

Optimizing efficiency through digitalization in chemicals, petrochemicals and refining
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Rodrigo Becerra Mizuno

Corporate Director & CIO
(Business & Digital
Transformation)
PEMEX

1. What does the subject of digital transformation and IoT mean to you?

For Pemex, digital transformation is a radical change in the way we drive our business leveraged by digital technologies and actionable innovation. The objective is to bring unprecedented value to our businesses. We apply digital transformation through three different layers:

- **People:** applying digital technologies in a disruptive way in the way we work and collaborate, but most importantly in the way we use information.
- **Services:** developing new and better services with a user centric approach that empowers the user and the business to make them more agile, efficient, and better connected to boost profitability.
- **Business models:** using digital to generate value through new offerings in products and services to reward our customers and partners.

Given the nature of our business, where we can have many things in our value chain connected, IoT is one of three key initiatives on which we are working this year to make digital transformation a reality. So far, we are running pilots in some of the following business units: Upstream – production monitoring; Midstream/Logistics – creating the digital fuel-storage facility; Downstream – predictive maintenance, and inventory monitoring.

2. What's the greatest impact IoT, data analytics and AI will have on the industry? What lies ahead of operators and how will they adapt?

- **Internet of Things** – Collecting, managing and driving value from data is at the heart of the oil and gas industry. Most oil companies are migrating IT infrastructure to the cloud and using data collected via mobility and the Internet of Things (IoT) to support decision making in

areas such as operational efficiency (increasing productivity by as much as 30%), predictive maintenance (saving up to 12% over scheduled repairs, reducing overall maintenance costs up to 30% and eliminating breakdowns up to 70%), supply chain/material tracking (5-10% cost reductions in spare parts), and increase in worker productivity (15-25% reduction in contractor labor costs)¹.

- **Data Analytics** – The use of analytics is becoming more routine in oil and gas, both to improve operational performance (improving production throughput by 3-10% and reducing 1-2% volume losses and quality issues) and applied to predictive analytics for optimized plant turnarounds and maintenance (increasing maintenance worker productivity by 5-10%, and reducing contractor and maintenance service costs by 10-20%).
- **Artificial Intelligence** – The oil and gas industry can benefit from technologies such as robotic process automation (RPA), artificial intelligence (AI or machine learning) and virtual agents as value levers. Machine learning can be used in many oil fields and plants to increase efficiencies (5-15% reduction in operating expenses and inventory costs), reduce downtime and avoid costly shutdowns (12% reduction over scheduled repairs and breakdowns elimination up to 70%), for example, providing operators with quick access to years of data and analytics rather than relying on the experiences of individual employees. Virtual assistants are becoming increasingly common, primarily in customer service, with many now specializing in conversational speech to help search and provide support. AI is being used to boost efficiency in RPA, making operations more efficient (additional 5% reduction in operating expenses) and freeing workers for insight-driven analytics work.

By boosting efficiency, digital advances could help oil companies overcome cost challenges in the short to medium term. However, they could go further, tearing up traditional operating models, transforming customer experiences, and finding new value, thereby securing alternative routes to revenue growth in spite of prevailing industry conditions. In this scenario, **operators will need to adapt accordingly:**

- **Identifying digital as a growth and value lever.** Proactively planning strategies and committing investment to create synergies across business units, optimize investment decisions and open their business to new opportunities
- **Focusing on new products and services built with digital technologies** from which similar value to that derived from the core oil and gas business itself is expected.

¹ World Economic Forum. Digital Transformation Initiative, Oil and Gas Industry. <http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/dti-oil-and-gas-industry-white-paper.pdf>

- **Focusing on the customer experience** across the wholesale and retail sides of the business, including integration with supply chain and procurement. Digital is increasingly important in global supply chains, by tapping into an ecosystem of new markets and players.
 - **Transforming their operating models** to one increasingly enabled by technology (e.g. gaining efficiencies from standardized processes; increasing automation; outsourcing non-core functions; engaging in a more variable approach to cost; and using analytics to optimize day-to-day operations) to **improve effectiveness and optimize the cost structure.**
- 3. How do you see the role of the Industrial Internet of Things in refining, petrochemicals & chemicals? What are the key benefits and opportunities of using IIoT solutions in downstream operations?**

There is a huge potential for the use of these solutions. IIoT is key to gathering information, and to automate the physical processes. In terms of Industry 4.0 paradigm², it is the base for a fully digitized facility since this technology combined with cloud, analytics, and AI can enable new operational models based on automation and augmented human activities, that rely on predictive analyses for operations and maintenance, production and inventory monitoring, and improving security.

One of the key factors to keeping the downstream business profitable depends on the adequate handling of Safety, Shutdowns, Turnarounds and Outages. This is the result of being proactive with regard to different decisions and IIoT is the basis to achieve such success.

This technology can help prevent human and monetary losses, reduce costs and improve performance.³ According to Accenture research, IIoT could help increase productivity by as much as 30% due to the introduction of automation, saving up to 12% in scheduled repairs, reducing maintenance costs up to 30%, and eliminating breakdowns by up to 70%. The US Department of Energy⁴ identified that 92% of the maintenance related shutdowns from 2009 to 2012 were unplanned, and some researchers estimated a daily cost per refinery in between \$340,000 and \$1.7M⁵. In the safety arena, the explosion of a Petrochemical Plant in the Czech Republic in 2015 cost about \$177 million, while a similar event in Canada in 2005 cost \$870 million.

² Design Principles for Industrie 4.0 Scenarios.

https://www.researchgate.net/publication/307864150_Design_Principles_for_Industrie_40_Scenarios_A_Literature_Review

³Elsevier. Challenges in Achieving Operational Excellence in Refining & Petrochemicals.

https://www.elsevier.com/_data/assets/pdf_file/0009/230868/RDS_OG_RP_WP_OPEX-in-Refining-Petrochemical_DIGITAL.pdf

⁴ U.S. Energy Information Administration. "Unplanned refinery outages leads to Midwest gasoline prices." Available <http://www.eia.gov/todayinenergy/detail.php?id=22552>

⁵ The estimate of \$340,000 is based on profit margins of \$5 per barrel, while the \$1.7 million per day figure is based on a profit margin of \$25 per barrel. Patrick J Christensen, William H Graf and Thomas W Yeung. "Refinery power failures: Causes, costs, and

In Pemex, we're sure that this technology will help augment our company's capabilities in a fast and agile way. The key benefits we expect are major savings by reducing unplanned downtimes, optimal use of our production facilities, and better response times. All these combined contribute to greater efficiency in asset utilization, thus resulting in better economic results.

4. How will this paradigm shift affect talent in manufacturing & downstream industry overall?

One of the biggest concerns of operational workers regarding process automation and digital operations is that eventually humans will be displaced. In our vision we are facing a full transformation that will speed up the way we work, the digital work. This constitutes a paradigm shift in the way we do things, and calls for new skills, competencies, and a new mindset that is different from the conservative "this is the way we do things here".

Recently, my digital team was discussing the implications of predictive maintenance from a systemic standpoint. The conclusion was that the **change needed is more significant at a process and human level than at a technological one**. The field maintenance engineer is focused on reactive repairs; thus, the whole operational discipline organization will change from this fix-the-problem approach to oversee a fully adaptive strategy to keep the infrastructure operational, improve performance, and reduce costs.

We anticipate the augmentation of human intelligence with the use of computing power of the cloud, the information gathering and remote operation characteristics of IIoT, and the decision-making improvement of Artificial Intelligence. This demands transforming the work force and developing skills such as Complex Problem Solving, Critical Thinking, Creativity, and competencies like Financial Modeling, Statistical Analysis, and Digital Savviness. These will allow them to obtain operational insights, anticipate unexpected situations, proactively improve performance, and reconfigure technology as needed.

We are currently assessing the new roles and skills that will be needed to address this shift and are taking small but meaningful steps through our different pilots. We are getting HR on board and have formed a dedicated group to address the cultural change component with strategies to "move from analog workers to digital collaborators", as I like to say. Those who adapt will be better equipped with tools and information and eventually become more agile and productive. At the same

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Tanushree Mulraj | Event Director Tel: +65 6590 3976 | Fax: +65 6223 9196
Email: tanushree.mulraj@clarionevents.com Web: <http://www.downstream-asia.com/>



time, we are working with academic institutions to develop new careers that address the skills needed for this new landscape.

5. What are the latest technology adoptions by downstream operators in Asia? Are there any success stories that other operators can learn from?

Asset-intensive industries—once known to be reticent to digital change—are quickly realizing the potential value of digital and Internet of Things (IoT). In Singapore for instance, downstream operators are investing in IoT to become connected, intelligent, rapid and scalable. According to an [Accenture research paper](#), 90% of business leaders say that it's important to act now to transfer their business models in the digital age. With a load of new production capacities going live across India and China, Asia will continue to maintain its competitive advantage as a downstream hub.

Moreover, the amount of data generated within an industrial site is astounding. Today, analytics translates vast amounts of data into meaningful and actionable insights. Data analytics is equipping decision makers with information they need to make cost-saving decisions quickly. An operator can be made aware of the top ten most urgent issues at any given point. Data collection and analytics are enabling uninterrupted remote surveillance of any piece of equipment, plant or production site.

IoT adoption, specifically results in increased asset utilization (by 3-5 percent) and maintenance productivity (by 10-15 percent), as well as reduced asset downtime (by 1-5 percent), total maintenance costs (by 15-30 percent) and technician overtime (by 20-25 percent). Digital can help operators anywhere from advising the plant, to taking completely automated decisions through the use of cognitive science.

As with any investment, executives will need to analyze projected returns before taking the digital plunge. Capex requirements vary, as existing infrastructure can often be utilized in the digitization process. Alternatively, leasing and renting has become a popular scheme with regard to IoT adoption. Cybersecurity may represent another concern for operators, and in an increasingly digital world, the stance needs to change from defensive to proactive.

6. Will Artificial Intelligence replace humans working in oil and gas?

Not likely. At least not in the short term. Rather than replacing humans, I expect AI to become a powerful tool to help us take better decisions and respond faster to ever-changing conditions in our industry.

Letting AI handle the analysis, predictions, and calculations could give humans the opportunity to focus on analyzing problems with a much wider lens that will enable them to understand the problem better and provide a better solution. Using domain experts and AI we can build a loop where experts direct the AI machines to solve the right problems, the AI gives back insights about these problems, that in turn allows the human to give better directions to the machines, and so on. Adopting this approach would lead the Oil & Gas ecosystem to be much more cost-effective and productive.

Digital transformation is not only about technology, but about people, which is the key success factor.

7. What is the current state of cybersecurity preparedness across refining, petrochemicals and chemicals and how is the cybersecurity market set to evolve?

Our industry is becoming more conscious about the security risks that could impact the core business processes. The more connected things are, the higher the risk. In the past there were few people that knew the specific protocols of industrial control systems and the connectivity was reduced.

Nowadays, the use of digital technology across the value chain results in a technological environment where the convergence of IT and OT (operational technology) is growing and the risks associated with each one can be exploited by an attacker. Therefore, we see cybersecurity practices in our industry growing and we are taking into consideration internal and external threat scenarios. These can be designed to steal sensitive and valuable information, but also to disrupt our core processes or even damage infrastructure and put lives in danger.

Our industry must have a comprehensive approach to cybersecurity. Just as we have invested in standards and protocols for physical safety throughout our history, it is now critical that we invest equally in cybersecurity, taking into account governance, processes, people, and technology. The challenge will be to make the cybersecurity market evolve at the same rhythm as the digitalization of our industry, so we can be prepared.

8. Are manufacturers concerned about cybersecurity in their organization?

With the rise of IIoT (Industrial Internet of Things) and the connectivity of equipment and components, cybersecurity has become a big operational concern. We need to protect not only our information assets, but our physical equipment operating in a digital way. The challenge is to enable an agile operation while all the protection protocols and mechanisms are in place. The larger manufacturers are concerned about cybersecurity because they have the resources to develop the software they need to protect the infrastructure they sell. However, cybersecurity in general is still seen as an IT concern and not an OT one.

9. What are the key technologies which your company would like to implement in the next 5 years? (for refiners, petrochemical & chemicals companies only)

At Pemex, we are driving aggressively a company-wide Digital Transformation strategy. We believe it will impact drastically our production capacity, while reducing costs and improving safety.

Beginning in 2018, we have defined IoT, data analytics, and mobility as key initiatives for the upcoming two years. Our approach is focused on small initiatives that quickly prove the value of digital. We are currently developing 6 to 9 pilots with the business units and are confident this will set the foundation for this 5-year horizon.

In the short and midterm, we will be establishing the base for a fully digital enterprise: IoT and Machine Learning for predictive maintenance; Mobility and IoT for field data collection in plants; IoT and facial recognition technologies for Digital Service Stations; Cognitive Computing for knowledge management solutions in plants, and Big Data/Analytics for consumption trends.

As part of this digital strategy, we have considered the different interactions, touch points, and critical interfaces that affect every business model at Pemex. This means we are approaching the system performance as a whole, and how products are delivered to and from our Downstream unit. We've seen an enormous potential in other technologies that will help us to accelerate and improve this business: Blockchain to accelerate our supply chain and delivery activities; Beacons and industrial networks to improve field work, and Artificial Intelligence to automate and expand operational and business decision making.

10. What are the current challenges and hurdles that affect the spread and deployment of the Internet of Things in your organization? (for refiners, petrochemical & chemicals companies only)

The lack of investment for updating equipment that can connect is the first hurdle to the deployment of IoT. The second challenge is the lack of understanding of its potential and therefore the human resistance to adopt the new technology.

11. What impact does Big Data have on operational efficiency and how is Big Data changing the industry?

The oil and gas industry produces enormous amounts of data. Cadereyta, one of our refineries, produces over 1.8 million data entries every day related with the operation of its different plants and fuel production. Activities such as drilling, exploration, maintenance, and production, all provide valuable data that has been too large to process effectively until recently.

If we look at this chain in full and how different activities are related with each other, we have several different sources of information: our own crude oil production, the raw material for fuel refining; sales and product demand from the gas stations; weather and consumer trends from market information; traffic behavior and sales from our competitors. This universe of information provides opportunity to improve our performance by adapting our activities to the market trends, and the only way to create value from it is to refine that data and create insights using tools like Big Data & Analytics.

In our case, we are working on taking advantage of these possibilities, since we produce a lot of data, but little actionable information. We think that Big Data, with powerful analytic solutions will have a big impact on the way decisions are made. The level of insight that Big Data produces nowadays was impossible before and this should have an immediate impact on the business. A recent [research paper](#) from DNV GL estimates that if the oil and gas industry could analyze and understand all of the data it produces, operational efficiency could be boosted by as much as 20%.

12. What are your views on Asia's downstream industries rate of digitalisation as compared to counterparts in other regions i.e. America, Europe and the Middle East markets?

We have been researching the environment on how digital is being used in our industry. In the past 3 years we noticed initiatives that fix either small operational problems or big bang efforts aimed at transforming different companies. In Asia's case, we've seen a very practical approach about creating a "digital culture" while fixing chronic problems at the same time, this is the case of PETRONAS.

This helps create a better use of digital in the organization since people are not afraid to perform first-hand experimentation, and get deeply involved because they use their operation experience to

create totally new ways to approach problem solving. In Mexico it is common to find a "seeing is believing" approach before fully investing in changing the "traditional way".

On the other side, BP, Shell, and Exxon, have been developing their digital capabilities for several years now. They all are reference cases in terms of IT spending (BP), improving, and refocusing their technological approach to build a strategic asset (Shell) and IT Management as Digital Enabler (Exxon through TBM – Technology Business Management).

These companies are already in a higher maturity level. They have solved the basics of digital and are now working on several applications.

- Shell is using digital to address safety by introducing industrial mobility, which has made fieldworkers 20% more efficient⁶.
- BP, through their Refining, Technology, and Engineering Centre, is focusing efforts on strengthening safety based on technology that predicts how crude oil impacts individual refineries. They are using phased array ultrasonic testing to confirm the safety and soundness of piping systems and pressure vessels and are using simulators to train downstream workers in different tasks such as: start-ups and shutdowns, and pump and valve operations under normal and abnormal situations⁷.

13. With these radical changes looming what opportunities lie ahead for manufacturers?

If the common goals among O&G players are Increasing effectivity, Increasing productivity, and Lowering costs, the next frontier is digital. There is not much space for this in the analog world.

Vendors such as GE, Emerson, Schneider, or Siemens will have great opportunities for integrated platforms that span from data acquisition to information analysis and exploitation in a model As a Service. They can become strategic partners if they cover the full range of solutions needed in our industry and they add new features such as robust security on the edge and the sensors, better analytics capabilities, more accurate predictions, and open integration to enable a healthy operational environment.

But they also have a challenge. With the rise of digital in the industrial environment, securing the virtual environment is increasing its importance. According to the World Economic Forum Risk Report, attacks are increasing in prevalence and disruptive potential⁸ and IIoT could be a target.

⁶ World Economic Forum. Digital Transformation Initiative, Oil and Gas Industry. <http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/dti-oil-and-gas-industry-white-paper.pdf>.

⁷ <https://www.bp.com/en/global/corporate/what-we-do/downstream/downstream-technology.html>

⁸ The Global Risks Report 2018. http://www3.weforum.org/docs/WEF_GRR18_Report.pdf

These manufacturers are becoming more involved in the security field because their products and services will be differentiated by their reliability. The challenge is huge, since they need to create open platforms that could work with the technology of different vendors and at the same time become strong barriers against threats and attacks. As an INTEL executive shared with us once: Secure to enable.

14. What will the future workforce look like in the digital age?

The Digital Age is now, this is disrupting every operational model. Businesses are now demanding new skills and competencies.

On the "soft" side, agility, flexibility, adaptability, team work, storytelling, and critical thinking are necessary to foresee the new reality and apply the use of digital in the context of every industry starting with a detailed identification of business issues and new opportunities.

On the technical side, professionals of the digital age should consider information analysis, data visualization, and a strong knowledge of the business processes.

The mix of this skill set, and competencies will enable a professional profile capable of improving business performance, find new business models, anticipate disruption of competitors, and be the leader of digital teams focused on business development.

15. What will be the highlight of your presentation at Asian Downstream Summit 2018?

Digital Transformation at Pemex: the journey and first tangible results.