / Process Automation	100 hours	115 to 130 hours
10	HVAC / Ductwork & Balancing	100 hours	110 to 125 hours
11	Roofing / Insulation / Painting & Waterproofing	100 hours	105 to 115 hours
12	Site In-Directs (Material Distribution, Site Clean Up, Site Support Labor, Scaffolding, Worker - temperature checks, dispensing masks, water for cooldown breaks, additional bus / transportation drivers, office / lunch area cleaning & warehousing.	100 hours	115 to 125 hours

Conclusion

- **OVERALL PRODUCTIVITY LOSS = 20%**
- **BOTTOM LINE FUTURE OIL & GAS / INDUSTRIAL CAPEX PROJECTS WILL REQUIRE 20% MORE DIRECT MAN-HOURS FROM PRE COVID PROJECTS**

Typical % breakout of a $10 million to $250 million Refinery / Chemical Plant / Industrial Project:

- Major Equipment (Pumps, Compressors, Columns, Tanks, Heat Exchangers (includes freight) 22.9%
- Materials (Bulks / Engineered). 21.5 %
- Labor costs – including sub-contractors. 24.3%
- Field In-directs / General Conditions / Preliminaries. 11.7%
- Detailed Design / H O support / Procurement / PM 13.9% (includes Owner Engineering) Includes all necessary design deliverables
- Construction Management (incl CM Gen Conditions) 5.7%

TOTAL 100%

Cost Impact on a **$50 million** Industrial Oil / Gas Project that Pre-COVID needed **400,000 man-hours** to complete.

A **$50 million** project pre-COVID needed approximately **400,000 direct man-hours**. To determine the number of workers required divide by the **400,000 man-hours** by the number of hours worked per year which is in the order of **2,000 man-hours / per man-year** = That would equate to **200 workers for 1 year**. (We know the workforce would peak at approximately **330** it would need to ramp up from the start of the work & would ramp back down at the completion of the project)

- COVID productivity loss of 20% (from our survey / research) **400,000 man-hours x 1.20 uplift** = **480,000 man-hours** divided by **2,000 man-hours / year** = **240 workers** for 1 year.

An extra **40 workers** or an additional **80,000 man-hour x $35 an hour** = Additional cost due to COVID of **$2,800,000**

Plus additional in-directs (Supervision, construction equipment (bulldozers, excavators & cranes etc.), site establishment / office trailers, construction support labor, scaffolding, small tools etc.) typically **20% - 35%** of direct man-hours = an additional cost of **$700,000** again attributed to COVID impact.

Order of magnitude increase on a **$50 million** Industrial project could be in **$2,800,000 + $700,000** = **$3.5 million** range or a **7% increase** to the project & possibly a longer construction schedule.

CHAPTER 2:

Project Execution Trends in 2021 & Beyond

Construction experts united in June 2020 to discuss selection and evaluation of contractors and possible technologies to overcome the loss of productivity and increase of project costs caused by the pandemic. Below is what they shared with Reuters Events.

EPC vs. EPCM contract

Thomas Abel, Borealis senior vice president for projects, said that with an EPC contract an owner has the convenience of a single contact point, or just one contractor who in turn subcontracts suppliers, services and labor. With an EPCM, the contractor only acts as a consultant.

Borealis signed an EPCM in a PDH (propane de-hydrogenator) project in Belgium, and an EPC or lump sum in other areas such as a for a U.S. cracker and polyethylene project in a venture with France's Total, as well as in other petrochemical projects in Abu Dhabi.

With an EPC "the advantage is that the contractor bears the risk." The contractor is responsible for cost, time and performance, he said.

An EPC contract, however, is not necessarily a guarantee against unforeseen variations. "Strong change and claims management and steering committees need to be in place," Abel said.

Projects best suited for an EPC are those where "you have a very clear scope," he said. Sometimes an EPC project may not be possible even if it was the company's first intention, he added.

For example, Borealis initially tried to get the PDH project in Belgium under an EPC lump sum accord but then it learned that "out of eight shortlisted bidders, only three were really interested."

An obstacle that made it harder to obtain an EPC contract in Belgium was European labor legislation. In Europe, "the labor environment is different compared with Abu Dhabi or in the U.S."

An EPCM has its own advantages. "With an EPCM you can start quicker," he said.

"A pitfall with EPCM is you don't have the commercial competition." The multiple bidding processes with EPC contracting and subcontracting help bring costs down, Abel added.

Another issue is that with an EPCM, the contractor "does its business by selling the hours to the client" so the motivation to keep timelines is not as strong.

Because of the bigger risk, with EPCM an owner must keep "enough contingency reserves."

Regardless of going with an EPC or EPCM contract, "good front-end loading always improves the outcome," Abel said. Time spent on market analysis, getting to know contractors and the contract forms they work with is never wasted.

Comparing contractors

Having a common metric to compare contractors' quality, cost, production and scheduling across diverse projects could greatly help both contractors and owners, said Taylor Auburg, vice president of projects at Freeport LNG.

For example, comparing safety between diverse projects and across all industries is easy because measuring incidents per 200,000 worked hours is the one standard international metric.

"You have to have a common metric to measure things consistently between companies over time," Auburg said. But when it comes to comparing contractors "a lot of people look at cost-size of the project," he said.

"You need to go a little bit deeper than that in order to have a commonality, a common factor, a way to normalize the variances between projects, and I call that the complexity factor of a project," he said.

Corporate specific guidelines can be set to assign relative levels of difficulty, measured with a points system, for equipment pieces and major infrastructure components. This can cover trayed towers, pumps, and control buildings. Under these guidelines, planning, equipment lists, and every part of a project has a point value assigned that "is not based on dollar value or throughput, but on the complexity," he added.

Once the point assignments is completed, a multiplier is used. "You add up the numbers and you get the relative complexity," he said.

Individual companies can set their guidelines for comparing performances across projects. The Construction Industry Institute (CII) also offers guidelines under its Engineering Productivity Measurement Procedure (EPMP).

The CII's EPMP involves seven disciplines and 17 metrics. Areas include for example piping, with metrics such as linear feet of pipe, number of fittings or number of hangers.

The CII guidelines set common metrics to ease project comparisons based on items like volume of concrete and steel used, or the size of buildings that are part of projects. On the electrical side, for example, there is the measurement of linear feet of wire and cable.

"This way they can normalize the complexities" across diverse projects.

Contractors can use this point evaluations and measurements to show that they have done projects in the past of similar complexity. They can offer detail to show similarities to a new project, rather than limiting comparisons to locations or cost.

Contractors can also evaluate changes in their performance over time. This can demonstrate to potential clients that they are getting better.

They "make performance a market differentiator," Auburg said.

Metrics are also good for self-management. They can help to "try to repeat positives from lessons learned and avoid the negatives," he added.

The assessment can include the impact of external as well as internal factors.

Contractors can also identify and show performance changes for example after the start of the use of 2D CAD or 3D CAD. For contractors, such metrics can provide "a proper analysis that can help see what went wrong."

Thinking that bad projects are an anomaly "puts yourself into a position of having a false sense of security," Auburg added.

Contractors can use the metrics to "train in what led to successful projects," he said.

For owners, analyzing the metrics should "identify the best and worst performers" for a given project, Auburg added.

EPC contractor also involved in FEED

For Meridian Energy Group it was important to have the EPC contractor involved also in the early design stages, said Charles Schwenck, executive vice president and chief commercial officer at this company planning a refinery in North Dakota.

"That required that we start with a front end engineering design package on a reimbursable cost basis to get to a project definition. We wanted to make sure that we did so with a contractor who could also be the turnkey EPC contractor," Schwenck said.

"We didn't want someone defining a project that they didn't have to live with," he added.

Another emphasis was on assuring "that we had an open book process, that it is collaborative, that everything is done where we see it happening , where all contingencies are identified and justified on a line item basis."

James Richard, construction manager at Shell, agreed that early contractor involvement is important. In cases where a FEED contract may not include them, hiring them as consultants could be a possibility, he said.

Early contractor engagement helps in "building the trust with them defining the CWA (Community Workforce Agreement) and the path for construction".

Advanced Work Packaging (AWP), which combines data from multiple sources into a planning tool that includes a virtual construction model "is new to a lot of people" so it is important to fully explain what project success looks like to all, Shell's Richard added.

Kristopher Lengieza, director of business development and marketplace at Procore Technologies, said "early engagement by all stakeholders, contractors, engineering procurement" participants is important to understand the multiple pieces in a project.

AWP "is all about transparency. Making sure that we have transparency that you can share that information across the stakeholders and understanding that you are measuring the things that are going to impact" the project, Lengieza said. "Everyone agrees that what comes out of AWP is the reduction in risk, having more predictability, having more confidence," Lengieza added.

Eric Crivella, director of business development for Digital Construction Works, stressed the role of technology in the need for coordination and sequencing the project.

"Going digital is all about creating close feedback loops," he said.

It should get "to the point where you have succinctly defined your path of construction" and then the rest is figuring out how engineering and procurement will fill that same path of construction, Crivella added.

"You are really striving for being more predictable and the only way you can get there is through a model centric approach, taking advantage of creating a virtual construction model that integrates the various project IT systems, materials, management system, schedule , alignments, the equipment list," Crivella said.

"You are creating a digital twin of the asset as you go along during construction," he added.

Once created, a digital twin during construction could later help train operators, as well as be used for procedures, debottlenecking and to plan shutdown turnaround processes.

Contractors doing maintenance related projects often find themselves lacking 3D models for the facility, Crivella said. Technology may also help with laying out 'smart' contracts designed to release payment as soon as works are completed.
Driving Productivity through alternative contract strategy

Scope definition is the first thing needed before signing a contract, said Michael Dailey, vice president and general counsel at Air Liquide.

"There is a notion out there that you can use alternative contract approaches to address situations where you may have a less defined scope. However, the better defined the scope, the more certainty that there is going to be project success," Dailey said.

"A second thing to consider during the pre-contract phase is really an honest assessment of the owner's organization," he added.

"There is some portion of the typical contract risk that is going to be shifted to the owner. That can work well if the owner has the skill set and resources to manage that risk, but before that someone needs to do a real assessment," Dailey said.

This requires looking specifically at potential risks for a specific project and considering them in the contract, he added.

There is a tendency to grab the last contract used and reuse it for the next project simply because it worked well.

"Its' much better for the owner and the contractor if they sit together and determine what the real risks are for that project and if there are steps that can be taken before that contract to reduce that risk," Dailey said.

For an owner it is also important to consider keeping within the company the most important roles in a project like site or project managers, he added.

Another issue to consider is the inclusion of incentives for contractors. Sometimes incentives are set up only tied to a specific completion, which leads to attention directed to moving faster but just within a specific area.

Rather than tying a milestone payment to some event, it is best to align incentives with the real objectives that an owner is trying to achieve.

Mark Cotugno, global procurement director enterprise at The Chemours Co., said that keeping a strong owner team involved in the project is key for success. "With higher engagement usually there are better project outcomes," he said.

Covid-19 impact to speed up technology adoption

There has been some reluctance on the part of owners to introduce new technologies in part out of concern about trying new tools with projects that sometimes cost billions of dollars, the participants said.

The Covid-19 impact provided an opportunity for technology to prove its worth and overcome concerns. This may help speed up investment and adoption of technology.

"A good example of that is the integration of various electronic platforms that we knew there was a use case for and it was highly theoretical just six months ago," said Mark Wyszynski, senior information technology advisor to projects and engineering at Shell.

As several construction projects around the world saw interruptions "we still had the ability to engage each other and to continue the engineering work," he added.

Potential for increases in digitalization that may bring cost savings include areas like platform integration, drones, digital twins and 3D modeling, Wyszynski said.

Now the interest lies "in integrating those systems whether it be our financial systems with our safety systems so that we can get a consolidated project report," he added.

Bridget Robinson, Reuters Events caught up with Mark Wrzyszczynski, Senior IT Advisor, Projects and Engineering, Shell, and Mark Fonda, Chief Technology Officer, Meridian Energy Group Inc. this May to discuss the future of innovation in downstream construction. Below is what they discussed:

Mark Wrzyszczynski
Senior IT Advisor -
Projects and Engineering
Shell

Q. Can you tell us a bit more about what your department at Shell is trying to achieve at the moment?
The organization that I work in is part of information technology. We support our projects and engineering organization which is responsible for the development of all of our new assets around the world and includes brown field developments. We are working very hard to become more efficient at the way we use information and to become more data centric in the ways we work. A big focus of that are digital twins, which I'm sure you've heard a lot about. It is a great enabling technology that helps our operations work more smoothly, as well as advanced work packaging, requirements management, estimating and the connection of all those different digital tools.

Q. And would you say that the focus of department has changed post COVID?
We aren't necessarily doing anything differently, but we have certainly championed digital twin technology on our plants since. Code inspection is a great example. We had the ability to do remote inspection, prior to COVID-19 but as a result of the restrictions all over the world, and our ability, the use of remote inspections has accelerated the technology. We have been using remote inspection all over the world to be able to continue our construction without having people go to site and quarantine for 14 days. So that's been a real enabling technology for us.

Q. How has this played a role in CAPEX in the past? And how would you think this will play a role in CAPEX in the future?
Shell's intent is to maintain cash and control our cash flow, which is resulting in a smaller capex plan for next year. From an IT specific perspective, we are remaining the same in total spend, however, we will be pushing to do even more with the same amount. It is a good story overall in our organization, but certainly a lot of pressure on costs across the board to actually increase the number of services and the amount of capability that we provide, without spending more money.

Q. When looking to the future, you have mentioned data, but what technology or innovation do you think is going to be a game changer for Shell and the rest of downstream construction industry?
We certainly started on this path prior to COVID, but it is not fully implemented and appreciated yet, especially cloud computing. Cloud computing has enabled the collaboration across business and geography. It has changed who and how the work is done. You name a service, this is a change in the business model that really lowers the cost of entry to world class computing and allows us to stay up to date with the latest technology. It also allows an organization to scale capabilities much more efficiently and deploy solutions from the centre as opposed to every workspace developing their own solutions.

Q. For Shell, how did this focus come about and what particular problem do you think it's been used to solve?
A whole host of problems can be solved. Everything from the quality of data, the ease of access data, the diverse geographical locations of our workers, the ability to bring in subject matter experts to view the situation without having to have them travel, the production and travel costs as associated with that. The ability to have confidence that the information that we have is accurate, and spending less time to ensure that. All are very broad brushstroke problems that we are solving by using data and by using cloud computing specifically. They can be broken down into much more granular examples as we go.

Q. Where is it going to have the biggest impact in the construction industry?
I mentioned about bringing technical expertise to bear on a problem without actually sending bite is key thing. The problem that really is going to drive cost increase of our support is the high cost of technical support on site. The cloud really allows us from an IT perspective, a process engineering perspective, a construction perspective, to bring that technical support from all over the world. Support can be delivered much more effectively, and has a father son type of model, if it is needed, as well as not having to have the individual expertise on site, or at least not as the same level of expertise on site.

Q. Are there lessons to be learned from innovation adoption so far?
I think there are lessons learned. We continue to find new use cases and scale our capability. We have got a left to right and a right to left strategy. The right to left is ideas from the centre of excellence being pushed out to our projects and our assets all over the world. Left to right is being responsive to what my supervisor refers to as "innovating at the edge". This is taking the ideas from the front line that are solving real world problems on site, then scaling them to the rest of the organization. This is enabled by the way we are working today, as opposed to say three years ago.

Q. The industry has been discussing data for a long time now. Why is there such an imperative to act now?
It is all about the integration of lots of tools. Due to the tools that are readily available and free to consumers right now, whether it be Google or Microsoft's, people are becoming appreciative of the value of the integration of that data. Therefore, it has become an expectation of employees, as well as our customers. There is a lot of work being done to integrate data that is opaque to most people, but it is an enormous amount of work to make it happen. The interoperability of systems that bring data together to gain the insights come from multiple sources of data is displayed very effectively by the likes of Google so that we are able to draw that insight very, very quickly. We have been doing the same thing with construction data, with operational data, with business data across our businesses, whether it be in retail, or trading, or downstream, and upstream.

Q. Who do you think the industry will look to for "best in class" insight on this process?
Well, I hope they say Shell! The IOGP (International Oil and Gas Producers) has been working for the last few years to create standards that will allow the data to be shared more effectively. JIP 33 follows the capital facilities information handover standard, and JIP33, which are procurement specifications, are really key to making this work. I encourage any of your readers to tune in to that work and even join projects that are shaping of those standards, because they are going to be really key to integrating that data and drawing out those insights. And Downstream USA 2021, of course!

Q. What area in construction in particular do you think could benefit the most from further innovation?
I'm a little partial, because I'm working on the team that's doing this but I think advanced work packaging is the most healing opportunity to me in construction specifically. And it's really enabled by the interoperability of systems that we were just talking about, to stitch together information and identify gaps in the conflicts before they make it to the field. If you can keep people supplied with materials and procedures that work and keep them working, we can make a huge gain in the efficiency of our construction projects. The integration of those tools are going to improve engineering and procurement and ensure construction goes smoothly. People think about AWP as a construction tool but it is really a ration tool of engineering, with planning and construction together.

CHAPTER 3:

Downstream Maintenance & Reliability Trends in 2021 & Beyond

Executive summary

There has arguably never been as much change in the downstream industry as there has been over the last 18 months. The twin shocks of the oil price crash and the coronavirus pandemic in 2020 have forced a global reassessment of the importance of sustainability and a focus on the energy transition as a central pillar within economic recovery plans.

These are shifts that have affected downstream operations and maintenance practically from day one—and the sector has generally responded well to the challenges. BP, for example, has more than 10,000 staff in China and yet was able to carry on with operations as normal despite COVID-19.

"We developed a plan, we had workarounds, and we had maintenance and still excellent reliability," says Walter Pesenti, BP's global manufacturing operational excellence manager, speaking at Reuters Events' Downstream Virtual conference last year.

The company moved quickly to implement the lessons learned in China across other plants worldwide, he says. These lessons included looking at such mundane issues as how people travelled to work and handed over jobs at the end of a shift. This rapid reassessment of the business to deal with an unprecedented shock has led to some surprising upsides.

Hour-long on-site meetings now get covered off in half the time via Zoom, Pesenti notes. Productivity is up and the company is delivering on key metrics.

This experience is not unique. At Ascend, which has five manufacturing facilities in the Southeastern United States and a plastics compound in Europe, "we were fortunate," says Cindy Gross, maintenance, reliability and turnarounds director.

"We looked at what other industry members were doing and put a lot of emphasis on logistics and planning to make sure [staff] were distanced. We gained a lot of efficiencies by doing that. We segregated to smaller groups and, so far, we've had very good results."

Nevertheless, there is no denying that the fundamentals of the industry have shifted and are continuing to shift. Although work practices are gradually returning to normal amid global vaccination programs, downstream operators are having to grapple with new, longer term issues.

Petroleum liquids pipeline projects continue to move towards completion in 2021 , but such endeavors are increasingly being accompanied by forays into new areas such as green ammonia and renewable diesel . At the same time, the digitization of operations and maintenance continues apace, and the industry continues to grapple with ongoing issues such as the integration of capital projects into turnarounds and the loss of qualified personnel.

Against this backdrop, this report aims to review the current status of downstream operations and maintenance and track some of the major trends affecting the sector in 2021 and beyond.

The impact of COVID-19

In 2021, there is little doubt that the primary concern of the downstream industry—and indeed most industries—is continuing to deal with the effects of the coronavirus pandemic. "The impacts are real," says Heith Robey, turnaround leader at chemicals firm Celanese.

Lockdowns and other restrictions have forced downstream players to reevaluate turnaround timetables, he says, while fluctuating market conditions have brought 2008 to mind. At the same time, the contract labor workforce has been sidelined, Robey says. And many companies have reduced their permanent staff. "Our contractor workforce is moving to much more stable job markets," says Robey.

On the plus side, he notes, contractor availability remains high. Nevertheless, most companies have delayed 2020 turnarounds to 2021, "and some are still evaluating how best to proceed."

This pushing back of turnarounds from last year to this one is expected to result in labor shortages and cost increases. The effect of these constraints could be hard to gauge since "budget impacts and execution cost increases are rarely forecasted correctly," says Robey.

Further uncertainties stem from local and regional differences in coronavirus response and the fact that most corporate impact evaluations only focus on main mechanical contractors. "Support contractors will become a bottleneck," Robey warns.

This rise in uncertainty could force chemicals companies to adopt new operating models, says the consulting firm McKinsey & Company. "Chemical leaders need to select the right talent for managing the new operating model and performance ambitions of the business," it says. "They must also put an effort into change management for the organization, to adopt necessary behaviors and skills."

One specific response to coronavirus has been the acceleration of digital programs and technology adoption. Companies such as Dow have been designated as 'critical infrastructure' in most major markets, so have not been subject to shutdowns—but have been forced to embrace new ways of working, frequently featuring a greater use of digital tools. "It's been a dynamic time," comments Billy Bardin, global digitalization director at Dow. "We've been working from home for most of our non-critical-to-operations employees, but we have had within our manufacturing facilities 14,000 people that have been to work every day, day-in, day-out, during the pandemic. And doing that safely."

The importance of digital at Dow is highlighted by the fact that Bardin sits on the company's crisis management planning team. "I've been leading the effort to look at modelling of how we expect the virus and the pandemic to progress," he says.

This information is used to inform Dow's return-to-work strategies around the globe. The company's pandemic response plan, created after the appearance of severe acute respiratory syndrome in Asia, has "held up pretty well," says Bardin.
Integrating capital projects into turnarounds

Although the downstream industry has weathered COVID-19 better than many, the pandemic has led to inevitable stoppages and delays. And this has exacerbated an already acute challenge for the sector: how to integrate capital projects into turnarounds. According to Jeremy Osterberger, president and chief operating officer at the Business & Industry Connection Alliance, about 90% of turnarounds in refining and the petrochemical industry are failing to meet their schedule and/or cost goals.

Adding capital projects into the mix makes it harder for turnarounds to stay on track. "Executing a turnaround is challenging because you are concentrating a lot of work into a small time," says Frank Engli, a senior advisor at Becht and former turnaround manager at Shell. "A huge amount of effort is required, and also a huge amount of operational loss is occurring. But the biggest challenge is the preparation upfront. Many times, folks don't maintain discipline in terms of the lead time required to prepare for work."

The need to integrate capital work into turnarounds has increased with the pandemic, he says. This requires significant technical capacity and requires a cohesive workgroup where "individuals become almost interchangeable," Engli says. Adding capital work late into a turnaround program can cause issues with a carefully calibrated plan, he says. But so can the cancellation of capital projects, which has happened with some frequency in recent months as a result of coronavirus concerns. Interruptions to the flow of capital projects could be a temporary affair, though.

The analyst firm Wood Mackenzie expects to see an uptick in the integration of refinery and petrochemical sites as the energy transition puts pressure on transport fuel demand and forces operators to seek greater operational efficiencies. Randy Pound, global director of maintenance and reliability at Olin Corporation, says the trend towards integrating capital projects into turnaround raises the question of why they should be considered separate issues at all.

"When it comes to turnaround, if we put artificial barriers between those two subject areas it does us a disservice," he says.

Other experts agree. "I think we should consider them as one exercise," says Junaid Muhammad, director of manufacturing at Huntsman. "Otherwise it will be difficult to plan, difficult to get the right team on the job, and you will have too many contractors."

Historically, the capital and maintenance aspects of turnarounds have tended to be seen separately because they are governed by different cost centers, Muhammad notes. Engli agrees that "the undertaking should be taken as one big event," but points out that capital projects tend to be cost-driven while turnarounds are usually schedule-driven.

Also, planning for a large capital project can begin up to four years out while turnaround plans tend not to be put in place more than two and a half years in advance, he says. For Russell Epperly, senior project controls manager at Zachry, "the main driver for the distinction is cost."

Effective asset reliability strategies

According to IHS Markit, COVID-19 has prompted the closure of up to 1.72 million barrels per day of refining capacity across 15 refineries worldwide. This could mean there will be less slack in the system to cover unplanned shutdowns in future, highlighting the need for improved process reliability. One way of achieving this is through asset performance management or APM.

According to the ARC Advisory Group, a leading technology market research firm for industry, manufacturing, infrastructure and cities, APM typically covers a range of disciplines, including:

- Reliability-centered maintenance
- Data visualization and analytics
- Asset integrity management
- Asset health data collection
- Predictive maintenance
- Condition monitoring

It "involves information sharing and application integration among operations and maintenance to provide a comprehensive view of production, asset performance and product quality," says ARC.

In practice, maintenance technicians working under an APM regime will schedule their own work based on the performance monitoring data of specific assets, rather than relying on operational schedules that may or may not be related to the state of an asset. With APM, says Ken Stevens of 4 Atmos Technologies, "We can use advanced analytics. We can make predictions. We can look at things differently, earlier into that performance failure curve than is being recommended, and act accordingly to minimize failures."

This allows downstream players to adopt "a more proactive strategy towards asset management, reducing the need for reactive maintenance and repairs," he says.

Moving to APM is important because Nasa and US Navy studies have shown that only 18% of equipment failures are age related. The remainder are due to a variety of causes, including how assets are operated. Hence, "a strategy that is time-based or consumption-based on runtime is only going to affect 18% of the assets," Stevens says. "The other 82% are random failure modes."

He adds: "Addressing that in the asset strategy provides the ability to transform how we maintain the assets. We're using APM to do that. We're bringing the process and the asset information together so we can transform how we interact with our assets."

The move from corrective and preventative to predictive and prescriptive maintenance is taking place across a range of asset classes, from downstream assets to personal vehicles. And it is being increasingly enabled by technologies such as sensors and data analytics. However, says Stevens, it is important to bear in mind that "you're only going to achieve 30% of the result by focusing on the technology. If you structure your work processes around the technology, you can achieve far greater returns—more than 100%."

Executed correctly, APM allows teams to carry out less low-value corrective work and more high-value predictive and prescriptive activities. "We want to remove tasks from the employees' activity lists," says Stevens.

Connecting the workforce

Although technology is only part of the equation, it is clear that APM depends on the deployment of digital tools and processes for success. In this respect, APM is just one of many fronts where digitization is transforming downstream operations. Digital technology is increasingly being deployed for downstream applications as diverse as optimizing refinery fuel consumption and scheduling crude logistics .

One area of particular interest for the downstream sector is how this technology can be applied to workforce management. "The opportunity in the turnaround space is just immense," says Colin Xander, executive director of turnarounds at Chevron Philips. "If you can get nine hours of wrench time per day per man instead of eight hours per day per man, either you get the turnaround done days earlier or you can do it with a lot less people. Whichever way you choose to do it, there's a big win that can be had."

Invista has been introducing digitization for turnarounds at its Victoria, Texas site for the last three years, says field services manager Jim Flynn. "We look at the value it brings with reducing time in turnarounds, we look at the value it brings with improved safety, and we look at the value of reduced headcount—how we can get more people off the site and do things just as efficiently," he says.

"It's the way of the future," he adds. "Safety, improvements, cost, schedule… it'll affect all of it. It's just such a win."

Dow's move to digital technology is being championed by leadership. There, "the opportunity really comes from productivity improvements, getting more out of your existing workforce," says Billy Bardin.

Digital tools also help with reliability, allowing operators to monitor assets and address faults before they become critical. This in turn allows companies to more accurately plan their resources, Bardin says. "One of the things we've used to push this forward at Dow is the improvement we can have from a safety perspective," he says.

For example, "in our maintenance activities we're removing individuals from potentially hazardous environments like confined space entries," he says.

Despite its obvious benefits, the process of digitization is not always easy. Flynn advocates checking to see if there are any particular applications that teams feel uncomfortable about digitizing—or believe could be improved through digital tools. "Find out what is really frustrating people today [and] where you think it brings the most value to your plant," he says. Furthermore, says Bardin at Dow, "You have to have the involvement and the initial buy in of all those individuals involved with deploying and making the technology successful. We've got technology groups that are global, that are accountable for identifying technology which can be deployed at multiple sites, in turnarounds or maintenance activity and operations, putting data in the hand of the field worker when they need it."

Improving reliability with data

One benefit of data is that a thorough analysis of failure records can be used to help improve the reliability of assets. This is an area that even leading downstream players are still grappling with. At Eastman, for instance, "there's a lot of good condition-based modelling [and] we've got a lot of data," says David Reed, director of plant maintenance. "Where we need to close our loop is with our management systems and how we utilize that data."

The company's data analysis "is still not robust enough," in Reed's view. Eastman is "pretty good on large, rotating equipment," he says, but has not yet identified all of its critical assets or implemented a comprehensive strategy to cover them.

Partly this is because the business is still largely relying on manual data collection and analysis processes. Hence, says Reed, a next step for the company will be to use tools such as machine learning and artificial intelligence to automate data acquisition and processing. The situation at BASF is similar, according to Amy Odom, asset manager for the polyols business in North America. "We do have some wireless vibration monitoring, for example on big agitators, and we've used that data to predict a few failures," she says.

But "typically the data is inconsistent [or] we're not interpreting it right. We're not checking all the boxes to make it as useful as it should be. So, we're pursuing some machine learning-type software."

One challenge at BASF is that the batch processing plants used for polyols do not run continuously, which makes it hard to establish a baseline for data processing. Furthermore, "agitators run very slowly so sometimes it takes a catastrophic failure to even know that something is going on," Odom notes. "We have a way to go in our journey."

Downstream assets may have hundreds of critical components and failure points, making them resistant to traditional condition monitoring analyses. It is hoped that tools such as artificial intelligence (AI) and machine learning can overcome this complexity. The use of such tools is giving rise to a concept known as 'digital reliability,' which "moves focus from the prognosis of equipment failure to diagnosis of equipment status," says Andrey Kostyukov, president and CEO of Dynamics Scientific.

"If you know exactly what's going on with your machine, with every piece of equipment, then you know exactly what should be done to prevent not [just] failure but even redundant maintenance or repair," he says.

This allows the operator to minimize the spend on maintenance while still ensuring the longevity of the asset, he says. "Digitalization brings transparency," comments Kostyukov.

Kimberly Gilbert, director of commercial technical engineering at Beyond Limits, an AI company, notes that one of the issues facing digital reliability is that many of the experts who might train and refine algorithms are close to retirement. Hence, "We encode the operator knowledge as part of the AI," she says. "We don't want that to be lost."

State-based control in process automation

Another area where data is transforming downstream asset maintenance is in process automation. Historically, the industry has relied on control systems for safe and reliable operations. Early plants were operated using large staff and control rooms, says Jonathan Huggins, process automation director at Dow. These control rooms were packed with instruments that each tracked a separate trend, so there was no integrated view of operations.

"The operator would make his rounds, walking around the control console, to look at these individual data points," says Huggins. "It was up to that operator to take individual pieces of data and put together how the asset was running."

Over time, the industry has improved upon this process by using mathematical models and electronics to enhance the capabilities of control systems and instrumentation. Control room space requirements have decreased to the point where an operator can now access detailed dashboards via a handheld device out in the field. The importance of control techniques is now such that they are often used to benchmark companies.

Even so, many traditional loop-based control strategies still rely on operator expertise. Operators are tasked with getting plants up to speed following a start-up, based on memory or written instructions. And their reaction to issues is conservative, defaulting to shut down the plant in the event of a problem. This maximizes safety but compromises productivity and reliability. Since the 1960s, though, Dow has been using automation to switch to state-based control. State-based control "is where all the plant operating modes and parameters are defined, documented and agreed to, and captured in the control system configuration," says Huggins.

This intelligence is then coded into the control computer, which then oversees operation of the process. Equipping the computer with the collective experience of operators, subject matter experts and technology specialists means "the best operator is always on shift," Huggins says.

At the same time, getting the computer to automatically reconfigure valve modes, enable alarms and change alarm set points as needed means that operator interactions are minimized. This can help reduce unscheduled downtime, which costs the industry $20 billion a year or 5% of yearly production, according to ARC. The advisory group says 80% of this downtime is avoidable and 42% is due to operator error.

"We invest in advanced computer software, people and maintenance to run at optimum condition, but we still are heavily dependent on manual intervention at the most stressful operational times to run our assets," Huggins points out.

At Dow, when plants have moved from traditional loop control to state-based control it has resulted in a 60% reduction in operator interactions, a 50% reduction in alarms and up to a 5% increase in production.

Smart assets

At the level of individual assets, one key area of interest to downstream operators is how to improve performance through technological enhancement. The downstream sector has already progressed beyond reactive maintenance for assets, says Jaclyn Arnold, vice president of Hexagon PPM. And "predictive maintenance is a hot topic," she says.

However, there is some way to go in terms of adoption of predictive maintenance; 67% of oil and gas operators still do not have digital twins to support more advanced maintenance strategies, Arnold notes. "The problem we see some run into is, do you have the digital enablers you need to bring in condition-based monitoring?" she observes.

The industry is to nevertheless trending towards the development of smart assets. Pal Roach, global process automation consulting leader at Rockwell Automation, defines these as "high-value process manufacturing equipment whose life-cycle performance has been enhanced by the use of digital technologies."

These could include compressors, pumps, heat exchangers, process units and so on. "The high-value assets are used to produce product in a downstream refining or chemical manufacturing facility," Roach explains.

Robin Harris, global projects control lead at Phillips 66, says smart assets can have improved predictability, reducing maintenance effort and cost. "At the end of the day all of these technological advances are around making better decisions," she says.

One of the barriers to achieving greater condition-based monitoring and proactive maintenance is that asset information may sometimes be lacking. At OQ Chemicals, for example, one of the things that has held back the implementation of higher levels of predictive maintenance is limitations inherent in condition monitoring systems, says Lauren Willard, maintenance and reliability manager.

It is important to ensure such limitations are overcome because "the last thing you want to do is make an investment and a year later no-one's using it," she says.

Similarly, "cleansing your data is pretty important," says Harris. "There isn't a lack of data. The problem is it isn't all clean." Yet another issue is that while many smart asset applications are user friendly there can still be problems with usability, often as a result of a general lack of digital awareness on the part of users. Willard says wearable technology has helped to smooth the path towards smarter maintenance practices, for example by allowing a technician in the field to initiate a zoom call with a remote expert when consulting a fault on a compressor or similar asset.

"We're easing our workforce into wearable technology," she says.

The deployment of wearables is dependent on the availability of wireless networks, so it is important to make sure the underlaying network infrastructure is available to support new technology. Phillips 66 has also piloted wearables and experienced significant safety benefits, although they "didn't increase our productivity [according] to expectations," Harris says.

Nevertheless, "It's almost commonplace to have an iPad or a smartphone while you're in the environment," she says. "We're getting that data a lot quicker in a turnaround environment. We're making real-time decisions based off getting information quicker."

The loss of talent

Challenges in user adoption of new technology highlight a creeping issue for downstream: experienced workers are getting older and there is a real danger of a loss of talent. The consulting firm Deloitte highlighted this trend back in 2015, noting that there were skills shortages in the generation that was replacing older employees and that the industry was generally an unpopular choice of employer.

In the United States, said the firm, "Within the next 10 years, 23% of the chemical workforce will be eligible to retire. On average, the workforce in the chemical industry is older than that of all other industries except agriculture, transportation and public administration."

Talent shortages are expected to have a particularly acute impact on senior professionals. This corresponds to the 10% to 15% of the workforce that drives any organization, says Junaid Muhammad at Huntsman. Research by the management consultancy firm McKinsey indicates that in very highly complex jobs there can be up to an 800-fold productivity gap between average and high performers, compared to 50-fold for low-complexity tasks.

"Therefore, it's important we get the right talent or the right skillsets for the positions," says Muhammad.

The loss of downstream talent cannot be remedied by procedures and systems, he says. Furthermore, problems in finding and retaining people with the right skills are exacerbated by the rapid pace of technology evolution, which tends to exclude older workers. Nevertheless, there are four simple steps that downstream operators can take to remedy the situation:

- Develop a good culture. Lisa Sordilla, vice president of human resources at employee engagement firm Energage, says companies with an 'intentional culture' can retain eight out of 10 employees, compared to 4.5 out of 10 for companies with 'accidental cultures.'
- Identify required skill sets. For this, it pays to develop a scoring matrix and customize it in as much granular detail as possible, covering technical, leadership and soft skills. And "please don't oversimplify your scoring metrics," Muhammad says.
- Establish a consistent hiring process, including group interviews and feedback. If no obvious candidates are available, look globally, outsource or automate, select the best alternative or supplement competencies from other team members.
- Train and retain. You need to develop a customized training plan for each individual, Muhammad says. "It should not be a tick-mark exercise," he says. "These individuals are highly motivated. And they want to grow within the organization."

Even following a successful talent recruitment drive, it is important for organizations to maintain a pipeline of candidates. "The talent will continue to move on. And we'll need to backfill the positions," says Muhammad. "Therefore, do as much scenario planning as possible. Identify the individuals who can take the key positions and train them. Make them ready to take on the challenges of these positions. They can be promoted whenever the opportunity arises."

Outlook and conclusions

To say the downstream sector has been affected by the events of the last 18 months would be an understatement. Oil majors lost an average 39% in market capitalization in 2020, according to audit firm PwC. Meanwhile, "Chemical companies are witnessing intensified cost pressures to protect margins," warns EY, another accountancy firm. Downstream operators have had to adapt to an unprecedented environment. "We're making sure we screen all our employees and go through all the precautions at our facility," says Dave Reed, vice president of sales and services at contracting firm Austin. "What we see most often is that the client is doing the same thing, so we're doubling up on our testing."

At Ineos, with any contractor that comes through the gate, "we are screening them for temperature," says John Clark, turnaround specialist. "We have a questionnaire that's filled out on site. We've had contractors we've had to turn away."

However, there is light at the end of the tunnel. At the start of July 2021, almost half the U.S. population was fully vaccinated. And many territories worldwide were pondering or initiating the easing of coronavirus restrictions. This could spell a return to normal operating procedures for downstream companies. But it would perhaps be a mistake to go back to old ways of maintaining assets and undertaking turnarounds.

What is clear is that beyond the unusual circumstances of the last 18 months the industry continues to face unique challenges and opportunities. Digitalization, for example, is delivering tools for improved efficiency, potentially making it easier to incorporate more capital projects into turnaround plans. Similarly, modern data analysis is helping facilities operators to make improved decisions, more quickly.

Against these plus points, resourcing is a growing challenge for the industry—and not one that can be solved purely through automation and efficiency gains. Plus, many downstream players still have some way to go on their technology journeys, meaning current investments in digital capabilities might not pay off for some time. Finally, the wider market environment remains uncertain.

Although demand for plastics is due to continue growing, the calls to cut plastic pollution and switch to more sustainable alternatives cannot be ignored. The upstream sector is already bearing the brunt of a surge in sustainable thinking, and downstream players would be naïve to imagine that they are immune to similar trends.

The takeaway for downstream is that the flexibility that has helped the industry overcome the adversities of the last 18 months should not be forgotten. Instead, there is a need to build upon that resilience and imagine new concepts, processes and models to deal with the future.

Part of that process must involve information sharing, and for this reason Downstream USA 2021, at the NRG Center in Houston, Texas, from October 12 to 15, will be a key event for the sector. Don't miss it.

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This whitepaper was released in connection to the Downstream USA 2021 hybrid conference (Oct 12-15, Virtual Oct 21-22, Houston). If you like what you read the same business critical insight will be shared across our 4 hybrid, dedicated tracks; Leadership Plenary, Engineering & Construction, Reliability & Maintenance and Shutdown & Turnarounds.

As the world's economies fire up for revival it has become clear that downstream, and the products we produce, are critical to global recovery.

To meet this obligation the industry must overcome volatility in demand, changing customer requirements, disrupted operations and an overwhelming imperative to harness technology.

The industry's most influential figures, including the CEOs of Dow, Chevron Phillips Chemical, the CIO of Shell and EVP, Downstream & Chemical of Chevron, have answered our rallying cry to unite this October for the most crucial downstream event in a generation to get downstream, and the world, back to business.

Join them at the world's most trusted destination of industry insight and collaboration, Reuters Events Downstream USA 2021. Where we unite the whole refining, petrochemical, chemical and LNG value chain and lead the charge to meet the demands of tomorrow's economies across a host of virtual and in-person events.

Check out the event here!