Smart Factory

Building the Future Manufacturing Enterprise

Manufacturing

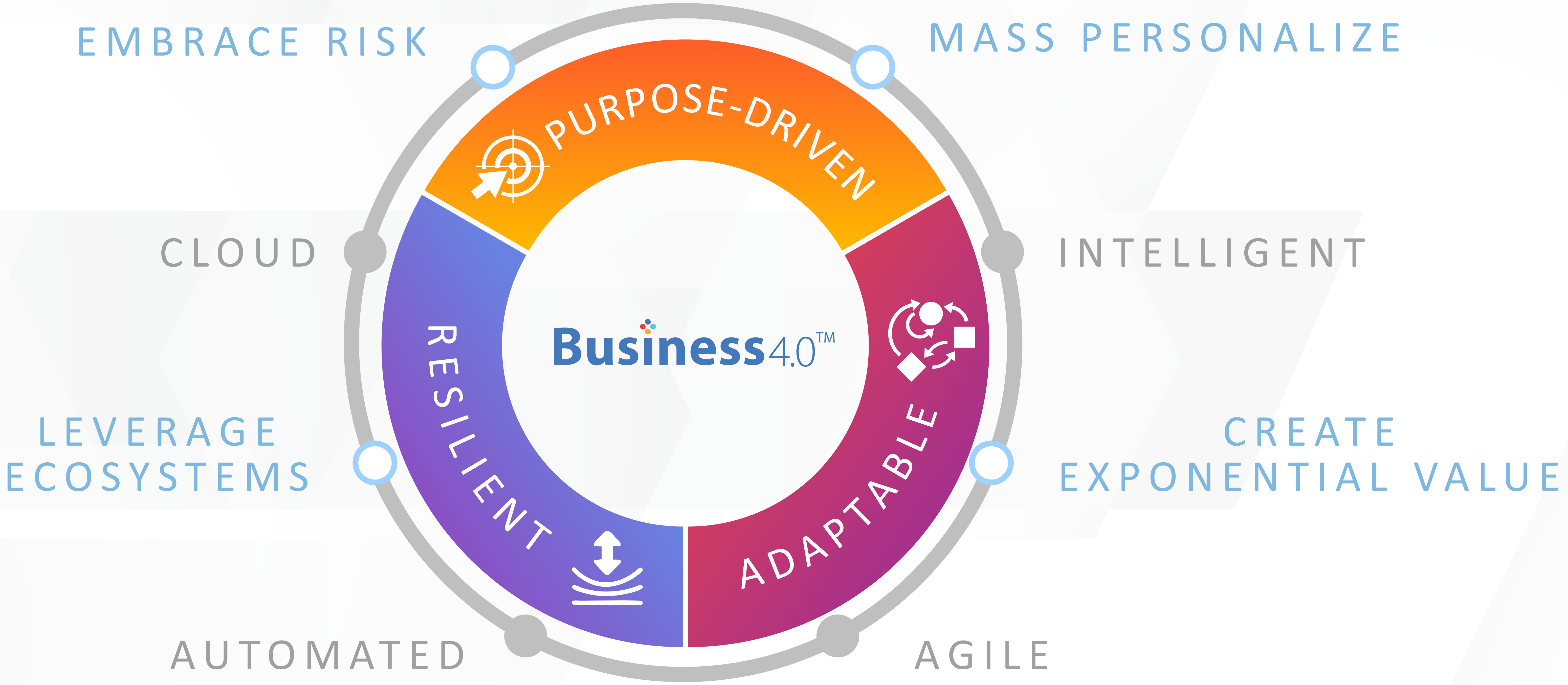
PURPOSE-DRIVEN

RESILIENT

ADAPTABLE

PURPOSE-DRIVEN, RESILIENT & ADAPTABLE

with Business 4.0™



PURPOSE-DRIVEN RESILIENT ADAPTABLE

Abstract

The uptick in digital technology adoption has pushed manufacturers to improve factory operations and transform their conventional factories into smarter facilities - an imperative to stay competitive and enhance bottom line.

This drive has been further exacerbated by the impact of COVID-19 across industries, with production stalling and the workforce reduced on the floor. A smart factory leverages digital technologies and data-driven decision-making to connect various manufacturing operations to enhance production and keep pace with ever-changing digital consumption behavior. However, building a smart factory requires a clear understanding of the operating model, objectives, and key performance indicators (KPIs), combined with meticulous planning and capability to transform a brownfield facility into a smart factory. This paper defines a smart factory and decodes its key tenets.

Introduction

The Fourth Industrial Revolution has provided immense opportunities for manufacturing organizations to benefit from digital technologies and transform their operations and improve customer experience. According to the World Economic Forum (WEF), more than 70% of manufacturing organizations are still stuck in 'pilot purgatory', while only few have successfully deployed advanced technologies at scale[1]. According to the WEF, pilot purgatory refers to the inability of manufacturers to use emerging technologies and scale them across the organization to realize returns and ensure improvements in key performing indicators (KPIs) for operations. To reduce this gap, the WEF, in collaboration with McKinsey & Co., started the Global Lighthouse Network in 2018 to bring together manufacturing firms using advanced technologies to set a benchmark. These firms serve as lighthouses for other manufacturers to benefit from them. The smart factories of the future will help manufacturers scale and sustain competitive advantage through an innovative and people-centric operating model. The Lighthouse initiative mentioned above has found that manufacturers that have successfully adopted smart factories have digitally connected not just their plant sites but the entire manufacturing value chain, thus delivering their business outcomes with agility. So, how can manufacturers build a successful smart factory?

> *Moving from a traditional factory to a smart one involves not just technological, structural, and operational transformation, but also commitment from multiple stakeholders across the value chain.*

---

[1] World Economic Forum; Global Lighthouse Network: Insights from the Forefront of the Fourth Industrial Revolution; January 10, 2020; https://www.weforum.org/whitepapers/global-lighthouse-network-insights-from-the-forefront-of-the-fourth-industrial-revolution

Building smart factories to weather future disruptions

A smart factory enhances asset efficiency, improves quality, and ensures high yield while managing the continuity of operations in times of crisis. At the same time, it improves workforce health and safety while bolstering in-plant logistics and inventory management. It prioritizes workforce health, improves supply chain management, and delivers value through crises such as COVID-19. However, implementing a smart factory is not a day's task. It requires a keen understanding of the overall factory value chain and shop floor operations. Key structural changes in terms of technology and architecture combined with a strong commitment to aid collaboration among multiple stakeholders build a responsive smart factory that not only weathers disruptions but also greatly increase efficiency.

This draws its inspiration from Neural Manufacturing, a thought leadership framework that enables an organization and its ecosystems to become connected, cognitive, and collaborative. It drives agility and exponential growth, providing an intelligent edge.

> *A smart factory brings about agility by connecting not just individual plant sites, but also the entire manufacturing value chain.*

Organizations can adopt a top-down or bottom-up approach to build a smart factory. A bottom-up only approach can result in multiple failed implementations due to non-scalable solutions with limited benefits. It results in pilot purgatory, thereby demotivating teams and causing delays. A top-down approach, however, spans the entire plant value chain across planning and scheduling, inventory management, production, maintenance, and quality, thereby ensuring a well-integrated technical smart factory architecture that results in positive business outcomes. A top-down approach can help manufacturers build an autonomous factory that is connected, intelligent, and self-aware with key operational characteristics and functional capabilities (see Figure 1).

The framework with the building blocks mentioned in Figure 1 serves as a guideline towards creating exponential value in a systematic way while establishing a people-centric digital organization. The building blocks of a smart factory will vary for every organization, depending on the operating model, current state of maturity, and business process architecture. This framework, at the lower level, delves into functional use cases that ergonomically support human work to deliver productivity. It transforms the business process while keeping the operator at the center of this transformation.

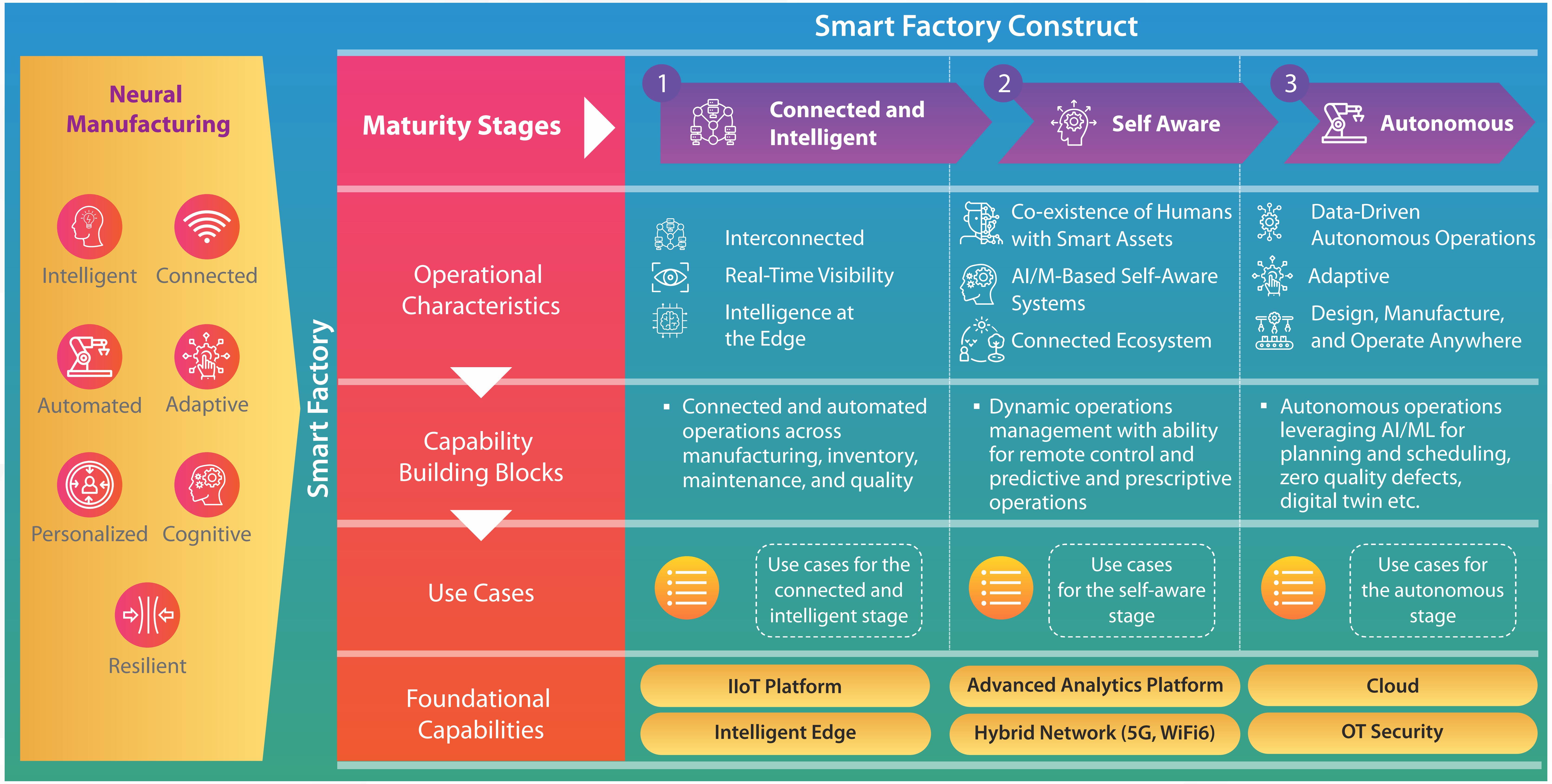


Figure 1: The building blocks of a smart factory

Defining the operational parameters for a scalable and secure smart factory

Every manufacturing plant has its own legacy and is typically an assimilation of disparate processes and technologies spread across a mixed network topology with variable automation. Thus, the transformation of such a traditional factory into a smart one requires meticulous planning as it graduates through different maturity stages, as depicted in Figure 1. In order to successfully implement a smart factory, manufacturers must identify the points of departure and arrival between the maturity stages. The point of departure refers to the maturity state of a manufacturing firm at a point by baselining the business process model and key KPIs. It also defines the target KPIs for the next stage of maturity transformation.

Similarly, the point of arrival is based on future business needs and the expected operating model of the organization. It outlines the key target KPIs and the modified business process model, which reflects the transition into the next stage of maturity.

The point of arrival that best suits a firm's business needs can be identified through a set of well-defined operational characteristics such as the following:

Interconnected and autonomous operations: Leveraging real-time data for remote monitoring and to orchestrate global plant operations. Machine learning is deployed to train assets on autonomous operations and human interactions.

Homogenous ecosystem of original equipment manufacturers, suppliers, and partners: Ensuring seamless transfer of information, intelligence, instruction, and execution of independent operations in an integrated ecosystem of OEMs and their partners. It blurs the traditional boundaries between various partners to gain collective efficiency.

Intelligence at the edge and cloud: Enhancing predictive decision making with edge-cloud integration capabilities with critical intelligence applied at the edge. This is critical to building digital lean shopfloor operations.

Adaptive manufacturing: Driving customer personalization with multi-variant and multi-product manufacturing on a single assembly line with rapid changeover.

Design and manufacture anywhere capabilities: Ensuring rapid production setup and interconnected design and manufacturing.

To transform a traditional factory into a smart one, a manufacturing firm must build a flexible integration architecture that cuts across enterprise systems and connects to the systems of record at the edge. Such an architecture requires a strong industrial internet of things (IIoT) platform supported by a polyglot data fabric construct, an active intelligent services capability with self-service, and model management. In addition, building a smart factory requires integrating an information and operational technology (IT-OT) layer with strong security features.

Reimagining manufacturing operations: Think big – start small – scale rapidly

Once a manufacturing firm has identified its operational characteristics for a smart factory, it can adopt a think big – start small – scale rapidly approach to navigate complexities efficiently and rapidly build a smart factory.

Think Big:

The key objective of this phase is to create an organization-wide vision with a detailed roadmap and plan. This requires a top-down approach with leadership buy-in in alignment with the organizational vision. While defining the vision and strategy, it is recommended to keep a futuristic outlook on production efficiency through innovation, plan new business models, identify geographical product manufacturing abilities, and ensure process standardization and harmonization across global operations. This will set a clear vision for extended teams to work toward building a smart factory.

Start Small:

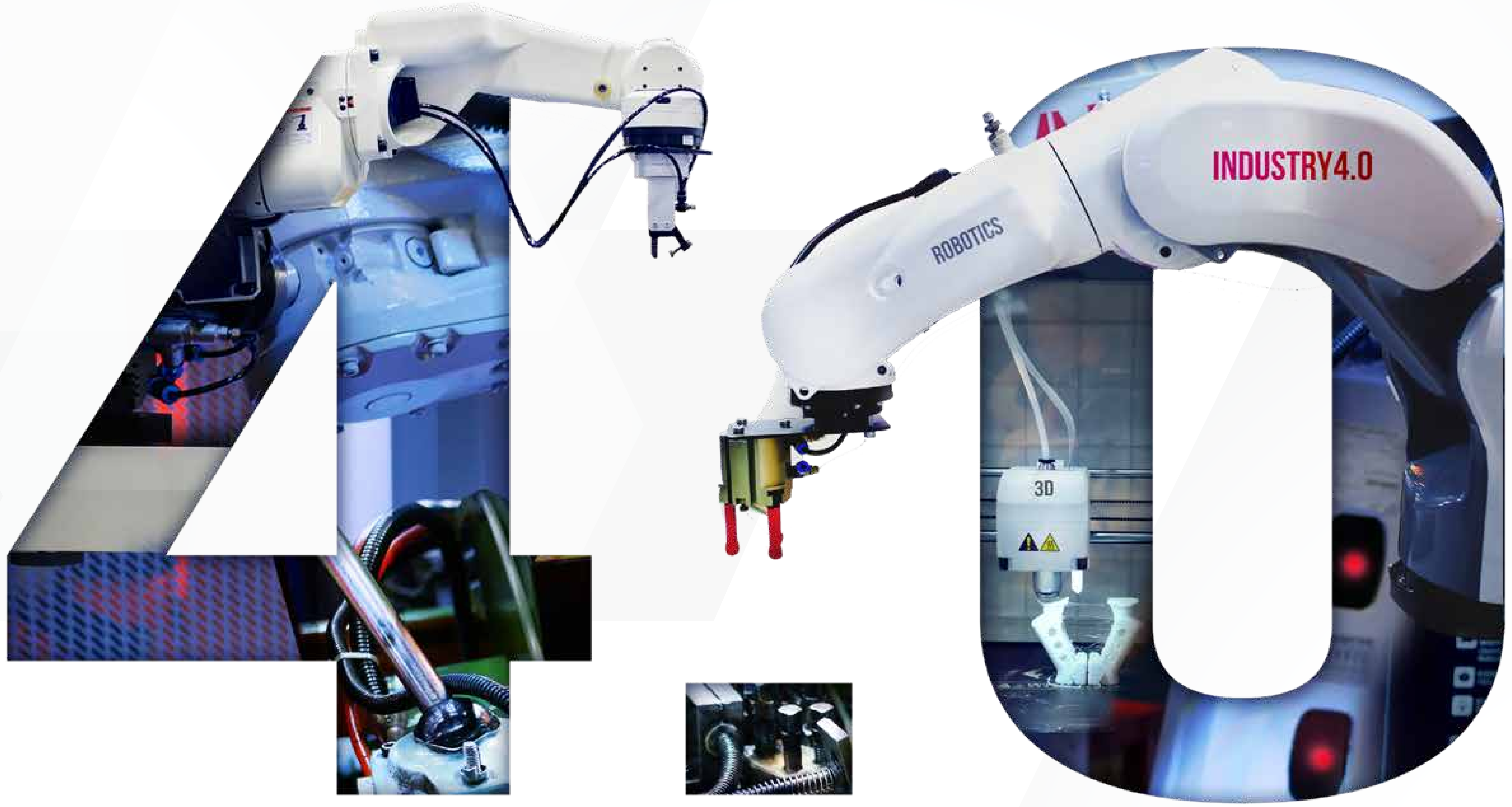
In this phase, organizations must build a scalable underlying platform and develop pilot use cases or a minimum viable product (MVP). It is important for firms not to fall into pilot purgatory through a fail fast-learn rapidly-move quickly approach. Successful organizations usually design short agile sprints of three to four weeks to develop pilots or MVPs to move through this phase. To execute this phase, organizations can build a model plant and then scale the smart factory across their global locations, or they can set up smart centers of excellence (CoEs) across various plants. The CoEs will ensure that individual plants take ownership and get hands-on experience in the early stages of setting up a smart factory. While both approaches have their pros and cons, deciding which one to adopt depends on the organization’s individual case.

Scale Rapidly:

In this third and last phase, organizations empower their global plants to replicate and implement digital solutions to extract benefits and transform business processes. A simple architecture with access to applications for adoption will ensure that firms implement the smart factory faster across their global locations.

The future of manufacturing is smart

Adopting a smart factory is a graduated journey with well-defined maturity milestones, involving a people-centric approach to the transformation. A clear understanding of the existing baseline, desired operational characteristics, associated technology, and architecture choices can help firms map functional capabilities and industry relevant use cases. Commitment from a firm's executive leadership and focus in facilitating change management will not only accelerate the overall transformation journey of factories but also measurably improve resilience to achieve speed and scale. The end result: building future-ready manufacturing firms that are competitive and that deliver value.



About the **Authors**

Babu Unnikrishnan

Babu Unnikrishnan is Chief Technology Officer for Manufacturing and Utilities at TCS. In this capacity, he is responsible for formulating strategies on emerging technologies in 5G, machine vision, augmented and virtual reality, and applied machine learning. These strategies are then used to develop differentiated industry solutions around smart factories, networked logistics, and intelligent asset inspection. With 23 years of industry experience, he has worked with global customers across the US, UK, Europe, and India. He is a practicing digital enterprise architect and participates in an advisory capacity in strategic initiatives and forums for TCS' customers. He holds a Master's degree in engineering from the Indian Institute of Technology (IIT), Bombay, India.

Sachin Bhavsar

Sachin Bhavsar leads the smart factory practice for Manufacturing at TCS. He is a subject matter expert in the manufacturing domain with 20 years of industry and consulting experience, where he advises customers on their digital manufacturing roadmap and contributes to building innovative solutions in smart factories and connected logistics. He holds a Bachelor's degree in mechanical engineering from Bharati Vidyapeeth's College of Engineering, Pune, India and also holds a post-graduate diploma in management from Narsee Monjee Institute of Management Studies (NMIMS), Mumbai, India.

Prasad Medepalli

Prasad Medepalli leads the research and innovation team in Manufacturing at TCS. He focuses on incubating emerging technologies and building differentiated solutions. He has more than 20 years of experience working across software development, design, and solution architecture. He holds Master's degree in industrial engineering and operations research from the Indian Institute of Technology (IIT), Bombay, India.

TATA CONSULTANCY SERVICES

Contact

For more information on TCS' Manufacturing Solutions and services, please visit https://www.tcs.com/manufacturing

Email: manufacturing.solutions@tcs.com

About Tata Consultancy Services Ltd (TCS)

Tata Consultancy Services is an IT services, consulting and business solutions organization that delivers real results to global business, ensuring a level of certainty no other firm can match.

TCS offers a consulting-led, integrated portfolio of IT and IT-enabled infrastructure, engineering and assurance services. This is delivered through its unique Global Network Delivery Model™, recognized as the benchmark of excellence in software development. A part of the Tata Group, India's largest industrial conglomerate, TCS has a global footprint and is listed on the National Stock Exchange and Bombay Stock Exchange in India.

For more information, visit us at **www.tcs.com**

Corporate Marketing | Design Services | M | 01 | 21

PURPOSE-DRIVEN RESILIENT ADAPTABLE