



Research Insights

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The chemicals and petroleum industry guide to closing the skills gap

Strategies to build and maintain a proficient workforce

IBM Institute for
Business Value



How IBM can help

Leaders must reinvent culture, skills, and experiences using digital technologies to help optimize processes and augment business decisions. The reinvention of your enterprise requires a focus on organizational development—improving all the ways your employees interact with customers, the business, and each other. Whether you use Workday, Oracle, SAP, or another human resources (HR) tool, IBM can offer the expertise to help your organization manage change.

Using artificial intelligence (AI), automation, new talent technologies, and the expertise of IBM, you can hire the right people and keep their skills sharp. IBM can guide your talent evolution toward a Cognitive Enterprise™. Learn more at ibm.com/services/process/talent.

Key takeaways

The “human” factor is essential to the industry

Chemicals and petroleum CEOs see workforce skills as the top business accelerator. The COVID-19 pandemic has exposed the industry’s digital capability, and made it even more difficult to hire and find skills—especially digital skills.

Skills availability and quality are in jeopardy

The Great Crew Change set the stage for a skills shortage, with declining employment, looming retirements, and large demographic age gaps in the workforce. The time it takes to close a skills gap has ballooned, and organizations must find ways to stay ahead of skills relevancy.

How organizations can help close the gap

Our research reveals that training and hiring are not enough. We explore strategies that suggest the greatest impact on closing organizational skill gaps and offer three key recommendations.

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Introduction

In recent years, a talent shortage was one of the greatest threats facing chemicals and petroleum organizations. Combined with the continuing harsh reality of the COVID-19 crisis, more workforce repercussions will surely follow.

Long before the pandemic, hiring cycles have typically followed industry cycles of oil prices. For instance, during downturns in 1986, 1998, 2008, and 2014, graduate recruitment and apprenticeships in the industry were virtually nonexistent.¹ In addition, during the oil downturn of 2014, the industry went through a major workforce reduction, cutting over 440,000 jobs.² As a result, the labor pool has declined over the past several decades, and due to limited investments in talent recruitment, many organizations have not kept up with the demand for workers.

The second shale-oil boom has created new jobs in oil and gas drilling and associated services. Organizations are now struggling to attract talent but have been unable to tackle the problem effectively.

For example, the number of UK graduates going into the oil and gas industry has plummeted since 2013 (see Figure 1). This decline is a global issue, as is evidenced by a survey of more than 33,000 people working in oil and gas, conducted by oilandgasjobsearch.com and NES Global Talent. Nearly 90 percent of respondents said skills shortages were damaging productivity, with gaps widening in every sector of the industry.³

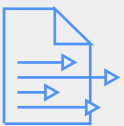
Multiple factors, including continued—and rapid—technological developments and business and operating model innovations, have contributed to market shifts that are redefining the chemicals and petroleum industry. During the Great Crew Change, the exodus of retirees imperiled knowledge retention and escalated the competition for talent.



Advances in general and industry-specific technology are the top 2 factors influencing chemicals and petroleum skills demand in the future⁴



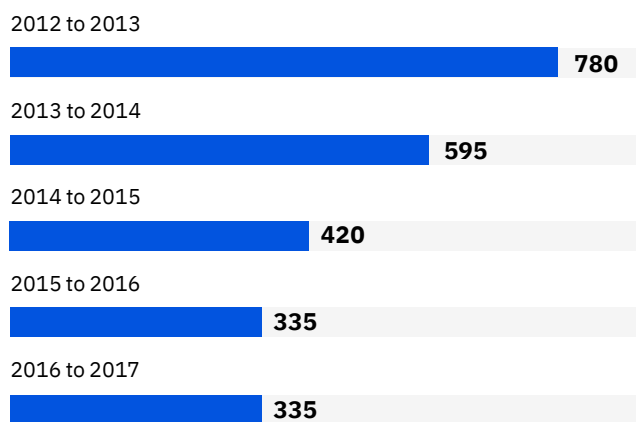
Talent acquisition is critical: chemicals and petroleum CEOs surveyed rank investment in people as the number 1 way to accelerate performance⁵



Closing a skills gap through traditional training has increased by more than 8 times in the past four years, jumping from 4 days to 35 days⁶

Figure 1

Declining United Kingdom graduates (undergraduates and postgraduates) employed in oil and gas within six months of graduation



Source: IBM Institute for Business Value analysis based on data from the Higher Education Statistics Agency: <https://www.hesa.ac.uk/data-and-analysis/publications#destinations-leavers-higher-education>

The industry has also faced challenges in attracting a younger workforce to what many perceive as an “out-of-favor” industry. Indeed, one of the root causes for the oil and gas industry skills gaps is that graduating talent, in general, is no longer attracted to the fossil fuels industry. This reduced interest, along with the demographic crew change, impedes the industry’s progress.

Three-quarters of surveyed chemicals and petroleum leaders tell us they have the people skills and resources required to execute their business strategy.

Combined with economic and market disruptions, these factors have created a perfect storm that is affecting the value of, need for, and availability of workforce skills. The result is a massive shortage of talent. New skills requirements that continue to emerge as others become obsolete only compound the problem.

Data management and analytics capabilities are in high demand due to the influx of enormous amounts of data. For example, one modern offshore production platform can have more than 80,000 data tags capable of streaming real-time data, including temperature, pressure, and well conditions.⁷ In addition, as business platforms mature and companies continue to introduce new intelligent workflows, continuous workforce reskilling will be paramount to remaining competitive.⁸

In and of themselves, hiring and traditional training methods are not sustainable solutions to the talent crisis. Successfully navigating this new environment requires fundamentally reshaping how organizations manage skills, talent, and culture. In this report, we offer a roadmap to guide chemicals and petroleum executives toward actions to help address this critical issue.

Our recommendations are based on insights from multiple IBM Institute for Business Value (IBV) research initiatives as well as performance benchmarking data. Through research and analysis, we discovered specific skills development tactics that appear to have a significant impact on closing skills gaps.⁹ We have compiled a set of recommendations that harness AI to help organizations close skills-related gaps:

- Personalize at scale
- Increase transparency
- Take advantage of ecosystems.

The human factor: The strategic importance of skills and talent

The labor force has a significant impact on enterprise vitality. Without skilled workers, organizations struggle to innovate, deliver value to customers, grow their businesses, and create new jobs. Chemicals and petroleum chief executive officers (CEOs) see the critical importance of skilled workers.

In fact, according to the IBM 19th edition Global C-suite Study, “Incumbents Strike Back,” investment in skills tops the list of business accelerators that would improve enterprise performance.¹⁰ This initiative was viewed as even more successful than other critical accelerators, such as:

- Improving motivation of business leadership
- Promoting more collaboration with startups
- Building new partnerships with dynamic innovators.

Industry executives also grasp the need for skilled workers, particularly when expanding into new markets. In fact, 86 percent of executives cite the availability and quality of skilled workers as the key factor for organizations making location investment decisions.¹¹

Industry leaders further underscore the criticality of skills. Three-quarters of Chemicals and Petroleum Reinventors—organizations we surveyed that outperform in profitability, revenue, and innovation—tell us they have the people skills and resources required to execute their business strategy. And 76 percent of those leaders report that they invest continuously in improving employee skills.¹²

“Our workers will need to be digitally educated and thus ready to adopt any kind of digital-enabled manufacturing process.”

CEO, Petroleum industry, US

The struggle is real: Current skills challenges

Data has been referred to as the new natural resource. However, without talented and innovative people, the power of data remains largely dormant. Humans are essential to the process of extracting value from data and applying it in new ways.

The availability and quality of these critical human resources are stressed. Areas such as the specialty chemicals sector face the biggest talent shortages because they require specialized skills, and this shortage is expected to grow over the next ten years.¹³ Examples of how vital digital technologies are to the industry include managing oil wells across multiple acres, monitoring well flows, and predicting well performance. Yet, these activities require software engineering talent.¹⁴

Energy skills organization OPITO estimates that the UK oil and gas industry needs to attract 25,000 new employees by 2025. Further, 4,500 of them will be in completely new roles that do not currently exist, in areas such as data science, automation, and new materials.¹⁵ The challenge is not a shortage of workers, but a shortage of workers with the right skills.

Talent deficiencies in Corpus Christi, Texas, have hindered the ability to build new projects, such as a proposed USD 10 billion steam cracker that would process ethane into ethylene. The plant could be constructed, but the workforce does not exist to run the processes.

Labor shortages also hamper the industry in the Permian Basin oilfield in West Texas, where it is estimated that approximately 15,000 jobs are open at any given time.¹⁶ Engineers have appeared on the list of hardest-to-fill occupations in the US for the past nine years. Globally, engineers are the fourth most difficult-to-fill position.¹⁷

The engineering and technology skill sets that the industry will need going forward are also shifting. The core industry skills of the future will focus on expertise in the areas of carbon, capture, utilization, and storage (CCUS), hydrogen, and offshore wind. One may wonder who is training new professionals on those new technologies today so the industry can sustain itself as it and its clients get to net-zero carbon emissions by 2050.

The rate at which professional skills become obsolete is increasing, which exacerbates the issue. The half-life of professional skills was once estimated at ten-to-15 years.¹⁸ This estimate means that the value of those skills would decline by half—or that half the knowledge associated with the skills would become irrelevant—in approximately a decade. Today, the half-life of a learned skill is estimated to be five years, and even shorter for technical skills. This assessment suggests that a skill learned today will be about half as valuable in just five years or less.¹⁹

Our historical data reveals another alarming trend: it's taking longer to close skills gaps using traditional training approaches such as classroom and virtual learning. In 2014, the median time it took to close a capability gap through training in the chemicals and petroleum industry was four days. In 2018, the median was an astonishing 35 days. In just four years, the time to close a skills gap increased by more than a factor of eight.

What led to this enormous increase in training time? There are likely a few contributors. For example, some skills required today take longer to learn because they are behavioral—such as teamwork, communication, creativity, and empathy. These skills are best developed through real-world experience rather than structured learning programs.

Other new skills take more time to acquire because they are highly technical, such as data science capabilities. Also, many of the skills themselves are rapidly changing due to the adoption of digital technologies, making it hard to keep pace with their latest requirements.

Digital technologies: A game changer

Advancements in technologies provide opportunities for chemicals and petroleum companies to manage and improve both physical and digital business processes. Chemicals companies can produce based on fluctuations in customer demand. Digital technologies allow oil and gas businesses to interconnect products, value chains, and business models. Analytics enable predictive maintenance, smart drilling, and smart oilfields to help drive profitability on every barrel of oil extracted.

Digital processes are also helping organizations create new personalized products and services and interact with customers across multiple channels. Digital technologies will also be the backbone of the energy supply and demand value chain of the future, which produces and sells a hybrid mix of gas and renewables.

Insights from C-suite executives indicate tremendous optimism regarding the benefits of intelligent automation to the chemicals and petroleum industry. Over two-thirds of executives from our 2018 Global Country Survey say advances in intelligent automation will improve industry productivity, and 57 percent anticipate expansion of organizational capability.²⁰

As executives consider the impacts on their organizations' processes and operations and the opportunities for improvements, they also ponder how digital technologies will influence their workforce needs. Technology is the key factor driving chemicals and petroleum skills demand (see Figure 2). As a result, 58 percent of executives expect advancements in technology will require roles and skills that don't even exist today.²¹ Most executives we surveyed said they expect to feel the pressure sooner rather than later: 59 percent predict that robotics, AI, and automation innovations will influence skills demand over the next five years.²²

Figure 2

Technology tops the list of factors impacting chemicals and petroleum skills demand



Technology

Other

Source: IBM Institute for Business Value (IBV) 2018 Global Country Survey. Q: What impact, if any, do you believe the following factors will have on demand for skills in the next five years? n=292.

Source: IBV Global Skills Survey, 2016. Q: What impact, if any, do you believe the following factors will have on demand for skills in the next five years? n=230.

Digital technologies will have a tremendous impact on chemicals and petroleum workers. In our 2018 Global Country Survey, we asked executives to estimate what percentage of their headcount would need to be retrained and/or reskilled as a result of intelligent automation. Based on their answers, we estimate that 4.5 percent of the workforce would require this skills update over the next three years.²³

The application of technology will also have a deep and urgent impact on skills requirements, compounding an already-significant challenge. Workers in the oil and gas industry are now expected to have a combination of digital, technical, and soft skills.

Digital skills consist of software engineering, data management, and analytical capabilities to measure operations in real time. Technical skills include instrumentation technologist expertise as sensors are applied to more field equipment and machinery. Soft skills comprise creative problem solving and the ability to manage change to analyze data in real time in the field, make course corrections, and innovate.²⁴

Yet, only one-in-eight chemicals and petroleum CxOs report they currently have the necessary data science, machine learning, and AI skills.²⁵ To keep pace with the skills crisis, it is clear that leaders must focus on retraining and reskilling workers.

Closing the gap: Strategies and recommendations

Solving the skills challenge will not be easy. Chemicals and petroleum organizations must move beyond hiring and traditional training initiatives and commit to the continuous, strategic exploration of new learning paths. Our study provided a list of strategies and tactics and asked executives which ones they were implementing to actively close their skills gap (see “Insight: What tactics are chemicals and petroleum executives using to close the skills gap?”).

Chemicals and petroleum companies are experimenting with a combination of tactics or are planning to act on their initiatives.²⁶ However, the path forward remains unclear.

Insight: What tactics are chemicals and petroleum executives using to close the skills gap?

- Acquire talent from outside the organization
- Move talent across business units and divisions
- Reskill employees based on business priorities
- Use visa programs to source international talent
- Take advantage of apprenticeship and internship programs to train talent
- Use new and emerging educational programs and platforms to enhance employee skills
- Apply analytics to analyze and predict skills supply and demand
- Implement skills recognition initiatives to recognize and track skills progression
- Access talent through ecosystem partners

Source: Unpublished data from the 2019 Open Standards Talent Development Benchmark Study. IBM Institute for Business Value Performance Data and Benchmarking. Q: Which of the following strategies and tactics has your organization implemented or planned to implement?

“We will train our employees with higher degrees in chemistry, geoscience, or biology as data scientists.”

CEO, Chemicals industry, Japan

What blend of traditional and emerging tactics can help organizations tackle the skills challenge? Where should they invest their time and money?

We examined the myriad of tactics cross-industry organizations are experimenting with to better understand if specific strategies have a high impact on closing organizational skills gaps. Topping the list are:

- Implementing skills recognition initiatives
- Using new and emerging education
- Applying analytics to predict and infer skills supply and demand.²⁷

The first tactic addresses what leaders tell us is the number one barrier to skill development: motivation for employees to proactively update their skills.²⁸ Individual incentive comes naturally if people can link training to purpose. For younger generations, helping tackle the

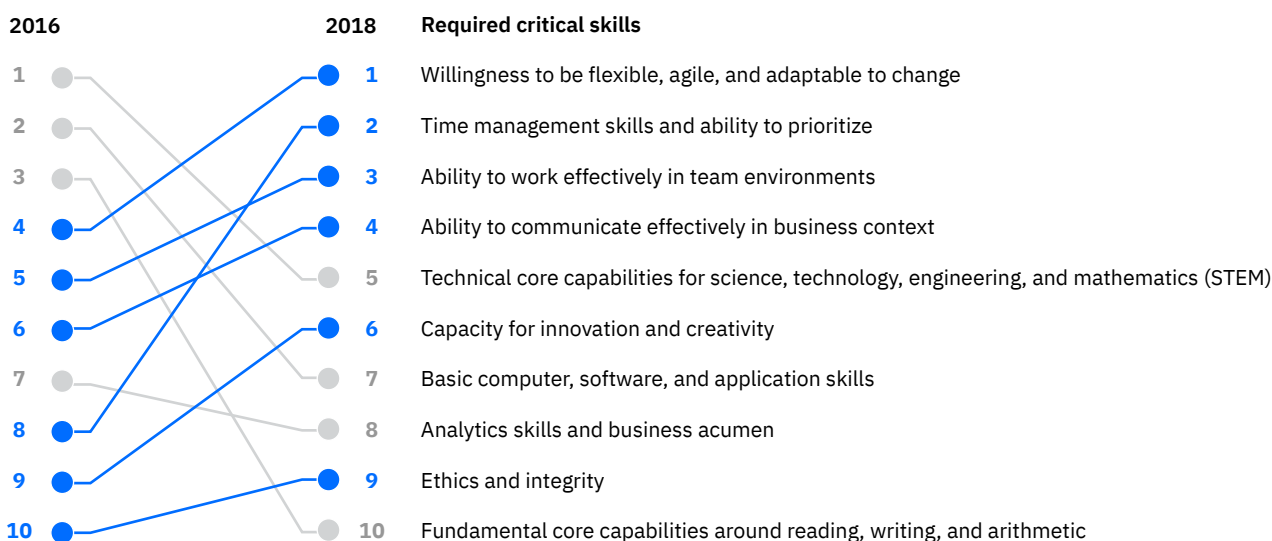
climate challenge offers a compelling reason to keep their skills current. In addition, skills recognition programs can provide the motivation current employees need, inspiring them to take the initiative.

For executives keen to expand their learning partnerships with academia and industry, taking advantage of new education programs—the second tactic—is an appropriate strategy. For example, the Pathways in Technology Early College High Schools (P-TECH) model focuses on preparing students for new-collar jobs. In addition to equipping students with critical, in-demand technical skills, the model also provides real-world, practical internship experiences. This type of program can provide students with the behavioral skills they need to help prepare them to succeed in the workplace.

In addition, the emphasis on soft skills—also called behavioral skills—has increased (see Figure 3). Digital and technical skills are still important, but soft skills dominated the top four core competencies that chemicals and petroleum executives sought in 2018.

Figure 3

Critical skills for chemicals and petroleum have shifted in just two years



Soft skills

Core and technical skills

Source: IBV 2018 Global Country Survey. Q: What do you believe are the most critical skills required of the workforce today? n=292. IBV Global Skills Survey, 2016. Q: What do you believe are the most critical skills required for members of the workforce today? n=230.

Shell: Building AI capability at speed and scale

Shell is an international energy company with expertise in the exploration, production, refining and marketing of oil and natural gas, and the manufacturing and marketing of chemicals. At Shell, one critical aim is to build AI capability quickly at scale where it's needed. Many activities are underway to achieve this.²⁹ For example:

- In 2018, the company started with a digital literacy campaign to build awareness across the organization, and since launch, it has reached around 25,000 colleagues.
- Leadership teams are joining in “immersive experiences” that include hands-on time with datasets and advanced analytics software. These engagements help to embed digital technology as a core part of its strategic agenda and the adoption of AI solutions.
- The company is running digital generalist programs, aimed to upskill employees to act as translator between business teams and digital specialists. These employees work to prioritize business challenges which can be addressed with AI and drive adoption of these solutions within their businesses.
- There are more than 2,000 members in the Shell.ai network that is used to share knowledge across the company. The Shell.ai Self-Service platform is used by over 800 citizen data scientists.
- Shell is also training and certifying professionals as part of its Architecture, Platforms, and Data initiative. Nearly 800 Shell employees have been certified in data analytics foundation and data engineering, and an additional 100 staff members achieved architecture certification.

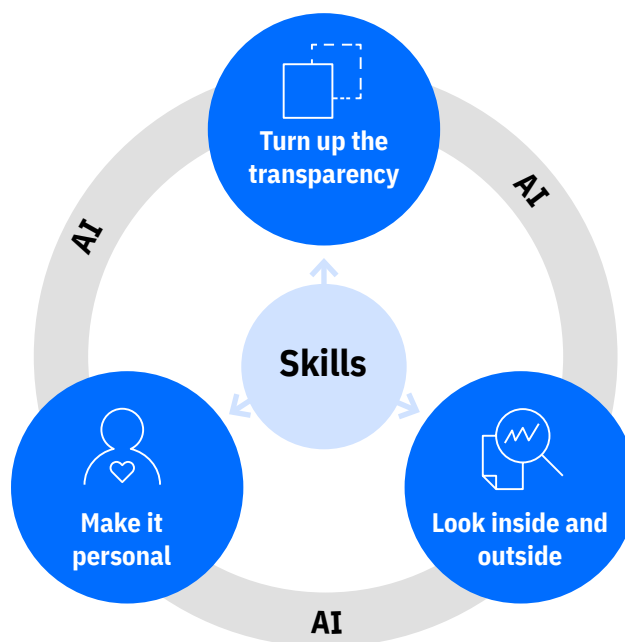
Executives recognize that navigating a continually evolving environment requires people who can communicate effectively, apply problem-solving and critical-thinking capabilities to drive innovation using new technologies, and draw and act on insights from vast amounts of data (see “Shell” sidebar).

Soft skills also demand creativity and empathy and an ability to change course quickly. AI-based real-time skills inference—the third tactic—is a formidable asset to address the massive fluctuations in demand and supply of critical skills.

From the three emerging tactics, three key actions surface as critical to the skills conversation, each of which is exponentially strengthened by AI (see Figure 4). Organizations should consider how to best apply each of them within the context of their unique culture, workforce, leadership, and business strategy.

Figure 4

AI helps enable transparency and skills personalization in an expanded learning ecosystem



Source: IBM Institute for Business Value analysis.

Action guide

Strategies for building and maintaining a proficient workforce

Three recommendations for closing the gap.

The time to act is now. Executives can start today by committing to a modern workforce strategy that:

- Prioritizes skills development
- Delivers deep visibility into the skills position of both the enterprise and individual employees, and personalizes skills development at scale
- Uses new partnerships and platforms that integrate data and insights across the employee lifecycle.

1. Make it personal

Employees want career, skill, and learning development uniquely tailored to their experiences, goals, interests—and, where possible—connected to individual purpose and meaning. Employee skills and learning experiences tailored to both customer and market needs and employee goals and interests help retain talent and build a future workforce.

To make the speedy organizational impact required to be competitive, companies must personalize “at scale.” This means going further than segmenting employees in the same job roles—or the same business units.

It means understanding the current skills of every employee, knowing where the company and the individual want or need to progress, and personalizing a learning and career path. AI can help enable this level of personalization and bring meaningful employee experiences to life.

Companies should take time to understand market, business, and workforce needs to create deeply personalized skills experiences that can then be integrated into the workflow. AI can be used to tailor employee notifications, learning paths, and content to fit both business and individual needs.

Organizations can also look beyond traditional learning methods, growing skills in different ways to accommodate different learning styles. Consider programs that encourage internal job mobility, ad-hoc projects, peer-to-peer learning, job shadowing, and coaching. Statoil (now Equinor) has set up a Digital Academy in which employees have a broad portfolio of learning opportunities to select from based on their preferences and needs.³⁰

Companies can also pursue partnerships and opportunities to make educational programs relevant and accessible to all employees. Evonik has entered into a strategic partnership with the University of Duisburg-Essen to focus on the people and skills that are at the center of digital transformation.³¹ Most importantly, companies should foster a culture of perpetual learning and personalizing the stages of the employee lifecycle to build, grow, and reward continuous skills growth.

2. Turn up the transparency

Chemicals and petroleum organizations need to place skills at the center of a people-oriented strategy and aim for deep visibility into the skills position across their enterprises. Over two-thirds of outperformers will change how their enterprises plan for their future workforce over the next two-to-three years.³²

A skills-based people strategy requires solutions that go beyond knowing the number of people in a specific role. Advanced analytics, AI, machine learning, and market-based skill data have shifted the conversation (see “Imperial Oil and Alberta Machine Intelligence Institute Imperial” sidebar). The discussion is now about obtaining actionable—often predictive—insights at scale, and then making these insights available to everyone, from individual employees to enterprise business leaders.

Companies should transparently inform employees about the roles and skills that are growing in market demand. From there, they can provide employees with engaging, meaningful ways to develop their skills in critical areas, demonstrate their skills proficiency, and be recognized for doing so. This new level of transparency provides employees with information to self-direct their learning and career choices, which is crucial to staying ahead of the shrinking half-life of skills.

Industry-owned OPITO has recognized that the UK oil and gas industry has a significant upskilling requirement for the existing workforce in the areas of enterprise skills, new ways of working, internationalization, general technology, and data skills. New demand for expertise will emerge in areas such as low-carbon energy, data science, data analytics, AI, machine learning, robotics, material science, remote operations, and cyber security.

OPITO's research also highlights additional skills requirements in areas such as change management, control of change, project management, and the social aspects of change.³³

Imperial Oil and Alberta Machine Intelligence Institute: Collaboration on machine learning

Imperial Oil, based in Canada, produces and provides petrochemical products and services through the Esso and Mobil retail network.

The Alberta Machine Intelligence Institute (Amii) and Imperial Oil have announced a two-year agreement to collaborate on the development of Imperial's in-house machine learning capabilities to help enable a range of applied AI projects.³⁴ Through these projects, Imperial will work to develop more effective ways to recover oil and gas resources, reduce environmental impacts, and improve the safety of its workforce.

Amii will provide business guidance and scientific mentorship to build Imperial's in-house machine intelligence capabilities and teams. Its experts will help define and validate machine-learning opportunities and provide help with applied projects and connections to the latest applicable AI research. The institute will also support Imperial Oil in attracting and developing its technical teams, with an emphasis on enhancing the skills of current employees.

3. Look inside and outside

Organizations must now find solutions to the skills challenge through broader internal and external ecosystems. Cultural shifts are required to welcome third parties as part of the team, embrace partners to manage specific internal functions, and prepare for integration of data across the enterprise and ecosystem.

Inside the organization, companies need to build agile teams with heterogenous skill sets to enable experiential, peer-to-peer innovation and create a culture where learning becomes viral. Creating opportunities for job sharing and internal mobility, and moving skilled talent across organizational boundaries can enhance skills development.

Across the external ecosystem, organizations can engage with a coalition of partners to continually explore and pilot innovative skills-gap closure strategies (see “Eastman” sidebar).

Investing in innovative skill-building technologies can be a highly effective strategy. Organizations can harness the power of initiatives such as massive open online courses (MOOCs), code schools, and industry expertise networks. Applying AI can source and harmonize the most relevant educational assets for employees.

Eastman: Partnership with government, business, and education

Eastman is a global specialty chemical company that produces a broad range of advanced materials, additives and functional products, specialty chemicals, and fibers.

Eastman helped launch the Advanced Manufacturing Partnership (AMP), a public-private partnership created to construct a Regional Center for Advanced Manufacturing (RCAM) and develop a robust workforce training partnership.³⁵ The primary objectives of the AMP and RCAM partnership are to:

- Meet employers’ skilled labor needs
- Promote advanced manufacturing careers
- Bring unique and differentiating workforce development capabilities to support regional economic development efforts.

The AMP and RCAM partnership is a collaboration of Eastman, Northeast State Community College, Domtar Paper Company, the City of Kingsport, the Kingsport Chamber of Commerce, and the Tennessee Department of Economic and Community Development. It also includes several other industry partners.

Is your organization ready to implement innovative strategies to close employees' skills gaps?

- How engaged and coordinated are your ecosystem partners? What opportunities exist to expand these relationships to improve outcomes for all stakeholders?
- How is your organization working to implement proven strategies and interventions to help improve skills relevancy?
- What is your organization's strategy for ensuring skills currency and a competitive workforce? What opportunities for improvement exist?
- What opportunities are available to include more experienced-based learning techniques or real-world learning experiences (such as internships and apprenticeships) in curricula?
- How are you using new technologies to enable personalized learning for individuals? What opportunities for improvements and new partnerships exist?

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