GE's Digital Industrial Transformation Playbook

Executive Summary

While much has been written about the digital transformation of industry, few industrial companies have undertaken the daunting work of actually transforming. GE has and is.

This paper provides an overview of the insights, lessons learned, tools, and techniques that GE acquired through its own digital industrial transformation experience.

The Age of the Digital Industrial

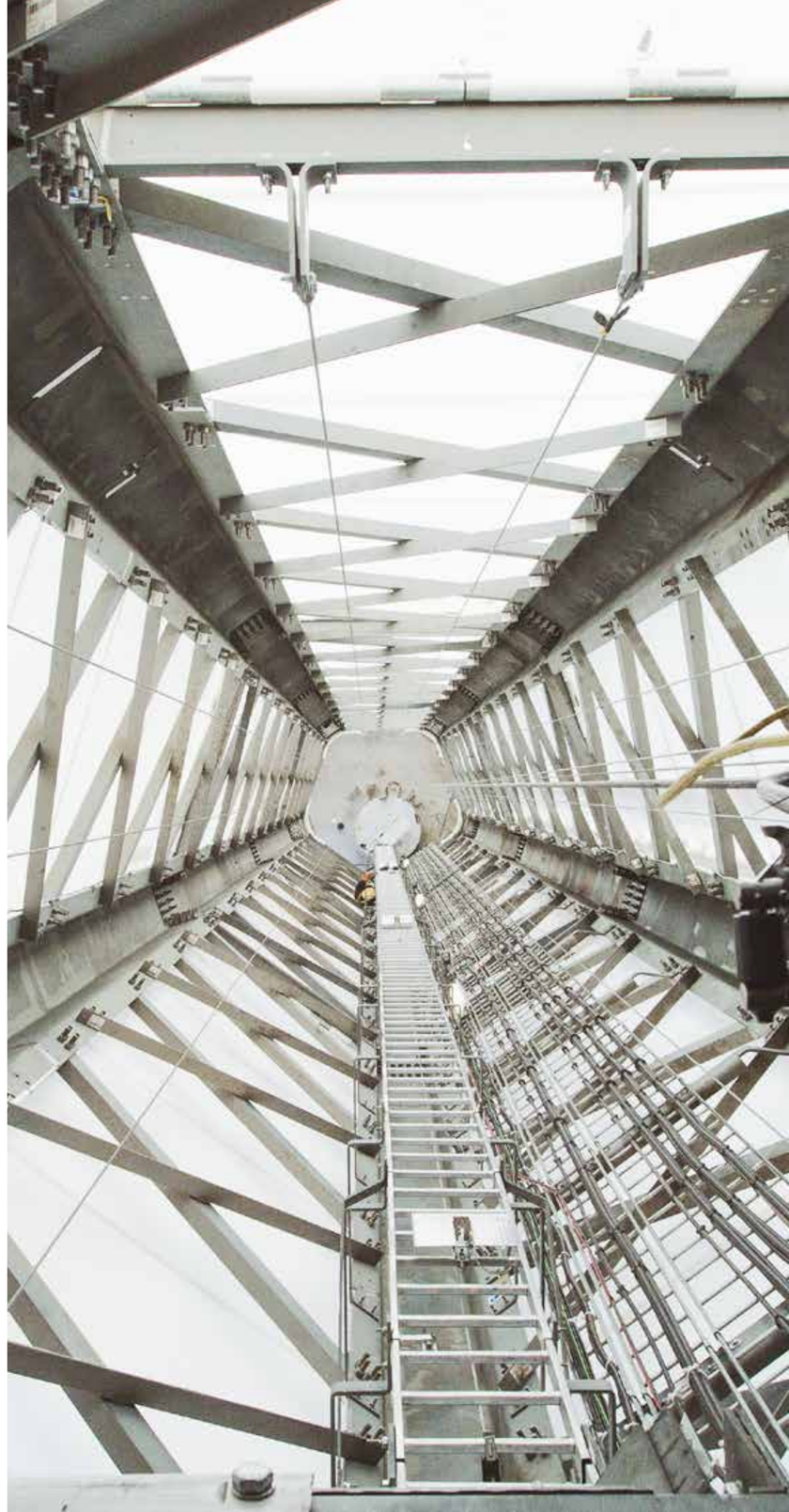
The industrial world has been shaped by a series of foundational technology changes over the last 250 years: steam and rail (1750-1830), electricity and telephone (1880-1920), computer and IT (1960-2000), and the current era of Industrial Internet of Things (IIoT), and big data (2010-present).

Each technology change introduced a wave of productivity improvements accompanied by market disruption, whereby some industrial leaders were displaced by the rise of agile new competitors. Those incumbent leaders that invested in new capabilities often retained their market position.

GE has survived many such disruptive waves since it first joined the Dow Jones Industrial Average as a founding member in 1896. The fate of GE's industrial peers has not been quite as fortunate. Today, GE is the only remaining member of the 1896 Dow Jones Industrial Average.

The current age of the digital industrial is marked by ever more powerful software and falling hardware costs. That is, today's predictive algorithms and machine learning capabilities enable use cases that were not possible even five years ago. And let's not forget the steadily falling cost of sensors, compute, storage, and bandwidth that has made the deployment of these capabilities a financial reality.

The first Industrial IoT use cases focused on reducing unplanned downtime of key industrial assets such as power generation machines and mining equipment. Industrial companies are now aggressively increasing the surface area of instrumented assets beyond just expensive critical machines. In other words, industrial firms are increasing both *the number of sensors on each asset as well as the number of assets with sensors.*



The result is not only the ability to develop a high-resolution view of the future behavior of critical assets, but also the ability to develop a system view of an entire enterprise operation. This operational agility and predictability is giving industrial companies the option to pursue business model innovation by offering efficiency, productivity, and virtually everything “as a service.”

Most recently, industrial companies have not matched the growth and valuation of the consumer Internet industry, with the latter enjoying much higher price-to-earnings multiples.

We believe this is about to change. Industrial companies are entering a new period of explosive value creation. The rapid spread of digital innovation will reboot industrial productivity growth.

McKinsey estimates that the Industrial Internet of Things will create $7.5T in value by 2025. The Industrial Internet is non-optional—in the same category as electrification of industry in the last century. Those that move quickly will likely enjoy lasting benefits. Those that move slowly... well, their future is less certain.

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What Is a Digital Industrial?

At its core, a digital industrial company uses data and analytics to create a "digital twin" of each of its key processes and physical assets. This digital foundation enables the company to drive down costs while delivering consistent quality.

It also enables the company to run a "digital thread" through the design, build, and service functions—using analytic intelligence to create a virtuous loop that delivers continuous improvements to equipment for customers. This enables industrial companies to rapidly refactor operations, improve existing offerings, bring new data-driven products to market, and innovate with new outcome-based business models.

The foundational digital industrial components emerged in the 1990s: industrial control software (HMI/SCADA), manufacturing software (MES), and asset management software (APM). These technologies are common in industrial environments. They deliver important capabilities that are necessary, but not sufficient, for digital industrial transformation. Up until the last 10 years, it was cost-prohibitive for many industrial companies to fully digitize and analyze their operations. Full digital transformation—with comprehensive digital twins and a complete digital thread—has been made possible by low-cost innovations.

A "digital thread" enables industrial companies to rapidly refactor operations, improve existing offerings, bring new data-driven products to market, and innovate with new outcome-based business models.

GE's Transformation Story

If we turn the clock back to the beginning of this decade, GE, like most companies, was very familiar with Moore's law and the falling cost of IT. But what caught many industrial companies by surprise was how these newly affordable technologies could be applied to an ever-growing set of use cases across the industrial world. With the cost to connect and leverage sensors continuing to drop, we could start to use this data in ways we had only imagined years ago—getting a richer, analytical view of assets, operations, demand, and supply. We also observed aggressive new competitors that attempted to disintermediate industrial hardware buyers from vendors like GE.

As we embarked on broader and deeper instrumentation of assets, we created an enormous amount of data that we fed into our predictive algorithms and machine learning technologies. It was then that a holistic view of operations began to emerge. It was also then that we started thinking about the Industrial Internet of Things as much more than a technology trend. We began to view it as a foundational technology that could deliver material value creation and sustained competitive advantage.

The result was that we moved from a defensive to an offensive market position. That is, we pivoted from focusing on defending our hardware service contracts to moving strongly into a growth orientation by investing in new capabilities and pursuing new business models.

GE's digital industrial strategy is straightforward. First, we focus on leveraging our digital industrial capabilities to drive internal productivity. This initiative, called "GE for GE," is on track to impact more than 400 GE factories around the world.

Next, we take the technologies, workflows, and productivity techniques hardened through our internal deployments and make them available to our customers. We call this "GE for Customers." In this category, we provide automation and predictive capabilities in the form of packaged applications.

Finally, we make our data and analytics operating system, Predix, available to everyone for co-creation. This initiative, called "GE for the World," features an open-innovation approach that is available to virtually any company in virtually any industrial category.

Digital Industrial Transformation Playbook

Executing a digital industrial transformation strategy can be daunting. As a nearly 130-year-old industrial firm, GE is not immune from the complexity required to implement meaningful change across culture, people, process, and technology.

With several years of digital transformation experience under our belt, we've been able to reverse-engineer a repeatable Digital Industrial Transformation Playbook that can be used by our customers and partners to embark on their own transformation journeys.

Our Playbook boils down digital industrial transformation into five key pillar initiatives:

1. Capabilities and operating model
2. Platform
3. Partner ecosystem
4. Digital talent and culture
5. Business model innovation

1

Capabilities and Operating Model

Successful transformations focus on capabilities that will differentiate the business and drive competitive advantage. The first step for any transformation is to re-think organizational capabilities needed to start, scale, and sustain your transformation. This requires developing an end-to-end view of the competencies, tools, processes, and governance needed across all functions—inclusive of sales, services, R&D, operations, and finance—as well as the accompanying component capabilities needed to succeed as a world-class digital industrial. The end-to-end view also serves as a tool to identify capability gaps, in addition to the plan for filling them.

Next, industrial companies need to determine where and how these capabilities are organized and executed within their organization (i.e., organization structure). A key consideration is the extent to which the company has vertical and horizontal business lines. That is, do you have horizontal product lines or capabilities that span across multiple industry business verticals? Do you have industry or product line specific capabilities? The key is to find that elusive balance between aiming for horizontal scale and vertical specificity.

At GE, we made a strategic choice to have our Asset Performance Management and Field Service Management as horizontal capabilities that could be leveraged across our business units. We created a new business unit, GE Digital, to not only own these horizontal capabilities but also to act as a digital change agent within the company. Each GE business, such as GE Aviation, creates vertical extensions on top of our horizontal capabilities. The result includes vertical digital applications such as GE Aviation's Flight Efficiency solution.

The connective tissue that makes this organizational structure work is the role of Chief Digital Officer ("CDO"). Each GE business has a CDO, who reports to both the business line leadership (e.g., GE Aviation) and to GE Digital leadership. This dual-reporting structure ensures that GE Digital is building capabilities that are relevant to its existing businesses and also ensures that the existing businesses are fully leveraging GE Digital's capabilities.

The CDOs play a vital role in leading digital transformation in their business. They're the digital role models leading this cultural transformation, formulating the end-to-end business strategy, and articulating and delivering on the digital vision for their business.

2

Platform

Many of our customers and partners are contemplating a “build vs. buy” decision when it comes to an IIoT platform. Many of these firms are surprised to find how expensive it is—in terms of both time and financial resources—to establish the foundational capabilities needed to even begin developing digital industrial solutions.

In other words, before you start building applications, you must take on tasks such as setting up the infrastructure, integrating software stacks, deploying and collecting sensor data, managing data and meta data, staffing world-class software and data science talent, building out industrial-grade IT and OT security, and defining user models and access.

GE built Predix because we needed an industrial-strength, edge-to-cloud platform that combined predictive analytics with 3-D models of physical systems, featured a modular architecture of microservices, and that leveraged all of the agile development practices that allow industrials to keep pace with rapid technology innovation. We spent close to four years just getting the underlying plumbing and commercial back-end right. The result is a world-class digital industrial platform that customers can scale up and down as market dynamics change.

With these foundational capabilities in place, customers are able to rapidly roll-out APM and field service solutions and accelerate their digital transformation journey.

3

Partner Ecosystem

We quickly realized we couldn't undertake true digital transformation on our own. The result is an open-innovation partner ecosystem that spans industrial markets and industrial outcomes.

First, we had to change the way we worked with our partners. Like many industrials, GE traditionally had a robust reseller and distributor channel. With GE Digital, we opened the aperture of not only which types of entities could become partners but also what types of activities we would do with partners.

Our partner program now features a co-innovation model that not only includes resellers and distributors, but also includes leading technology partners, independent software vendors (ISVs), and thousands of developers. To onboard these new partners, we vastly simplified our partner program across products, businesses, and geographies. Today, we have one unifying partner program that features clear partnership tiers for all partners. This single program serves the largest companies in the world right down to early-stage startups.

Perhaps most importantly, our partner program features an "open-innovation" model, where partner solutions that are built on Predix can be certified and made available to the global GE Digital user base.

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Digital Talent and Culture

This is arguably the most important of the digital transformation pillars. As Peter Drucker once said, “Culture eats strategy for breakfast.” Digital industrial transformation requires us to think and lead differently. The outside world is moving fast, and a “leap of faith” is needed to keep up.

At GE, we needed to rebuild the culture around rapid decision-making, learning from failure, and a new people management process. We needed to compete for talent in the technology space; we had to look and feel like a fast-moving technology company. What you sell as the vision needs to feel real to employees, and your culture must reflect an environment that thrives on innovation.

To that end, we rolled out what we call “GE Beliefs” as an aspiration. To become a digital industrial company, our leaders and employees are role-modeling these beliefs to make them a reality of our day to day:

- Customers determine our success
- Stay lean to go fast
- Learn and adapt to win
- Empower and inspire each other
- Deliver results in an uncertain world

Next, we developed a specific toolset and methodology to help us iterate faster, to be more entrepreneurial, and to ensure we’re always building products and services that deliver better outcomes for our customers. We call this FastWorks, which combines the principles of Lean Manufacturing with those of Agile Software Development. It’s at the heart of how we do what we do.

Finally, we had to change the way we conducted performance appraisals and talent management. We did away with the one-time annual performance management process and replaced it with real-time feedback tools. Performance Development, or PD as we call it, ensures that all employees stay aligned with the GE Beliefs and are continuously leveraging FastWorks.

While these tools have been instrumental in transforming the GE culture, we didn’t have all the talent capabilities we needed to be a digital industrial leader. This also required an enormous shift in how we recruit, develop, and incentivize talent. Specifically, we needed more software DNA—both from an engineering and commercial perspective. To make that happen, we aligned our recruiting and compensation practices to match those of leading software companies.

The final step involved moving our corporate headquarters to the heart of downtown Boston, one of the world’s most innovative technology centers.

5

Business Model Innovation

Before we innovated at the business model level, we drove digital transformation of our internal operations, driving millions in productivity savings. This is where we encourage our customers to start considering their goals for growth and business model change. We believe that in the industrial world, business model innovation relies on operations agility as a foundation.

By focusing on delivering tangible ROI today through productivity improvements, you can:

- Drive internal improvements that self-fund the next step in your transformation journey such as new product introductions, x-as-a-service model
- Build out the operational agility needed to innovate at the business model level
- Enlist early internal champions and momentum needed to drive more radical transformation

Success breeds success. Building credibility is the key to any successful transformation. With the data, insights, and improvements from these internal wins, you're now in a credible position to take those same productivity improvements to your customers in the form of best practice sharing or even new products and services. Once you have proven ability to deliver repeatable outcomes, you're ready to experiment with new business models that leverage your operational agility.

GE Digital Today

We've used these principles to transform GE into a world-class digital industrial company. Today, we have over 19,000 GE employees focused on digital transformation across the company. Our customers and partners are leveraging our Digital Industrial Transformation Playbook to improve their competitiveness and to unlock billions of dollars of value. **The result is that GE is on track to becoming one of the world's leading data and analytics companies.**

Getting Started on Your Digital Industrial Transformation

To help drive our customers' digital transformation journeys, we have set up **Global Foundries** across various locations, including Shanghai, Paris, and San Ramon. In these state-of-the-art co-creation centers, we bring together our designers, data scientists, software engineers, and domain experts to co-create our customers' digital transformation steps customized to their maturity and aspirations. You can work side-by-side with a GE Digital Foundry and domain expert to create a strategic business case for digital transformation, develop proof-of-concept/value, learn more about Predix, and develop a roadmap for your digital industrial transformation. Learn more about our **Global Foundries** to start your digital industrial journey!

GE is on track to becoming one of the world's leading data and analytics companies.

We transformed GE into a digital industrial company. We continue to reimagine and refine the capabilities, culture, and talent needed to optimize GE, our customers, our partners, and the Industrial Internet for the world. With our Digital Industrial Transformation Playbook, we can now accelerate the transformation of other like-minded industrial companies.

Why not your company? Why not now?

What does successful digital industrial transformation look like?

For our customer, Pitney Bowes, it means helping 1.5 million clients in approximately 100 countries generate real-time insights and drive higher levels of operational performance. With solutions powered by Predix—the operating system for the Industrial Internet—Pitney Bowes is driving equipment and operational productivity with real-time analytics enabled by connected industrial sensors, machine data, people, and processes.

Learn more about Pitney Bowes' digital transformation.

Taking the Industrial Internet to the next level

Schindler, a 142-year-old leader in elevators, escalators, and moving walkways, tracks and monitors its assets with Predix, the operating system for the Industrial Internet. Predix allows Schindler to track its products to identify service issues and, through analytics, start predicting maintenance issues long before equipment fails. It will help the company realize savings by reducing unplanned downtime and maintenance costs—an example of the power of digital industrial transformation at work.

Learn more about Schindler's path toward transformation.

Authors

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Akanksha Manik Talya is the Director of GE Digital's Global Foundry Strategy and Operations. Ms. Talya has a background in management consulting experience, advising technology companies on driving digital, operating model, culture, and organizational transformations. She joined GE in 2016 to lead the global development of GE's Global Foundries. Ms. Talya has an MBA from Darden Graduate School of Business at the University of Virginia and an undergraduate degree in electrical engineering from India.

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About GE

GE (NYSE: GE) is the world’s Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. GE is organized around a global exchange of knowledge, the “GE Store,” through which each business shares and accesses the same technology, markets, structure and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry.

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