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Modern Industrial Productivity Development Challenges and Its Big Data Solutions

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Abstract: *Since the establishment of the modern industrial production mode, it is faced with the dilemma, shortages of resources and market, and the detail labourer, which limiting its productivity development. These problems are further deepened after three industrial revolutions and manifested in the present day as follows: the inefficiency and poor resilience of the production system; the structural contradiction between supply and demand structure triggering a decline in the vitality of the production organism; and the inability of the efficiency of production and utilization of knowledge to meet the needs of productivity development. The root cause of the problem is the division of labour in modern industrial, which destroys the internal links of the production organism. Big Data technology provides new solutions to solve those dilemmas: firstly, it overcomes the impact of uncertainties on the production system and increases total factor productivity; secondly, the demand-oriented production model generates new demand and stimulates the development of productivity; finally, it imbues things with human intelligence, provides a platform for innovation for the people and fully releases human intelligence resources.*

Keywords: *Productivity; Production Mode; Modern Industry; Big Data*

1. Introduction

Marx and Engels pointed out that, in comparison with the past modes of production, "the bourgeoisie has created more and greater productivity in less than a hundred years of its class rule than all the productivity created in all past generations" [1], and that this mode of production, which has created enormous productivity, is modern industrial production. "As the general conditions requisite for production by the modern industrial system have been established, this mode of production acquires an elasticity, a capacity for sudden extension by leaps and bounds that finds no hindrance"[2], and with the help of the huge profits generated by the application of machines, modern production expanded from individual to all sectors of production. The machine-based industry replaced the workshop crafts and promoted the development of industry, commerce, navigation, and railways, which in turn involved all national production and consumption, thus making it the dominant mode of social production. It swept across the globe with devastating force, clearing its way with the destructive effects of blind expansion wherever it encountered obstacles. But after more than two hundred years of crude development, the sustainable development of the productivity of modern industry is currently under unprecedented pressure. Once modern industrial productivity has reached a certain point, it faces two major challenges to its development: the constraints imposed on it by lack of raw material and distribution markets [2] and the changing labour demands that require the replacement of the partially developed individual with the fully developed individual [2], which shackle the continued development of modern industrial productivity.

2. Current challenges to productivity development

Since the first industrial revolution, human society taking liberation and development of the productivity as the theme of practice has experienced three industrial revolutions, each of which has developed social productivity. However, the mode of modern industrial production has two major difficulties in development of social productivity still have not been fundamentally solved. Because the internal logic of the previous three industrial revolutions for the liberation of the productive forces is the same that division of labour separately combination with the individual factors of production in modern

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industries drives the development of productivity. The improvement of productivity is the result of an increase in marginal productivity of the individual factors of production. The negative effects of this logic of development of productivity manifested themselves in a more prominent form. As machine production transformed the mode of production in individual production sectors and caused changes in the mode of production in other sectors, which led to a further strengthening and deepening of the division of labour within society as a whole and to the further destruction of the social production whole.

First, technology continues to develop, but the contribution of Total Factor Productivity (TFP) to productivity development continues to decline, resulting in low production efficiency and poor system resilience. Total Factor Productivity is an economic concept proposed by Robert Merton Solow, winner of the Nobel Prize in Economics, which refers to the efficiency of the exploitation of resources (including human, material, and financial resources) and is used to measure the role of technological progress in production. Statistics show that the failure to increase total factor productivity in line with technological progress is a common problem faced by all countries in their development process. Data from the US Bureau of Labor Statistics shows that the US maintained an average annual growth rate of 2.1% in total factor productivity for 100 years during the industrialisation phase from 1870 to 1970, but the average annual growth rate of total factor productivity from 2007 to 2014 was only 0.5% [3], with 60 industries experiencing a decline in total factor productivity in 2020 alone [4]. China maintained a growth rate of nearly 4% in total factor productivity, along with the intensification of industrialization in the four decades of reform and opening up, but the average annual growth rate fell to 2.1% between 2010 and 2018[5]. The scope for the contribution of total factor productivity to economic growth has objectively shrunk in all countries as overall productivity levels have continued to rise. This will not only cause a slowdown in economic growth but will also affect the quality of economic development. The stagnation of total factor productivity reveals a prominent contradiction in current economic and social development, namely that the efficiency of social production in the use of resources has not increased in line with technological progress. This contradiction exists mainly in two aspects of social production: production within enterprises, and coordination among upstream and downstream in the industrial chain. The interference of uncertainty in the production process is responsible for the reduction in the efficiency of resource use. Uncertainty is widespread in the production process within the enterprise as well as in social production. In the production process within an enterprise, uncertainties can lead to a range of problems such as unplanned downtime, wasted raw materials, increased defective products, and caused wear and tear on equipment, seriously affecting production efficiency and product quality. For the industrial chain, the outdated global supply chain cannot adapt to the development trend of the deepening division of labour in the global industrial chain. The global supply chain disruptions caused by the New Crown epidemic have exposed the vulnerability and inefficiency of the current supply chain. According to Chicago-based supply chain consultancy FourKites, container ships waiting to unload cargo will spend an average of seven days in US ports from November 2021 to early 2022, a 4% increase compared to the whole of 2021 and a 21% increase from the start of the epidemic [6]. The driver shortage is one aspect of the supply chain pandemonium; the deeper reason is that outdated technology limits shipping companies' ability to anticipate and solve problems, causing the global supply chain system to become overwhelmed in the face of external disruptions. How to improve the utilization of resource within companies and optimize collaboration between upstream and downstream of the chain, thereby increase the total factor productivity of companies, industries and countries is the current development challenge of productivity.

Secondly, there is a structural contradiction between market supply and demand, causing an imbalance in the dynamics of the social production organism and leading to a lack of economic growth. Data released by the International Monetary Fund in July 2022 expects global economic growth to slow to 3.2% from 6.1% in 2021, well below the 4.1% expected in January 2022[7]. One of the reasons why global economic growth continues to slow and is in recession is that the current industrial supply is unable to meet the increasing abundance of demand. The current industrial chain starts with corporate production. This production model suffers from inefficient and low-end supply. In the past, due to technological constraints, enterprises are unable to fully grasp market trends. To maximize their profits, they presuppose consumers as groups with consistent needs in the modern production process, focusing on the commonalities of consumer groups and producing products to meet the needs of the majority. For example, in the decade 1915 to 1925, Ford painted its cars black to increase production efficiency. Henry Ford once said that "any customer can paint the car any colour he wants, as long as it is black". This disregard for the diversity of consumer demand has increased production efficiency but has the obvious disadvantage of failing to meet consumer demand effectively, which can easily lead to an imbalance between supply and demand. Some economists argue that the continued lack of market demand is causing economic stagnation, but in fact, it is not a lack of demand but a lot of unmet demand that is not being incorporated into the global market. Further liberation and development of social productivity must

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unlock new markets and stimulate new dynamics of economic growth.

Thirdly, the efficiency of human production and use of knowledge is no longer sufficient to meet the requirements of the current increasingly complex production system, and the partial development of the workforce is hampering the development of productivity. Labour is the sum of the physical and intellectual resources employed by man in the production of a certain use value and is an important factor of production. But in the past, when the level of productivity was low, the intellectual resources of labourers were not fully utilised. In Capital, Marx distinguishes between the application of machinery and the capitalistic employment of machinery. In short, the former is man dominating machines, the latter is machines dominate man. The capitalistic employment of machinery traps the worker at present in the process of product production, performing mechanical, simple manual labour and becoming a component part attached to the machine. "Machinery not only acts as a competitor who gets the better of the workman, and is constantly on the point of making him superfluous"[2], but workmen with a single skill set are also relegated to find a way out in the low-level, difficult to mechanize or cost effective labour sectors. Not only that, but for long periods of time lacking intellectual exercise and sticking in a particular fixed physical job is a serious constraint on the development of workers' creative abilities. In general, "the machine does not free the labourer from work but deprives the work of all interest"[2], and the capitalistic employment of machinery creates the detail labourer. Before the industrial revolutions, the factors of production had not yet reached the frontiers of their marginal productivity, where there was still room for the physical resources of labour to develop, and the limits to the development of social productivity manifested by the partially developed workman were not yet evident. But technological progress continues to increase the degree of automation of production, which makes social production less demanding of human physical labour. Not only that, but the efficiency of the unilaterally developed workforce in producing and utilizing knowledge also cannot meet the requirements of the current increasingly complex production system, "limited by knowledge and experience, a large part of the value of the production system driven by human decision making is not unlocked"[8]. The more complex social production becomes, the more it requires that human intellectual resources must be fully unleashed to facilitate productivity development. The full realisation of intellectual resources is not only a requirement for the development of productive forces, but also for the full development of the human being, and the two complement each other. Therefore, for social productivity to develop, the capitalist application of machines must be abolished for the full value of human resources in the production system to be realised.

In general, the development of productivity is currently limited in three ways: firstly, in terms of production coordination, the limited means of regulation are unable to meet the growing social production, enterprises have entered a bottleneck period of production efficiency. The supply system is inefficient and resilient, resulting in a decline in total factor productivity in society. Secondly, in terms of production dynamics, the production model based on enterprise's oriented in the past is unable to adapt to the increasingly diversified and individualized market. Thirdly, as far as innovation is concerned, the demand for manual labour in social production has been declining and the demand for intellectual labour has continued to rise, but the current efficiency of human production and use of knowledge cannot meet the needs of productivity development. In fact, the challenges that constrain the development of the productivity of modern industries do not just appear today but have existed since the very beginning of the emergence of modern industrial modes of production. If these new forms, which have evolved from the problems of the development of the productivity of modern industry, are not properly understood, it will be difficult for the social productivity to develop further. In Capital, Marx examines the three basic historical forms of capitalist enhancement of social productivity--collaboration, workshop craftsmanship and modern industrial production--and points out that machine modern industry is the most suitable technological basis for the capitalist mode of production, providing us with theoretical guidance for understanding and analysing the difficulties of the development of modern industrial productivity. Return to the classical texts to find the roots of the problem of the development of the productive forces of modern industry and, in turn, the theoretical basis for its solution.

3. The dilemma in Capital concerning the development of modern industrial production

The productive activity of a relatively large number of workers under the command of the same capital and in the same space and time is the historical and conceptual starting point of capitalist production. "When numerous labourers work together side by side, whether in one and the same process, or in different but connected processes, they are said to co-operate, or to work in co-operation"[2], and the collaborative mode of production transforms what was previously an interdependent individual labour process into a combined social labour process. Capitalism has created the most developed and complex production system in history, a social production that "requires more or less, a directing

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authority, in order to secure the harmonious working of the individual activities, and to perform the general functions"[2]. In this process, capital assumes a managerial, supervisory, and regulatory function, seeking to exploit the labour process more favourably to increasing its productivity. Essentially, before the emergence of industrial production, the artisanal production of the workshops, the dominant form of the capitalist mode of production, was artisanal because its productivity highly relied on human organ. The development of the artisanal mode of production was not only limited by the physical limitations and labour capacity of the workers but was also constrained by the "narrow technical basis excludes a really scientific analysis of any definite process of industrial production"[2]. If these limitations could not be removed, workshop crafts could not be fully realized, nor could a modern industrial mode of production based on them be truly established.

How did the invention of the machine and its conscious application in the field of production overcome the dependence of the workshop craft on man? Marx scientifically deconstructed the components of the machine to find the starting point of modern industrial production. He pointed out that "all fully developed machinery consists of three essentially different parts: the motor mechanism, the transmitting mechanism, and finally the tool or working machine"[2]. The motor mechanism provides the power for the operation of the machine, the transmitting mechanism transmits the power generated by the motor mechanism to the working machine, which drives it to grasp the object of work and transform it according to a certain purpose. The fundamental difference between machine production and handicraft production lies not in the type of power, but in whether the tool is operated by a human being. The working machine transfers to itself the tools that would otherwise be operated directly by man, replacing the mere tool with a machine. This transfer allows for a substantial increase in production efficiency free from the limitations of the number of human body organs. "Once the real tools have been transferred from man to the body, the machine replaces the mere tool"[2] and becomes the starting point for the transformation of the social mode of production from workshop craftsmanship to modern industry. It was when the subject of the operation of tools switched from man to machine and at the same time the number of operating tools was no longer limited by the number of human hands that "the motor mechanism acquired a form of independence and complete freedom from the limitations of human power"[2], and it was for this reason that the revolution of the steam engine became necessary. By dismantling the totality of man in the production process, the machine replaced the worker who used the tools with a working machine and the man who was the driving force with some other power. The development of the motor mechanism made it possible to increase the number of working machines being driven at the same time, and the transmitting mechanism linking the various parts of the machine developed into a huge apparatus. The object of labour is processed in turn by a series of different but complementary machines, and eventually the most developed form of machine production, the machine system - "an organised system of working machines driven by a central automaton through a transmission machine"[2] - comes into being. The transformation of the means of labour from tools to machines was the starting point for the change in the mode of production of modern industries, and the acquisition of an organised system of machines in factories was the most developed form of machines.

The completion of the transformation of the means of labour did not yet allow for the dominance of the modern industrial mode of production; the principle of the division of labour in the production process also had to be transformed. The machine system not only freed industrial production from dependence on skilled workers, but also enabled the objective principle of the division of labour to take shape in the factory. Marx pointed out that "if the worker adapts himself to the process, then the process adapts itself to the worker beforehand. In machine production this subjective principle of division of labour disappears"[2] and that the objective division of labour in machine production replaces the subjective division of labour that must be adapted to the workers in the workshop industry. The objective division of labour in modern industry forms a principle of modern industry that "breaks down each production process into its own constituent elements"[2], so that the whole of production within the factory can be objectively broken down according to its own nature, using technology to solve the problems of each local process. Thus, an organised production process is formed within the factory in accordance with the objective principle of division of labour.

An analysis of the transformation of the social mode of production from workshop crafts to modern industry shows that through the dismantling of the human labour power and the social production organism, modern industrial production burst into great productivity. But in fact, after a certain point of industrial progress, the overall liberation of the productivity through the decomposition of the social organism of production and the human labour power became its own opposite, the cause of the fettering of the productivity. Both Marx and complex systems science tell us that we must pay attention to the totality of social production. In the preface to the first edition of Capital, Marx points out that society is an organism in constant flux and development, and that "in the developed factory, it is the continuity of

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the particular processes that plays a dominant role"[2]. But the development of modern industrial production is based on the division of social production into whole groups, and when the productivity has developed to a certain extent, the scope for this model of development is exhausted. The principle of the increase of entropy and complexity science tell us that a system with less information and energy exchange with the outside increases the likelihood of moisture accretion within the system, and that a reduction in the number of connections within the system due to blockages also results in a reduction in system emergence. If social production is considered as a complex system, the increase in internal moisture and the decrease in emergence imply inefficiencies in production, a decline in system resilience, an imbalance in the dynamics of the organism and a reduction in the capacity for innovation. The current problems of productivity development discussed in the preceding chapters are the 21st century form of the two major problems of the development of the productive forces of modern industries, which are dealt with in Marx's Das Kapital. Breaking down information barriers, increasing connectivity and facilitating the flow of information are therefore key to solving the problem. The growing technology of Big Data offers new solutions for rebuilding the internal connections of the social organism.

4. Big Data offers new solutions to productivity development challenges

From the beginning of civilisation, when we began to use data and information to understand the world, it was not until the emergence of modern information technology, represented by computers, that mankind made a qualitative leap in the mastery and processing of data, laying the technical foundation for the emergence and application of Big Data. Big Data refers to a large and diverse amount of data that emerges at high speed. The following links are required for Big Data to function: Big Data collection, Big Data pre-processing, Big Data storage and management, Big Data analysis and mining, Big Data presentation and application; these links involve technologies such as the Internet of Things, sensing technology, 5G communication and artificial intelligence. The 13th NPC Standing Committee lecture on the topic of Big Data pointed out that "the value of Big Data is essentially reflected in the fact that it provides a new way of thinking and a new means for humans to understand complex systems"[9]. Specifically, Big Data can construct a digital virtual image of the real world. With sufficient computing power and efficient data analysis methods, the in-depth analysis of this digital virtual image can understand and discover the operational behaviors, state, and laws of complex systems. This is the most fundamental reason why Big Data has triggered economic and social change.

4.1 Applying Big Data technologies to improve total factor productivity

In the previous chapters we have learned about the negative impact of uncertainty on social production. Applying Big Data technology within enterprises and in industrial chains can effectively solve the problem of inefficient use of resources, thus improving total factor productivity and building a resource-efficient and environmentally friendly green development system.

The smart factory is a typical example of Big Data technology applied to the production sector to improve the efficiency of resource utilisation. In advanced smart factories, sensors for collecting production data are embedded in key aspects of the entire production line to monitor the status of production materials and machine operations in real time. The data collected is transmitted in time to the central control room via communication and IoT technologies. These Big Data are analyzed using appropriate models to uncover valuable information. This information is then fed back into the production system as input for feedback regulation, which enables autonomous regulation of production. By adding advanced analysis and flexible adjustment functions, Big Data technology empowers production systems to be self-configuring, self-controlling and self-optimising, truly achieving worry-free production. Wolong Holdings Incorporated - a smart factory - has greatly improved production efficiency by applying Big Data technology to actual production. In the company's intelligent production workshop, numerous systems and equipment are running independently and efficiently around the clock, with no manual operations required for all production, storage, handling and testing processes, from raw materials to final products. The intelligent workshop has increased overall production efficiency by 79%, reduced production and operating costs by 33.5% and increased energy efficiency by 16.7% compared to the traditional workshop [10].

The production of any enterprise is part of the overall social production, and the upstream-downstream enterprises in the industrial chain are closely linked and influence each other. The problem of stagnant total factor productivity of the whole social production cannot be fully solved by improving the utilization of resources within an enterprise starting with the production of individual enterprises

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alone. It is also necessary to apply Big Data technology to the global supply chain system and improve the collaborative production capacity between enterprises up and down the industrial chain to fundamentally solve the problem of poor resilience of the global supply system. By working with Amazon Cloud Technologies to migrate its 124 factory sites to a unified digital cloud, Volkswagen Group's digital production platform connects equipment at 122 factories and connects more than 1,500 suppliers, increasing overall supply chain productivity by 30% [11]. Opening the data pools of related companies in the chain and enabling data convergence will help drive the digitisation, networking, and intelligence of lengthy and complex value chains, thus building a decentralised, digital value ecosystem for domestic and international markets.

4.2 Big Data creates demand-oriented production chains

With the significant increase in productivity, people's standard of living has also increased, and people have more expectations for a better life, not being satisfied with food, clothing, and warmth at the material level of life, but demanding to meet their own needs at a higher level, with an increasing demand for personalised products. Personalisation is a huge potential market, but in the past modern production, which ignored the diversity of consumer needs, was unable to meet this demand. The application of Big Data technology may achieve a balance between improving production efficiency and meeting the diverse needs of consumers. As Nobel Prize winning economist Ronald Coase said, "If you torture data to a certain degree, it will confess everything"[12]. The application of Big Data to gain insight into different consumer preferences allows industrial production to combine customization and scale, economically producing products that meet consumer expectations. Pablo Isla, CEO of the Inditex Group, attributes Zara's success to three factors: its ability to respond quickly to market demand, its complete supply chain, and its global operations, in which Big Data plays an important role. By analyzing market trends and daily sales data from its shops, Zara accurately grasps the market dynamics, designs the products that consumers want, and quickly distributes the new products produced to more than 5,000 shops worldwide through a superb logistics system. Zara has set a record of launching an average of 120 latest styles of clothes every day by "testing the market in small quantities" and quickly adjusting production and distribution according to market feedback. [13]

The advantage of a demand-oriented production model is not only to respond quickly to market feedback, but also to extend the value chain of a product and find new dynamics for production. From the consumer's point of view, a product is not bought to possess it, but to use it to satisfy some need in one's own production or life. In the past, producers produced products just to sell them, and when the product was sold to the consumer it meant the end of the value chain. But in fact, due to the natural wear and tear of the product and the intangible losses caused by technological upgrades, the consumer's needs were not fully satisfied during the use of the product. This production model of selling the product in one go makes it difficult to incorporate new demands arising from the use of the product. The Internet industry was the first to overturn the traditional production mindset of "selling products", emphasising user experience, and the shift from providing products to providing services extends the product value chain to the whole process of product use. Take Microsoft's Office software as an example. In the past, if users wanted to use Office, they had to buy a one-off installation package, and when Office was upgraded to a new version, they had to buy the upgraded installation package again. This model required a high one-off payment and led to users choosing alternative products or delaying the upgrade, which did not provide a sustainable market demand for production. To address this issue, Microsoft introduced an Office subscription system instead of a purchase system, allowing users to pay a small membership fee to use the latest version of Office software for the duration of its validity. Microsoft's subscription system significantly extends the value chain of the product. The development of Big Data technology allows the extension of the product value chain to be applied to physical products. The option of purchasing a service without taking direct ownership of the product is made possible by the application of Big Data technology. Data generated during the use of a product is collected by sensors and transmitted via the Internet of Things back to the manufacturer, who analyses this usage data to provide end-to-end services. For example, freight companies buy tyres to get value out of them rather than to take possession of them, making it more attractive to pay the tyre manufacturer for the number of kilometres used as opposed to buying new tyres on a regular basis. Monitoring the use of a product through Big Data technology not only provides consumers with proactive maintenance, reducing maintenance costs while increasing product risk resistance and extending product life, but also creates new service models for producers and extends the product value chain.

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4.3 Big Data technology liberates human intellectual resources

The application of Big Data technology enables workers to leave the direct labour production process, freeing them from the heavy production labour and giving them more free time to play the subjective initiative of labour. Big Data plays an important role in this regard. Firstly, Big Data objectifies the individual's empirical knowledge to things, giving them human wisdom and allowing the application of empirical knowledge to break through the limits of the individual; secondly, Big Data provides a platform for the people to bring their creative abilities into play. The following will explain in detail how Big Data unleashes human intellectual resources from these two aspects.

In human decision-driven production systems, experience and knowledge are stored in the individual person, which poses two problems: knowledge cannot be applied efficiently and at scale, and knowledge dissipates as the individual passes away. In addition, production systems become more and more complex as they develop, and the traditional model of human learning, which relies on day-to-day accumulation, is increasingly unable to keep pace with technological progress. The question of how to unlock the intellectual resources of people has become the answer to the current bottleneck in productivity development. One of the goals of intelligent manufacturing is "to allow the system to adjust itself to changes in the manufacturing process according to the processing conditions of the product, and to realise the 'self-reflective' function of the system on the basis of the original automation". A 'self-reflective' production system uses data collection, analysis, and machine learning to establish a production evaluation model that intelligently determines normal and abnormal production status, enabling dynamic monitoring of the production process. When production systems are 'autonomous', people are freed from the labour of watching over the operation of the machines. The human being no longer acts as a tool to complete the work of production, but as a subjective and motivated worker who plans production.

Every leap forward in human society has been made possible by technological innovation. The importance of innovation to human society and human development cannot be overstated. The American scholar Clayton Christensen classifies innovation into three main types: continuous innovation, efficiency innovation and pioneering innovation [14]. Sustained innovation is an improvement on an existing solution in the marketplace; this type of innovation aims to generate higher sales revenues and higher marginal profits; efficiency innovation aims to help companies achieve higher profits with fewer resources; and pioneering innovation is innovation that creates new markets. While all three types of innovation are important for economic development, the power of pioneering innovation is particularly strong. iPhone innovation is a good example of the potential of pioneering innovation. When Apple's iPhone was launched in 2007, it took over half of the mobile phone market with its beautiful design, user-friendly interactive experience, and novel touch screen, beating out a host of former strong competitors such as Nokia and Motorola. Apple won not only because the iPhone is an excellent product, but also because its App Store has over 1.31 million third-party applications, providing users with a rich consumer experience. The success of the Apple App Store is due to an open and innovative model. Apple has abandoned the model of relying on its own strength to oversee app development and has built an open development platform that provides an ecosystem for over 100,000 companies or individuals to showcase their creativity, thus achieving a breakthrough from 0 to 1.31 million apps in less than two decades. As of 2015, the app economy pioneered by Apple generated over US$100 billion in revenue worldwide, more than the film industry, which has existed for over a century. This leap forward is a creation that could not have been achieved by a handful of engineers alone. The Marxist view of the history of the masses, which sees the people as the creators of history, has the unlimited potential to create history that is blossoming in the era of Big Data. Big Data technology provides technical support to stimulate the creativity of the people, returning the stage to the masses to showcase their creativity, and greatly mobilising and stimulating the creative energy of technical talents and society. The pioneering innovations brought about by Big Data not only create huge profits for enterprises but are also of great value to social and economic development. The pioneering innovations brought about by Big Data have greatly expanded the application scenarios of mobile phones, from instant messaging to information access, from mobile payment to travel cards, which have laid a solid foundation for the spread of digital lifestyles and are a prerequisite for opening the digital economy.

5. Summary and outlook

The growing division of labour and the widespread availability of machinery have led to the dominance of the industrial mode of production, which inevitably encounters problems of one kind or another in the process of development. These problems are rooted in the disruption of the connections

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within the organism, which ultimately leads to the inability of the elements within the system to work together. Big Data technology enables the fusion of the physical and digital worlds, visualises previously invisible elements and facilitates the integration of data from various fields, offering the possibility of making the most of existing natural resources, creating new markets and unlocking the intellectual resources of people in bondage. At the same time, we need to recognise that the full potential of Big Data technology will not be realised overnight. The spindle, a symbol of the first industrial revolution, took 120 years to move out of Europe and into the world, and there is still a long way to go before the potential of Big Data technology is effectively and fully unleashed. The fourth industrial revolution, based on Big Data technology, will bring technological innovation, and create new results that will spread far faster, have a wider impact and be far more transformative than the previous industrial revolutions. Until then, we must turn the challenges into opportunities and explore the full potential of Big Data to achieve the prosperity of human society.

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