

Cultivate Sustainable Innovations For The Global Manufacturing Industry

Rockwell Automation

Introduction

Manufacturing is the heart of a country's economy. It plays an important role in supporting the national economy and the livelihood of its people. China, similar to other major world economies, prioritizes the advancement of its manufacturing industry, cultivating and consolidating sustainable competitive advantages over the global manufacturing industry.

Currently, with the backdrop of supply-side reform and dual circulation, China is at a critical stage of evolving from low-cost manufacturing to data-driven, smart manufacturing. Technological and industrial breakthroughs provide a historic opportunity to transform Chinese manufacturing into an advanced, intelligent, and green industry.

China's manufacturing industry must seize this opportunity. Previously, the core value of the manufacturing industry came from the high efficiency and low cost achieved by large-scale production. However, it was difficult to connect the manufacturing industry with the entire value chain – for example raw materials and supply chain, and value-added after-sales services. With continuous development and innovation in information technology, it has become easier to integrate the full value chain.

The key to sustainable innovation in the manufacturing industry is digitalization. There are challenges to this transformation, such as the complexity of the processes, lack of preparedness, and difficulty connecting IT and OT systems to be able to leverage data. But enterprises can create a feasible, sustainable path by paying attention to certain factors and collaborating with a reliable partner.

On a technical level, Rockwell Automation integrates professional knowledge and technical insights with information technology (IT) and operational technology (OT). The success of digital transformation in the manufacturing industry lies in swiftly matching the actual demand with the corresponding digital capability, and widely advocating its innovation value. Step-by-step planning and rapid iteration will facilitate continuous improvement, allowing prompt responses to changes and fluctuations in market demand.

For methodology, Rockwell Automation advocates a “Think Big, Start Small, Scale Fast” policy. Take the status quo diagnosis as the starting point, the digital transformation blueprint as the strategic goal, and the pilot quick win as the first step.

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Rockwell suggests a four-step strategy to carry this out.

It is important to recognize that the competitive advantages of digital transformation are not only at the technical level, but more importantly, elevate traditional business theories. Enterprises should prioritize the strategic value and significance of digital transformation, invest in digitalization and big data, and open up the original value chain, to create new business models and generate new values. The organic connection between digital transformation and the innovation mindset of manufacturing employees is important, and digital transformation should provide an opportunity to upgrade talent structures and free up the innovative capabilities of employees.

Based on the above insights, Rockwell Automation strives to collaborate with enterprises in the manufacturing industry, to transform manufacturing and upgrade the overall industrial structure, supporting “China Smart Manufacturing” in earning its place in the fiercely competitive global manufacturing industry.

I. The significance of cultivating sustainable innovations for the manufacturing industry

(I) Challenges associated with sustainable innovations

With the development of a truly global economy and improvements to social productivity, the global manufacturing competition has entered a new stage. As the heart of a country's economy, the manufacturing industry is the lifeblood, which is vitally important in the continuous improvement of people's living standards, and the prosperity and steady development of the economy. It provides a strong driving force for the continuing emergence of new technologies, new industries, new patterns, and new models. Thus, manufacturing has become an important stage for competition among major economies around the world.

With globalization has come many opportunities, and China's rapid development and growth have benefited from the strong rise of the manufacturing industry. The status of "world factory" and China's huge market volume have added strong stimulus to a sustained economic growth. At the same time, traditional manufacturing giants including Europe, the United States and Japan are also constantly adjusting their manufacturing strategies, such as the Strategy for American Leadership in Advanced Manufacturing, the German National Industrial Strategy 2030, the Japanese Society 5.0 and the European Union Industry 5.0. These initiatives aim to reinforce or reshape their comprehensive strength in manufacturing and facilitate sound economic development.

In the face of climate change, high energy prices and rising challenges to economic growth, sustainable development in manufacturing industry has become a focal point of the global manufacturing industry. Sustainability in this context not only refers to environmental protection and energy consumption, but also includes innovation, competitiveness and an industrial ecosystem.

Significant achievements have been made in the new generation of information and communication technologies, such as 5G, cloud computing, big data and Internet of Things, which provide unprecedented technological advantages to support sustainable innovation in the manufacturing industry. The key to manufacturing centers winning the dominant edge in global competition is to seize the opportunity that exists in upgraded innovation models and systems, creating a systematic and sustainable evolution path for the manufacturing industry.

(II) Directions and requirements for the sustainable development of Chinese manufacturing industry

In leveraging sustainable innovation, China's manufacturing industry has shown some

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similarities and differences from other manufacturing centers in terms of direction and requirements. This is due to the specific environment and periodic characteristics of the country's manufacturing industry.

Currently, with the backdrop of supply-side reform and "dual circulation", China is at a critical point in transforming the nation from a low-cost manufacturing hub to data-driven, smart manufacturing. The 14th Five-Year Plan for Intelligent Manufacturing Development notes that due to further development of the global scientific and technological revolution and industrial transformation, breakthroughs have been made in the new generation of information technology, biotechnology, new material technology and new energy technology. These advancements married well with advanced manufacturing technology, providing a historical opportunity for transforming Chinese manufacturing into a high-end, intelligent, and green industry.

With respect to the division of labor in global manufacturing, the definite path for the sustainable development of China's manufacturing industry is to transform manufacturing into an advanced industry. The inevitability of this requirement is in response to the rapid changes of manufacturing model and ecological layout shaped by global intelligence trends.

In the past, the relationship between the primary, secondary and tertiary industries in the industrial structure of a national economy was much further apart than it is today. The core value of the manufacturing industry, which is the secondary industry, was traditionally high efficiency and low costs, achieved by large-scale production, as well as optimization and integration of human resources and other functions. It was difficult to connect upstream and downstream players in the value chain in the primary, secondary and tertiary industries; the values of each sector remained relatively independent.

However, with continuous development and innovation in information technology, it has become much easier to integrate upstream and downstream in global value chains, and the forms of products and services have also evolved. The industrial value of automation and digital technology is increasingly extending beyond the secondary industry to the primary industry and the tertiary industry. The entire value chain is constantly converging with interconnected information.

For example, in the industrial and commercial environment where digital capabilities are evolving and spreading rapidly, collaboration, trackability and traceability of the whole industrial chain based on real-time big data has been greatly improved. For consumer-facing products, the whole process from design and development, to raw material supply, to manufacturing, logistics and distribution, to after-sales service has become increasingly transparent. Concurrently, with improvements to online marketing, no matter if the product is a machine, a car, a bottled beverage, or a can of milk powder, tailored production that is end-to-end and on-demand is becoming the new norm. This means that the value of enterprises is highly integrated in the whole value chain from raw material production (primary industry), to manufacturing (secondary industry), to value-added after-sales services (tertiary industry).

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Under this trend, more and more consumer goods manufacturers are trying to integrate the upstream raw material production supply chain, and guarantee quality and safety to meet consumer demand. For example, some dairy manufacturers are building more milk source channels or incorporating the quality control links of third-party milk source tracking suppliers into their own digital management systems. Even more, some have started tracing the quality and source information of cow feed to ensure product quality and safety.

The delivery mode of goods by manufacturers is also changing. In the past, the transaction between manufacturers and consumers was complete once the physical products were delivered, leaving consumers to enjoy the functional value of the products. Today, the delivery of those physical products is only the first step in transactions. Consumers can now continuously enjoy value-added information services that are provided after the delivery has happened.

There has been a growing abundance of electric vehicles (EVs) over the past two years. Competition in the automotive industry has been disrupted, and EV manufacturers have sprung up everywhere and triumphed over traditional automakers. One important factor in this disruption has been the value proposition that EVs provide. Compared with traditional factors that have been used in automotive buying decisions, such as driving performance and comfort, new EVs have offered value-added services based on intelligent algorithms, big data, and mobile internet technology, such as automatic driving and intelligent services. These have become the core values that consumers pay more attention to. Even more, these new value indicators increasingly influence the market competition pattern.

Despite the runway for growth, manufacturing enterprises will need to fully open up and continuously examine the entire value chain based on digital innovation. They will need to bid farewell to the sea of homogeneous products and low value-added business so that sustainable efforts can be made to transform to an advanced industry.

China's manufacturing industry should not only encourage companies themselves to innovate, but also nurture comprehensive overarching innovation integration capabilities at the industrial level and create innovation models in a systematic way. This will enable sharing of best practices that can be applied to empower other enterprises and create a sustainable lifecycle in the manufacturing industry. Therefore, top-level blueprint design, industrial guidance and spontaneous innovation by enterprises can supplement each other and sustain productivity improvements.

II. Key elements in achieving sustainable innovation and transformation

(I) What are the challenges of sustainable innovation and transformation driven by digitalization?

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The key to sustainable innovation in the manufacturing industry is digitalization, which is a leading factor in driving advancement and continuous improvement of the entire value chain. According to analysis of digital transformation in the manufacturing industry, many manufacturing enterprises have begun their digital transformation journey in recent years due to the challenges and needs they have encountered, and are hoping to lay a solid foundation for sustainable innovation. However, the path forward is not always smooth sailing. In fact, statistics show that more than half of digital transformation cases failed to achieve the expected results.

Companies have mistakenly sought out the key elements for successful digital transformation by only analyzing successful cases. However, specific context for those success stories — such as local conditions, environment and needs at a certain time — are often overlooked. Considering the varied industries, enterprise backgrounds and specific context, it might not be easy to take these success stories to a more scalable level. Therefore, companies should also do the opposite. By analyzing some common misunderstandings and challenges of manufacturers who have undergone digital transformation, we can eliminate "minefields" for industrial digital development and clear the obstacles in advance.

Rockwell Automation has summarized three main aspects of the challenges companies in the manufacturing industry face that can result in insufficient digital transformation.

First is the challenge caused by the complexity of the manufacturing industry itself. Compared with those industries of common processes, management, and operation models, the manufacturing industry is very intricate. There are numerous sub-industries, and each of them possesses its own features, process system, management, and operation mode that are unique to the vertical sub-industry. In addition, despite the significant differentiations among the sub-industries, different enterprises within the same industry can vary greatly in their needs and status quo. As a result, manufacturing enterprises often show high expectation to customized digital transformation.

Moreover, overcapacity in the manufacturing industry can often result in wasted resources, which impacts what the enterprise can accommodate during its digital transformation. This additional aspect can hinder the sustainable development and economic effectiveness of the enterprise, and affect the willingness of decision makers to further promote digital transformation when results cannot be seen in the near-term.

The second challenge lies in the lack of preparation for digital transformation. Manufacturing enterprises hold uneven capabilities in digital transformation due to different levels of automation and digitalization, which can require case-by-case analysis but are restricted by a “one policy for one enterprise” mindset. These manufacturing enterprises can lack understanding of the true value and significance of digital transformation, as well as a clear path and execution plan. This results in

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digital transformation outcomes that rarely meet the expectations of the manufacturers.

Last but not least, are the new challenges that are intertwined with the first two challenges mentioned above. For example, manufacturers may find it difficult to match their data collected in hardware systems with what the digital system needs. This would lead to difficulty in real-time data acquisition for operation and production management, or the failure to form an interconnected information flow among various departments and processes. This results in data silos, which turn the digital transformation into merely a formality.

Although some achievements may have been reached by several enterprises, considering the barriers between different categories of manufacturing and its sub-industries, it is hard for other enterprises to adopt and scale quickly, and even harder to create a systematic pattern for cross-over innovation.

Enterprises attach great importance to economic benefits but fail to take the actual situation into consideration during the digital transformation. They lack a step-by-step executional roadmap and clear assessment mechanism for the results. This often makes it difficult for decision makers to effectively evaluate the input-output ratio and expected return, and ultimately they lose interest due to the excessive investment in the overall scheme.

This is why vendors for digital transformation consultancy and execution may work well with customers from other management areas, whereas finding it tough to promote digital transformation in the manufacturing environment.

(II) Key factors for digital transformation and innovation of the manufacturing industry

With the challenges outlined, key factors to digital transformation and innovation can be analyzed. The demand of the manufacturing industry must be matched with appropriate digitalization capabilities that take into account the detailed context of each enterprise and sub-industry. Innovative values must be quickly scaled while continuously improving amongst the rapid change of the market via feasible planning and upgrading at each stage.

Rockwell Automation believes that to create a sustainable and innovative path toward digital transformation, enterprises need to pay attention to the following elements.

First is to "know yourself and your enemy." Many cases show that the proponents and decision makers are limited to their own experience and vision during the digital transformation. Often, their requirements and indicators cannot fully reflect the in-depth and true needs of the enterprises. Therefore, it is essential to identify the actual pain points and needs, and assign different priority levels. The deep-seated problems and "shortcomings" that were hidden underneath are the key to unearthing true value for the enterprise.

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Secondly, during planning and execution, enterprises should collaborate with a reliable partner to set up a roadmap of digital transformation, goals and corresponding execution plans by phase, and an evaluation of the current level of automation and digitalization. This will help to avoid the inadaptability of data collection, circulation mode, and collaboration process. Selected solutions must be verified and conform to the foreseeable technical development trends in the future.

The last key element is to be prepared for the future. Manufacturers seeking digital transformation must establish and then consolidate sustainable and innovative advantages for the creation of an innovative industrial ecosystem. Digital transformation should be seen from a sustainable perspective. The paths and roadmap should not only satisfy near-term needs, but also prepare for iteration, expansion, and continuous improvement, contributing to cross-industry innovations in the long run.

III. Suggestions to nurture sustainable innovation in the manufacturing industry

(I) Methodology to drive sustainable innovation with digital transformation

On a technical level, Rockwell Automation advocates that manufacturing enterprises actively embrace the Internet of Things, focus on the interaction among the three elements of physical world, digital world, and people, and create applicable scenarios that are more in line with real industrial enterprises. The goal is to make the digital transformation more feasible and the evaluation and measurement standards more quantifiable.

In-depth cognition, professional knowledge, and technical insight should be integrated with industry attributes of sub-sectors and their industrial chains with information technology (IT) and operational technology (OT). This will extend the intelligent value derived from digitalization to the forefront of industrial applications, realize the comprehensive link between data and entities, promote the integration and intercommunication of industrial data, release the potential hidden in big data, and build a solid foundation for real-time decision-making.

Rockwell Automation advocates companies' use of the methodology of "Think Big, Start Small, Scale Fast." Companies should use the status quo diagnosis as the starting point, the digital transformation blueprint as the strategic goal, and the pilot program's quick wins as the first step. This will help enterprises realize transformation of production, empowerment of data elements, and an entire reshape from concepts to technologies, thus forming an excellent pattern of digitalized "two-wheel drive" of operations and business modes.

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Rockwell Automation's methodology consists of four steps.

Step 1: When an enterprise decides to unlock digital transformation, it first needs to sort out its value stream. Enterprises should conduct detailed diagnoses internally, either via their own capabilities or by collaborating with a third-party. This will help identify the weakest shortcoming and determine if it's quality or delivery, inventory or payment collection, or supply chain. The value stream mapping can help uncover the precise pain points and the true challenges for the company, which is why it should always be the first step in a digital transformation project. Following the value stream identification, a tailored goal and roadmap for the enterprise is needed.

Step 2: Enterprises should optimize and further develop automation to overcome identified weaknesses or gaps. These elevated automation capabilities can be leveraged to achieve critical Safety, Energy, Environmental and Efficiency goals. If an enterprise does not have automation capability and, for example, still collects data manually, it is not yet ready to begin digital transformation or smart manufacturing. Automation gaps should be addressed first.

Step 3: Digital transformation should be targeted. This requires a clear top-level blueprint and value stream for a systematic architecture of data and information. At this stage, enterprises should partner closely with those of industry expertise and digitalization empowerment to jointly solve a series of problems during the digital transformation. For example, companies should discuss, based on the identified needs, what are the standards to be adopted for system construction? What kind of platform should be constructed to realize the integration of IT/OT? How to connect the redundant information from various systems in the factory? How to build an open, controllable, and scalable industrial Internet of Things foundation?

Step 4: Digital insight should be used to examine the existing data for potential innovative opportunities. Manufacturers typically do not have a shortage of data, and with big data, artificial intelligence, self-learning and self-perception, these large amounts of data can be translated to valuable information that can be used to assist enterprises in decision-making and innovation development. This data will continue to provide new ideas for enterprises to enhance their competitiveness and innovation.

(II) Four-step strategy in practice

Rockwell Automation's four-step approach provides benefits beyond the methodology framework to include proven and quantifiable practices at all dimensions of sustainable development. It encourages enterprises that lack experience in digital transformation to start at the beginning and believe the transformation will succeed. Once the path for digital transformation has been laid, enterprises have the very positive potential for sustainable development and initiative innovations. There are successful cases of different industries that manufacturers have achieved qualitative changes from such methodology, improving in multiple sustainable dimensions such as Safety, Energy, Environmental and Efficiency.

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For example, Rockii Solutions of Rockwell Automation has grown into a future-proof and end-to-end digital transformation platform with integrated innovative technologies such as IIoT, artificial intelligence, augmented reality/virtual reality, big data and predictive maintenance. Rockii Solutions has helped Nanchang Mineral Systems Co., Ltd. forge ahead towards the new mode of smart operation and maintenance (O&M).

The digital transformation empowered by Rockii Solutions has enabled the brand with self-sufficient capability in sustainable innovations. In addition to developing the smart O&M platform, the collaboration has enabled the new business mode of Platform-as-a-Service (PaaS). By doing so, Nanchang Mineral Systems is now working towards the goal of no emission, no accident, and no downtime, taking on a sustainable and intelligent path of development.

SVOLT Energy Technology Co., Ltd. initiated a strategic partnership with Rockwell Automation to jointly build up an AI Ecosystem for the EV industry. Key targets include comprehensive solutions in the industry, empowerment to the transformation of the entire industrial chain, world's lighthouse factory project, and acceleration in green energy and the goals of Carbon Peak and Carbon Neutrality.

Rockwell Automation has also worked with a top biopharmaceutical company, that carries over 4,400 R&D projects in more than 30 countries to achieve seamless integration of various high-end detection instruments facilitated by the lightweight IT/OT lab customized by Rockwell Automation. With this lab, researchers are able to easily manage formulars, personnel, instruments, batches and reports. The lab was able to improve its instrument utilization by 20%, reduce the error rate by 15%, and increase overall profits by 25%.

In the food and raw materials industry, full control over the process "from farm to table" is essential for food safety. With the help of the United Nations Industrial Development Organization, Rockwell Automation has cooperated with the Ministry of Agriculture to implement Nanchang in an intelligent agricultural project. Through data monitoring and big data, the solutions provided by Rockwell Automation have addressed pesticide residues and heavy metal pollution issues, improved soil fertility, and raised the soil remediation utility rate by 15%, significantly enhancing crop management and resilience against natural disasters.

(III) Disruptive cross-over

Sustainable innovations in the manufacturing industry through digital transformation should be about more than upgrades at a technical level and, more importantly, trigger breakthroughs and transformation of traditional business thinking and values.

Enterprises should embrace the strategic value and significance of digital transformation. Digital transformation should be about more than upgrading software and hardware, and prioritize shaping key capabilities such as open-mindedness, collaboration, continuous improvement, and discipline. This includes value

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penetration and linkage, while linking the entire value chain and the whole industry together. The mindset should not only be adopted inside enterprises, but also extend to disruptive and innovative values across the industry moving forward.

Under the guidance of digital transformation, more and more enterprises have nurtured disruptive thinking as a way to add value. The orientation of their business and value has changed from the traditional horizontal-scale to vertical-scale, meaning that it has become more about just expansion, merging and acquisition to involve being a role model in the industry value chain.

Rockii Solutions has helped Nanjing Puyuan Ice Cream Machinery Manufacturing Company, the top ice cream equipment manufacturer in China, to build an industry-leading digital benchmark factory, and upgraded OT with IT communication technology to build an intelligent production line. This production line is not only the first fully automatic intelligent ice cream production line from filling to delivery in China, but also the only fully automated intelligent 3D ice cream production line in China. After the digital upgrade, the enterprise saved 90% in labor costs, waste materials have been reduced by 122 tons/year, and the output improved by more than 30%.

More importantly, after the digital transformation, the company changed the previous business model from an equipment and production line-pilot to the crossover role of ice cream original equipment manufacturer (OEM) and original design manufacturer (ODM). It is now the one and only fully automated and fully intelligent ice cream manufacturing enterprise in China. While realizing the leap-forward growth of turnover, it has also set a benchmark for the ice cream industry to further accelerate the internal circulation and promote industrial transformation and upgrading.

The effect of the changing business model is not only reflected in the industry, but also conducive to meeting the vigorous innovation needs of society as a whole. With the further refinement and improvement of social industrial division of labor in the background of informatization, many innovative brands of light assets with creative design and development as the core competitive elements have emerged in China, and this trend is significant in EVs, fast-moving consumer goods, and food and beverage industries. The manufacturing industry must redefine its role, core competences, and cross-over innovation through digital transformation, to better adapt to these emerging innovative cooperation modes and meet the diversified and personalized needs of the consumer market.

The same disruptive innovation is also reflected in giving full play to the advantages of digitalization and big data, opening up and thoroughly understanding the original value chain, thus creating new business modes and generating new values. For example, Rockwell Automation has helped global protein market leader Tyson Foods Inc. to connect three major industries (agriculture, industry, and consumer goods) using Rockii Solutions. With the partnership, they identified the industrial closed loop from breeding to production, packaging, logistics, and sales, building a two-way traceability system from farm to table and from products to raw materials. This

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created an agile, intelligent, efficient and low-carbon supply chain, and truly realizing the switch of business model from B2B to B2C. It provides a useful reference for reshaping the industrial ecosystem value chain and accelerating the digital upgrading of the industry.

To improve the manufacturing industry in China wholistically, attention should be paid to the organic connection between digital transformation and manufacturing talents' innovation. Digital transformation should be regarded as a disruptive opportunity to guide the upgrading of manufacturing talent structure and free up the independent innovation ability of talents, rather than as a simple substitute for manual labor. In the past, many manufacturers simply regarded automation, digital transformation and upgrading as the replacement of human labor, and mistakenly understood intelligent manufacturing to be machines replacing humans.

Correcting this misconception should start in the very beginning, working with universities and professional technical schools to break the original discipline barriers that focus on vertical professional technology, and instead incorporate more forward-looking disciplines, such as digital twin, IoT and big data application. Courses such as digital marketing and business mode innovation should be developed to nurture the cross-over innovative thinking of manufacturing talents before they enter the workforce. Rockwell Automation has experience working with universities in this way. Launched in 1998, Rockwell Automation China University Partnership Program now covers more than 22 provinces and municipalities throughout China and Hong Kong SAR at more than 70 universities. Rockwell Automation has donated equipment and scholarships valued over 250 million RMB to date. Additionally, through Rockii Solutions, we are committed to opening up an innovative path integrating Industry-University-Research, and helping broom more cross-over manufacturing talents in China to accelerate the innovation and implementation of intelligent manufacturing.

IV. Summary

As Chinese saying goes: the scenery is unlimited and needs a broad mind to measure. Rockwell Automation sincerely hopes that the above suggestions and sharing can help China's manufacturing enterprises successfully transform, nurture sustainable, cross-over, competitive, and borderless innovation power, promote the upgrading of the overall industrial structure, and provide continuous support for the global competition and rapid development of "China Smart Manufacturing."