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NextGen Series

Advancing Industry 4.0 through steady digital foundations

How secure and modern network infrastructure creates sustainable and progressive digital transformation
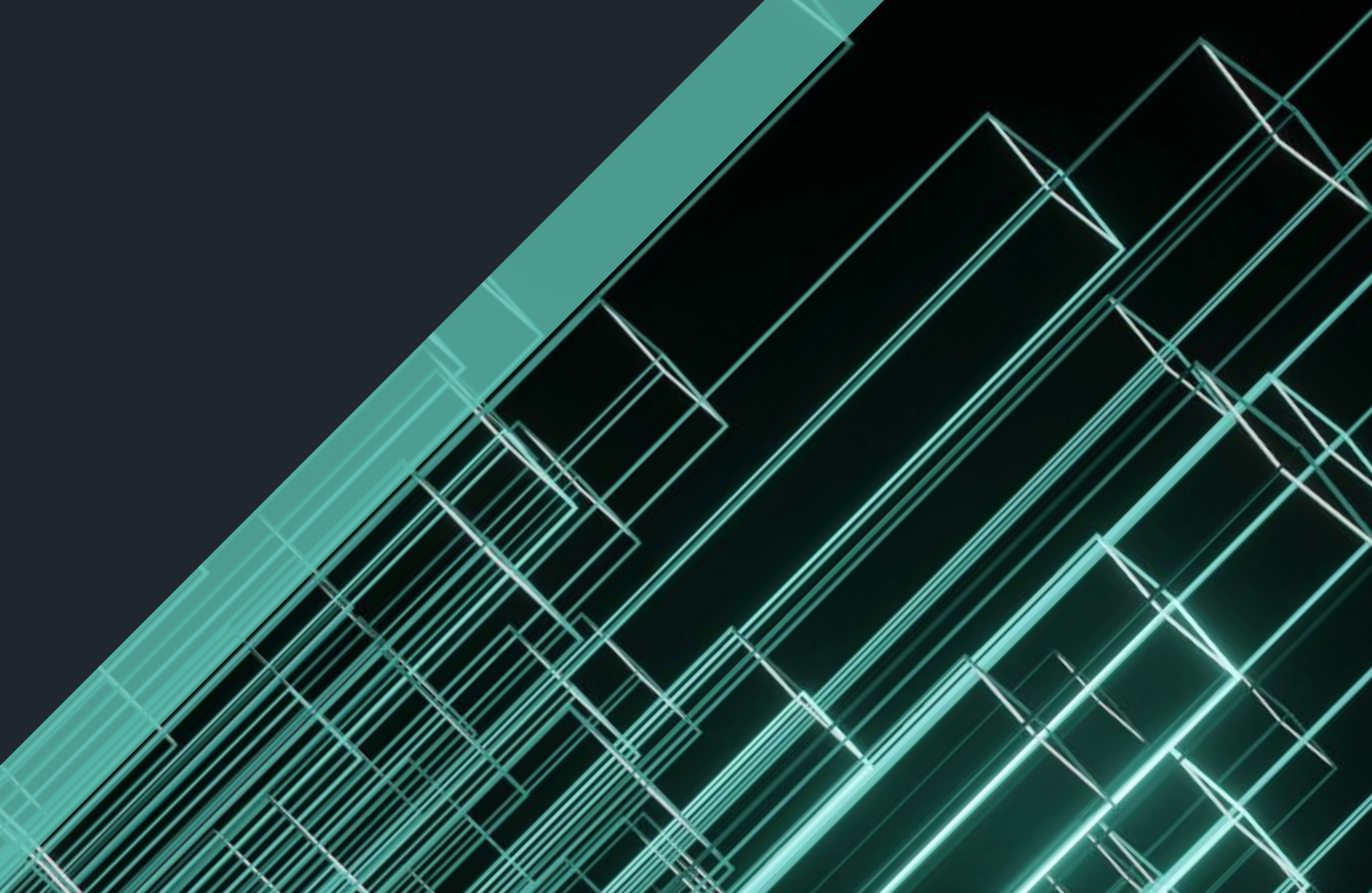
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Industry 4.0: what is it and why do we need it?

Manufacturing has played a pivotal role in societal progress since the First Industrial Revolution in the 18th century. Marked by large-scale machine production in industries like agriculture and textiles, it laid the groundwork for the rapid growth and development that we experience today.

Fast-forward to the 21st century and technology has improved by leaps and bounds. Manufacturing has evolved from using basic machinery and siloed technological innovations to interconnected and autonomous systems, driving our production capacity further than before and thrusting us into the Fourth Industrial Revolution, or Industry 4.0.

While Industry 4.0 has been defined in many ways, it broadly refers to the rise of digital industrial technology, focusing on interconnectivity, automation, machine learning, real-time data, and more[1]. In fact, the six principles[2] that underpin Industry 4.0 are interoperability and interconnection, information transparency, decentralization and autonomous decisions, real-time capability, technical assistance and service orientation, and modularity.

Many of the technologies involved in Industry 4.0 are likely to be familiar, such as the Internet of Things (IoT) and Industrial Internet of Things (IIoT), artificial intelligence (AI), automation, cloud computing, and data analytics. Smart factories and smart manufacturing are also key in Industry 4.0.

Despite the pandemic and several macroeconomic and geopolitical hurdles in the last few years, Industry 4.0 advancements have helped the sector achieve an upward trajectory with a projected average growth rate of 5% from 2019 to 2030[3]. The use of these smart technologies has become necessary to meet the burgeoning demands of society at large. Moreover, Industry 4.0 has enabled a new level of flexibility and productivity previously unheard of in the sector, allowing businesses to rapidly identify processes that could benefit from enhancement and other areas of improvement, even in the recent challenging business landscape.

Tools like data analytics, digital twins, and more have become critical in ensuring the continuous improvement and sustained profitability of manufacturing. The synergy resulting from the increasing use of such tools will pave the way for further evolution of the industry, leading to more progressive transformations.

What's the state of play?

Industry 4.0 is a critical phase for manufacturing today. Since its inception in 2011[4], the use of smart and interconnected tools and solutions has greatly benefitted global manufacturing, allowing it to streamline operational processes, pursue continuous improvement, and overcome supply chain issues. This trend of increasing digitalization is only set to grow thanks to the efficiency and convenience these new technologies provide.

While it is widely understood that Industry 4.0 is necessary and can help enterprises take their operations to the next level, not many organizations can successfully digitally transform due to a range of technological, operational, and human resource factors. These include the lack of necessary digital infrastructure, inadequate digitalization knowledge, a gap in skills and talent to implement such a change, cybersecurity concerns, and more. Addressing these issues should therefore be high on the priority list for manufacturing leaders as these new network and operational synergies are critical for constant progress – whether they approach change from within or source for external solutions from a managed services partner.

To find out more about the current state of Industry 4.0 and understand what manufacturers are doing to accelerate their digital transformation, we spoke with business leaders and digitalization experts on the ideal methods for advancing the sector and achieving more sustainable manufacturing practices in the long run. We also explore the need for the right network infrastructure, and talent to maintain these systems, to ensure the data-intensive processes of Industry 4.0 can run smoothly and securely.

By uncovering these insights, we aim to share what manufacturing leaders must do to identify their current infrastructure weaknesses and evaluate areas that can be improved so that Industry 4.0 initiatives can be adopted successfully to enable sustainable, scalable, and robust operations for long-term success. Through this, the path towards Industry 4.0 will become clearer for leaders and organizations, empowering them to achieve digital transformation that is effective and enduring.

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Key insights

Over the past two decades, the global manufacturing industry has experienced a 25% increase in productivity[5] – a trend that is expected to continue with increasing Industry 4.0. This is a constantly evolving space as emerging technologies appear, yet one thing remains certain – a robust digital infrastructure that functions as an effective underlying foundation for new tools and solutions is crucial.

1. Manufacturers urgently need to adopt Industry 4.0

The COVID-19 pandemic highlighted several key weaknesses in manufacturing, ranging from supply chain disruptions to manpower shortages.

Manufacturers now need to embrace new methodologies so they can react with agility and flexibility, and develop a robust framework to thrive even in the face of uncertainty and stay ahead of the competitive landscape. Through Industry 4.0 technologies like data analytics and automation, have evolved to become indispensable tools.

New metrics that were previously unobtainable can also enable better predictive measures, leading to greater operational and business resilience.

2. Connectivity and robust networks are essential for Industry 4.0

Modern digital solutions require an immense amount of data and resources to ensure smooth operations. That's why enterprises need to ensure that their network infrastructure is future-proof and can handle the demands of these new technologies before they embark on Industry 4.0 transformation initiatives. Failing to do so could hinder their transformation, leading to unsatisfactory results and outcomes.

3. Network scalability is critical in successful digital transformation

A flexible and scalable network will allow enterprises to effectively deal with the copious amounts of data that typically results from Industry 4.0.

Furthermore, enterprises will be able to analyze the data to uncover insights to help them improve and optimize existing processes and systems, enhancing operations across the enterprise for greater productivity and efficiency.

4. Cybersecurity is now more important – and more challenging

The explosive rise of the cloud as well as the widespread use of decentralized databases and systems have led to increased cybersecurity concerns. Enterprises must ensure that their networks and infrastructures have sufficient security features to keep data safe and secure, from storage to transfers.

5. Enterprises must find ways to work around the existing skills shortage

The rapid pace of technological development and implementation has led to a dearth of skills and talent across the globe, and some organizations may lack the resources to compete in the talent war. Enterprises must find new ways to meet the growing demand for skilled workers, be it through learning and development (L&D) or by engaging a technology partner.

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Why Industry 4.0 adoption is vital for manufacturers to stay competitive and resilient

Industry 4.0 helps to drive manufacturing productivity, providing many tangible and intangible benefits[6] that lead to better business outcomes, such as improved flexibility and robustness. This capability not only enables scalability but also the ability to adjust their operations efficiently based on demand fluctuations.

Despite the proven benefits of Industry 4.0, adoption rates remained relatively low even after its initial introduction as a concept over a decade ago by the German government. At the time, it was considered 'good to have' and not 'essential'. Perhaps this set the tone and influenced Industry 4.0's uptake in the past decade, as a report by IOT Analytics[7] found that less than 30% of companies had adopted Industry 4.0 initiatives and technologies in 2020.

However, things changed when the pandemic struck. Many critical manufacturing weaknesses – from supply chain disruptions to irregular and fluctuating demand – were uncovered, highlighting the pressing need for digital transformation and Industry 4.0 to adapt to a new global landscape rife with uncertainty.

Enterprises that were quick to acknowledge the importance of Industry 4.0 and were willing to adopt new processes and digital solutions, were able to react with agility and increase their resilience, thus leading to better odds of surviving periods of instability.

A reported 94% of respondents in a 2021 Industry 4.0 survey[8] said that this adoption had helped them to keep their operations running during the pandemic, while 56% indicated that Industry 4.0 technologies played a vital role in their organizations' crisis responses.

Adopting Industry 4.0 has helped many manufacturing companies stay afloat and successfully navigate the choppy and often unpredictable waters of the sector. New tools and solutions that were catalyzed by digitalization like cloud computing, digital twins, and additive manufacturing have already shown their worth by enabling superior data management, machine monitoring, and more.

Technology as a critical tool to improve performance

For example, the use of digital twins provides not only a productivity boost thanks to process simulation but also a more sustainable method of production. "Digital twins were originally created to simulate production planning, throughput, productivity, and bottleneck analysis. Due to supply chain disruptions, the virtual twin has also evolved to allow manufacturers to simulate their own supply chain and develop resilience," says International Centre of Industrial Transformation (INCIT) Founder and CEO Raimund Klein.

Such advanced technologies and tools have helped manufacturers increase production capacity and reduce material losses while improving customer service and lead times. In turn, this has improved employee satisfaction and reduced the organization's environmental impact. These improvements highlight the discernible operational benefits that can be gained with the support of improved networks.

In contrast, manufacturers who have lagged behind in digital transformation have lost out on these benefits – and now run the risk of falling behind. Without advanced digital solutions to streamline and optimize processes, production is not as efficient, leading to losses in productivity and more. Supply chain resilience is also negatively impacted without the right tools and technologies to develop robust systems. Such enterprises may eventually be overtaken by more agile organizations that have embraced the digital shift and can adapt to quickly changing market trends.

## Industry 4.0 technologies elevating manufacturing

Cloud computing: Cloud has provided numerous scalability, storage, and cost benefits to enterprises, helping them drive innovation and accomplish real-time processing on a vast scale.

Edge computing: Edge computing shortens data 'distance' and reduces latency by performing data processing where the data originates rather than at a decentralized server. This enables quicker response times and greater reliability.

Data analytics: Big data has enabled manufacturers to leverage metrics to optimize processes, reduce waste, amplify productivity, and strengthen forecasting to remain agile.

AI and automation: The use of advanced robotics and AI has helped to improve business processes, efficiency, predictive maintenance, cost efficiency, and more.

Digital twins: Creating virtual and simulated copies, or digital twins, of processes, systems, and supply chains allows companies to visualize and improve workflows without wasting resources.

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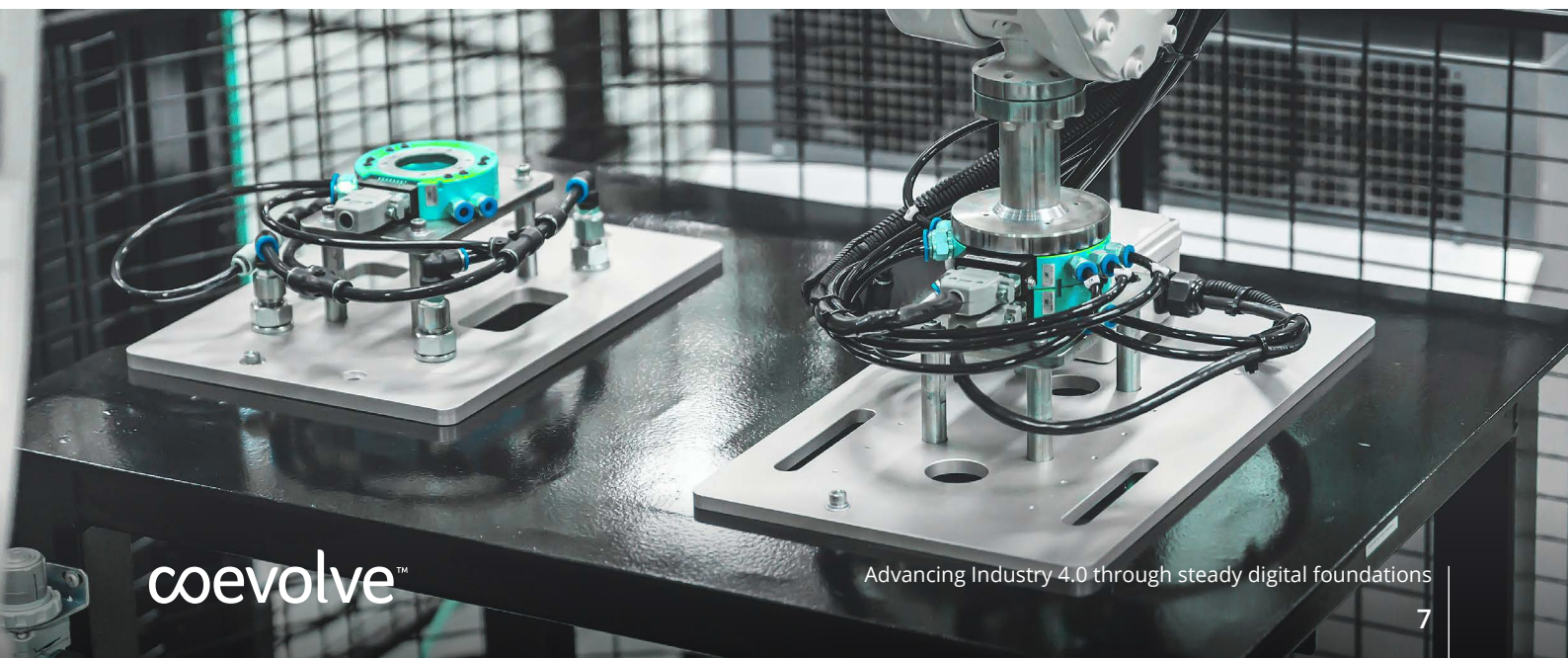
The importance of interconnectivity, flexibility, and security

While connectivity in the 1990s to 2000s operated mainly on data across shorter distances and predictability – enterprises typically concentrated most of their organizational and data needs in a few main geographical areas – the operating model of today has evolved.

In the current digital landscape, systems, and networks rarely ever work in isolation. Increased interconnectivity has provided us with the ability to plan and execute operations across much larger distances at much faster rates, enabling high-volume and low-latency data transfers through both physical and virtual domains. From consumer electronics to manufacturing machinery, our devices and software communicate and work with each other seamlessly thanks to innovations in tech and advanced network infrastructure like cloud computing supporting these services.

The growth of interconnectivity has also led to growth in data flows. It has been projected that the world will create over 180 zettabytes of data by 2025[10], up from 64.2 zettabytes in 2020. This means that there is a pressing need for enterprises across various industries, including manufacturing, to ensure that network infrastructure is stable enough to meet this surge.

This explosion of data means manufacturing companies must also determine whether their network infrastructure can handle the demands of the new technologies before embarking on Industry 4.0 transformation initiatives. Failing to do so will likely lead to many problems during adoption and transformation. They may also find that the results and outcomes of their initiatives are not ideal.

Understandably, expanding existing network capabilities may be a daunting task for some enterprises that do not have the right information technology (IT) aptitude and resources to keep up.

Third-party IT partners can therefore be viable options to help facilitate the process, relieving manufacturers from needing to spend time and money on training existing or new staff.

In addition, government involvement will be vital for enterprises that want to undergo their own transformation but lack the human resources to do so, says McKinsey Associate Partner Bo Huang. For instance, Singapore has several initiatives such as the Industry 4.0 Human Capital Initiative (IHCI) and the Career Conversion Program (CCP) that are designed to help with Industry 4.0 skills acquisition. Through these programs, digital transformation planning and implementation will become easier and more accessible for more organizations.

> "Government support, subsidies, and grants will allow companies to trial proven solutions and technologies, and help them build their infrastructure IoT technology backbone."
>
> **Bo Huang,**
> Associate Partner,
> McKinsey & Company

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Scalability: a critical infrastructure factor

Industry 4.0 adoption is a continuous improvement process. But more than that, Industry 4.0 will enable enterprises to carry out data analytics to uncover insights – and then act on these to improve processes and systems and enhance operations for greater productivity and efficiency. This means that enterprises need to have a network infrastructure that can scale when needed to cope with increased data flows when monitoring and analyzing these metrics.

Developing future-capable infrastructure is therefore paramount for ensuring longevity and flexibility, whether through cloud or edge computing. While edge computing solutions were once considered less desirable as they were more difficult to implement, there has been a shift towards it from cloud-based architecture due to increasing network and connectivity demands that require faster response times and stability.

"Creating the necessary structure to allow that is a big challenge for enterprises," says Ciaran Roche, Co-Founder and CTO of Coevolve. "But it's becoming much more of a conversation than it was previously because the architecture and the orchestration are finally catching up to where it needs to be to make it viable."

Edge computing has seen increasing use over the years and the market is expected to grow even further with greater interconnectivity needs, at a CAGR of 48% over a 10-year period[10], from US$9 billion in 2020 to US$445 billion in 2030.

It's easy to see why there is growing adoption of edge computing for scalability – users can expect benefits like improved reliability, enhanced cybersecurity, reduced latency, and more.

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Co-Founder and CTO,
Coevolve

A focus on data and cybersecurity is a must

While cybersecurity has always been at the top of business leaders' minds, Industry 4.0 adoption and more complex data processing across decentralized networks mean that enterprises must ensure that their systems have sufficient security features to keep data safe and secure. This applies to storage, the transfer of information to and from cloud, and between networks.

The importance of cybersecurity cannot be understated whether it's for Operational Technology (OT), IT, or the convergence of both. "In the past, you could think of the OT environment as being very much a closed system. It was walled off from everything else and self-contained," says Roche. "Now, you can't just look at it as that closed system.

You have to contemplate a future where that data has to be able to securely get out into the internet and out into the outside world. And that's driving all these enterprises to really carefully look at the security of how this whole thing is put together."

The rising concern in the cybersecurity space can also be clearly seen from how insurance premiums for cybersecurity have climbed greatly in recent years. As IT/OT convergence continues to revolutionize the manufacturing industry, the attack surface for malicious actors has grown due to legacy and unpatched systems. For a fully digitalized factory, cybersecurity breaches can lead to total paralysis and costly downtimes, clearly underscoring the symbiotic nature of networks and operations today.

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Ciaran Roche,
Co-Founder and CTO, Coevolve

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Enterprises must find ways to work around the skills shortage

This spike in demand for skilled talent has been compounded by the pandemic, with a Deloitte report[11] forecasting that the US manufacturing sector will have around 2.1 million unfilled positions by 2030. The firm also found[12] that talent retention remains a top priority for many manufacturing companies.

To combat the labor challenge, many organizations have turned to upskilling existing staff. But it should be noted that long-term L&D must be prioritized to see real results. According to a recent survey[13], while 38% of enterprises trained staff to maximize the capabilities of their business systems, around 61% of them had no plans to build long-term skills training programs. This lack of planning will result in not only ineffective talent management but also a waste of financial resources, especially with regard to Industry 4.0 transformation. Without the commitment to continual training, capital investment, and time spent, attempts to adopt Industry 4.0 initiatives will face a higher likelihood of failure.

However, even with the right investment, addressing the skills shortage is set to become even more difficult due to the intensive costs involved in talent acquisition and retention. "Having the right people throughout your organization is going to become very difficult in different geographies," says Andrew Loughlin, Senior Technical Consultant at Coevolve. "Your robots are going to become cheaper. Your technology automation is going to become cheaper. But the people that can keep them running are going to become more expensive."

Furthermore, the skills of today are going out-of-date much quicker than before with the high rate of digital transformation leading to the constant need for newer, in-demand skills, adds Loughlin.

Addressing the skills gap

Alter your talent management mindset: Management must lead the way by determining and clearly communicating the enterprise's stance, whether it's through reskilling workers or engaging external technology partners.

Learn what type of talent you need: Identify the right skills, talent, and labor you require, both now and in the future. It may help to refer to industry-specific or national roadmaps which highlight areas that lack certain expertise.

Leverage external training programs: Internal L&D opportunities are important but it may also be beneficial to establish training programs for external parties. Companies like Microsoft and Amazon have created educational platforms for third parties to groom workers of the future.

Provide work flexibility: This is a major factor in an employee's decision to stay or leave, so management must consider hybrid working arrangements and flexible hours in their retention strategies.

Hire people with the right soft skills: Workers who have the right personality and desire to learn may deliver more value to the organization than those who are more technically skilled but have less desire to upskill themselves.

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Architecting for the future as a cohesive unit

Today's uncertain business landscape necessitates digital transformation whether it's Industry 4.0 or beyond. Manufacturing companies need to adapt and pivot, and having the right infrastructure will help them cope with unpredictability. So, how should enterprises approach the future of industrial advancement, so they can maximize their chances of success?

Strategize and plan ahead to enable effective, lasting change

To effectively plan ahead, manufacturing enterprises must not view their network and operations as silos. They must also first identify what they have; understand what they want to achieve and how to achieve it; then strategize and build a roadmap to get from where they are, to where they want to be. While this may be easier for larger multinational corporations (MNCs) who have the resources and manpower to oversee extensive enterprise-wide change, the same cannot be said for small and medium enterprises (SMEs).

"SMEs or micro-SMEs need even more guidance than the MNCs who have enough resources to do strategic planning. We need something underneath to develop and manage these strategies; this is the backbone for all industries," says INCIT's Klein.

Only with the right frameworks and strategies in place can lasting change occur. Manufacturers can then use these frameworks to establish network infrastructures which are suitably robust, flexible, secure, agile, and interconnected to support the incoming technologies before embarking on Industry 4.0 adoption.

Prioritize Industry 4.0 today for a sustainable future

More manufacturers need to understand the benefits of Industry 4.0 and embrace new technologies to drive progress. The use of advanced smart solutions is a game-changer that can provide clearer overviews, more granular control over processes, and optimized methodologies to maximize efficiency to generate better outcomes.

While there has been talk of Industry 5.0 – the next industrial revolution which places a firm emphasis on human-robot synergy and sustainability – it may still be too early to think about due to two factors: low Industry 4.0 adoption and the lack of sophisticated technologies to drive human and machine collaboration. The focus now should remain on Industry 4.0 and digitally transforming factories of today into smart factories.

"Industry 5.0's biggest challenge is promoting synergies using a complete wave of new technologies, like advanced robotics, cyber-physical systems, and cognitive engineering capabilities," says Klein. "We are still far away from these currently."

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Embrace change led by top management

Global events and issues have caused operational disruptions and increased costs across the board. Manufacturing enterprises must find ways to do more with less by leveraging Industry 4.0 technologies to reduce overheads, raise efficiencies and increase productivity.

Achieving this will require a top-down change in mindset, where everyone learns to embrace transformation. This means having role models within the organization leading the way as workers will benefit from knowing that top leadership buys into systemic change to gain holistic improvement.

"Adopting digital solutions might change your way of working. If you're not onboard and don't like it, your staff won't like it," says McKinsey's Huang.

However, management must also understand that change management and transformation strategies are not one-off events – clear roadmaps and constant check-ins are essential to ensure consistent progress over time.

"These are not three-week projects. They're 12-month, 18-month projects," says Loughlin. "Education is the key, so those departments understand the need for the infrastructure and what they're about to do."

Moreover, effective change management can only take place if there is transparency in both leadership and teams, and transformation can only be achieved by developing a culture of openness working across the enterprise, says Klein. This sentiment is echoed by Huang, who agrees that clear communication is critical in driving this change. "Communication is key to explain why change is needed and to provide clarity and assurance for those worried that digital transformation might impact their roles," he says.

Develop a strong, positive L&D culture and encourage upskilling

A company culture that embraces L&D will help advance your workforce and enable you to work around the skills shortage and tight labor market. This is becoming a more pressing issue even without major transformation as jobs continue to evolve. Recent findings[15] conclude that a projected 40% of core skills will change for workers even if they perform the same tasks in the company.

However, creating an environment that encourages upskilling and reskilling depends largely on the management and how much they value employee training opportunities. Employees know intuitively if their leaders are walking the talk in terms of L&D, so top management must demonstrate commitment to providing these opportunities.

Additionally, on-the-job training is also often more important than paper qualifications as new technologies and systems are popping up faster than before. "It took me four years to complete an associate diploma. But after four years, some of the technology was just so irrelevant," says David Stork, Project Manager and CX Consultant at Coevolve.

Therefore, being prepared to always learn and develop within the company is a great advantage for both employers and employees. You can also consider third-party partners who can provide the technical expertise and skills that you need.

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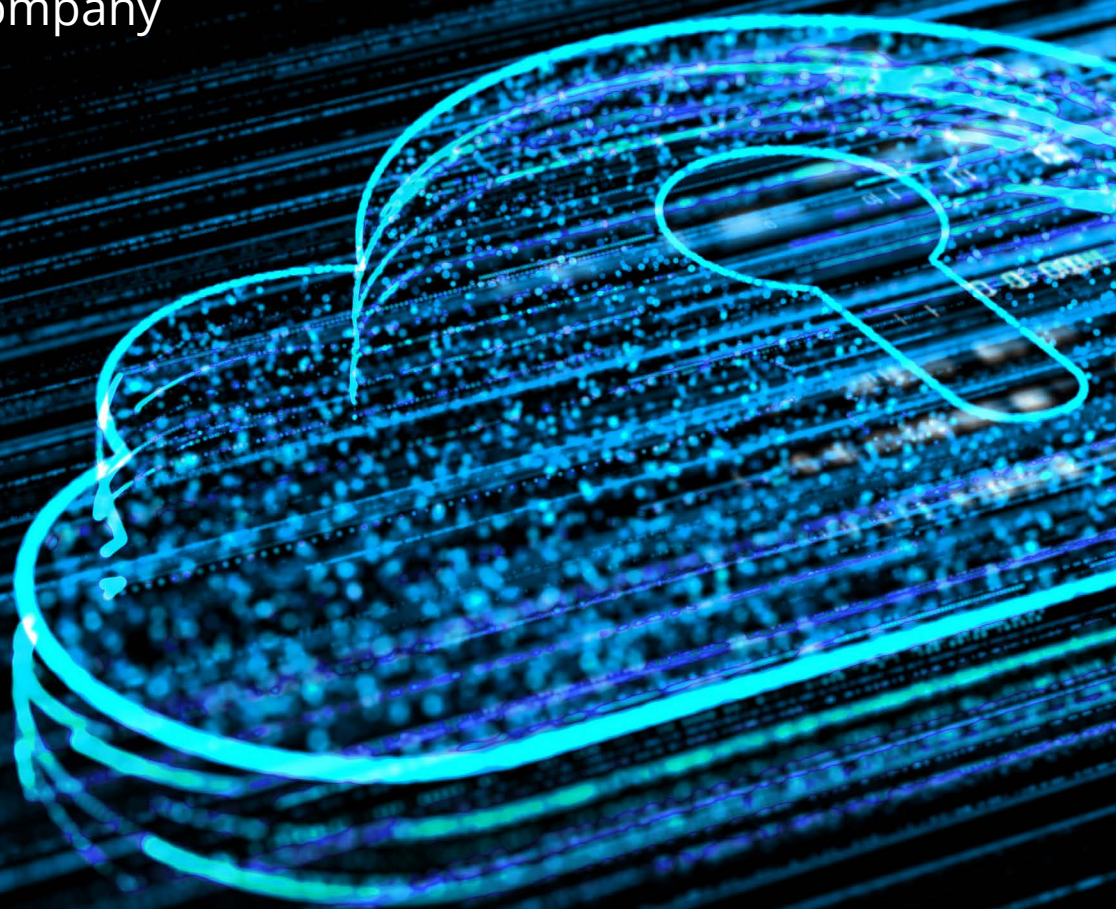
Closing the gap

Industry 4.0 is well established, but many manufacturers have still yet to fully embrace it to reach the next stage in manufacturing. As demand grows and the market expands, Industry 4.0 adoption must be accelerated so that manufacturing enterprises can remain competitive and flexible.

To enable next-generation progress, the underlying technological infrastructure must be robust and future-proof and intertwined with business and strategic planning. So, how can manufacturers ensure that they don't get left behind in the world of smart manufacturing and build up their own network capabilities?

Identify network needs and gaps

Legacy infrastructure is often ill-equipped to handle large-scale data and processing needs, so manufacturing enterprises must pay attention to the networking areas to improve and upgrade. Identifying the functions that should be hosted remotely on the cloud and those that should be run locally will help with resource, security, and cost allocation as well.
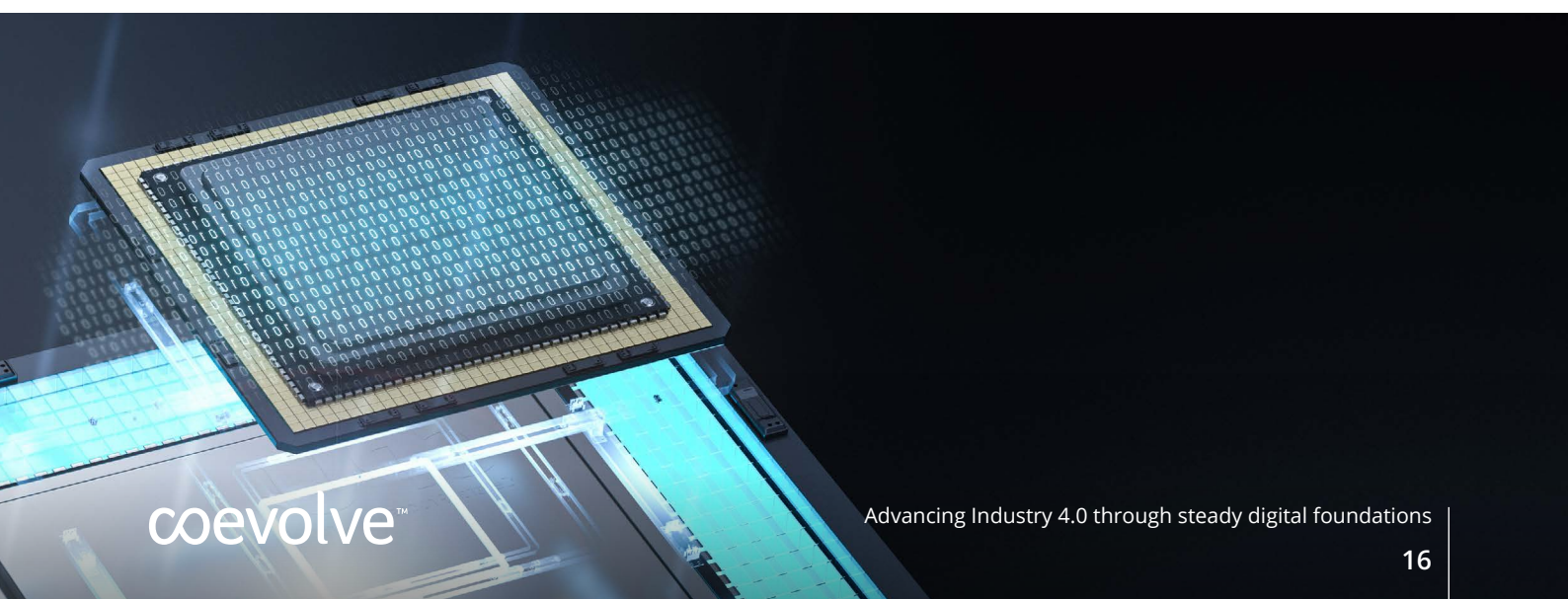
Recruit or train talent and skills

The rapid pace of digitalization has resulted in a severe skills shortage across most geographies, industries, and sectors. To combat this, manufacturers need to provide the necessary training and development opportunities for existing staff or engage the services of the right IT partners to help manage this shift.

Monitor the latest developments and costs

As technology advances, new solutions, and platforms will be launched, so manufacturers need to ensure that they have access to the latest solutions for greater efficiency. But not all solutions are suitable for everyone, so IT and business leaders must track and identify the right tools that are appropriate for their infrastructure to properly manage costs.

Digital transformation often requires an overhaul of existing systems and can be difficult for manufacturing enterprises to implement. But the long-term benefits of having a future-proof, scalable, and agile network infrastructure in place to support the demands of the increasingly heavier data processes that come with Industry 4.0 are unparalleled.

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