

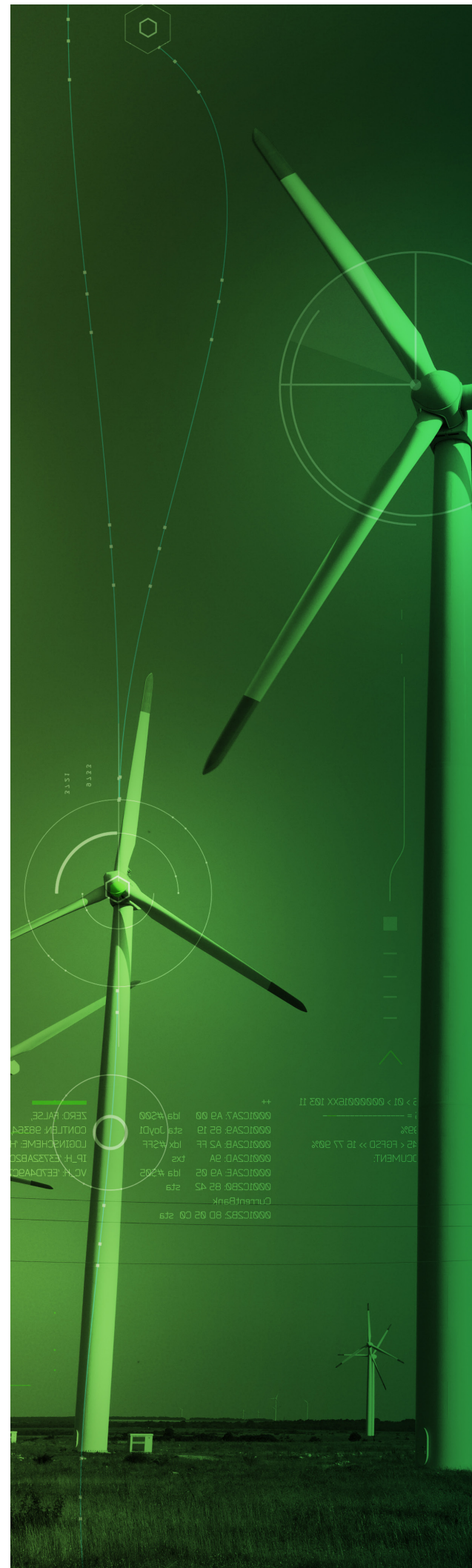


The State of Industrial Digital Transformation

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WHITE PAPER



In nature, evolution is driven by disruption. As species compete to dominate a habitat, forces of disruption provide open niches for new and evolving species to establish themselves. A similar phenomenon happens in business where these disruptions take the form of speed and innovation. Global scale disruptions such as the industrial revolutions have reshaped the way economies are structured and operate, and, in turn, have led to the downfall of many companies and the rise of others. At the current churn rate, about half of today's S&P 500 firms will be replaced over the next 10 years. Success in riding these transformative waves has proven to be dependent on embracing change, rather than holding fast to existing methods while these waves crash.

This research report focuses on the impact of digital transformation on industrial companies, who face particularly unique challenges; industries associated with high barriers to entry like automotive or aerospace and defense have seen increasing threats from new entrants with the success of Tesla, SpaceX, and Blue Origin. The threat of substitutes is making traditional business models obsolete as crowd-sourcing and peer-to-peer apps disintermediate manufacturers from the customer lifecycle as we've seen with Uber, AirBnB, and other digital natives. Industrial companies face not only the digital forces that are shifting the way companies and customers communicate with the world, but the physical changes in machine, product, and human capabilities that these digital forces engender.


“To compete and succeed today, companies need to stop viewing change as a place, or an outcome that can be achieved. Instead, companies and their employees need to embrace a constant pace of change. From a place, to a pace.”

– Jim Heppelmann, CEO – PTC

Industrial enterprises have faced generational change before, but this digital revolution is dwarfing previous revolutions in terms of societal impact and implications. This digital disruption is impossible to ignore and has already shaped the way companies operate to succeed. Eighty-five percent of industrial respondents to a recent McKinsey survey cite major disruptions posing the need to make a significant shift, with the speed of change as the primary impact. As PTC's CEO Jim Heppelmann explains, “To compete and succeed today, companies need to stop viewing change as a place, or an outcome that can be achieved. Instead, companies and their employees need to embrace a constant pace of change. From a place, to a pace.”

Digital transformation (DX) is a broad business strategy, applicable across all industries, to solve traditional business challenges and create new opportunities through the use of technology. It requires acceptance of entirely new ways of working and delivering value to customers.

But, for industrial enterprises, there are unique sets of challenges, use cases, drivers, and decisions that must be made to successfully navigate the new normal. While these industrial themes are similar, company-specific DX goals can still vary greatly. For an automotive manufacturer facing growing competitive pressures, it could mean new customer experiences with digital touchpoints in connected car initiatives. For an oil & gas provider, it could be connecting a remote rig to drive operational efficiencies and worker safety.



IDC forecasts DX spending in 2019 will be \$1.25 trillion by year's end and a large portion of that spending comes from industrial markets: discrete manufacturing spending on DX will reach \$220 billion, process manufacturing projected to be \$135 billion, and transportation to \$116 billion.

To what technologies does this spending go? What challenges do those technologies address, and what opportunities will they help industrial companies capitalize on? As digital transformation strategies mature, companies are no longer asking what benefits are attainable, but whether they can outpace the benefits of others in their markets.

In this analysis, we will provide a unique industrial perspective on the significant research that has been compiled on digital transformation to help industrial enterprises develop DX strategies that are positioned to succeed in today's rapidly changing industrial markets.

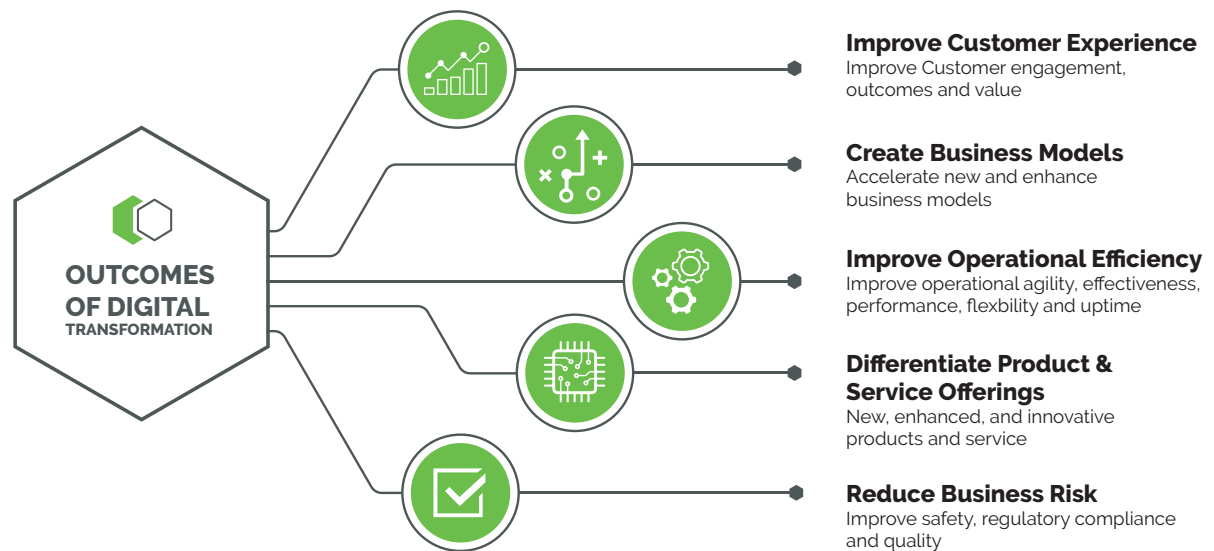
You Are Here: The Current State

PTC's analysis reveals that most industrial enterprises are still in the early phases of DX adoption; earlier proof of concept initiatives are beginning to be rolled out into production. As they do so, there are notable early successes and trends identified by digital pioneers on this new frontier of innovation. They have taken on large-scale technology initiatives and integrations and have illuminated the untapped potential DX can have in the industrial world.

Shifting from largely experimental programs and homegrown implementations, the current state of DX for industrial companies in heavy asset-intensive verticals including manufacturing, utilities, and transportation, is categorized by solutions that accelerate time to value, the scaling up of proven use cases and digital business infrastructure, and new attitudes and acceptance toward emerging technologies.

Industrial Digital Transformation Outcomes and Drivers

DX is not aligned to a single outcome; across industry surveys of executives and practitioners, however, our analysis uncovered some common opportunities. With myriad global forces disrupting the way industrial enterprises do business, DX must be approached with a mix-and-match strategy that starts with goals unique to each industrial company, their competitive landscape, strengths, and weaknesses. From this virtually endless menu of goals business leaders are being advised to pursue, we've distilled the key drivers of change in industrial markets to five overarching outcomes that are fundamental to the success of DX initiatives.



Improve Operational Efficiency

- 39% of technology and business decision makers cite reduce costs as a DX driver (Forrester)
- 'New efficiencies are still the primary driver for large companies to invest in new technologies.' (WEF/Accenture)
- 42% of DX strategists and executives cite operational efficiencies as a top metric for tracking DX progress (Altimeter, a Prophet Company)

Technologies that involve automation and data analysis are improving these metrics by facilitating change to processes. Companies can now apply connected technologies to gain visibility into their operations where only stopwatches and speculation existed previously. Applied correctly, these technologies can be used to identify inefficiencies and a company with a proactive strategy can develop agile processes that allow them to capitalize on the insights this visibility brings. Wasted time and materials can be avoided through this constant analysis and optimization. Furthermore, automation capabilities are improving operational effectiveness by unlocking new levels of quality and consistency from machine assets.

Differentiate Product & Service Offerings

- '50% or more B2B companies will differentiate themselves offering easier, more personalized, more connected purchasing experiences' (B2B Online)
- 25% of technology and business decision makers cite product and service innovation as a DX driver (Forrester)
- 46% of DX strategies and executives claim evolving customer behaviors and preferences as a key driver of DX (Altimeter, a Prophet Company)

Differentiation is a core driver for many industrial companies, especially for product manufacturers that often compete in crowded markets. DX can enable differentiation of product and service offerings by creating opportunities for new capabilities and optimizing current product and service delivery. The key measures of differentiation show up in time to market, rate of new product or feature introductions, and improved product quality.

To achieve these goals, enterprises are leveraging technology to better understand their products and create proactive enhancements that set them apart from the competition. Examples include real-time simulation of product changes and improved collaboration across the value chain from design through service. Augmented reality is differentiating value propositions and additive manufacturing is enabling net-new design possibilities, meaning technology is being used to drive a state of constant change and adaptation. Closing the loop between the planned and realized value propositions, companies can quickly recognize customer needs and go to market faster with solutions that better meet their customer requirements.

Improve Customer Experience

- 41% of technology and business decision makers are looking to improve the customer experience through DX (Forrester)
- 75% of consumers are more likely to make a purchase from a company that knows their name and purchase history and recommends products based on their preferences. (Accenture)
- 71% of executives view understanding the impact digital technology will have on their customer's behavior and preferences as their top challenge (Altimeter, a Prophet Company)

Organizations across the globe are recognizing that customer-centricity is fundamental to their DX strategies and to effectively compete in the digital marketplace. Buyers expect customizable products and experiences and for issues to be addressed in real time or before challenges arise. Digital interfaces and communication coupled with new services are strengthening customer engagements and brand reputation. From net promoter scores to increased service revenues, customer experience can now be measured in more meaningful and actionable ways than ever before.

At the core of this new normal of customer success is the ability to create more intimate relationships with customers through technology capabilities and building a culture of customer-centricity. Extending the customer lifecycles can be achieved with use cases like equipping aftermarket services with customer intelligence that monitors performance of deployed products, enabling more proactive service and upselling to meet customer demands and avoid unplanned challenges. It can also take the form of new direct communication channels to achieve and accelerate customer time to value, as is the case with guided maintenance and remote service enabled by connected product monitoring.

Create New Business Models

- 41% of executives cite new business models as the top DX driver (Forbes Insights)
- 30% of industry revenues will come from new business models by 2020. (WEF/Accenture)
- 'Companies are recognizing that digital customers increasingly demand high-quality experiences and guaranteed outcomes, rather than just products and services. This development is leading to new, outcome-based business models.' (WEF/Accenture)


There is a massive shift of companies moving from selling standalone products, to providing end-to-end services or for manufacturers 'products-as-a-service'. As customer expectations rise, buyers become more cautious about large capital spend and prefer the reduced commitment offered by usage or outcome-based business models. Buyers are experiencing the same uncertainty and rate of change as providers, and the 'servitization' of all things has emerged as a way for both parties to mutually reach value. These new business models shift traditional metrics like top line growth by recognizing service and future recurring revenue as equally or more important than current sales.

Traditionally, the monetization of products has ended at the point-of-sale; however, with the proliferation of digital capabilities including cloud computing, mobile applications, and IoT, services and related revenue can be gained post-sale. There are many examples of this 'on-demand' business model proliferating through industries with the development of the 'sharing economy'. For industrial enterprises, this business model transformation is creating the opportunity to offer new SLAs that promise specific pay-per-value outcomes for customers – and these new SLAs come at a profitable new price.

Reduce Business Risk

- 21% of technology and business decision makers cite regulatory compliance as a DX driver (Forrester)
- 42% of companies cited IT security and risk management as the main focus of digital transformation efforts (HBR)
- 39% of DX strategies and executives claim new standards in regulatory & compliance as a key driver of DX (Altimeter, a Prophet Company)

Risk is more of a driver of change for industrial enterprises than ever before. Between the shifting buyer-supplier dynamics we've discussed and uncertain global trade and regulatory conditions, companies simultaneously cannot afford to take risks and yet are required to take them. Supply chains have become more complex, and materials and goods move globally at breakneck speed. Yet many industrial companies still rely on heavy use of paper to do business, where information can be challenging to interpret, maintain, and scale, creating compounding compliance hurdles. Risk can be measured by the number of compliance incidents such as worker safety incidents, data loss, or with product and service liability and warranty claims.



DX technology being applied to meet these ends and reduce risk by enabling smarter decision making and more calculated risk taking, as well as yielding fast reactions when challenges arise. This is prevalent in mission-critical industries like pharmaceuticals or automotive, where performance is crucial and regulatory compliance with Food and Drug Administration (FDA) or the National Highway Traffic Safety Administration (NHTSA) is continuously top-of-mind. Analytical capabilities and connected technologies are providing real-time compliance reporting systems such as plant risk assessments, work forecasting systems, and quality inspection reviews.

Connecting workers can alleviate overhead costs for OSHA standards and health and safety (HSE) policies, while connecting physical assets can verify critical systems such as infrastructure are properly functioning. Regulatory compliance has historically been an organizational hurdle; however, DX adopters are not just using technology to comply but differentiate and drive new business value.

Tools of Transformation – 8 Key Technologies to Enable Success

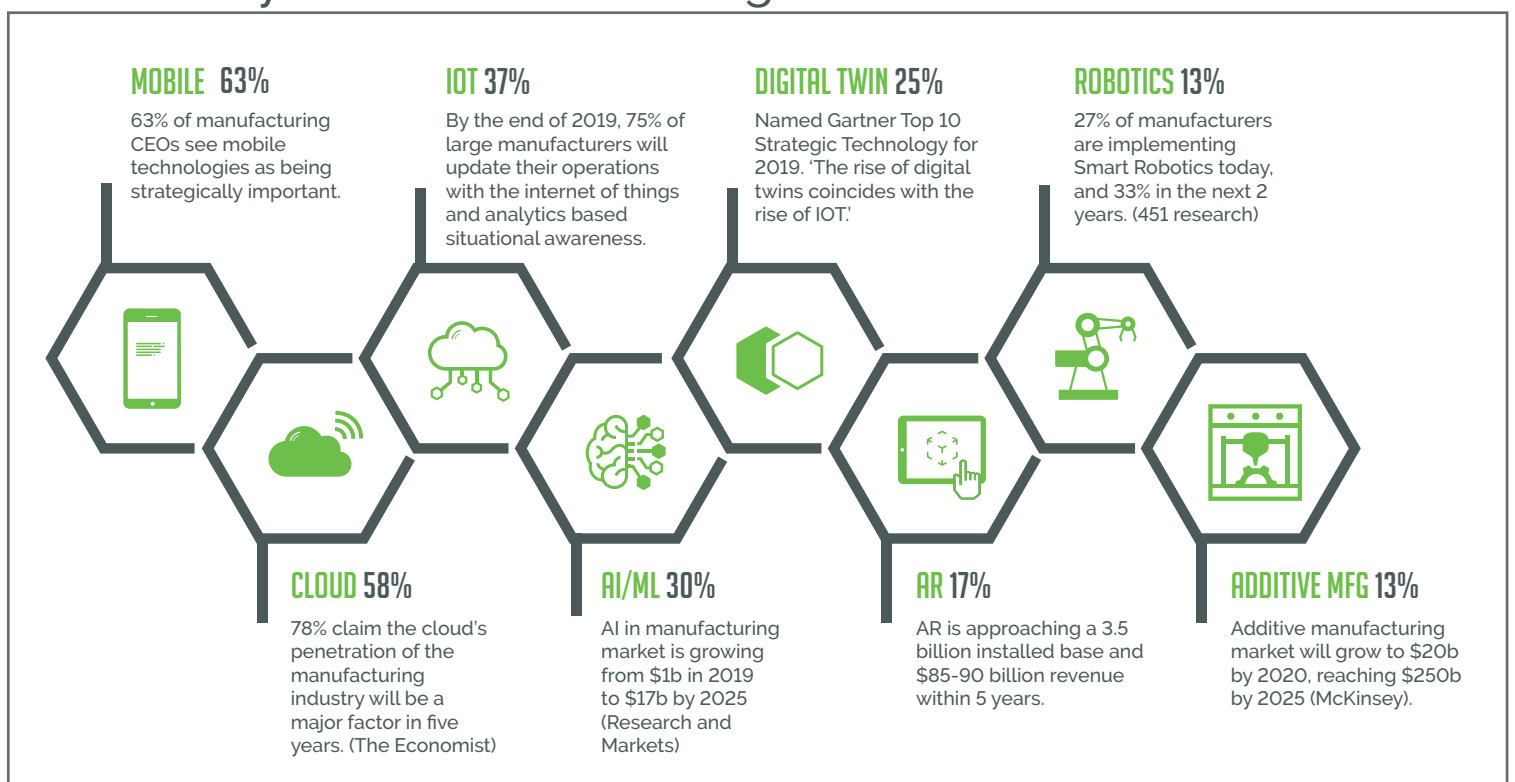
To achieve the outcomes detailed above, DX strategies must combine cultural, process oriented, and customer-centric initiatives. While these initiatives include implementation of technologies that add necessary enterprise capabilities, they are not being executed solely for technology's sake. In fact, many DX strategies fail when they are viewed as simply technology strategies; lack of understanding of technologies available to support digital transformation projects is the main cause of failure, cited by 51% of firms polled. Companies must think of DX technologies as levers or tools to support business value-oriented initiatives.

Through our analysis, we've aggregated a common set of technologies fundamental to achieving those DX initiatives that are top-of-mind for industrial CxOs. While many of these technologies are considering cutting-edge, value is predominately recognized as it is integrated with existing systems in place, with other technologies and tied to business outcomes. Over time, many of these technologies will become table stakes as manufacturers take on DX initiatives.

The cloud, once thought of as optional, is already reducing costs and driving operational efficiencies, while providing the scalable infrastructure required to support the increasing amount of heterogenous IoT devices in industrial environments. Augmented reality will improve the customer experience by increasing asset uptime and improving service KPIs, using artificial intelligence (AI) for futuristic use cases like computer vision enhanced quality inspection. While these may be perceived as bleeding edge now, over time the value they deliver will be a baseline requirement to enabling the next level of progress.

As industrial companies embrace change, they're adopting these eight technologies as levers to achieve business-critical outcomes. Today, these technologies are essential to create competitive advantage, and as these average adoption percentages continue to rise, they will eventually become table stakes to defend market position in industrial markets.

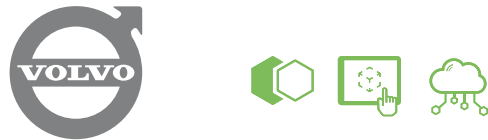
8 Key Tools of Industrial Digital Transformation



The percentages associated with each technology are the average current adoption rates for industrial companies, analyzed by PTC based on research from World Economic Forum, Accenture, International Data Corporation, Harvard Business Group, International Data Group, Cognizant, 451 Research, McKinsey, ResearchandMarkets, Forrester, and Gartner.

Tales of Transformation

The following case studies showcase how combinations of these eight technologies are assisting industrial enterprises in implementing their digital transformation strategies.



Reducing operational costs, enhancing quality, and improving worker productivity with information sharing. The Volvo Group is turning to DX as a differentiator for its trucks through maintaining rigorous quality standards, flexibility, and agility in its manufacturing processes. To drive enhancements to their operational effectiveness while improving product quality – a key differentiator – they're implementing a digital thread spanning information systems across design, manufacturing, and quality control. Synchronizing its upstream and downstream data, Volvo can rapidly adjust its production processes to keep up with changing customer requirements and custom configured products. By ensuring the workforce across different roles has continual access to the latest information, they're driving transformation in the way they share and consume information across the value chain.



Improving production yield and quality to effectively compete in the increasingly competitive food and beverage industry. Lavifood is taking a fresh look at its production environments by integrating IIoT, industrial-grade connectivity, and real-time analytics down to the floor-level. Bringing plant-level intelligence to its production lines enables this agricultural giant to provide more dynamic responses to potential issues, reducing downtime and consequential impacts on the perishable goods it provides. This granular attention-to-detail is needed for Lavifood to provide high-quality products that improve the customer experience as well as drive operational efficiencies and product yields in its own plants.

POLARIS



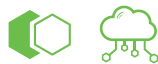
Accelerating new product and feature introductions to differentiate from the competition. Polaris is at the forefront of executing DX as a product and service differentiator from design through manufacturing and sales and marketing. The manufacturer has implemented additive manufacturing to improve the tooling design process, creating more complex product parts faster and with less scrap. Reducing design iterations and validation process time quickens time-to-market for new products and differentiates Polaris from competitors. Expanding out of the factory, Polaris is equipping its dealerships with live augmented reality experiences illustrating potential variations of products to customers.

Howden



Reducing business risk and unplanned downtime. The global air and gas handling equipment provider is driving risk reduction and value to its customers through its DX program called 'Data Driven Advantage'. Implementing several industrial technologies to support its deployed products in customer operations, Howden is improving uptime and saving customers millions in unplanned downtime, substantially reducing business risk. Howden is constantly improving intelligence of its products and operations through digital twins. These twins further leverage AI to predict failures and utilize the cloud as the underpinning infrastructure of choice.

WOODWARD



Improving agility and intelligence to drive operational effectiveness.

Woodward, a major provider of controllers and components for industrial and aerospace markets, is executing DX across its production environments to gain agility, cost savings, and improved decision making from previously black-boxed pockets of siloed operational data. The company is creating a 'manufacturing information system' to synthesize this data; an accumulation of multiple pieces of existing digital technologies (ERP, CAD, PLM) and embedding IoT into its machines to gain a live plant-wide view of operations. With people at the forefront of its DX, Woodward is now able to develop role-based lenses to different employees underpinned by the same digital twin (MIS) of the plant. These lenses enable workers to respond to change rapidly and make more informed decisions.



Creating a nimble platform designed for better engagement. The major network operator Vodafone is expanding its value proposition to cities and municipalities through digital technologies. With IoT, the operator can differentiate its own and its correlating customer connected services to improve citizen engagement, cost management, sustainability, and economic prosperity. With its connectivity and IoT platform backbone, Vodafone can begin rolling out next-generation smart city applications including smart parking and air quality monitoring, further improving operational efficiencies on a city-wide scale.

Executing on an Industrial Digital Transformation Strategy

Whether enterprises are just starting out or building on existing DX initiatives, it's crucial to align business needs with the desired value or outcomes and the DX technology and solution to achieve it. Often a combination of multiple technologies as well as people-driven process transformation are required to achieve true differentiation. DX initiatives frequently fail when companies rely too heavily on one silver bullet technology rather than taking a holistic approach to their transformation strategy.

Complementary capabilities of multiple technologies are required to enact step change to transform products, processes, and people. Navigating these interdependencies can be daunting and complex. Identifying strategic partners that recognize, understand, and can guide industrial enterprises through these choices is critical. From discovery stages aligning overall objectives and priorities, through proof-of-concept trials, and implementing enterprise-wide solutions at scale, it takes a small army to drive true transformation. Applying strategic technologies to the right outcomes will expedite time-to-value and drive industrial companies through the disruptive waves and enable them to ride the momentum of the digital revolution.



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