

2018 Achieving Operational Excellence in Maintenance and Turnarounds

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The 2018 Achieving operational excellence whitepaper provides a critical analysis of some of the top challenges owners are facing today with downstream turnarounds and maintenance. Interviews with top managers illustrate some of the gold-standard innovations and best practices maintenance and turnaround teams are using to solve these dilemmas.



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Our analysts are known for independence, fundamental research, foresight and original thinking. Our clients are petrochemical operators, refining operators, LNG operators, contractors, service providers and other consultancy firms.

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This whitepaper covers:

1. Top challenges turnaround and maintenance teams have faced and the innovative solutions they created that led to operational excellence including: scheduling and planning changes, job description updates, developing review processes and implementing Industry 4.0.
2. Balancing technology with communication, and leadership strategies that promote operational excellence.
3. Augmenting communication and management with technology and game changers that help teams automate turnaround tasks and reduce non-productive time and end paper tracking.
4. Plus, technology to increase collaboration and show a full audit history of who is doing what, when and why.

Featuring Insight from:



Chris Vaughn,
Manager Turnarounds,
Addivant



Chris Leonard,
Continuous Improvement Project Director,
Dow



Kevin Strader,
Turnaround and Reliability Engineer,
BP



Glenn Healey,
Regional Vice President, Sales
Appian Corporation

Introduction

The US downstream industry's renaissance continues in 2018 with capital spending expected to rise by more than 6% from 2017 and planned maintenance spend to increase by 38.5% to \$1.26 billion, according to the latest data from trade associations.

U.S. refiners are poised to spend at least \$1.26 billion on planned maintenance spend in 2018, according to estimates from Industrial Information Resources (IIR).

Refiners will increase planned maintenance spend by 38.5% to \$1.26 billion in 2018, according to IIR. The chemicals processing sector will see a 4% increase.

Scheduled plant outages, turnarounds and shutdowns increased by 5.4% to \$10.43 billion across all U.S. Industrial Markets in 2017, according to IIR.

With bigger outlooks amid increasingly squeezed budgets, reduced margins, aging assets and pressure to improve productivity and efficiency; one of the key priorities across both Maintenance and Turnaround departments is to look for innovative solutions to age old problems while achieving operational excellence.

To achieve operational excellence, teams must shift the culture away from an outlook of 'this is how we have always done things' to one where new innovations, process and technologies are embraced organization-wide.

Turnaround and maintenance teams face many challenges in achieving this gold standard including organizational culture, staffing, change fatigue, adequate and appropriate training, lack of technology infrastructure, and even communication.

With the next 3-5 years expected to see a high number of shutdowns, turnarounds and outages at petrochemical plants & refineries in the US, it is more important than ever for owners to build effective and innovative plans and processes to deliver projects on time, on budget and safely.

This white paper features insight from seasoned turnaround managers, maintenance teams, and industry consultants in North America to highlight the key strategies and latest lessons learned at petrochemical and refining facilities that have significantly improved their turnaround programs and developed a culture of operational excellence. This paper places emphasis on:

- How turnaround managers can use technology to address the most pressing challenges
- Communication and leadership strategies that promote operational excellence
- Innovative solutions to the most common problems turnaround and maintenance teams face

Outlook

In its year-end 2017-2018 outlook, the American Chemistry Council (ACC) noted that American chemistry is experiencing a “renaissance” as new investments come online while others continue to be announced. At the same time, US chemical companies continue to research improving efficiencies and product development.

U.S. chemical manufacturers remain advantaged with access to cheaper and more abundant feedstocks and energy, helping push the number of announced chemical production projects to nearly 320 with a cumulative value of over \$185 billion, according to the American Chemistry Council (ACC).

In addition to the new projects, chemical industry capital spending continues to surge, reaching \$38 billion in 2017 and accounting for one-half of total construction spending by the manufacturing sector. Capital spending increased 6.0% in 2017, but will grow by 6.3% in 2018 and 6.8% in 2019, reaching \$48 billion by 2022, the ACC said.

“Our fundamentals remain incredibly strong and the U.S. remains the destination for chemical investment,” said Kevin Swift, chief economist of ACC, noting that 62% of the \$185 billion in announced projects is foreign direct investment.

Capital spending for bulk petrochemical and organic intermediates, along with spending for plastic resins, will dominate, according to the ACC.

(thousand metric tonnes)									
Company	Country	Location	2016	2017E	2018E	2019E	2020E	2021E	2022E
USA									
CP Chem	USA	Cedar Bayou, TX	-	-	1,500	1,500	1,500	1,500	1,500
Dow Chemical	USA	Plaquemine, LA	805	1,009	1,009	1,009	1,009	1,009	1,009
Dow Chemical	USA	Freeport, TX	-	750	1,500	1,500	1,750	2,000	2,000
DuPont	USA	Orange, TX	680	680	703	771	771	771	771
ExxonMobil	USA	Baytown, TX	-	-	1,500	1,500	1,500	1,500	1,500
ExxonMobil / SABIC	USA	Corpus Christi, TX	-	-	-	-	-	900	1,800
Formosa Petrochemical	USA	Point Comfort, TX	-	-	300	1,250	1,250	1,250	1,250
Formosa Petrochemical	USA	St. James Parish, LA	-	-	-	-	-	400	1,200
Indorama	USA	Lake Charles, LA	-	-	370	370	370	370	370
LyondellBasell	USA	Corpus Christi, TX	771	1,134	1,134	1,134	1,134	1,134	1,134
Occidental - Ingleside	USA	Ingleside, TX	-	550	550	550	550	550	550
Sasol Polymers	USA	Lake Charles, LA	-	-	375	1,500	1,500	1,500	1,500
Shell	USA	Monaca, PA	-	-	-	-	-	750	1,500
Shintech	USA	Plaquemine, LA	-	-	250	500	500	500	500
Total / Nova/ Borealis	USA	Port Arthur, TX	-	-	-	-	-	500	1,000
Westlake	USA	Calvert City, KY	286	318	318	318	318	318	318
Westlake	USA	Lake Charles, LA	590	660	660	660	660	660	660
Westlake / Lotte	USA	Lake Charles, LA	-	-	-	500	950	950	950
Nova / SABIC (Williams)	USA	Geismar, LA	900	900	900	900	900	900	900
Incremental Capacity			341	1,969	5,068	2,893	700	2,800	2,950
Total USA Capacity			29,002	30,970	36,038	38,931	39,631	42,431	45,381
Capacity Growth			1.2%	6.8%	16.4%	8.0%	1.8%	7.1%	7.0%
Canada									
Nova Chemicals	Canada	Corunna	894	949	1,007	1,007	1,007	1,007	1,007
Incremental Capacity			55	55	58	0	0	0	0
Total Canadian Capacity			5,291	5,346	5,404	5,404	5,404	5,404	5,404
Capacity Growth			1.1%	1.0%	1.1%	0.0%	0.0%	0.0%	0.0%
Mexico									
Braskem	Mexico	Nanchital	525	1,050	1,050	1,050	1,050	1,050	1,050
Incremental Capacity			525	525	0	0	0	0	0
Total Mexican Capacity			1,909	2,434	2,434	2,434	2,434	2,434	2,434
Capacity Growth			37.9%	27.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Total N. American Capacity			36,201	38,750	43,876	46,769	47,469	50,269	53,219
Total Capacity Growth			2.6%	7.0%	13.2%	6.6%	1.5%	5.9%	5.9%
ROW									
Incremental Capacity			2,698	2,807	4,238	3,582	3,032	1,764	1,119
Total Global Incremental Capacity			3,619	5,356	9,363	6,475	3,732	4,564	4,069
Total Global Capacity			163,981	169,337	178,700	185,175	188,907	193,471	197,540
Total Capacity Growth			2.3%	3.3%	5.5%	3.6%	2.0%	2.4%	2.1%
Global Operating Rate			88.9%	88.6%	86.5%	85.0%	87.0%	87.8%	88.9%

Note: Shaded areas represent prospective capacity expansions

Source: Chemical Data, Company Reports, and Vertical Research Partners

Spending for buildings and structures present strong opportunities during this period, beginning with spending for site preparation and utilities and then building and installation taking over. Major process equipment has largely been specified and procured for most projects although delivery will still occur.

“American chemistry is riding a synchronized global upswing,” Swift said. “Manufacturing has turned a corner, business investment is on the rise, and domestic oil and gas production is on the rebound. It all sets the stage for tremendous momentum, expansion, and capital investment,” he added.

The United States has now been favorably re-evaluated as an investment location by analysts, and petrochemical producers have announced significant expansions of capacity in the U.S., reversing a decade-long decline in the 2000s.

A new capital spending cycle began in 2010 as chemical manufacturers recovered from the financial crisis and as significant expansions of existing petrochemical capacity emerged due to new supplies of natural gas. The gains to basic olefins capacity during the 2010s are estimated at nearly 40%, according to the ACC.

As a result, chemical industry capital spending in the U.S. surged 67% in the subsequent seven years, reaching \$33.8 billion in 2017.

During recent years, chemistry has accounted for one-half of total construction spending by the manufacturing sector.

By 2022, U.S. capital spending by the chemical industry is expected to reach \$48 billion, nearly two-and-a-half times the level of spending at the start of this prolonged cycle in 2010.

“The dynamics for sustained capital investment are in place and ACC continues to track the wave of new investment from shale gas,” the ACC said.

Accelerating growth in U.S. chemistry across all segments

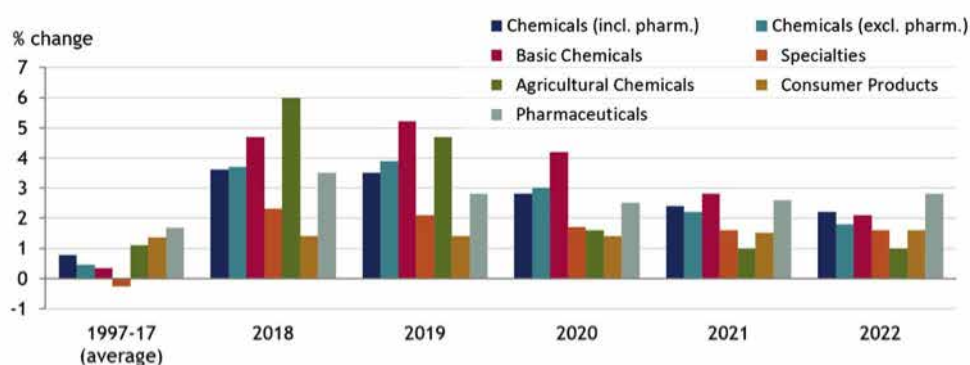


Image: American Chemistry Council

Operational Excellence in all phases

Operational Excellence is much more than just the mechanical execution of turnarounds, top managers believe.

“Operational excellence happens in all phases of the turnaround – Planning/Scheduling, Execution, and Critique,” said Chris Vaughn, Plant Manager at Addivant. “Significant energy and effort takes place years or months before a turnaround is executed. Operational excellence cannot happen in execution if it doesn’t happen in the planning and scheduling phase.”

Operations, Maintenance, Capital, Contract Administration are all stakeholders in every phase of the turnaround and the teamwork, or lack thereof, can influence the performance during execution.

“The teams that I had the privilege of leading took a focused approach towards operational excellence in identifying the turnaround scope, scheduling the work activities and understanding the commissioning sequence,” Vaughn said. “We have several successful turnarounds because the team was focused in all phases including critique.”

Review procedures

Post-event feedback is important as it provides the reality check of what went right or what went wrong during the turnaround or maintenance event beyond scheduling and budgets. Keeping track of problems is important to progressively avoid these pitfalls again and can be the motivation to develop a new system.

Organizations that hold themselves accountable as well as other organizations share a mature characteristic of operational excellence.

An open and honest discussion on what went well and what needed improvement was the key to turning things around after Vaughn’s first critique with his team. The critique was used to develop the group’s turnaround procedures and practices and has led to greater accountability.

“Organizations are holding themselves and other organizations accountable in the critique and action plans that we developed,” Vaughn said. “Complacency is the biggest risk when performing critiques. Teams need to be introspective and work to develop their skills in the gaps identified in critiques.”

Assigned key roles

A huge challenge managers mention is being able to put 100% focus on the turnaround during the planning and scheduling period. Employees have their day to day job and are consumed with the day to day activities and sometimes fire-fighting issues as well.

“Leaders need to balance day-to-day activities and long-term objectives of a safe and efficient turnaround,” Vaughn said. “Turnarounds are usually neglected until it is time for execution and then it is far too late for a miracle.”

Vaughn said he brings on a dedicated turnaround leader and dedicated planners and schedulers during the events.

“Turnarounds can be the biggest capacity release source for a site or organization, but some leaders don’t share that perspective,” Vaughn said. “A dedicated team will pay for itself.”

Contingency plans

As much as any maintenance and turnaround team wants scope frozen as early as possible, inevitably there will always be discovery work or scope growth.

The best way to prepare is to identify any high-risk inspections or work activities in advance. Engaging the appropriate MIQA Inspectors, SME’s (senior mechanical engineers), and Contract Administration on Risk Assessments and Contingency Plans early has proven to be effective for Vaughn.

Contingency plans should be developed because of the risk assessment, Vaughn said.

“Most of the risk in turnarounds is already identified within the scope, it’s a leader’s responsibility to engage the resources and find out how the team will adjust to discovery work or scope growth,” Vaughn said. “It does take significant time and energy, but is critical to turnaround success.”

Excellence in Execution

Turnaround and maintenance leaders are tasked with more than ever before as they must deliver streamlined operations in a challenging climate. Leaders are pressured to deliver more turnarounds per year, with less time available to plan and execute each event. Turnarounds are complex and difficult to manage, requiring major capital outlays and even a small risk can put operators at risk.

Technology

Glenn Healy, vice president of sales at Appian believes a key factor for these issues is having outdated technology, and depending too much on manual systems across a company’s many departments.

As organizations have grown over the years, rather through acquisitions or general organic growth, various departments and technology have been separated into silos. A company may have a stellar maintenance department, another great procurement group, a finance department, but all these lines of business with the organization have their own technology to support their own departments.

"The challenge is these core business processes go across all these systems and people," Healy said. "Today the way these systems work, nothing is unified, so this presents a real challenge because there is this white space between the lines of business and departments and people. You can't see who is doing what and who is working on what. There is a lack of visibility, a lack of control and a lack of agility."

Moving to an automated system is the answer for collaboration issues and a host of other problems, according to Healy. Project management tools like Appian start with a solution such as Oracle's Primavera, SAP or Microsoft and provide a centralized platform of project intelligence throughout project completion that increases organizational competence, provides a common framework for project management, and helps contractors get up to speed quickly.

Automating turnaround tasks reduces non-productive time and ends paper tracking; increases collaboration by showing a full audit history of who is doing what; helps to meet forecasts with real-time access to performance and task completion data; and can the Appian interface can integrate with SAP, Oracle Primavera, Microsoft and more, Healy said.

"I look at operational excellence as the opportunity to fix the accidental architecture of the last couple of decades within organizations," Healy said.

Appian Case Study 'Reducing the manual processes'

One Appian customer documented a \$35 million savings with one turnaround that was across seven refineries.

"Each turnaround found there was multimillion-dollar savings in automating the processes and replacing the manual paper based processes," Healy said.

Automating reducing paper tasks. Being able to optimize resource allocation, inspection, schedules, integration is the ability to maximize data access without having to log into multiple systems.

This group was spending years in advance, planning for a turnaround when the unit would be shut down 30 plus days. They brought in many contractors and worked them 24 hours around the clock. Any hour lost, any day lost, cost the organization millions of dollars, Healy said.

When turnarounds are planned, most units are using a planning program such as Oracle or Primavera on front end. But when it gets time to start the turnaround, they print everything on paper for the contractors. The contractors may have 1000 tasks at a time to complete in a short period of time.

Contractors are not familiar with the standard work flow at the plant, so changes and status reports are particularly difficult, Healy said.

"People don't know who is doing what, or when. And often times plans must change," Healy said. "At the end of the shift, someone only finished two of their five tasks and they have to update the system so the new crew coming in realizes where to pick up work and they will in turn spend hours doing the handoff when the new shift comes in."

This was an issue if a contractor noticed something that needed to be addressed during his shift, Healy said.

"Imagine a contractor going through a turnaround and they see something that needs to be addressed that was not part of the plan. Now that work must be stopped, completed, but first it must be approved, then they have to update the plan and add it to the schedule," Healy said.

"When working on manual systems, this is all paper based, so it takes them time to know how to add

to the system. Another challenge is once one system is updated, the other systems still need to be updated. That lack of visibility and agility really slows things down," he added.

Appian was able to help this refiner by developing a user system in real time.

"Imagine if we take information in from Oracle or Primavera, and then we manage those 1,000 tasks, look at who is working on what, how much lag time there is, how long each task took, etc. Based on the decision of that next step, we can go many different ways on that next step. We can build in rules and exceptions," Healy explained.

Photos and voice additions can move to the next person via simple integration. That takes away the task of having to call and set up meetings and find the right person to help get to next step. The ability to find those areas of automation are key. This system gives mobile ability to work anytime on any location.

When contractors are coming off a 12-hour shift and hand off new areas where they left off. They now have a 5-minute handover versus a one-hour status meeting.

Contractors take photos and do voice recordings on the job. So if they go through a maintenance project, they can add photos and voice to the system, and it is all in one single case easily transferred on to the next person.

When a contractor found a leaky valve that was not part of the maintenance plan, he was able to save time by getting approvals quicker. In the past, the contractor would need to submit this through a lengthy process to get approval to fix it. Now, the contractor can add details, images and more directly to Primavera so the detail gets to the decision maker quicker.

Appian has helped companies turn the accidental architecture around and save millions of dollars by helping connect people, processes and data in a cohesive environment that allows a single user interface to be able to put the right information to the right people at the right time in the right context, regardless of where the data lives.

"The idea is to put the right processes and data in the right hands at the right time," Healy said. "We need to be able to orchestrate an environment where people can gain the visibility of who is doing what, how decisions are made, in real time as well as a historical lookback."

The historical lookback function has been particularly helpful for groups to understand what went wrong in the past and how to avoid it.

"When we look back at historical turnarounds, often what happens is we have completed this turnaround and it was a 30-day turnaround and we missed our deadline by 5 days, so we ask why did we miss. We don't know. No one knows. We don't have the answers," Healy said. "Everything is all paper based, so we have to look back at all the paper documents and track back. It becomes an exercise of analysis. Analysis causes paralysis, and nothing gets done."

Companies want to shave hours off these projects per day and reduce risk from project slippage or unscheduled incidents and that means having the necessary information available at your fingertips instead of having to chase it around the organization, Healy said.

Dow Case Study 'Innovation and Continuous Improvement'

At Dow Chemical, innovation, and investing in its people is key to success and driving continuous improvement.

"In Dow, operational excellence in maintenance and turnarounds means we strive to be the safest, most cost-effective teams for delivering reliability, maintenance, turnarounds, and projects. We also ensure our assets operate in an environmentally sound manner, and we meet our customers' expectations," said Chris Leonard, Reliability Project Director at Dow. "This is achieved through integrated (operations, maintenance, projects), empowered teams working as a highly skilled, highly leveraged, highly productive and innovative work force coupled with consistent, effective corporate metrics to gage performance."

"Dow's work processes coupled with our people's knowledge, skills, and teamwork enable our success," he added.

Industry 4.0

Recently, Dow has implemented its own version of Industry 4.0 targeted specifically for manufacturing.

"It is important understand the innovations in technologies available and how best to exploit them to improve the bottom line," Leonard said. "This positions Dow operations as a leader in the Fourth Industrial Revolution by identifying opportunity and narrowing our focus so we are ready to deploy people and capital as available."

Powered by five support technology thrusts; analytics, robotics, digital thread, process control/ process automation, and mobile solutions, these enablers provide the smart technology and real time data needed to define value generation for Dow and establish Dow as a top competitor in a rapidly changing environment

"This effort is a breakthrough initiative in our operations strategy that is designed to improve productivity and competitiveness while driving continued growth and raising enterprise-wide performance," Leonard said.

Continuous Improvement

Dow has embraced a policy of Continuous Improvement and utilizes a number of key processes and tools to ensure that Continuous Improvement is a way of life for its employees.

"Top down support is critical. From the CEO to the shop floor, it is understood that for Dow to be competitive, we must continue to improve and exceed our customers' expectations in a safe and environmentally sound manner," Leonard said. "As such, we have to continually improve employee access to the Continuous Improvement support needed for success."

Applying this approach to Dow's efforts in improving holistic reliability from raw material to customer delivery has led not only to the liberation of billions of pounds of production, but also improved performance in areas not historically associated with reliability such as accurate customer invoicing, Leonard said.

Training and investing in people are a key part of the continuous improvement plan.

"Our people are our greatest asset. We invest not only in skills and knowledge training, but also help them understand the behaviors needed to operate and maintain our assets reliably," Leonard said. "We

invest in our leaders in unique ways to help them understand how to motivate their organizations to achieve results.”

Continuous Improvement is built into everything Dow does and is an expectation of every employee, but training employees in every continuous improvement enabler would not be value added, Leonard said. Instead, the Dow approach is to provide information on the continuous improvement enablers and allow employees to customize their learning based on what they need for success in their role or project.

“Ensuring the continuous improvement mindset or culture is sustained takes constant reinforcement from every level,” Leonard said. “Part of the effort requires our employees to know where to find effective and efficient training on the enablers they need as well as who the subject matter experts are that can help accelerate their progress.”

“In addition, the key to success is to make continuous improvement personal...something that every employee can act on and contribute to overall improvement,” he added.

Operational excellence involves operations

Operations must be involved with understanding all the pre-turnaround activity and help to build the schedule and execute it, managers say.

“Operations needs to be fully integrated into maintenance events. There cannot just be a wall where people say, ‘oh that’s a maintenance event and no concern to us,’” said Kevin Strader, Petrochemicals Turnarounds Assurance and Reliability Engineer at BP. “Operations needs to actually pull maintenance in and have the mindset that it is a one team event.”

“We want to be fully integrated,” Strader said. “If we don’t get these things right from an operation standpoint, it leads to a very ineffective, inefficient turnaround.”

Operations needs to be involved with pre-activities such as scaffold, putting together the lay down areas before the turnaround, sectioning off areas that are going to be designated for parking or materials staging, or things of that nature,”

It is important for operations to be involved in getting as much pre-turnaround work done as possible that does not involve the unit being shut down including civil work and pre-turnaround activities. Operations should think through things that need to be done closer to the turnaround, what can be done anytime, what can be done ahead of the turnaround, what can be done during the turnaround, Strader said.

A lot of scaffold must be built before the turnaround, but scaffold has a way of getting in the way of operating the unit. Operations can help make sure that scaffold is built in a way that will minimize daily operations.

“Some things you can even do while equipment is operating, like de-insulating a vessel, and operations needs to be involved with understanding what that work is that needs to be done and with the schedule,” Strader said.

A big challenge operation struggles with, according to managers, is helping to identify all the scope of the work ahead of time, but freezing the scope early will lead to operational excellence.

BP’s goal is to freeze the scope ideally nine months ahead of time before the turnaround begins.

"We recognize that the plant will run nine months and something may break and we may need to add on stuff, but we want to get operations involved in getting items in the system as much as possible early on. and not dragging their feet to freeze the scope," Strader said.

BP Case Study 'Turnaround Common Process and Reviews'

BP has developed a Turnaround Common Process, which are activities and milestones that must be done in certain times, and operational responsibility is assigned for some of those activities.

The operations turnaround plan needs to be completed two months in advance of the event, planning starts six months in advance. A maintenance coordinator from operations is assigned to manage the event. Their responsibility is to coordinate the maintenance efforts in the unit, and to be the interface between maintenance and operations.

"They know the unit. They have worked in operations. They are responsible for writing the notification that can turn into maintenance work orders," Strader said. "They are the chief person they are involved in developing the scheduling, understanding the density of the work orders."

Ideally the coordinator is assigned full time to the turnaround six months in advances. It is rare for this to be a year-round job, a person generally transitions to this full time role just for that turnaround, and then after the activity they go back to that normal job.

Maintenance Transformation Reviews

During reviews, BP realized that a key issue was the inconsistent, emotionally charged priority put on various maintenance tasks. After hiring consultant Renoir, to help develop and implement a new system, the refiner is seeing seven-figure return on investment across its plants, Strader said.

"We are seeing in the millions in efficiency gains combined across the sites. Its'been a good investment," Strader said. "For measurement, we are constantly looking at our KPIs and staying on track doing self-verification activities."

"When you talk about operational excellence and the fundamental blocking and tackling of maintenance activity, this has been a big win for us," Strader added.

The maintenance transformation involved improving the efficiency of the executing of maintenance work and assigning priorities to tasks, plus adding a review.

Rather than writing a problem on a piece of paper and handing it to the maintenance coordinator, BP has trained its team proper notification writing which includes being specific, adding the equipment number and details about the issue.

BP then introduced a criticality matrix to help prioritize this work which involves a number system. Each piece of equipment has a number and the type of work needed has a number. These numbers are multiplied together to get the criticality matrix number. The bigger the number, the bigger the job.

We had to train around proper notification writing and we had to train operators on what type of information is important to have," Strader said. "It is a whole new learning for everyone, from operations to engineering. It is has made for more efficient understanding of work."

Connect the human chain

Downstream operators focus on technology and high-level charting when it comes to turnarounds, maintenance and major projects; but, many projects and teams are often missing the communication aspect, according to analysts.

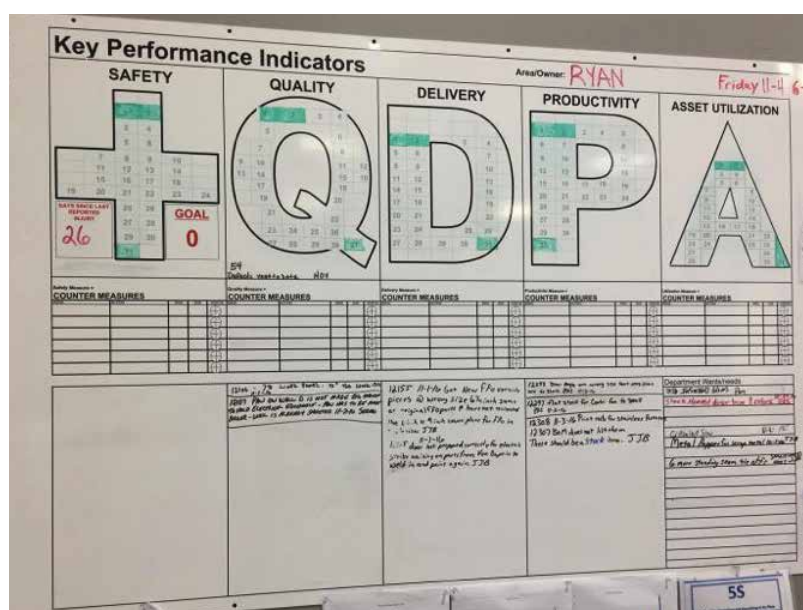
Advanced sustainment and lean operation methods are used by operators like Suncor, Shell, and ExxonMobil to get through turnarounds and projects. Documented improvements have been seen in schedule accuracy and attainment by more than 15%, work order quality by more than 20%, and reducing contractor needs by more than 15%, according to Argo Consulting.

Advanced sustainment methods focus on building people skills and interactions, while lean operations focuses on improving the process. By using components like visual boards, visual management tools and leader standard work, operators can channel high-level work programs down to a pragmatic real-time and flexible communication approach so that employees are interconnected at the right points for maximum project success and able to react to unforeseen events.

Visual management boards are used to communicate the status of safety, quality, cost, and delivery on a real-time basis and are also used to update manually a metric(s) that means something to a craft team, such as work orders completed per shift, materials returned to warehouse or repeat work.

"Visual management techniques, if implemented properly, represent the targets and the status in real time. If the right people are in the room at the time and at the right frequency, collaboration, accountability and problem-solving happen naturally, because everyone is looking at the same data," Jorge Mastellari of Argo said.

"People who are responsible for getting the work done are making commitments face-to-face with their colleagues. This diminishes the dysfunctional modes that happen with one-way communication such as e-mail. The daily huddles typically end with commitment around the three critical actions to win today" he added.



"Visual management boards encourage individuals to engage "the conscious brain" which according to DWD findings is essential to promote the PDCA (plan/do/check/act) cycle for problem solving. The end game is to convert front line people from passive by-standers to active problem solvers," Mastellari said

Status Meetings

Various visual management styles can work effectively and the status meeting technique depends on the complexity of the turnaround or project, the amount of contractors, the length of the event and the particular site, Vaughn said.

"Smaller projects and standard turnarounds with less contractors might benefit with weekly status updates," Vaughn said. "A more complex turnaround or project with multiple contractors and day-to-day activities would necessitate daily status updates."

Vaughn's management process for smaller and less complex turnarounds would typically involve two 30-minute status update meetings each week and keeping a recap visual board updated daily for all participants to see. The status meetings typically take place twice a week, on Monday mornings to check in and establish the week's priorities, performance measurement, resources needed and any potential roadblock or barriers. Then, a check out meeting on Thursday afternoon is held to provide status updates and discuss performance and improvement goals for the following week.

"The supervisor leads the conversation around a clear target to win today and allows craft to adjust schedules according to priorities and potential issues," Mastellari said. "The supervisor has a finger on the pulse of every team and demands explanation for misses every time a craft team does not meet its work order target for the day. This provides engagement and accountability."

Weekly Check in Check out Board

	Maintenance RYG Indicator	Capital Project 1 RYG Indicator	Capital Project 2 RYG Indicator	Commissioning RYG Indicator
Objectives				
Results				
Barriers, challenges, risks				

Daily Recap Visual Board

Safety	Operations	Minor Capital Projects	MIQA Inspections	Status
Recognition	Maintenance	Major Capital Projects	Discovery Work	Problem Solving Sessions, Action Items, Announcements

Daily Recap Visual Management Agenda Items

SAFETY	OPERATIONS	MINOR CAPITAL PROJECTS	MIQA INSPECTIONS	STATUS
Daily safety theme	Status of Decommissioning, Prep, Commissioning and Start-Up Activities	List of all capital projects status with RYG Indicators	List of equipment inspected during day	Overall
Safety KPIs			List of equipment that can be returned to service	Critical Paths
Audit behavior and trends				Units
RECOGNITION	MAINTENANCE	MAJOR CAPITAL PROJECTS	DISCOVERY WORK	PROBLEM SOLVING SESSIONS, ACTION ITEMS, ANNOUNCEMENTS
Simple and Impactful	List of work activities completed per schedule	List of all capital projects status with RYG Indicators	Status of outstanding repairs to be completed before returning to service	Track action items with responsible personnel and timing
Broadly communicated to Site and Contractors through TAR Update Status E-Mail	List of work activities that did not get worked or completed per schedule			

Visual data board examples courtesy of Chis Vaughn

Conclusion

Although turnarounds and shutdowns are often planned months or even years in advance, Emerson Process Management found that 74% of plant turnarounds and outages fail to meet their performance goals.

40% of turnarounds miss their schedule and or budget targets by 30% or more. Schedule overruns average five days longer than planned, with an average cost impact of \$2 million per day late. Five-day overruns equate to around \$8 million loss for a turnaround project valued at around \$39 million, according to consultants at Aveva.

AP-Networks' study of medium and high-complexity turnarounds executed since mid-2012 shows that turnarounds most often fail due to increased event complexity, inefficient organizational capability, lack of engaged leadership, ineffective scope development and scope freeze, as well as inadequate capital project integration.

With the next 3-5 years expected to see a high number of shutdowns, turnarounds and outages at petrochemical plants & refineries in the US, it is more important than ever for owners to build effective and innovative plans and processes to deliver projects on time, on budget, safer and better than ever.

Innovative managers have looked at old problems and created innovative and new solutions which have in turn brought about a culture of operational excellence within their facilities.

By changing traditional processes, job descriptions and priority systems; improving technology and balancing human interaction, managers have brought about much needed change and operational excellence in the turnaround and maintenance sector.



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