THE INTELLIGENT REFINERY
DIGITAL. DISTILLED.

DIGITAL REFINING SURVEY 2018
This deck provides highlights from the second annual Accenture Digital Refining Survey, conducted by PennEnergy Research on behalf of Accenture in collaboration with Solomon Associates.

It is an online survey of 170 oil refining and gas industry professionals from a cross-segment of the industry, including:

• engineers,
• mid-level and executive management,
• business unit heads and staff, and
• project managers.

The survey was conducted in January 2018 by PennEnergy Research in partnership with the Oil and Gas Journal. Respondents are subscribers to PennWell publications.
DIGITAL REFINING
KEY TRENDS

TREND 1:
CONVERGENCE IS A REALITY – Oil refining executives are increasingly converging their IT and operational agendas. Over 20% are taking multiple actions to address the organizational changes required.

TREND 2:
DIGITAL IS AS DIGITAL DOES – Almost 50% of refiners rate themselves as mature or semi-mature with regard to digital technology deployment compared to 44% in 2017. Refineries rate themselves mature with deployment of advanced process control (APC), cybersecurity tools and updated IT systems.

TREND 3:
MOST REFINERS ARE YET TO REALIZE POTENTIAL VALUE – Digital is adding to the bottom line, but a large proportion of refiners are missing trapped value because they are implementing only a small portion of the digital spectrum.

TREND 4:
LACK OF DIGITAL INVESTMENT INCREASES RISK – Change and disruption from digital is accelerating and might outpace a refiner’s ability to compete. Lack of investment can impede the ability to realize the cost savings and margin improvements digital technologies can bring. For refiners, this is augmented by the lack of a digital focal point within the organization.

TREND 5:
WORKFORCE SKILLS ARE INCREASINGLY IMPORTANT – While cost and strategies relating to digital are cited as the top barriers to wider digital adoption, there was a significant increase in the 2018 survey in concerns about relevant digital skills and expertise in refining.
Accenture, Inc. partnered with PennWell Knowledge Center to conduct the second annual digital refining survey to understand how organizations are using digital technologies in the refining area of their business. The survey questionnaire has been reviewed in collaboration with Solomon Associates.

In addition, the survey sought to understand what respondents believed were the benefits and barriers to adopting digital technologies.

The survey was sent to 8,320 potential PennWell participants. The survey was also sent out through Accenture and Solomon Associates social media platforms. Complete responses were received from 169 individuals (2017 survey was sent to 16,536 potential participants. Complete responses were received from 203 individuals)

The confidence level for the survey is 95% with a margin of error of 7.5% (2017 confidence level for the survey was 95% with a margin of error of 6.8%)

### Respondent Location

<table>
<thead>
<tr>
<th>Location</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia/New Zealand</td>
<td>1.5%</td>
<td>2.9%</td>
</tr>
<tr>
<td>Africa</td>
<td>7.9%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>15.7%</td>
<td>19.2%</td>
</tr>
<tr>
<td>Europe</td>
<td>11.3%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Middle East</td>
<td>6.9%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Russia/Central Asia</td>
<td>2.0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Latin America</td>
<td>12.3%</td>
<td>11.6%</td>
</tr>
<tr>
<td>North America</td>
<td>36.0%</td>
<td>32.6%</td>
</tr>
<tr>
<td>World</td>
<td>6.4%</td>
<td>7.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
</tr>
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### Respondent Title

<table>
<thead>
<tr>
<th>Title</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-Level</td>
<td>9.8%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Senior VP or VP</td>
<td>8.9%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Managing Director or Director</td>
<td>11.3%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Mid Level Manager/BU Manager</td>
<td>13.7%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Business Unit Head</td>
<td>8.9%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Engineer</td>
<td>28.6%</td>
<td>15.7%</td>
</tr>
<tr>
<td>Project Manager</td>
<td>7.9%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Refinery Economist</td>
<td>n/a</td>
<td>7.0%</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1.0%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Other</td>
<td>9.9%</td>
<td>15.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Company Type

<table>
<thead>
<tr>
<th>Type</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant</td>
<td>20.7%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Contractor</td>
<td>9.9%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Independent Refining Company</td>
<td>16.7%</td>
<td>27.3%</td>
</tr>
<tr>
<td>International Oil Company</td>
<td>16.3%</td>
<td>18.0%</td>
</tr>
<tr>
<td>National Oil Company</td>
<td>31.0%</td>
<td>30.2%</td>
</tr>
<tr>
<td>Other</td>
<td>5.4%</td>
<td>1.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
TREND 1
CONVERGENCE IS A REALITY

How is your organization addressing the convergence of information technology operational systems (i.e. manufacturing execution systems for your refining operations)? Please select all that apply.

- Changing the role of IT: 36.6%
- Creating new organizational structures/models: 33.7%
- Creating a steering committee: 27.9%
- Creating a new C-level position: 15.1%
- All the above: 22.1%
- No change/none of the above: 16.9%
- Other: 1.2%

More than 20% are taking multiple actions to address IT/OT convergence.
Trend 1
Convergence is a Reality

Explained

The Reality

Oil refining executives are increasingly bringing together their IT and operational agendas by, for example, creating new organizational models, changing the role of IT; as well as setting up steering committees and creating new C-level roles.

Analysis

Digital is a key enabler to help refiners accelerate to their goal of IT/OT convergence by facilitating seamless collaboration to achieve business outcomes and greater future performance. But there is some way to go...

The Opportunity

Most refiners appear to be acting in some way to address the convergence of information technology operational systems in their refineries, with over 20% taking multiple actions to address the organizational changes required. There is still some way to go however – for example – only 15% of oil companies reported having created a new C-level position so far. Setting these foundations for wider digital transformation is key to the creation of the intelligent refinery.
TREND 2
DIGITAL IS AS DIGITAL DOES

How mature would you rate your company in terms of the deployment of the following specific digital technologies in your refining operations? Please select one per technology type?

(Top Five – Most Widespread Adoption)

2017

44% are digital or semi-digital

2018

While more than 48% rate themselves as digital or semi-digital, the key technologies employed do not support this.

- Advanced Process Control: 35%
- Tools to improve cybersecurity: 14%
- Updated IT systems to enable other digital capabilities: 13%
- Operations application migration to Cloud infrastructure: 8%
- Advanced data analytics: 8%

While more than 48% rate themselves as digital or semi-digital, the key technologies employed do not support this.
**TREND 2**

**DIGITAL IS AS DIGITAL DOES**

explained

**THE REALITY**

In 2018, 48% of refiners rate themselves as mature or semi-mature with regard to digital technology deployment compared to 44% in 2017. Refineries rate themselves as mature with deployment of advanced process control (APC), cybersecurity tools and updated IT systems.

**ANALYSIS**

Of all the technologies rated most mature by refiners in relation to their core operations, it is no surprise APC is ranked highly as it is long established. However, we see digital as a game changer for improving process control through the use of artificial intelligence, machine learning and more robust data science modelling.

**THE OPPORTUNITY**

No refiners are near to full-scale digital adoption. There is no widespread use of digital technologies and, as yet, little use of more cutting-edge digital technologies. There is opportunity to expand and scale the mix of digital technologies further into refining operations as well as employ a better combination of digital technologies.
TREND 3

REFINERS ARE YET TO REALIZE POTENTIAL VALUE

Can you quantify in terms of value, how much digital technologies are adding to your business today?

- **Significant** – Over $100 million in total value: 6.4%
- **High** – Over $50 million in total value: 13.9%
- **Average** – Over $50 million in total value: 32.6%
- **Low** – Less than $50 million in total value: 12.8%
- **We do not measure this value**: 13.4%
- **Don’t know**: 19.8%
- **None**: 1.2%

80%* of refiners are getting $50 million or less value from digital

*Includes don’t knows and those who do not measure
**TREND 3**

**MOST REFINERS ARE YET TO REALIZE POTENTIAL VALUE**

Which of the areas in your refining operations are digital technologies having the most positive impact?

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance and reliability</td>
<td>56.4%</td>
</tr>
<tr>
<td>Production planning and scheduling</td>
<td>50.0%</td>
</tr>
<tr>
<td>Production execution</td>
<td>47.1%</td>
</tr>
<tr>
<td>Health, safety and environment (HSE)</td>
<td>27.9%</td>
</tr>
<tr>
<td>Energy management</td>
<td>23.8%</td>
</tr>
<tr>
<td>Engineering and capital projects</td>
<td>22.1%</td>
</tr>
<tr>
<td>Quality management</td>
<td>18.0%</td>
</tr>
<tr>
<td>Trading</td>
<td>15.1%</td>
</tr>
<tr>
<td>Hydrocarbon supply chain</td>
<td>13.4%</td>
</tr>
<tr>
<td>Non-hydrocarbon supply chain</td>
<td>4.1%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>3.5%</td>
</tr>
<tr>
<td>Other</td>
<td>4.1%</td>
</tr>
</tbody>
</table>
Almost 60% of refiners are spending more on digital in 2018 which is delivering some impact and value but it is only a fraction of what it could be, with 80% of refiners reporting that digital is adding $50 million or less value to their business.

Refiners are implementing only a small portion of the digital spectrum and are seeing the most impact from digital in their maintenance and turnaround operations. However, the majority are not realizing the value they could from digital technologies and many are not even measuring digital value.

Refiners see the impact of digital in important refining processes with digital having a positive impact on maintenance and operations, and production operations in particular. However there is still significant scope for digital to influence a broader set of refining operations to deliver plant-wide transformational change and release trapped value.
TREND 4
LACK OF DIGITAL INVESTMENT INCREASES RISK

What risks to your business do you see from a lack of investment in digital technologies? (based on top 3 most important risks)

- Loss of competitive advantage: 67.4%
- Lack of ability to continue to reduce costs/increase margins: 64%
- Increasing plant reliability issues: 57.7%
- Lack of agility to react & optimize due to market dynamics: 41.9%
- Loss of workforce/talent: 24.4%
- Lack of ability to respond and transition to new energy developments: 21.7%
- Lack of ability to react to natural disasters: 9.3%
- Other: 1.2%
TREND 4
DIGITAL INVESTMENT AND RISK explained

THE REALITY
Change and disruption from digital is accelerating and might outpace a refiner’s ability to compete. Lack of investment can impede their ability to realize the cost savings and margin improvements that digital technologies can bring. Competitiveness, ability to reduce costs and plant uptime are at risk.

ANALYSIS
More investment in digital can bring changes to the cost base and refining operating model and increase the ability of refiners to predict and react to change. This increased agility will be key to cost competitiveness.

THE OPPORTUNITY
Investments in digital to deal with greater risks in the increasingly complex oil industry landscape are crucial. Wider digital adoption can be a fundamental defense against industry disrupters as well as a key enabler for further cost reduction and margin improvement.
## TREND 5

**WORKFORCE SKILLS ARE INCREASINGLY IMPORTANT**

Which barriers, if any, prevent the successful adoption of digital technologies in your organization? Please select all that apply.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of digital deployment</td>
<td>49.8%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Lack of clear strategy relating to digital</td>
<td>38.4%</td>
<td>43.0%</td>
</tr>
<tr>
<td>Data security concerns</td>
<td>36.0%</td>
<td>43.0%</td>
</tr>
<tr>
<td>Lack of clear business case</td>
<td>38.4%</td>
<td>36.1%</td>
</tr>
<tr>
<td>Lack of workforce skills and subject matter expertise</td>
<td>22.2%</td>
<td>33.7%</td>
</tr>
<tr>
<td>Resistance to adopt digital solutions</td>
<td>24.1%</td>
<td>33.1%</td>
</tr>
<tr>
<td>Lack of internal ownership</td>
<td>23.2%</td>
<td>29.1%</td>
</tr>
<tr>
<td>Lack of maturity of digital technology</td>
<td>14.8%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Lack of digital delivery capabilities in order to scale</td>
<td>21.7%</td>
<td>17.4%</td>
</tr>
</tbody>
</table>

An increase in excess of **50%**
TREND 5

WORKFORCE SKILLS ARE INCREASINGLY IMPORTANT

explained

THE REALITY

While cost and strategies relating to digital are cited as the top barriers to wider digital adoption, there was a significant increase in the 2018 survey (compared to 2017) in concerns about relevant digital skills and expertise in refining, which is also impacting digital maturity.

ANALYSIS

While refiners can hire digital talent, it is scarce and expensive. There is potential for this lack of a digital skills base to hold refiners back from creating more intelligent refineries. Reskilling and redeploying employees for digital is crucial.

THE OPPORTUNITY

Refining leaders need to address digital skills gaps and redeploy people whose roles are being replaced by automation, and technologies like artificial intelligence. By retraining employees already familiar with their operations, as well as enabling more collaboration between employees and machines, refiners will save time and money on their digital journey and accelerate their route to a more intelligent refinery.
If all companies were to invest in AI and human-machine collaboration at the same level as the top performing fifth of companies, they could boost revenues by 38% and lift employment levels by 10% between 2018 and 2022.

That equates to an average of $7.5 billion and 5000 jobs for an S&P 500 company....

ACCENTURE – FUTURE WORKFORCE STUDY 2018
CONCLUSION

DIGITAL TECHNOLOGIES CAN HELP OIL & GAS COMPANIES UNLOCK SIGNIFICANT VALUE

Digital is key to oil companies optimizing cross-value-chain decisions to grow margins. However, digital commercial optimization needs to happen at scale and speed to create competitive advantage. Oil companies also need to combine digital technologies to improve their impact. Reskilling and redeploying the refining workforce is crucial for future competitiveness and achieving transformational value.

CURRENT STATE

Refiners are not fully utilizing digital’s potential, and are failing to realize maximum value as a result. From combining technologies, to scaling them and reskilling their workforce to use them, they need to build more rapidly upon the digital foundation they have created to enable a more intelligent refinery.

KEY TAKEAWAY

When the correct technologies are combined and implemented at scale digital can deliver significant value and drive additional market capitalization.

43.9%
ADDITIONAL GAINS IN MARKET CAPITALIZATION FOR OIL COMPANIES

Source: Accenture Industry X.0 Survey
WHO DO WE CONTACT FOR MORE INFORMATION ABOUT THE SURVEY?

TRACEY COUNTRYMAN
Managing Director
Global Resources Industry X.0, Accenture
.tracey.m.countryman@accenture.com

ANDY COWARD
Managing Director
Refining Digital Plant - Europe, Accenture
.andy.coward@accenture.com

The Intelligent Refinery Research
conducted on behalf of Accenture by PennEnergy Research in collaboration with Solomon Associates, surveyed refinery professionals worldwide.

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