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High-Quality Development for the Future: Connotation, Framework and Implications of Industry 5.0

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Abstract: *The era of Industry 5.0 has quietly arrived, sounding a new round of global industrial transformation. Industry 5.0 pays more attention to human well-being and puts human needs at the core of the manufacturing system, which means that industrial development is no longer just pursuing economic growth and employment, but is looking at a more ambitious social goal, that is, creating a solid foundation for the sustainable development of all mankind. However, the current exploration of Industry 5.0 is still in its infancy, and although some forward-looking thinking and research are ongoing, systematic results are still relatively few. This paper first reviews the development process from Industry 1.0 to Industry 5.0, trying to find out the inevitability and rationality of this transformation from the historical context. Then it systematically combs the definition, characteristics, and framework of Industry 5.0 in order to summarize and sort out a clear and comprehensive understanding of Industry 5.0. Finally, in order to cope with the opportunities and challenges brought by Industry 5.0, the enlightenment of China's development of Industry 5.0 is put forward. This paper provides an important reference for further research on Industry 5.0 and China's development of Industry 5.0.*

Keywords: *Industry 5.0, Evolution, Definition, Features, Architecture*

1. Introduction

Currently, our world is undergoing unprecedented transformations. These changes, not only reshaping the global political and economic landscape, but also posing a significant test for global manufacturing supply chains. Since the outbreak of the COVID-19 pandemic, production, supply chains, and logistics worldwide have been severely disrupted. As a key pillar of the global economy, manufacturing has attracted unprecedented attention regarding its stability and resilience. Meanwhile, the rise of anti-globalization sentiment has led countries to reassess their industrial development strategies, with resilience in manufacturing becoming a major topic of common concern among major world economies. Manufacturing is no longer merely a production tool. It has become a foundation for national competitiveness, economic security, and sustainable development. Against this backdrop, the European Union released the "Industry 5.0: Towards a sustainable, human-centric, and resilient european industry" report in April 2021, formally establishing the basic concept of Industry 5.0 within the EU. Since then, Industry 5.0 has garnered widespread attention from various sectors. Industry 5.0 is no longer just a frontier topic within academic research but has elevated to a strategic issue being implemented at the national level.

The evolution of the industrial process will inevitably drive changes across various social subsystems. The introduction of Industry 5.0 signifies not only the transformation and upgrading of manufacturing itself but also profound effects on socioeconomic, environmental, cultural, and other aspects. It has the potential to become a new market access standard, along with other EU market entry criteria, collectively influencing critical issues such as supply chain layout, positioning, products, and market strategies of Chinese manufacturing enterprises[1]. China is currently at a critical transitional stage—moving from having built a moderately prosperous society to basically achieving socialist modernization. At the same time, it represents a convergence point for China in its effort to achieve the "Two Centenary Goals," marking historic social changes and development in China. However, this is not an easy task, as it also involves challenges and opportunities from a new round of technological

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revolution and industrial transformation. In the current global environment, the impacts of international uncertainty are becoming increasingly evident. The drastic changes in global trade, intensified geopolitical risks, and the continued impact of the COVID-19 pandemic have brought unprecedented challenges to China's industrial development. These challenges require China not only to be resilient enough to deal with short-term risks but also to have foresight and strategic vision to respond to long-term changes. Against such a backdrop, Industry 5.0 provides a new perspective and solution for China’s industrial development.

Nevertheless, the current exploration of Industry 5.0 remains in its infancy. Although the EU has issued pioneering reports and research interest is rising globally, systematic research findings remain relatively limited. Current explorations mainly focus on conceptual definitions, visionary ideas, and preliminary technological exploration, without forming a complete and systematic theoretical framework or practical model. This implies that the transition of Industry 5.0 from theory to practice will still be a long and challenging journey. Furthermore, there are relatively few studies specifically addressing Industry 5.0 in China. Inspired by this, this paper attempts to systematically summarize the connotation, framework, and potential impact of Industry 5.0 by examining the evolutionary context of industrial revolutions and proposes strategic recommendations for advancing Industry 5.0 in China, in the hope of providing valuable reference for China’s future industrial upgrading and transformation.

2. From Industry 1.0 to Industry 5.0

The primary objective of the industrial revolution has always been to separate human labor from machine work. Each stage of the industrial revolution has been accompanied by significant technological changes that fundamentally altered the relationship between humans and machines (or technology), and subsequently led to transformations in the forms of social development [2].

Industry 1.0 is mechanical production. Industry 2.0 is mass production. Industry 3.0 is automated production. Industry 4.0 is digital transformation (or smart manufacturing). Industry 5.0 is human-centric manufacturing. Industry 4.0 aimed to reconnect humans and machines, finding ways for them to collaborate effectively to increase resource efficiency in production. This stage emphasized transforming manufacturing facilities into intelligent environments using cognitive computing and the Internet of Things (IoT), interconnected through cloud services. In contrast, Industry 5.0 focuses on integrating human hands and minds into the industrial framework. Most research views the starting point of the Industry 5.0 revolution as the shift in the relationship between humans and intelligent systems. Existing literature[3] indicates that the differences between Industry 5.0 and Industry 4.0 can be summarized in the following aspects. Industry 5.0 emphasizes both productivity-driven competitiveness and sustainable development, Industry 5.0 empowers human labor by promoting the development of human-centered technologies, Industry 5.0 advances technological innovation in the field of environmental sustainability (e.g., intelligent renewable systems), Industry 5.0 enhances the primacy of stakeholders in areas such as technological governance, innovative growth, and sustainability performance management, Industry 5.0 extends the scope of corporate responsibility across the entire value chain by leveraging certain technologies and functional principles. According to this study, the most significant distinction is that Industry 5.0 returns to a human-centric approach, thus entering the stage of human-centric manufacturing. Industry 4.0 is characterized by the combination of cyber-physical systems (CPS), whereas Industry 5.0 is about human-cyber-physical systems (HCPS).

Industry 5.0 is a vision for the future industrial revolution. Currently, there are four distinct visions. The first vision is human-machine collaboration. In this vision, robots and humans will work together anytime and anywhere. Humans and robots will collaborate and share responsibilities—humans will focus on tasks that require creativity, while robots will handle other types of work. This vision of human-machine collaboration is also the mainstream focus of current research. The second vision is bioeconomy. Skillfully incorporating biological resources into industry will help achieve a balance between ecological, industrial, and economic sustainability. The bioeconomy has tremendous innovative potential because it utilizes a wide array of sciences (such as life sciences, agronomy, ecology, food sciences, and social sciences), enabling technologies and industrial technologies (such as biotechnology, nanotechnology, information and communication technology, and engineering), as well as local and tacit knowledge. Biologization is the guiding principle of the bioeconomy and has the potential to bring about a fundamental transformation in industry. Therefore, the bioeconomy may be a theme of the next industrial revolution, or at least a significant part of it [2]. The third vision is personalized production. The consumption pattern of mass convergence is gradually being replaced by a consumption model characterized by personalization and differentiation. Similarly, mass standardized

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production is increasingly being replaced by small-batch, customized production. In the era of Industry 5.0, the aim is to integrate humans and machines into intelligent factories, thereby enabling key factors like mass customization and personalization, taking Industry 4.0 to a new milestone. The focus of Industry 5.0 is on mass personalized customization, where users can select personalized and customized products based on their own needs and preferences. During this era, humans will guide robots, and the skill levels of workers will also significantly improve [4,5].The fourth vision is the EU's vision. The EU's vision does not focus on a single theme or direction but instead represents a comprehensive vision that serves as a macro-level guiding ideology for future industrial development. The three primary goals of the EU's Industry 5.0 are sustainability, human-centricity, and resilience. Essentially, the EU's Industry 5.0 reflects the needs and goals of the EU for industrial economic development amidst changes in the global economic landscape and in the context of a new wave of globalization. It aims to move away from a technology-centric, profit-driven mindset and ensure that advanced technologies (particularly digital technologies) adapt to changes in people, society, and the environment, thereby elevating both workers and the industrial system within the EU to a new level [6].

In addition, other themes, such as space habitation, space industry, and space mining, may also be part of the next revolution or the next phase of industrial transformation. Scientists have already warned us to be cautious when utilizing space resources. Space mining might become the next "gold rush" [2].The central theme of the industrial revolution has always revolved around the relationship between humans and machines, making human-machine collaboration a major focus of future industrial development. However, the vision proposed by the EU is the first to introduce the values that humans should consider in industrial development, elevating these values to serve as guiding principles for future industrial practices. As a result, compared to other visions, the EU's vision has had a greater impact and has garnered significant attention from various sectors of society.

3. The Connotation of Industry 5.0

3.1 The Origin of the Concept of Industry 5.0

There are three perspectives within the academic community regarding the earliest proponents of the concept of Industry 5.0. The first perspective was proposed by Wang [7] in 2014, and subsequently gained traction among Germany's industrial and academic circles, eventually forming an international consensus. He believes that Industry 5.0 is a "human-machine-object" integrated system that can integrate various elements of human society in real time and online, thereby better meeting the developmental needs of future manufacturing and smart industries. The second perspective was proposed by Rada[8] in 2015. He considers Industry 5.0 to be the first human-led industrial evolution, based on the 6R principles (Recognize, Reconsider, Realize, Reduce, Reuse, and Recycle) of industrial upgrade cycles. This approach includes systematic waste prevention technologies and logistic efficiency designs, with the goal of enhancing living standards, fostering innovation, and producing high-quality customized products. It emphasizes empowering humans by meeting individual and personalized customer demands. The third perspective was proposed by the European Union in 2021. The EU paints a vision for the future of industrial development, viewing Industry 5.0 as a critical pathway for promoting the prosperity and stability of human society. The EU considers Industry 5.0 to be committed to enhancing productivity in a sustainable manner while preserving the status of industrial laborers in the manufacturing sector. This is similar to Germany's Industry 4.0 initiative, which was proposed in 2011 in response to the changing social and geopolitical landscape.

According to the EU report, the four industrial revolutions have centered around general-purpose technologies. Industry 5.0 places greater emphasis on integrating and reinforcing values that are closely linked to social and ecological aspects, while simultaneously driving technological advancement. This shift in the development paradigm is built on the idea that the direction of technological development can and should be steered towards supporting broader social values, and that the process of technological transformation can be carefully designed and adjusted based on the actual needs and expectations of society [9]. The reason why the EU's proposed Industry 5.0 has gained the most widespread attention and recognition is primarily due to the new values it advocates for.

3.2 The Definition of Industry 5.0

Industry 5.0 is still in the early exploratory phase, and its conceptual definition remains underdeveloped, making it challenging to reach a universally accepted definition. This is primarily due

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to differing perspectives and emphases on Industry 5.0 across various industries and individuals with diverse knowledge backgrounds.

Table 1: The Definitions of Industry 5.0 in Selected Literatures.

Source of literature	Definition
Rada, 2015[8]	Industry 5.0 is the first human-led industrial evolution, based on the 6R principles (Recognize, Reconsider, Realize, Reduce, Reuse, and Recycle) of industrial upgrade cycles.
Koch et al.,2017[10]	Industry 5.0 is the era of collaborative robots and human interaction within socially intelligent factories. Socially intelligent factories utilize enterprise social networks to enable seamless communication between personnel and CPPS (Cyber-Physical Production Systems) components.
Özdemir et al., 2018[11]	The core objective of Industry 5.0 is to establish a complex and highly interconnected digital network, ensuring the long-term security and sustainability of the innovation ecosystem and its associated members.
Demir et al., 2019[2]	Industry 5.0 can be defined from two perspectives. One perspective advocates that Industry 5.0 focuses on promoting human-machine collaboration and building an intelligent society. The other focuses on the bioeconomy to achieve a higher level of sustainable development.
Leong et al., 2020[12]	Industry 5.0 is an incremental advancement of Industry 4.0, representing symmetric innovation and the next generation of global governance. It aims to design orthogonal safety exits through hyper-connected automated systems that decouple manufacturing and production.
Breque et al.(European Commission), 2021[13]	Industry 5.0 places the well-being of industrial workers at the core of the production process, steadily promoting economic prosperity to achieve broader societal goals beyond employment and growth.
Zhuang Cunbo et al., 2021[14]	Industry 5.0 ensures that production activities are carried out within the Earth's carrying capacity, while promoting the exchange, collaboration, and integration of knowledge among humans, machines, materials, and the environment. It places the well-being of industrial workers at the core of the production process, thereby achieving broader societal goals beyond mere economic growth.
Maddikunta et al., 2022[4]	Industry 5.0 is a human-centered design solution, where ideal human partners and collaborative robots work together with human resources to achieve personalized autonomous manufacturing through enterprise social networks.
Ma Nanfeng, 2022[15]	Industry 5.0 is a continuation and evolution of Industry 4.0, representing a new industrial development model characterized by value-driven growth built on the framework of Industry 4.0.

From Table 1, it can be seen that the existing literature on the definition of Industry 5.0 mainly focuses on two perspectives. The first perspective views Industry 5.0 from a human-centric manufacturing angle. The second perspective focuses on human-machine interaction. Clearly, these definitions integrate human-centricity, system resilience, sustainability, and collaborative intelligence. However, there are also some differences. While most definitions of Industry 5.0 involve both technological and social aspects, a small number of definitions focus more on industrial transformation. From the perspective of development trends, Industry 5.0 is an open and evolving concept that is moving toward a vision of collaboration and co-creation in the future global industrial system.

3.3 The Characteristics of Industry 5.0

Today, it is widely believed that Industry 5.0 differs from previous industrial revolutions because it represents a stakeholder-driven socio-technical phenomenon, systematically shifting from a traditional profit- and consumption-driven economic model to a circular, regenerative, sustainable, and resilient value-creation economy[3]. It will fundamentally change society, quality of life, and the economy. Industry 5.0 acknowledges the power of industry in achieving societal goals beyond employment and economic growth, becoming a provider of resilient prosperity by ensuring production respects the boundaries of our planet and placing the well-being of industrial workers at the center of the production process. The COVID-19 crisis has underscored the urgency of re-examining existing work methods and pathways, including the vulnerabilities in global supply chains, with the goal of making the industry

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more forward-looking, resilient, sustainable, and human-centered [16]. Industry 4.0 primarily focuses on technology, robotics, and interconnected systems, whereas Industry 5.0 emphasizes the people working alongside factory systems, bringing the human element back to manufacturing. In Industry 5.0, collaborative robots (cobots) will be responsible for routine tasks such as data mining, while humans will take on higher-level tasks. Humans will manage and supervise these systems, making real-time decisions and looking for opportunities to improve quality and manufacturing processes. As a result, workers will receive more meaningful, practical, and rewarding work. Therefore, it is evident that Industry 5.0 will be highly technology-intensive[17].

Industry 5.0 further enhances collaboration between humans and machines by combining the speed and accuracy of automation technology with human critical thinking and creativity, continuing to advance more sophisticated human-machine interfaces. The key significance of Industry 5.0 is matching human intelligence with machine intelligence and training collaborative robots to adapt to changes in the human brain while working alongside humans. As a result, human intelligence can be used for critical thinking in customized logic, while collaborative robots can perform labor-intensive tasks, thereby efficiently utilizing collaborative robots to complete such work. Moreover, ongoing projects in Industry 5.0 ensure that AI will optimize industrial processes, resulting in more customized products with faster performance[4].Industry 5.0 places workers at the center of the production system, valuing human intelligence more than ever before. It paves the way for human curiosity, empathy, creativity, and judgment, ensuring a balance between humans and technology. Technology will serve humans, marked by innovation and shared goals.[18].Sustainable manufacturing is crucial for the sustainable development of society, especially in areas such as renewable energy. The sustainable implementation of Industry 5.0 involves adjusting the position of each pillar at different stages, better achieving the global construction of Industry 5.0 in terms of higher quantity, faster speed, better quality, and cost savings [18].Industry 5.0 can help enterprises reduce costs, pursuing a business model that seeks maximum revenue with minimal resources. By enabling humans and machines to work together, companies can make the best financial choices [17]. Resilience refers to the ability of a system to maintain or quickly return to a stable state during and after major incidents caused by natural emergencies such as geopolitical changes or the COVID-19 pandemic, or when under ongoing significant stress. Achieving a high level of resilience is a recognized fundamental capability of Industry 5.0. On a broader scale, the industrial system of a country or region must also demonstrate sufficient resilience and adaptability to unknown risks[18].

4. The Framework of Industry 5.0

Currently, systematic research results on Industry 5.0 remain relatively scarce. Existing framework studies (including system architectures and conceptual models) interpret the development paradigm of Industry 5.0 from multiple dimensions, providing a logical framework that guides the future development of Industry 5.0 at both the conceptual and practical levels[3,13,14,18-20].

Based on the existing research, the frameworks and conceptual models of Industry 5.0 depict a brand new blueprint for the future of industrial development, emphasizing that industrial systems in the Industry 5.0 era will be deeply integrated with humans, information, and physical systems. This deep integration is not only reflected at the technological level but also extends into multiple dimensions, such as value creation, organizational structure, and goal orientation. In the value dimension, Industry 5.0 no longer emphasizes solely economic growth but instead places greater importance on human-centric approaches, sustainability, and system resilience. This means that future industrial production must not only meet user demands but also focus on environmental protection, resource conservation, and social responsibility. This shift implies that industrial production in the Industry 5.0 era will place greater emphasis on comprehensive value creation rather than merely pursuing economic value. In the organizational dimension, Industry 5.0 proposes a clearly layered structure, ranging from intelligent units to intelligent systems and finally to a system of systems. This hierarchical structure allows industrial production to be more flexible, efficient, and intelligent. Moreover, the deep integration of humans, information, and physical systems ensures that every aspect of industrial production is more closely linked, forming a highly collaborative and intelligent production system. In the technological dimension, Industry 5.0 requires a range of advanced enabling technologies to achieve its objectives. These technologies include, but are not limited to, human resource management, digital twins, blockchain, big data, the metaverse, and ergonomics. The application of these technologies will make industrial production more intelligent, precise, and efficient, providing strong technological support for achieving Industry 5.0 goals.

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However, the realization of Industry 5.0 is not an easy task. It requires the joint efforts and cooperation of governments, enterprises, and research institutions. In practice, the evolution of Industry 5.0 needs to follow certain pathways and strategies to ensure its steady progress and the achievement of its intended outcomes. At the same time, we must recognize the challenges and risks brought by the Industry 5.0 era, such as data security, privacy protection, and changes in employment structures, all of which require proactive consideration and response.In conclusion, the Industry 5.0 era will be a time filled with both challenges and opportunities. It will drive deeper integration and transformation of industrial production, making a significant contribution to the sustainable development of human society.

5. Conclusions and Implications

A new round of industrial revolution, centered on value-driven development, is profoundly changing the paradigm of industrial economic development and propelling the global industrial economy onto a new path of sustainable growth. This study has reviewed the evolution from Industry 1.0 to Industry 5.0, discussing the definition, characteristics, and the diverse nature of Industry 5.0 from various perspectives. On this basis, a framework of Industry 5.0 has been outlined. This new industrial revolution brings new challenges to China's industrial transformation and upgrading but also provides a valuable strategic opportunity for China to transition from being a large industrial nation to becoming an industrial powerhouse.As China's economy enters a new normal, the industrial economic environment has changed, with rising industrial costs, insufficient capacity for independent innovation, and increasing tensions in the international environment. The Chinese government has launched major initiatives such as "Made in China 2025," "Supply-Side Structural Reform," and the "Belt and Road Initiative" to promote industrial transformation and upgrading. Today, a new wave of industrial revolution is rising globally, and the question of how to promote the transformation and upgrading of Chinese industry under this new environment has become a crucial issue for China’s future. To promote the development of Industry 5.0 in China, the following strategic recommendations are proposed:

First, enhance top-level design by developing long-term plans and strategic goals for Industry 5.0 development. Strengthening top-level design is the primary task in advancing China's Industry 5.0 development. According to the national strategic deployment, the overall goal of China's industrial development in the coming years is to become a manufacturing powerhouse. The specific goals are "high technological content, good economic benefits, low resource consumption, minimal environmental pollution, and full use of human resource advantages." These goals align with the value orientation advocated by Industry 5.0. However, more specific implementation measures are needed to develop a comprehensive strategic plan and layout for China's Industry 5.0. Firstly, a clear long-term plan should be developed, outlining the development goals, key tasks, and priority areas of Industry 5.0.This plan should consider not only technological innovation and industrial upgrading but also talent cultivation, policy environment, and market demand. Secondly, specific strategic goals should be established, such as improving the level of manufacturing intelligence, reducing production costs, enhancing product quality and competitiveness, and accelerating the formation of new productivity. These goals should be measurable, actionable, and achievable to ensure the orderly and efficient progress of Industry 5.0 development.In the economic dimension, promote high-quality, competitive economic development, specifically by exploring future industries driven by new technologies, prioritizing product quality, and cultivating resilient industrial and supply chains. In the social dimension, focus on human-centric approaches with broad social benefits. Industrial development must begin with actual needs and aim to promote societal progress. This includes increasing job opportunities, raising workers' salaries, optimizing income distribution, and actively fulfilling social responsibilities. In this way, industrial development can meet economic needs while contributing positively to social harmony and stability. In the environmental dimension, promote green industrial growth within resource and environmental constraints. Strengthening top-level design and developing long-term plans and strategic goals will provide clear guidance and direction for China’s Industry 5.0 development, driving Chinese manufacturing to a higher level.

Second, plan ahead by developing and implementing scientific and effective Industry 5.0 implementation strategies. In the coming years, the global industrial structure will undergo profound adjustments, and international industrial competition will intensify. Against this backdrop, China should closely align its Industry 5.0 strategy with its development trajectory and external competitive landscape, flexibly adapt to the dynamic global environment, seize the opportunities of the era, and focus on addressing the challenges and risks encountered during development. First, strengthen innovation-driven development to achieve breakthroughs in core technologies. The core of Industry 5.0

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lies in technological innovation and application. China should enhance R&D in frontier technologies like artificial intelligence, big data, cloud computing, and the Internet of Things, promoting breakthroughs in core technologies and improving independent innovation capabilities. It is also important to strengthen the integration of industry, academia, and research to translate technological innovations into actual productivity. Second, build an intelligent manufacturing system to enhance manufacturing capabilities. Smart manufacturing is a core aspect of Industry 5.0. China should accelerate the R&D and promotion of intelligent manufacturing equipment and systems to achieve smart, flexible, and efficient production processes. Additionally, promoting the transformation of manufacturing towards servitization and achieving deep integration of manufacturing and services will enhance overall competitiveness. Third, strengthen talent cultivation and attraction to build a high-quality workforce. Industry 5.0 is technology-intensive, and its development requires high-quality talent. China should strengthen the cultivation and attraction of Industry 5.0-related talent, establish a comprehensive talent development system, and attract and retain top domestic and international talent to support Industry 5.0. Fourth, deepen international cooperation and exchange to promote global industrial innovation. Industry 5.0 is a global trend requiring international collaboration. China should actively participate in international industrial cooperation and exchange, strengthen technical cooperation and trade relations with developed and developing countries, and promote global industrial innovation and growth together. Fifth, leverage cultural excellence to enhance the soft power of industrial development. The high-quality development of Chinese industry requires cultural momentum, and a unique "industrial culture" should be fostered to bring Chinese industrial brands to the global stage, promoting traditional Chinese culture. Sixth, pursue differentiated development. Given the coexistence of various developmental stages from Industry 1.0 to Industry 4.0 among Chinese manufacturing enterprises, the development of Industry 5.0 in China will inevitably be diverse and multi-layered.

Third, strengthen systematic thinking and consolidate the support system for China's Industry 5.0 development. High-quality industrial development relies on related support factors. In terms of production factors, China's industrial competitive advantage still depends on basic elements like labor and land. However, it is crucial to effectively utilize and continually develop advanced production factors, such as human capital, industrial ecosystems, and data resources[21]. Industry 5.0 is technology-intensive, and its implementation must prioritize learning, innovation, technology, and workforce. In terms of management practices, Industry 5.0 requires balancing specialized labor, advanced technology, higher productivity, close integration with customers, high-quality products, and reduced environmental impact, which is challenging and thus necessitates fundamental improvements in related management practices. In terms of institutional support, it is vital to address key problems and weaknesses in industrial development and consolidate the foundations of industrial growth. For instance, Industry 5.0 will increase human-machine interactions, enabling individuals to express themselves through customized products and services. However, without the necessary regulations and guidelines, collaboration between humans and robots may face numerous issues. Therefore, it is essential to formally define what a robot is. In legal and regulatory systems governing human-robot collaboration, the differences between automated machines, robots, drones, and collaborative robots must be clearly defined. Additionally, regulations for the development, production, certification, use, and supervision of robots must be accurately established.

China's Industry 5.0 development framework is a complex and systematic project requiring concerted efforts from the government, enterprises, and society. By enhancing top-level design, technological innovation, talent cultivation, and international cooperation, China is poised to take a leading position in the global development of Industry 5.0, laying a solid foundation for becoming a manufacturing powerhouse.

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