Implementation Opinions on the "AI + Manufacturing" Special Initiative

The integration of artificial intelligence (AI) with the real economy is accelerating, profoundly changing production models and economic formats in the manufacturing industry, and becoming a key variable driving industrial upgrading and reshaping the global landscape. These *Implementation Opinions* have been formulated in order to thoroughly implement the *Opinions of the State Council on Deepening the*

Implementation of the "Artificial Intelligence+" Initiative,[1] speed up the integration and application of AI in the manufacturing sector, create new quality productive forces (新质生产力), and empower new-style industrialization (新型工业化) in an omnidirectional, in-depth, and high-level fashion.

I. Overall Requirements

Guided by Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, we shall thoroughly implement the spirit of the 20th Party Congress and all plenums of the 20th CCP Central Committee, fully, accurately, and comprehensively implement the new concept of development (新发展理念), accelerate the formation of the new pattern of development, and coordinate development with security.[2] Adhering to approaches that are innovation-driven, scenario-driven, and market-led, that are safe, secure, and trustworthy, and feature openness, sharing, inclusiveness, and interconnectedness, we shall focus on the supply of technology on one hand, to promote the "industrialization of intelligence," and focus on enabling applications (赋能应用) on the other hand, to accelerate the "intelligentization (智能化) of industries." And we shall holistically strengthen and grow industrial ecosystems, promote the deep integration of AI scientific and technological (S&T) innovation with industrial innovation, promote "two-way empowerment" between AI technologies and manufacturing applications, and accelerate the intelligentized, environmentally friendly, and integrated development of manufacturing, thereby strongly supporting the building of China into a manufacturing powerhouse[3] and a cyber powerhouse,[4] and the construction of a Digital China.

By 2027, China's AI key and core technologies (关键核心技术) shall achieve

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[1] CSET's English translation of the *Opinions of the State Council on Deepening the Implementation of the "Artificial Intelligence+" Initiative* is available online at: https://cset.georgetown.edu/publication/china-ai-plus-opinions-2025/.

[2] Translator's note: The Chinese word 安全 encompasses the meanings of both "safety" (protection from accidental harm) and "security" (protection from deliberate harm). In this translation, it is variously translated as "safety," "security," or "safety and security" at the translator's discretion.

[3] Translator's note: This translation renders the Chinese word 强国 qiángguó—which literally means "strong nation" and is sometimes translated "superpower"—in English in two different ways, depending on context. Where the translator judges that qiángguó is used in the general geopolitical sense, it is translated as "world power." Where the translator judges that the text refers to a specific flavor of qiángguó, it is translated as "powerhouse," as in the phrase "manufacturing powerhouse" (制造强国).

[4] Translator's note: Alternate English translations for the Chinese term wǎngluò qiángguó (网络强国) —here translated as "cyber powerhouse"—include "cyber superpower," "network powerhouse," "network superpower," and so on. For a more thorough discussion in English of the meaning of the term wǎngluò qiángguó, see: https://www.newamerica.org/cybersecurity-initiative/digichina/blog/lexicon-wangluo-qiangguo/.

secure and reliable supply, with their industrial scale and enabling capabilities firmly ranking among the highest in the world. We shall promote the deep application of three to five general purpose large models in the manufacturing sector, we will form industrial large models specialized for full coverage of every sector (形成特色化、全覆盖的行业大模型), put out 1,000 high-level industrial intelligent agents (智能体), create 100 high-quality datasets in industrial fields, and popularize 500 typical application scenarios. We shall incubate two to three globally influential ecosystem-dominating enterprises (生态主导型企业) and a group of professional, precision, specialized, and innovative (专精特新) small- and medium-sized enterprises (SMEs), create a group of enabling application service providers that "understand AI and know industry," and select 1,000 benchmark enterprises. We shall successfully construct a globally leading open-source and open (开源开放) ecosystem, comprehensively enhance safety and security governance capabilities, and contribute Chinese solutions to the development of AI.

II. Laying the Foundation for Innovation: Strengthening the Underpinnings of AI-Based Empowerment

(1) Strengthen the supply of AI computing power ("compute"). We should: Promote the coordinated development of hardware and software for AI microchips, and support breakthroughs in key technologies such as high-end training chips, on-device inference chips, AI servers, high-speed interconnects, and operating systems for cloud-based intelligent compute.[5] In an orderly fashion, advance the deployment of high-level intelligent compute facilities, and accelerate the construction of a monitoring and scheduling platform for the nationwide integrated compute network (全国一体化算力网), promoting the efficient utilization of compute resources. Launch pilot programs for intelligent compute cloud services, promote the deployment of large model all-in-one machines,[6] edge computing servers, and industrial cloud compute, in order to raise the supply capacity of intelligent compute resources.

(2) Develop high-level industry models. We should support innovation in model training and inference methods, and develop high-performance algorithm models adapted to the real-time, reliability, and safety and security requirements of manufacturing. Nurture development of large models for key industries, develop the "cloud-edge-devices" model system, and continuously increase generalization capability. Create small AI models tailored to niche industrial settings, and encourage

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[5] Translator's note: "Intelligent compute" (智算) typically refers to computing power specifically designed and optimized for AI model training, inference, or use.

[6] Translator's note: In Chinese computing parlance, an "all-in-one machine" (一体机) is a server or other turnkey piece of hardware that is sold with a particular Chinese AI model pre-installed and ready to use.

collaborative innovation between large and small models. Promote deployment of lightweight models and accelerate their application in industrial scenarios. Create a public model service platform to provide high-level models and supporting tools and services. Support the development of a large model evaluation benchmark system, create authoritative rankings, and publish evaluation results at regular intervals, thereby driving iterative technological upgrading.

(3) Launch a "Model-Data Resonance" ("模数共振") initiative. We should: Promote the establishment of Chief Data Officer systems within enterprises, continuously push forward implementation of national standards for data management capability and maturity, and thereby strengthen the foundation of enterprise data governance. Compile a list of data resources addressing industry model requirements, publish guidelines for constructing high-quality manufacturing datasets, and make good use of platforms such as manufacturing industry digital transformation promotion centers (制造业数字化转型促进中心), and promote the transformation of foundational data into high-quality industry datasets, achieving "drawing out data by means of models" ("以模引数"). Guide enterprises to strengthen data engineering capabilities, promote the in-depth integration of enterprise data development and model construction, and explore establishing a mechanism integrating "data collaboration, model training, application development, and security assurance," to achieve "using data to empower models" ("用数赋模").

III. Intelligence-Empowered Upgrading: Expanding and Extending High-Value Application Scenarios

(4) Accelerate application empowerment in key industries. We should more fully launch the AI Empowering New-Style Industrialization "In-Depth Tour" campaign (人工智能赋能新型工业化"深度行"活动), organizing high-level experts, enterprises, and research institutions into empowerment service teams to engage deeply with industries, local governments, and industrial parks. Build an AI application linking platform to facilitate precise supply-demand matching. Referencing the *Guidance for the AI-Empowered Transformation of Key Manufacturing Sectors* (see Appendix 1), develop differentiated "AI + Manufacturing" industry application overviews and transformation road maps; accelerate empowerment across key manufacturing-related sectors including raw materials, equipment manufacturing, consumer goods, electronic information, and software and IT services; and speed up the extension and application of benchmark solutions and experiences.

(5) Accelerate full-process transformation and upgrading. We should: Systematically sort out and review the application scenarios in key segments, deepen the tiered cultivation of smart factories, promote the embedding of large model

technology in core production and manufacturing segments, and transform the full process, from R&D and design (including industrial design), pilot testing and validation, production and manufacturing, and marketing and services, to operation and management, thereby enhancing capabilities in [computer]-aided design, simulation and modeling, production scheduling, and predictive equipment maintenance.

——R&D and design. Focusing on advancing AI-assisted design, software coding assistance and compiling, and pharmaceutical R&D, create novel research, development, and design models that are personalized, low-cost, and highly efficient. Strengthen industrial R&D dataset construction and open-source sharing, and explore establishing AI prediction result evaluation systems, so as to increase engineering innovation capabilities, and clear away the barriers holding back AI-driven scientific discovery.

——Pilot testing and validation. Vigorously advance the intelligentized transformation of pilot testing, and accelerate the application of technologies such as virtual simulation and multimodal fusion technologies in pilot testing. Optimize processes, raise pilot testing efficiency, and reduce experimental costs through comprehensive sensing, real-time analysis, scientific decision-making, and precise execution.

——Production and manufacturing. Deepen AI applications in areas such as industrial core process control, process optimization, and production scheduling, and promote intelligentized analysis, decision-making, and execution in the production process. Promote the spread of industrial quality inspection technologies such as machine vision and intelligent unmanned inspection, strengthen real-time production line monitoring and predictive maintenance, increase the accuracy of equipment failure identification, and achieve production safety risk warnings and incident alerts.

——Marketing and services. Promote the spread of smart customer service, digital humans, and 3D merchandise models. Focus on making breakthroughs in personalized recommendations, customized after-sales support, and service-oriented extension, and develop AI technology-based functions such as Q&A and training, thereby improving pre-sale, sale, and post-sale experiences, and increasing service value.

——Operation and management. Give full play to the inference and prediction abilities of large models to accelerate intelligence-based upgrading of order processing, sales forecasting, inventory alerts, and other areas, in order to optimize supply chain management. Utilize large model analysis and generation abilities to boost the management capacity of enterprises in areas such as strategy, human resources, financial matters, and risk.

(6) Raise application levels among key enterprises. We should conduct assessments of intelligentization maturity level among manufacturing enterprises, and implement the *Guidelines for Artificial Intelligence Application in Manufacturing Industry Enterprises* (see Appendix 2), so as to provide implementation pathways and methodological guidance for the intelligentization-based transformation and upgrading of enterprises. Encourage leading enterprises and central state-owned enterprises[7] to pioneer and experiment, provide large-scale application scenarios, develop and apply industrial intelligent agents, and explore new models of AI-empowered manufacturing. Deeply implement the Special Initiative for the Digital Empowerment of Small- and Medium-Sized Enterprises, support the digital and intelligentized transformation efforts of SMEs, and so accelerate the replication and extension of AI applications among SMEs.

(7) Advance the extension of applications in key regions. We should develop and open up a series of "AI + Manufacturing" application scenarios, and build innovation hubs with industry-specific characteristics. Leverage the advantages of national independent innovation demonstration zones (国家自主创新示范区), China national high-tech industrial development zones (国家高新区), and China national economic and technological development zones (国家级经开区), such as resource aggregation and talent concentration, to accelerate the large-scale deployment of new AI products, new services, and new business formats (新业态). Support advanced manufacturing industry clusters and digital industry clusters in implementing AI-enabled applications, and promote the intelligentization-based transformation and upgrading of regional manufacturing industries.

(8) Promote intelligentization-based upgrading in key areas of research. We should: Strengthen the synergies between AI and information and communication networks, promote the AI integration and empowerment of industrial internet platforms, research and develop datasets, large models, and intelligent agents for infrastructure such as the industrial internet, and push forward the deep application of AI technology in the infrastructure planning, construction, operations, and maintenance domains. Deepen the integration of AI technology in green manufacturing, and research, develop, and promote the spread of integrated intelligentized and environmentally friendly solutions to meet the requirements of scenarios such as

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[7] Translator's note: The term "central state-owned enterprises" ("central SOEs"; 央国企) refers to state-owned enterprises (SOEs) directly under the PRC Central People's Government (aka the State Council) whose leaders are appointed by the State Council or the Chinese Communist Party (CCP) Central Committee, either directly or by the CCP Central Organization Department, the State-owned Assets Supervision and Administration Commission (SASAC), or another central Party or government department.

energy management, carbon emission management, and resource recycling. Create a set of industry-specific application security solutions, accelerate the adoption of secure large models and intelligent agents, build secure operation systems, and enhance security standards in the industrial fields.

IV. Product Breakthroughs: Building New Intelligence-Based Products and Industry Formats

(9) Promote the iteration of intelligent equipment. We should accelerate the integration of intelligent agents into various types of industrial equipment, including machine tools and industrial robots, and develop computer numerical control (CNC) systems powered by new generation AI, in order to increase autonomous decision-making, analysis, and execution capabilities. Accelerate the development of surgical robots and intelligent diagnostic systems, and speed up the product innovation and clinical application of intelligent medical equipment. Promote the integration of AI technology in the R&D, manufacturing, and operation of major technical equipment including large aircraft and ships, and develop drones and other intelligent low-altitude equipment. Conduct testing and safety assessments for intelligent connected vehicles with autonomous driving capabilities, and systematically advance pilot programs for market access and on-road operation of such products.

(10) Accelerate upgrading of intelligent terminal devices. Support technological breakthroughs in on-device models and application development toolchains, and foster development of AI-enabled devices including smartphones, computers, tablets, and smart home devices. Focusing on key scenarios such as industrial inspection and telemedicine, accelerate and enhance the industrialization and commercialization of new types of terminals such as augmented reality/virtual reality (AR/VR) wearable devices and brain-computer interfaces. Promote innovation in embodied AI products, and construct humanoid robot pilot bases and training grounds. Create benchmark production lines for humanoid robots, and prioritize their application in typical manufacturing settings.

(11) Create new business formats for intelligent agents. Conduct technological research on task planning and collective coordination of industrial agents, strengthen the integration of industrial mechanisms and agentic decision-making models, enhance interactive adaptation between agents and industrial systems, and promote deployment of agents to the cloud. Develop open and collaborative agent protocols and interfaces to improve interconnection and interoperation efficiency. Support the establishment and operation of agent app stores, showcase typical industrial agent use cases, and publish guidelines on putting enterprise-level applications into practice, so as to accelerate the scaling-up and commercialization of agents. Build a categorized

and graded (分类分级) management system for agents, and research agent internet architectures. Explore mechanisms for agent registration and discovery, identity authentication, and access management, and guide the healthy development of new business formats. Accelerate the upgrading of traditional software products and services, and promote the deep integration of AI with industrial software to raise design and production efficiency.

V. Incubating Entities: Building the Main Force for AI Development and Enabling Applications

(12) Incubate enterprises in a tiered fashion. We should support enterprises in stepping up their innovation investment, actively undertaking major national tasks, and pooling resources to build globally influential and ecosystem-dominating enterprises. Develop AI enterprise incubators and implement SME startup support programs. Using a tiered approach, incubate more professional, precision, specialized, and innovative "little giant" enterprises, high-tech enterprises, manufacturing industry single-item champion (单项冠军) enterprises, unicorn enterprises, and gazelle enterprises. Encourage relevant local governments to give enterprises "compute vouchers," "model vouchers," and other forms of support, strengthen public services that empower SMEs, and reduce the development and application costs for enterprises.

(13) Create vehicles for innovation. Establish a national manufacturing industry innovation center (国家制造业创新中心) in the AI field to increase supply capacity for critical general purpose technologies. Deploy a number of key laboratories in the AI field to strengthen exploration of cutting-edge technologies such as brain-inspired intelligence and world models. Emphasizing high quality, construct national AI application pilot bases (国家人工智能应用中试基地) in key manufacturing sectors, thereby aggregating industrial innovation resources and accelerating the development of industry solutions that can be replicated and promoted.

(14) Develop providers of AI-empowered application services. Improve the service system for the digitalized and intelligentized transformation of manufacturing, and develop a set of AI-empowered application accelerators. Incubate high-quality providers of AI-empowered application services to create AI-empowered solutions combining standardization and customization, and offer services such as industry model fine-tuning, data governance, and security assurance. Encourage industrial enterprises, AI enterprises, and industrial internet enterprises to pool resources such as tools, technologies, and platforms, and thereby build ecosystem partner service providers. Support telecommunications operators and the digitalization-intelligentization S&T companies of central SOEs in enhancing service capabilities and undertaking industry-empowering application services. Guide relevant industry

organizations to regularly publish directories of outstanding service providers.

VI. Ecosystem Expansion: Strengthening Resource Allocation to Optimize Industrial Ecosystems

(15) Strengthen leadership on standards. We should leverage the roles of the Artificial Intelligence Standardization Technical Committee of the Ministry of Industry and Information Technology, National Technical Committee 609 on Data of the Standardization Administration of China (SAC/TC609), the Artificial Intelligence Subcommittee of National Information Technology Standardization Technical Committee 28 (SAC/TC28) of the Standardization Administration of China (全国信标委人工智能分委会), the Artificial Intelligence Chip Working Group of the National Integrated Circuit Standardization Technical Committee 599 (SAC/TC599) of the Standardization Administration of China, and the Emerging Technology Security Standards Special Working Group of National Technical Committee 260 (SAC/TC260) of the Standardization Administration of China (全国网安标委新技术安全标准特别工作组), and strengthen construction of standardization technical organizations. Enhance collaboration across industries and fields. Using graded and categorized (分级分类) approaches, promote the development of foundational standards for security, governance, and ethics, general standards areas such as hardware-software coordination (软硬协同), [AI-]empowered application standards, and metrology technical specifications. Deeply carry out the "AI Standards Tour" (人工智能标准行) initiative to enhance indoctrination in and application of standards. Encourage enterprises to participate in international standardization efforts.

(16) Promote open-source and open-access initiatives. Build high-quality open-source AI communities, deploy and implement a set of high-quality open-source projects covering models, datasets, agents, etc., and build a globally influential open AI ecosystem. Research, develop, and promote the spread of open-source licensing agreements tailored to AI project characteristics, in order to build a new open-source rules-based order (规则秩序) for AI. Guide cloud service providers, empowered application service providers, and open-source communities to actively link up, and promote the implementation and application of open-source projects in industrial sectors. Host developer conferences, campus open-source tours,[8] and similar events to propagate the concept of open source, foster a thriving open-source culture, and form a good environment for collaboration and sharing.

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[8] Translator's note: The OpenAtom Foundation (开放原子开源基金会), a nonprofit foundation founded by a consortium of Chinese tech companies and banks to promote open-source software, began organizing "campus open-source tours" ("校源行") on Chinese college campuses in 2023 as a way to recruit talent for China's open-source software industry.

(17) Strengthen talent recruitment and cultivation. Conduct talent demand forecasting for the AI industry, publish talent demand forecasting reports, and support universities and research institutions in proactively planning and optimizing relevant academic disciplines and programs. Effectively establish and utilize institutions such as Zhongguancun Academy, Shanghai Innovation Institute, Shenzhen Loop Area Institute, the National Artificial Intelligence Industry-Education Integrated Innovation Platform (国家人工智能产教融合创新平台), national elite institutes of engineering (国家卓越工程师学院), and national practice bases for outstanding engineers (国家卓越工程师实践基地); develop specialized curricula to cultivate interdisciplinary talents proficient in both AI and manufacturing industry applications; and enhance AI awareness education and training, in order to increase AI literacy and skills across all sectors. Strengthen the cultivation of talents highly skilled in AI, leverage relevant national talent initiatives and projects to develop S&T leading talents and innovation teams, establish unconventional new models for cultivating leading talents, and actively recruit high-end overseas talents.

VII. Security Safeguards: Laying a Firm Foundation for Application-Enabling Security Assurance

(18) Elevate security assurance capabilities. Tackle such key technologies as deep synthesis (深度合成) deepfake detection, industrial model algorithm security protection, training data protection, adversarial example detection, and smart terminal device security evaluation, and strengthen data security management, thereby strengthening AI security protection capabilities. Build resources such as security risk libraries and corpora, and construct industrial security large models. Enhance AI transparency and explainability, and lower hallucination risks, through knowledge base optimization, training corpus error correction, and annotation of generated and synthesized content. Put the *Measures for Artificial Intelligence Technology Ethics Management Services* (人工智能科技伦理管理服务办法) into practice, strengthen industry self-discipline, and increase corporate AI ethical risk prevention ability.

(19) Establish security governance mechanisms. Research and formulate security policy standards for AI categorization and grading, evaluation and assessment, and emergency response in industry and information technology (工业和信息化) sector, and support local main oversight departments (主管部门) in exploring flexible governance mechanisms. Establish technical capabilities for AI security risk monitoring and early warning, and strengthen risk monitoring, assessment, and prevention. Develop guidelines for the reporting and sharing of AI security risk information in the industry and information technology sector, coordinate efforts across all parts of the production chain, and strengthen information sharing, risk notification, and

collaborative response.

VIII. International Cooperation: Shaping New Advantages in International Cooperation and Competition

(20) Support industrial cooperation. Encourage enterprises to customize AI products and empowered application solutions that address the particulars of different countries and regions. Launch "overseas editions" of the AI Empowering New-Style Industrialization "In-Depth Tours," support industry organizations and specialized institutions in providing enterprises with overseas expansion support services, and guide companies in efficiently conducting technology validation and compliance certification, so that they better serve the orderly overseas development of industries. Channel foreign investment toward the AI sector, and encourage foreign-invested enterprises to engage in generative AI technology development and product production.

(21) Build international cooperation platforms. Actively participate in AI-related discussions within cooperation mechanisms such as BRICS, the Shanghai Cooperation Organization, China-ASEAN, the G20, and APEC. Support the regulation-compliant hosting of globally influential high-end competitions, exhibitions, and conferences, such as the World Artificial Intelligence Conference and the Humanoid Robot Games, and actively publicize China's benchmark AI cases. Emphasizing high quality, construct the China-BRICS Artificial intelligence Development and Cooperation Center (中国—金砖国家人工智能发展与合作中心) to enhance practical cooperation and promote the synergistic development of global industries.

IX. Assurance Measures: Strengthening Omnidirectional Policy Support Assurance

Establish a work facilitation mechanism featuring interdepartmental collaboration, central-local government coordination, and industrial collaboration, and encourage local governments to formulate policy measures according to local conditions. Guide enterprises toward development based on complementary advantages, to prevent "rat race" competition[9] in industries. Do overall planning of existing funding channels, and assign tasks to support technology R&D and empowering applications related to "AI + manufacturing." Leverage the National Artificial intelligence Industry Investment Fund

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[9] Translator's note: The Chinese term "rat race competition" ("内卷式"竞争), also known as "involutionary competition" or "nèijuǎn-style competition" after its Mandarin pronunciation, refers to a peculiarly Chinese phenomenon of being locked in competition with so many similar, seemingly innumerable competitors that one feels hopeless about one's chances of ever succeeding or standing out from the pack.

to enrich the reserves of high-quality projects, attracting and encouraging more social capital[10] to increase investment in an orderly fashion. To release the domestic market's latent demand, launch large-scale application demonstration initiatives for new technologies, products, and scenarios, and make good use of policies for first-instance, first-batch, and first-version applications to advance the wider adoption and iterative upgrading of new technologies and products. Conduct AI industry size estimation, establish a system of application monitoring and evaluation metrics, and enhance AI industry monitoring and analysis platforms to dynamically track global industry trends.

Appendices: 1. Guidance for the AI-Empowered Transformation of Key Manufacturing Sectors
2. Guidelines for Artificial Intelligence Application in Manufacturing Industry Enterprises

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[10] Translator's note: The Chinese term 社会资本, translated literally as "social capital," refers to any source of funding outside of government budget outlays. This term encompasses investment by private individuals and private institutions. However, investment from state-funded entities such as state-owned enterprises (SOEs), including state-run banks, also falls under the umbrella of "social capital."

Appendix 1

Guidance for the AI-Empowered Transformation of Key Manufacturing Sectors

The manufacturing industry is the mainstay of the national economy. It is the basis on which the nation is established, the instrument of national rejuvenation, and the foundation of a world power.[11] The deep integration of artificial intelligence with the manufacturing industry is an important pathway for developing new quality productive forces and building a modernized industrial system. This *Guidance* has been formulated to leverage the advantages of the manufacturing sector's large size, comprehensive range of industries, and rich variety of application scenarios, and to promote the application of AI in the manufacturing sector through differentiated measures that take into account basic conditions such as the characteristics of different industrial fields, and levels of technological maturity and digitalization, thereby accelerating the intelligentized, green, and integrated development of the manufacturing industry.

I. Raw materials industry

(1) **Enhance the intelligentization level of the steel industry throughout the production process**. Establish public dataset and knowledge base products for the steel industry, build AI commercialization (工程化) application platforms, and provide intelligentization solutions. Research and develop a series of dynamic models covering the entire steel production process. Research and develop large models and intelligent agents for vision, prediction, and decision-making in the steel industry based on knowledge of steel production mechanisms and practical experience, to achieve functions including real-time perception of critical equipment operating conditions, adaptive optimization of process parameters, product performance forecasting, defect traceability, global optimization of scheduling tasks, and real-time intelligent adjustment. Promote AI-empowered transformation across the entire steel industry value chain, and thereby increase production efficiency, product quality, resource use efficiency, and safety and service levels.

(2) **Promote quality improvement and efficiency gains in the petrochemical and**

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[11] Translator's note: The first two sentences of Appendix 1 (制造业是国民经济的主题，是立国之本、兴国之器、强国之基) are lifted directly from the first line of the *Made in China 2025* strategy. CSET's English translation of *Made in China 2025* is available online at: https://cset.georgetown.edu/publication/notice-of-the-state-council-on-the-publication-of-made-in-china-2025/.

chemical industries. Integrate large model and digital twin technologies to make paradigm breakthroughs in oil and gas exploration and development, and in new materials R&D in the chemical industry. Build large models for the petrochemical and chemical industries by deeply integrating process mechanisms, expert knowledge, and operational production data in oil and gas production operations, pipeline network storage and transportation, and chemical processes. Promote the integrated application of large and small models to achieve oilfield work zone and chemical plant safety monitoring, predictive equipment maintenance, adaptive process optimization, and product quality forecasting. Build high-quality industry datasets, data resource nodes, and other data infrastructure to support training and development of industry-specific large models and intelligent agents, thereby boosting AI application levels in complex settings.

(3) **Accelerate the deep integration of AI with new materials R&D**. Establish a National New Materials Big Data Center (新材料大数据中心) to construct high-precision, long-sequence, multimodal datasets for the materials industry, and raise the level of industry data format standardization. Develop cross-scale (跨尺度) computational frameworks for alloys, ceramics, polymers, and energy materials. Build industry-specific large models for the molecular design, synthesis and preparation, and process optimization of new materials, and increase inverse design (反向设计) capabilities based on the "composition-structure-property" paradigm. Construct an evaluation system for large-model-based prediction results to enhance model forecasting accuracy. Increase capabilities in human-computer collaboration in materials science research, as well as capabilities in high-throughput automated experimentation and preparation in new materials.

(4) **Promote AI-empowered transformation in the non-ferrous metals sector**. Develop technologies and tools for automated data governance and annotation, create high-quality industry datasets covering mining and equipment operation, ore dressing process optimization, and smelting process control, and thereby build a data foundation support system. Develop large models, scenario-specific models, and intelligent agents for the non-ferrous metals industry that integrate "physical mechanisms, process data, and environmental variables," and promote collaborative application of large and small models to meet usage requirements of reliability and dynamic adaptability, to achieve innovation in models for new materials and new process R&D, precise control of mining, dressing, and smelting processes, real-time optimization of key parameters, and accurate classification and identification of recyclable resources.

(5) **Promote the application of AI to empower innovation in the building materials industry**. Prioritizing industries such as cement and plate glass, deploy a set

of scenario-specific models tailored to typical unit operations, train and build a large model for the building materials sector, and promote in-depth application in scenarios such as mining, raw material mixing ratio optimization, kiln calcination control, and cement clinker strength prediction, thereby increasing the level of intelligent optimized control of production processes. Promote the R&D of intelligent algorithm systems for "data-driven and mechanistic models," and build datasets for advanced inorganic non-metallic materials such as advanced ceramics and intraocular lenses (人工晶体), so as to promote new product development and production process optimization.

II. Equipment manufacturing industry

(1) Promote a dramatic increase in the flexibility and intelligentization of industrial machine tools. Use deep integration of AI technology into CNC systems to empower the entire process of "real-time perception – autonomous learning – intelligent decision-making – closed-loop execution," and increase the adaptive operation and execution abilities of industrial machine tools. Build large-model-based intelligent diagnostic systems to precisely perceive and accurately assess equipment status, thereby achieving remote monitoring and predictive maintenance. Leveraging modular production units and intelligent decision-making services, achieve autonomous responses to order modifications, real-time production line reconfiguration, and agile production for manufacturing systems through low-code configuration-based workflow orchestration and autonomous resource scheduling.

(2) Accelerate full-chain intelligentization upgrading in the automotive industry. Develop automotive large models to automatically generate body styling and interior layout proposals, achieve the dynamic simulation and optimization of structural strength, drag coefficient, and other parameters in real time, and promote a new intelligent R&D paradigm. Accelerate the application of AI technology in hardware configuration and parameter tuning, develop modular process islands (工艺岛), and build flexible, reconfigurable production lines. Establish AI-driven full-process quality control and predictive maintenance, and promote online whole-vehicle performance testing and total life cycle quality traceability.

(3) Push forward the total life cycle intelligentization of electric power equipment. Based on AI technology, intelligently optimize structural parameters of generators and other core components, and advance the use of digital twin design and simulation testing for large-scale power generation equipment. Utilize AI algorithms to enhance analysis of power equipment manufacturability, with intelligent assessment of component machining difficulty and assembly compatibility. Build AI-driven health assessment and lifespan prediction platforms, and carry out condition-based maintenance to improve intelligent monitoring and scheduling optimization for power

generation and transmission equipment.

(4) Promote the application of AI technology in the shipbuilding industry. Construct large models for the shipbuilding industry and explore new R&D and design approaches. To address demand for manpower-saving and intelligentized production of large vessels and marine equipment, push forward the intelligentization-based upgrading of critical processes such as "cutting, welding, spraying, and logistics," and promote the development of AI application scenarios in marine equipment manufacturing and intelligent ports (智慧港口). Based on data governance, machine learning, and other AI technologies, establish operational performance models for ship equipment systems to realize such functions as voyage energy efficiency optimization and equipment troubleshooting.

(5) Create an intelligentized manufacturing system for aerospace. Develop an AI-algorithm-based simulation platform that combines aerodynamics data with fluid mechanics models to automatically iterate fuselage shape and wing profile designs, achieving validation in extreme working conditions and shortening testing cycles. Create industrial decision-making systems, and deploy intelligent agent applications in areas including design, manufacturing, operations and maintenance (O&M), and management. Construct AI solutions such as intelligent processing and assembly of large and complex material components, additive manufacturing and intelligent inspection of specialty materials, and intelligentized spacecraft final assembly, integration, and testing, thereby comprehensively raising the level of intelligentization in the industry.

III. Consumer goods industry

(1) Improve personalized design and efficient production capabilities in the textile and apparel sector. Create an intelligentized product planning platform for the apparel industry, deeply mine vast quantities of consumer data, and use data analysis decision-making models to rapidly identify trending apparel products and design responsive solutions. By integrating physics engines with 3D generation models, create personalized design and virtual fitting systems to elevate the consumer shopping experience. Promote the deployment of adaptive production systems to achieve micron-level yarn tension monitoring and automatic blemish repair, boosting product yields. Research and develop intelligent technology and equipment for sorting waste textiles based on multispectral intelligent recognition, increasing recycled resource utilization.

(2) Enhance intelligentized operation and smart product supply capabilities in the home furnishings sector. Establish data-driven product design agents to optimize

structure and functionality, enhance smart control capabilities, and accelerate the pace of new product launches. Integrate industrial scheduling large models with industrial internet technology, and connect multi-source data from production equipment, orders, and materials, to achieve collaborative multi-line production scheduling and warehouse scheduling, enhancing manufacturing flexibility and responsiveness. Develop smart home products featuring human-computer interaction, intelligent sensing, and smart connectivity functions, creating diverse scenarios, and construct proactive service-oriented home appliance reminder systems (家电提醒系统) to provide energy-saving solutions and predictive maintenance, improving equipment reliability and user satisfaction.

(3) Establish a safe, efficient, and intelligentized management system for the food processing sector. Encourage the application of AI technologies, and enrich the supply of AI large model products for the food industry. Organize food enterprises and specialized service firms to provide intelligentized solutions including smart monitoring and traceability for food production, "5G + industrial internet" for food industry industrial parks, and intelligent management of raw material production and supply. Accelerate the R&D and deployment of multimodal production safety monitoring large models to increase capabilities for real-time identification of illegal operations and hazardous conduct at food production sites. Improve supply chain risk prediction and emergency response capabilities to perceive supply chain disruption risks in real time, ensuring food supply stability.

(4) Raise the level of intelligent R&D and supply management in pharmaceuticals. Build an AI-driven platform for new drug discovery and virtual screening, and accelerate target identification and candidate drug discovery using multimodal drug efficacy prediction models, thereby cutting drug R&D cycles and costs. By integrating quantum chemical simulation and AI technologies, precisely design drug molecular structures, and thereby improve efficacy and safety. Speed up the application of AI in areas such as drug synthesis pathway planning and raw material combination optimization, and build an automated, high-throughput, low-cost intelligent drug synthesis system. Construct an intelligent pharmaceutical supply chain management platform to track demand fluctuations in real time and dynamically optimize inventory and distribution routes, preventing drug shortages and waste.

(5) **Advance full-chain innovation-based development in the biomanufacturing sector**. Using AI technology, discover and generate high-performance biological components, efficient synthetic metabolic pathways, and highly bioactive enzyme and protein structures (高活性酶蛋白结构), enriching the foundational databases. Develop an intelligentized microbial strain (菌种) construction platform to precisely simulate cell factory mechanisms and create industrial strains with high conversion yield (高转化率).

Establish predictive models linking process parameters to product yields to shorten process development cycles and boost the success rate of pilot testing and validation. With the help of AI and other technologies, optimize and iterate core bioreaction process parameters such as temperature, pH, and oxygen level to achieve intelligent reaction process control and accelerate the commercialization process.

(6) Promote the renewal and upgrading of historically Chinese industries. Accelerate the building of "brains" (大脑) for historically Chinese industries, build an industry data foundation integrating core techniques including textile patterns (纹样), porcelain glaze formulations, and tea leaf roasting processes, and achieve precise alignment between market demand perception and product innovation. Leveraging AI and industrial internet technologies, promote customized and collaborative design innovation to drive the conversion of cultural intellectual property (IP) into fashionable consumer goods. Employ machine vision technologies to build full-process quality control systems. Using 3D modeling and digital twin technologies to recreate the production scenarios and craftsmanship processes of traditional industries, create immersive cultural spaces that integrate arts and crafts demonstrations, interactive experience, and customized production, thereby enhancing the consumer shopping experience.

IV. Electronic information industry

(1) Raise the intelligentization level of electronic component design. Employ generative AI and digital twin technology to achieve fully virtual simulation and debugging of electronic components, and build cross-domain collaborative R&D platforms. By integrating advanced computing engines with multimodal large models, bridge data silos between electronic design automation and product lifecycle management systems, and support rapid iteration and validation of complex microchip architectures and new-style display devices. Prioritize making breakthroughs in high-precision simulation and prediction technologies for electronic components to shorten R&D cycles and reduce physical trial-and-error costs.

(2) Promote flexible smart manufacturing in the consumer electronics and new-style display industries. Leverage industrial large models and edge intelligence technologies to dynamically reconfigure production lines and build adaptive and flexible production systems for the electronic information industry. Deploy AI-driven process parameter optimization models combined with machine vision and multi-scale physical property characterization to achieve millisecond-level fine-tuning in critical processes such as electronic component mounting, assembly, and testing. Develop modular, intelligentized electronic information manufacturing equipment and low-latency networks to support multi-variety, small-batch production in the consumer

electronics and new-style display industries, significantly reduce production line changeover time, and increase the overall effectiveness of equipment.

(3) Strengthen quality control capabilities for electronic information components and products. Accelerate the construction of an electronic information industry knowledge graph to achieve intelligent root-cause analysis of quality issues, and build a full-process quality control platform. Integrate machine vision, non-destructive testing, and multispectral recognition technologies to develop online quality inspection systems covering printed circuit board design and chip packaging, in order to boost electronic component inspection efficiency and accuracy. Establish a knowledge base and predictive models for electronic information product quality defects to effectively reduce defect rates, increase quality traceability response speed, and promote a transition from reactive fixes to proactive prevention.

(4) Innovate intelligent solutions for green and low-carbon development in the electronic information industry. Integrate AI and blockchain technology to achieve precise, total-life-cycle carbon footprint accounting and trusted data sharing for electronic information products. Develop large models for carbon management in the photovoltaics and lithium battery industries, and integrate industrial internet identity resolution (标识解析) with energy consumption prediction algorithms to dynamically optimize equipment parameters and energy scheduling. Deploying intelligent power forecasting and station operation systems, promote a significant reduction in energy consumption per unit of output in the energy electronics sector, increase the reliability of carbon emissions data, and support extension toward higher-end segments of the global value chain.

V. Software and IT services industries

(1) Create an intelligent toolchain product system for the entire software lifecycle. Focusing on multimodal large models, behavior analysis, and time-series forecasting, construct intelligentized development toolchain products covering software requirements and design, development, testing, and O&M. Create AI-driven DevOps products to achieve intelligent scheduling and risk warning. Incubate low-code platforms for industry verticals (垂直领域), and incubate intelligent agent development platforms. Utilize modular AI components to achieve rapid industry knowledge encapsulation (知识封装) and automated task design and execution, and promote a shift from "human-dominated" to "intelligent collaborative" software development.

(2) Speed up the intelligentization-based upgrading of traditional software and services. Promote the integration of AI technology with system software (基础软件), industrial software, and manufacturing industry application software to achieve the

intelligentized upgrading and value reconstruction of traditional software. Enhance the dynamic perception, self-optimization, and self-evolution capabilities of software to achieve dynamic reorganization of software functional modules and software performance optimization. Integrate technologies including predictive analytics and business process mining to empower software with intelligent decision-making capabilities. Research and develop high-performance intelligent communication middleware based on domestically produced agent interconnection protocols, and thereby achieve efficient collaboration between software and large models, and the unified analysis of multi-source data.

(3) Develop and create intelligent agents for industry verticals. Research, develop, and deploy agents for software programming, software requirements [analysis] and auditing, and software testing; create industrial agents for surface design, automated modeling, and automated programming; and develop specialized agents for intelligent scheduling and planning, dynamic report generation, automated interface design, and intelligent data monitoring and governance. Research and develop industry-specific agents for the healthcare, education, finance, and legal industries.

(4) Construct high-quality datasets for the software industry. Make breakthroughs in technologies including automated multimodal data cleaning and intelligent semantic annotation, and create standardized software R&D datasets. Employ synthetic data and adversarial testing techniques to simulate complex corner cases (边界场景) such as high concurrency and network anomalies, and build a real-world scenario testing database. Build semantic domain knowledge assets based on fine-grained entity relation extraction and heterogeneous multi-source knowledge alignment technologies. Establish an open-source compliance-as-code (代码合规) cleaning pipeline to effectively filter license conflicts and vulnerability risks, and comprehensively strengthen the data foundation for "AI + software" integration-based innovation.

Appendix 2

Guidelines for Artificial Intelligence Application
in Manufacturing Industry Enterprises

The deep integration of artificial intelligence with all manufacturing industry factors of production (要素), processes, and chains is an important pathway to resolving industrial upgrading bottlenecks and shaping international competitive advantage. These *Guidelines* have been formulated to accelerate and promote the deep integration of AI and the manufacturing industry, promote the better combination of digital technologies with manufacturing strengths, and increase the level of science (科学化) and standardization of AI application by manufacturing enterprises, thereby comprehensively empowering new-style industrialization.

These *Guidelines* are applicable to enterprises utilizing AI to carry out R&D and design, production and manufacturing, and operations and management, as well as those that provide AI extension services (延伸服务).

I. Conduct assessment and planning of intelligentization

(1) Carry out diagnostic assessment of intelligentization levels. Comprehensively employing reference standards such as Data Management Capability Maturity, Intelligent Manufacturing Capability Maturity, Digital Transformation Maturity, Management System for Integration of Informatization and Industrialization,[12] and the General Assessment Indicator System for Digital Transformation in Manufacturing (制造业数字化转型通用评估指标体系), clarify the digitalization, networkization (网络化), and intelligentization levels of enterprises and identify their bottlenecks in transformation and upgrading. Combine economic analysis with risk assessment to scientifically determine AI application requirements.

(2) Formulate AI application plans. Referencing typical application cases of new-style industrialization empowered by AI, determine core AI application scenarios

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[12] Translator's note: These four terms are references to Chinese national standards. "Data Management Capability Maturity" refers to GB/T 36073-2018, *Data Management Capability Maturity Assessment Model* (数据管理能力成熟度评估模型). "Intelligent Manufacturing Capability Maturity" refers to GB/T 39116-2020, *Maturity Model of Intelligent Manufacturing Capability* (智能制造能力成熟度模型). "Digital Transformation Maturity" refers to GB/T 43439-2023, *Information technology services—Digital transformation—Maturity model and assessment* (信息技术服务 数字化转型 成熟度模型与评估). "Management System for Integration of Informatization and Industrialization" refers to the GB/T 23030 series *Evaluation Rules for Integration of Informatization and Industrialization at Industrial Enterprises* (工业企业信息化和工业化融合评估规范) and other standards including GB/T 23003-2018, *Standard for the Management System for Integration of Informatization and Industrialization* (两化融合管理体系标准).

and technology adoption priorities, and rationally set application objectives. Prioritizing intelligentization-based upgrading in the business management and R&D design scenarios, phase in the transformation and upgrading of pilot testing, production and manufacturing, and other processes. Leverage the supportive role of the industrial internet's digital foundation, and strengthen coordination and integration with the digital transformation efforts of enterprises, to ensure that AI applications precisely support development of their core businesses.

II. Increase foundational capabilities for intelligentization

(3) Upgrade foundational capabilities in hardware. Implement digital transformation and upgrading of "dumb" equipment ("哑设备") and "dumb" job positions ("哑岗位") in industries, and build a hardware support system that combines a unified technical foundation with scenario-specific application suites. Comprehensively elevate information perception, transmission, decision-making, and control capabilities in various scenarios by installing sensing equipment and smart meters and instruments, deploying edge computing devices, promoting the upgrading of industrial private networks, and applying general purpose digital transformation tools and products. Accelerate the transformation of existing data centers into intelligent computing centers through the optimization and upgrading of computing, storage, and networks.

(4) Increase the intelligentization level of software. Accelerate the intelligentized transformation and upgrading of core software such as industrial real-time operating systems, and control optimization software such as manufacturing execution systems and online real-time optimization tools, as well as control and execution units such as distributed control systems and data acquisition and monitoring systems, in order to enhance intelligentization support capabilities. Optimize system software kernels by embedding intelligent scheduling algorithms, thereby boosting resource allocation efficiency and enhancing system responsiveness. To strengthen the native intelligence foundation of industrial software, deploy industrial software for industrial design, production control, operational management, and service support, integrating digital twin, large model, and other digitalization and intelligentization technologies.

III. Build high-quality datasets

(5) Construct data resource platforms. Establish databases of enterprise specialized knowledge to form a data resource pool covering all business scenarios, including R&D and design, production and manufacturing, supply chain management, and business decision-making and management. To effectively support enterprise AI

dataset requirements, construct an industrial knowledge base incorporating a mechanism library (storing knowledge of foundational principles such as industrial mechanism models, technical documentation, and design drawings), a simulation library (storing multidisciplinary simulation models), and an experience library (storing failure case studies, best practices, operational techniques, and other practical knowledge). Construct an integrated enterprise data management platform to support the aggregation, processing, annotation, and quality assessment of multi-source heterogeneous data, thereby improving enterprise data processing and utilization capabilities, and increasing dataset quality.

(6) **Apply dataset processing toolchains**. Strengthen the use of data processing tools, and progressively cover key steps including data aggregation, collection, cleaning, augmentation, annotation, synthesis, storage, transmission, analysis, and application, in order to continuously provide high-quality, efficient, and secure dataset support for enterprise AI applications. Emphasize strengthening the use of tools in areas such as intelligent labeling, expert collaborative labeling, fusion mechanism (融合机理) and simulation data synthesis, dataset quality assessment, and security monitoring.

(7) **Establish a data management system**. Encourage enterprises to explore Chief Data Officer (CDO) systems, establish a data management framework covering planning, implementation, evaluation, and improvement, and strengthen data standardization to promote cross-system data integration. Establish a differentiated, tiered, and graded management mechanism for enterprise datasets, giving comprehensive consideration to data types, data systems, application scenarios, security, and other factors, to ensure the secure application and effective circulation of enterprise datasets. Clarify key steps and quality criteria for data collection, preprocessing, data labeling, augmentation, and synthesis, and for dataset product development, and formulate dataset quality assessment standards to guide the quality enhancement and efficient utilization of datasets.

(8) **Construct diverse datasets**. Focusing on industrial R&D and design, production and manufacturing, and operation and management, create high-quality multimodal industrial datasets covering scenarios such as enterprise process design optimization, process control, fault diagnosis, and smart operations. Encourage manufacturing enterprises to collaborate with third parties in developing synthetic datasets, deep chain-of-thought datasets for industrial sectors, cross-disciplinary and cross-sector knowledge graphs, and other datasets, to create high-quality industry datasets, and to explore developing dataset products supporting industrial AI applications in complex scenarios.

IV. Rationally plan and allocate compute resources

(9) Scientifically plan the scale of compute. In accordance with overall national deployments and taking into account enterprise development realities, formulate plans to deploy compute in a phased, incrementally increasing fashion. In the selection of compute services, encourage prioritizing those that are capable of achieving instantaneous response and scaling (扩缩容).

(10) Rationally allocate compute resources. Encourage giving priority to utilizing cloud computing services to rapidly build intelligentized foundational service capabilities while reducing technology investment costs. Enterprises with good digitalization foundations and high data security requirements can leverage their own compute infrastructure to build intelligent compute resources, deploy AI applications, and achieve intensive (集约化) resource utilization.

(11) Strengthen the collaborative scheduling of compute resources. Encourage enterprises to integrate diverse heterogeneous chip (异构芯片) resources and achieve collaborative cloud-edge-device compute based on their business characteristics, with tasks like model training, fine-tuning, quantization, and distillation being performed on the cloud, while deploying lightweight models on the edge to satisfy the low-latency requirements of industry. Dig deeply into compute usage requirements and application scenarios and deepen compute supply-demand alignment and the efficiency of compute resource scheduling and operation.

V. Conduct model selection and fine-tuning

(12) Scientifically determine application scenarios. Focusing on resolving critical technological or process challenges across the entire manufacturing process, select high-value scenarios that have a significant role in driving productive forces (生产力) forward for AI technology R&D and application implementation. Emphasize deployment of AI applications in the following five types of scenarios: R&D and design: Emphasize promotion of intelligent design assistance and rapid creative drawing (创意图纸) generation. Pilot testing and validation: Emphasize intelligent simulation model construction and automated intelligent generation of test data. Production and manufacturing: Deepen applications in intelligent production scheduling and intelligent inspection of industrial vision. Marketing and services: Emphasize achieving breakthroughs in personalized recommendation and customized after-sales support. O&M and management: Focus efforts on implementing predictive equipment maintenance, energy efficiency optimization analysis, and assisted business decision support.

(13) Quantify key indicators of scenarios. Taking both scenario characteristics

and business objectives into consideration, establish quantifiable indicators for model selection and use them to evaluate application effectiveness, providing a basis for model selection and fine-tuning. For R&D and design scenarios, emphasize measuring design iteration frequency per unit of time, the number of design solutions generated, and solution adoption rates. For pilot testing and validation scenarios, emphasize evaluating simulation and modeling efficiency and test indicator coverage. For production and manufacturing scenarios, emphasize monitoring overall optimization efficiency and production pass rates (合格率), as well as rates of failure to provide warning (漏报率) and false alarm rates. For marketing and service scenarios, emphasize examining conversion rates and response timeliness. For O&M and management scenarios, focus attention on failure prediction accuracy rates and maintenance cost reductions.

(14) **Select models based on business considerations**. Conduct model evaluation and selection based on business scenario requirements, taking into account compute infrastructure circumstances. Giving overall consideration to compatibility, reliability, and usability among different models, development frameworks, compilers, and inference deployment toolchains, prioritize selecting mature solutions validated through industry practice. In building intelligentization solutions, encourage the R&D of intelligent agent products tailored to manufacturing sub-sector scenarios. Make security an important consideration in model selection. Comprehensively consider model origins, vulnerabilities and flaws, and security protection mechanisms, and give priority to selecting highly secure and trustworthy model foundations. Encourage enterprises to build end-to-end model collaboration capabilities across production, supply, and sales chains to enhance the efficiency of connection and interaction between different steps in the process.

(15) **Adopt prompt engineering and retrieval-augmented fine-tuning**. Build prompt libraries covering routine industrial issues and edge cases, and establish multidimensional indicators including syntactic correctness, semantic completeness, and user satisfaction. For scenarios with high-frequency knowledge updating (知识更新) such as market analysis and new technology application, link industry databases with information platforms and implement data source authoritativeness evaluation and content monitoring mechanisms to ensure information authenticity.

(16) **Utilize model fine-tuning adapted to typical scenarios**. For quality inspection and defect identification scenarios, focus on fine-tuning based on small-sample annotated defect data from pre-trained models, so as to improve the models' ability to extract complex and subtle features. For production scheduling scenarios, focus on full-parameter fine-tuning of time-series prediction models based on historical production line data, to dynamically allocate resources and boost core task

efficiency. For equipment fault diagnosis scenarios, focus on optimizing fault prediction models by using time-series, audio, and other multimodal data to carry out real-time monitoring and prediction.

(17) Carry out hybrid fine-tuning (混合调优) based on actual conditions. Encourage enterprises to prioritize using prompt engineering and retrieval-augmentation technologies, based on their actual conditions, and gradually experiment with parameter-efficient fine-tuning and full-parameter fine-tuning to increase model capabilities. Taking practical realities into account, build a multimodal model candidate library, and comprehensively employ approaches such as parameter fine-tuning, [neural] architecture search, and large-small model collaboration to determine optimal solutions.

VI. Model deployment and integration

(18) Validate model performance. Carry out trial operation validation in actual production environments to ensure models can operate effectively in real-world scenarios. Giving comprehensive consideration to requirements such as resource allocation, data security, real-time performance, stability, responsiveness, and system scalability across different model types, use microservice architecture, API interfaces, middleware, and other technologies to centrally deploy models or implement cloud-edge-device collaboration based on business characteristics.

(19) Increase model usability. Develop specific model application interfaces, low-code components, etc., according to business requirements, and achieve flexible data access configurations and model analysis result presentation based on business requirements.

VII. Continuously increase application effectiveness

(20) Assess application capability levels. Form specialized teams to conduct targeted assessments and make analyses and improvements at regular intervals. Assess issues in the application of AI within enterprises in terms of model accuracy, compute utilization rates, inference latency, investment costs, security, and stability.

(21) Promote iterative optimization and upgrading. At regular intervals, analyze the impact of AI applications on enterprises in terms of raising operational decision-making levels, boosting business processing (业务处理) efficiency, enhancing product quality, and improving operating effectiveness. Formulate next-phase application objectives and implementation plans, taking into account corporate development strategies and AI technology trends. Strengthen intensive management and control, and promote thorough integration of intelligentization and green

technologies, in order to achieve sustainable development.

(22) Deepen technological integration and innovation. Bring universities and research institutions together to tackle critical technologies for the real-time performance, on-device deployment, and reliability of models during the industrial application process. Based on application effectiveness, promote secondary innovation[13] and deeply embed industry-specific large models throughout the entire process, from R&D and design to pilot testing, production, and operations. Strengthen parameter optimization and knowledge inference capabilities to incubate industrial intelligent software and hardware tools and products for uses such as intelligent software development and smart O&M, and thereby build AI-driven new quality productive forces.

(23) Encourage the dissemination of excellent solutions. To foster collaborative innovation throughout production chains, [encourage] industry-leading enterprises with technological advantages to disseminate comprehensive technical solutions both upstream and downstream in their production chains by opening up platform interfaces, making general purpose models and toolchains open-source, sharing high-performance algorithm models, and developing standards and specifications.

VIII. Ensure security protection for AI applications

(24) Strengthen data security protection. Thoroughly implement laws and policies such as the *Data Security Law*[14] and the *(Trial) Administrative Measures for Data Security in the Industry and Information Technology Sector* (工业和信息化领域数据安全管理办法（试行）). Based on the data characteristics of different industrial sectors, organize efforts in data categorization and grading, full-lifecycle security protection, risk monitoring and early warning, and risk assessment, providing data security assurance for AI applications across industries. To raise the level of data security risk prevention, enhance data validation, detection and evaluation, identity authentication, and access management for processes such as data labeling, aggregation, training, and synthesis.

(25) Guard against application security risks. For typical AI application scenarios including R&D and design, pilot testing and validation, production and manufacturing, marketing and services, and operation and management, encourage enterprises to conduct security testing and evaluation of industrial large models for hallucination,

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[13] Translator's note: "Secondary innovation" (二次创新) is a Chinese euphemism that refers to acquiring advanced technologies from other countries, through purchasing, copying, stealing, or other means.
[14] Translator's note: An English translation of China's *Data Security Law* is available online at: https://digichina.stanford.edu/work/translation-data-security-law-of-the-peoples-republic-of-china/.

accuracy, and robustness at regular intervals. Establish double-ended—input and output—filtering and security monitoring capabilities for AI applications to strengthen the ability to prevent risks such as malicious command inputs and abnormal inference outputs. Enhance AI application supply chain security management by including the security capabilities of upstream and downstream suppliers as key aspects of partner management, thereby perfecting supply chain security governance capabilities.

(26) Elevate cybersecurity protection levels. Promote the permeation of cybersecurity throughout all stages of AI planning, deployment, and application by manufacturing industry enterprises. Implement the *Cybersecurity Law* and the *Measures for the Categorized and Graded Management of Industrial Internet Security* (工业互联网安全分类分级管理办法); carry out work on self-grading (自主定级), information registration, tiered protection, compliance evaluations, and security [problem] rectification; and improve corporate cybersecurity management and protection systems, thereby enhancing industrial control system cybersecurity capabilities, and improving risk prevention during the AI application process.

IX. Strengthen organizational assurance

(27) Reinforce the fact that enterprises bear the main responsibility. Systematically draw up management systems for digitalized and intelligentized transformation and upgrading, enhance resource assurance for enterprises, and efficiently and steadily promote the gradual deepening of AI applications.

(28) Strengthen development of hybrid talents (复合人才). Strengthen industry-academia-research institute-user (产学研用) collaboration. Encourage universities and enterprises to leverage the National Artificial Intelligence Industry-Education Integrated Innovation Platform and model specialized colleges (示范性特色学院) to support the cultivation of top-tier, innovation-oriented AI talent. Improve the AI talent recruitment, evaluation, and incentive mechanisms of enterprises, foster a favorable talent development environment, and cultivate hybrid talents with both industry knowledge and practical technical expertise.

(29) Actively participate in joint ecosystem construction. Sum up and draw conclusions from successful experience in a timely fashion, actively share AI solutions, and establish industry application benchmarks, in order to promote higher levels of intelligentization in the manufacturing sector.