

Development Status and Innovation Direction of China's Digital Creative Industries

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Abstract: The creative content and creative manufacturing industries that make effective use of digital technology are collectively termed as the digital creative industry; these industries transform inputs such as science and technology, and culture and art into outputs providing economic value and cultural influence. The digital creative industry has been recognized as one of China's national strategic emerging industries for the first time during the 13th Five-Year Plan period, and has played an important role in advancing China's industrial transformation and upgrade and in the growth of the digital economy. In this study, we evaluate the direction of innovation and development of the digital creative industry at a macro level, summarize the development experiences in China, and discuss the future development of the industry. The developmental characteristics, status, and problems of China's digital creative industry are systematically analyzed by comparing the concepts and implications of the national and international digital creative industries, based on which an idea is formed for the overall development of this industry in China. Furthermore, four major directions are proposed for the continuous innovation and development of China's digital creative industry, namely, digital cultural creative technology and equipment innovation, digital cultural content innovation, innovative design, and integrated innovation. Moreover, countermeasures and suggestions are provided for the development and expansion of the digital creative industry in terms of scientific and technological research, innovation institutions, platform enterprises, talent training, supervision services, and industrial clusters.

Keywords: digital creative industries; technology and equipment; cultural content; innovative design; integrated development

1 Introduction

At present, the rapid development of digital technologies, such as artificial intelligence (AI), cloud computing, Internet of Things, fifth-generation mobile communication (5G), virtual reality (VR), and blockchain, has promoted the transformation and growth of the digital creative industry and enabled its global development to reach new heights. Several developed countries prioritize the development of digital creative industries, regarding it as an important aspect that can be used to seize opportunities for future development, consolidate the advantages of technological innovation, and expand soft power and cultural influence.

Following this international trend, China is vigorously cultivating and developing its digital creative industry, including it in the national strategic emerging industries catalog. Furthermore, the industry constitutes a strategic direction of China's industrial development. The *13th Five-Year National Strategic Emerging Industry Development Plan* proposes that by 2020, a chained digital creative industry development pattern with cultural leadership and advanced technology will be formed, and the value outputted by related industries will reach 8 trillion yuan. In

Received date: December 13, 2019; **Revised date:** February 26, 2020

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Funding project: CAE Advisory Project "Strategic Research on Emerging Industry Development (2035)" (2018-ZD-12)

Chinese version: Strategic Study of CAE 2020, 22 (2): 055-062

Cited item: Huang Jiangjie et al. Development Status and Innovation Direction of China's Digital Creative Industries. *Strategic Study of CAE*, <https://doi.org/10.15302/J-SSCAE-2020.02.008>

general, China's digital creative industry has entered a period of rapid growth, encountering unique development opportunities and demonstrating significant growth potential.

This study is based on the research results of the consulting project "Strategic Research on Digital Creative Industry Development (2035)" of the Chinese Academy of Engineering, starting with the analysis of the concept and connotation of the digital creative industry, combing the typical characteristics of industrial development, elaborating the current status of industrial development, and condensing existing problems. The focus of our study is to provide a reference point for the innovation direction of China's digital creative industry.

2 Concepts of digital creative industry

Currently, there is no consensus on a uniform definition for the digital creative industry. Concepts similar to the digital creative industry include creative industries, copyright industry, digital content industry, and cultural creative industry. Developed countries have different interpretations of digital creative industries and follow varied paths of development. For example, the United States integrates the entire digital creative industry through copyrights so that digital content and technology can develop in a coordinated manner [1]; the United Kingdom focuses on lightweight creative industries, drives industry development through culture, highlights the integrated management concept of the "big culture," and adapts to the trends developed in the integration of creativity and digital elements [2]; the digital content industries in Japan and South Korea are growing at a rapid pace, and the government mainly guides the development of related industries through technology and industrial policies.

To promote and lead the high-quality development of the digital creative industry, China has clearly defined the industry connotation and its definition. The *13th Five-Year National Strategic Emerging Industry Development Plan* has executed a long-term development plan for China's digital creative industry through four aspects: innovative promotion of digital cultural creative technology and equipment, digital content innovation, innovative design, and integration of related industries. *The Strategic Emerging Industries Classification (2018)* comprehensively defines the national economic industry and key products and services involved in the digital creative industry. This provides a clear indication for the direction of a standard, organized, and rapid development of China's digital creative industry.

China's digital creative industry includes several subindustries, such as design, film and media, digital publishing, animation and game, online education, tourism, human settlement design, fashion apparel, sports and health, toys, cultural relics, and museum industries, as well as the industry digitization, information equipment, and software industry, which have various subdivisions (Table 1). The concept of China's digital creative industry is different from that of developed countries, and more emphasis is placed on the organic integration and collaborative development of technology, culture, and creativity [3].

3 Developmental characteristics of digital creative industry

3.1 Fully-connected network structure

The digital creative industry is supported by digital creative technology and innovative design, with cultural creativity, content production, and copyright utilization as the core elements of development, and the development of peripheral industries is promoted through integration and penetration [3]. From the perspective of structural composition, the digital creative industry has a fully connected three-layer network structure, namely "TD + 4C + X" (Fig. 1): (1) The input layer serves as the basic support (TD), which provides key technical support for digital and creative content, products, and services; (2) The middle layer is the core content (4C), which comprises core production and services, and mainly provides high-end cultural and creative content to the consumer side to form a copyright; (3) The output layer incorporates the fusion and penetration industry (X), which includes the toy industry (Toy), tourism (Travel), sports and health industry (Gym), and other nodes. With the help of digital creative technology and design, new forms of business and consumption points are developed through cross-field integration.

In general, the digital creative industry promotes the transformation and upgradation of traditional cultural creative industries and traditional manufacturing industries by expanding two basic capabilities, digital creative technology and innovative design, to form digital creative content industries and digital and creative manufacturing industries.

3.2 Generation of multi-valued outputs

The comprehensive embodiment of the digital creative industry is based on the input of science and technology as well as culture and art, and the output of economic value and cultural influence [4]. The output of the digital

creative industry generates multiple values (Fig. 2). First, through the innovative transformation of digital technology and cultural and artistic resources, existing industrial boundaries are broken and efficient content creation methods, communication channels, and consumption forms are generated, which further improves the service capacity and service level of the industry. Second, it can realize multidimensional interaction and integration with other industries, export economic value, and provide a new momentum for social and economic development. Third, it can output excellent cultural content and play a positive guiding role, providing basic support for China's cultural power strategy.

Table 1. Definition and classification of digital creative industries in various countries.

Country	Name	Definition	Classification
United Kingdom	Creative industries	Activities originating from personal creativity, skills, and talents, through the generation and use of intellectual property, enable an industry that creates economic benefits and employment	Advertising and marketing, architecture, craftsmanship, design (products, graphic, fashion), film/TV/video/broadcast and photography, IT/software and computer services, museum/library/gallery, music/visual and performing arts, publishing
United States	Copyright industry	Businesses that derive their motivation from personal creativity, skills, and talents, and activities that create potential wealth and employment opportunities through the development of intellectual property	Core copyright industries, partial copyright industries, interdependent industries, non-dedicated support industries
Japan	Digital content industry	Industries that process and produce information materials such as text, video, music, and games, and distribute information products to users through the media, including information that can be received and consumed instantly, and literary works that attract many readers over a hundred years	Content manufacturing industry, leisure industry, fashion industry
South Korea	Digital content industry	Use of new media such as movies, games, anime, records, cartoons, radio and television, or digital media to store, circulate, and enjoy cultural and artistic content	Digital games, digital animation, digital learning, digital content software, digital audio and video, mobile value-added services and network services, digital publishing, etc.
China	Digital creative industries	Creative content industry and creative manufacturing industry that make effective use of digital technology	Digitization of design industry, film and media industry, digital publishing industry, animation and game industry, online education, tourism industry, human settlement design industry, fashion apparel industry, sports health industry, toy industry, cultural relic and museum industry, etc., and the information equipment and software industry of the above related industries

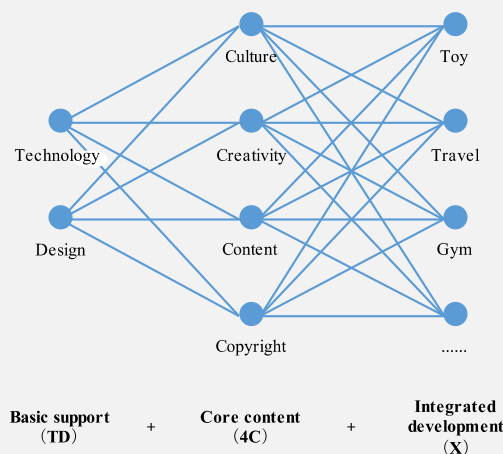


Fig. 1. Panorama of network structure of digital creative industry.

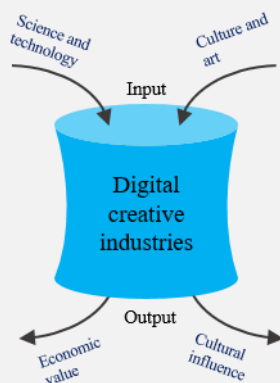


Fig. 2. Multiple-valued output of digital creative industries.

3.3 Imagination as a guiding source

The development of the digital creative industry depends on imagination, manufacturing abilities, and knowledge levels (Fig. 3). Among these, imagination plays a key role in leading and organizing. As can be seen in Fig. 3, the innovation and improvement of digital cultural creative technology equipment requires high imagination and high manufacturing ability; the innovative development of digital content requires high imagination, high manufacturing ability, and a high knowledge level; the development of innovative design requires high imagination and a high knowledge level.

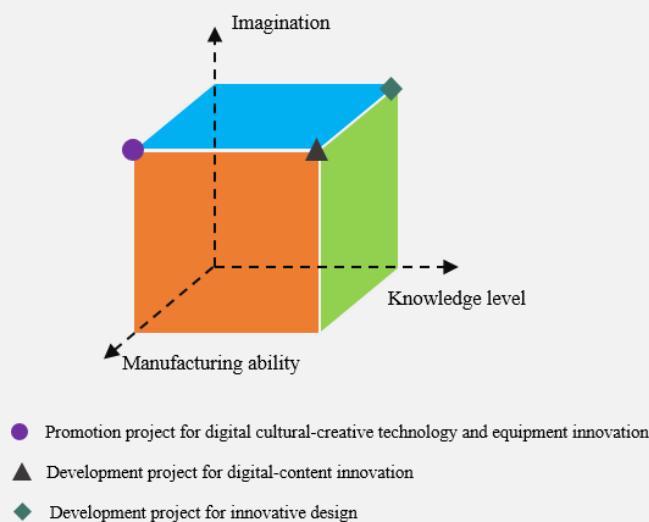


Fig. 3. Three capabilities of digital creative industry.

3.4 Possessing powerful endogenous power

The digital creative industry has actively introduced new digital technologies, which have led to constant changes and innovations in the industrial structure and business model while increasing the uncertainty of the industrial boundaries and having a strong endogenous power. Furthermore, digital content service platforms have restructured the relationship between content creators and content consumers through the application of digital technologies (such as AI). Digital technology companies have promoted the rapid development of online literature, film and television, games, animation, music, sports, and other industrial fields and accelerated the advancement of digital creative industries by leveraging their own technology and platform advantages. In general, digital technology promotes the structural transformation of the digital creative industry and reduces the cost of modifying the industrial structure [5]; creators can act as distributors of their own creative content through digital platforms; content distributors can easily play the role of a content producer; consumers of creative content and products can also use platform-based enterprises (such as short video platforms) to create and share creative content and become content producers.

4 Development status and problems of the digital creative industry

4.1 Overall development

As one of China's strategic emerging industries, the digital creative industry has effectively promoted national economic and social development. According to the statistics of the cultural industry, China's above-scale culture and related industries achieved an operating income of 8662.4 billion yuan, which is an increase of 7.0% compared to that of 2018. This increase is marginally higher than the development rate of China's equipment manufacturing industry during the same period. Relevant data show that the related industries maintain steady and rapid growth, and the industrial structure continues to be optimized. From the perspective of subindustries, the operating income of both the content creation and production industry and the cultural consumption terminal production industry exceeded 1.6 trillion in 2019, becoming the leading field in industrial development. The growth rate of news information services, creative design services, and cultural investment and operation industries exceeded 10%, becoming an important growth point for industrial development (Table 2).

Table 2. Operating income of national cultural and related industries (2019).

Industry category	Absolute amount (billion yuan)	Growth rate (%)	Proportion (%)
News information service	680	23.0	7.9
Content creation and production	1858.5	6.1	21.5
Creative design services	1227.6	11.3	14.2
Cultural communication channels	1100.5	7.9	12.7
Cultural investment and operation	22.1	13.8	0.3
Cultural, recreational, and leisure services	158.3	6.5	1.8
Cultural auxiliary production and intermediary service	1389.9	0.9	16.0
Cultural equipment production	572.2	2.2	6.6
Cultural consumer terminal production	1653.2	5.5	19.1

Note: Based on data released by the National Bureau of Statistics.

4.2 Staged developmental achievements

During the 13th Five-Year Plan period, driven by a series of important policies, China's digital creative industry has made many significant developmental achievements.

4.2.1 Innovation and promotion of digital cultural creative technology equipment

With the rapid development of digital technologies such as VR, AI, 5G, ultra-high definition (4K/8K), holographic imaging, and perception interaction, innovations and developments in digital cultural creative technology equipment are being made in the direction of providing higher resolution, better interaction, a variety of media formats, and a more immersive experience.

In the field of ultra-high-definition display technology and equipment, the coordinated development of China's intelligent ultra-high-definition technology, products, services, and applications is shaping and driving the large-scale development and rapid expansion of the digital economy. In 2019, the advanced panel production line (10.5/11 generation) achieved mass production, with a panel production capacity that accounts for 53% of the global production capacity. At the same time, ultra-high-definition video codec technology and standards are at the forefront, with the ability to design and produce chips that conform to the third generation audio video standard, supporting 8K resolution and a 120 Hz refresh rate. In addition, an ultra-high-definition AI chip was successfully developed and implemented into batch application of media players. Consequently, China's 4K industry chain has evolved, 4K TVs have entered the stage of popularization, and major events such as the CCTV Spring Festival Gala and national celebrations have achieved 4K live broadcasting capabilities.

In the field of VR and augmented reality (AR), the focus of industrial development has gradually shifted from full-machine foundry to core component research and development, with a focus on improving general-purpose technologies such as network architecture, 3D modeling, and high-performance algorithms to effectively strengthen software development. The industrial chain is expanding downstream with a rich supply of digital content. In addition, both VR and AR can be integrated with other technologies such as AI, 5G, and 4K/8K, to promote the

creation of new products, technologies, and models.

4.2.2 Innovative development of digital content

In recent years, the digital content industry has maintained a rapid development trend, becoming an important industry leading cultural revitalization and implementing cultural power which constitutes an important force in China's digital economy.

In 2018, the overall revenue scale of China's digital publishing industry was approximately 833.08 billion yuan, with a year-on-year increase of 17.8%. Owing to the continuous advancement of digital technology and industrial policies, the digital transformation and upgrade of the traditional publishing industry has been strengthened, and the digital publishing industry continues to maintain a trend of steady growth in many fields [6]. AI technology has been promoted and applied as a new digital content production method. Driven by the Internet, AI, and other technologies, the knowledge service industry is thriving, providing high-quality knowledge content and service experience, and changing the way traditional knowledge is produced and consumed.

In terms of "going global" in digital content, China became the second largest market in the global online cultural and entertainment field and the largest market in the field of online games, by the end of 2018. Simultaneously, as a major online literature creation country, China has exported more than 11 000 online literary works. In addition, live broadcast and short video platforms have undergone changes in terms of a global layout and have entered the application market in many countries or regions, resulting in the formation of new content production and creation groups, and new forms of employment and services.

4.2.3 Development of innovative design

Today, the agglomeration and radiation pattern of China's innovative design area has taken shape. It is worth mentioning that UNESCO has awarded the titles of "Design Capital," "Craftsmanship and Folk Art Capital," "Film Capital," and "Media Art Capital" to many cities in China, such as Shenzhen, Shanghai, Beijing, Wuhan, Hangzhou, Suzhou, Jingdezhen, Qingdao, and Changsha. In October 2019, the first China (Hangzhou) International Intelligent Products Expo was held in an impressive manner, comprehensively presenting the transformation, integration, driving force, and application progress of the digital economy and AI technology.

In terms of enterprise innovation design, many key enterprises have attained international competitiveness. In addition, China's innovative design industry strategic alliance was successfully established. It has developed a diversified technology and service platform by combining the forces and resources of innovation, such as production, education, research, media, user, and finance, thus laying the foundation for the implementation of the overall national innovation design capability and the implementation of innovation-driven development strategies.

4.3 Problems and challenges

The digital creative industry is a key area for winning new competitive advantages in the future [7]. Although it has been in a stage of rapid development in recent years, development bottlenecks have emerged, and the problems encountered cannot be ignored.

4.3.1 Insufficient innovation support for digital cultural creative technology equipment

There is a certain gap between China's digital cultural creative technology and equipment field and that of developed countries. (1) In the 4K/8K field, China is at a disadvantage in terms of transmission and storage, codec/chip, display technology, etc., and there are shortcomings in the key technology system [8]. Moreover, a standard system is yet to be completely established, and high-end products and key devices are still dependent on imports; in addition, there is insufficient innovation in the collaboration of acquisition, production, transmission, and presentation of UHD video. (2) In the field of VR technology and equipment, technologies such as near-eye display, perceptual interaction, rendering processes, and content production need to be further unraveled; in particular, the system integration capabilities of hardware and software such as chips, sensors, display devices, and optical devices are insufficient, and there is a lack of high-end VR equipment and interactive devices.

4.3.2 Digital content innovation with low overall quality

Issues such as insufficient innovation ability, low content quality, insufficient cultural connotation, few high-quality masterpieces, and a weak sense of social responsibility in the creation of digital content are relatively prominent in China, and this trend should be reversed in time. In terms of software tools, the dependence on imported high-end digital content production and design software is extremely high, which is not conducive to the independent and stable development of the digital creative industry. Intelligent content generation is at the forefront of digital

content production [9], and foreign countries have been dominant in intelligent design technologies, systems, and platforms, which has led to major challenges for China in the digital content production field.

4.3.3 Weak innovative designs

There has been a significant but insufficient improvement in the overall innovation design in China. In terms of interdisciplinary collaboration and innovation in system integration, many enterprises are challenged by a lack of willingness for innovation and the ability to provide innovative designs. Therefore, it is difficult to effectively support the rapid development of the digital creative industry. In many creative fields, the integration of knowledge and technology is a necessity, and it is necessary to implement innovative strategies to integrate cutting-edge technologies such as AI, big data, cloud computing, digital perception interaction, and VR, to achieve a high-level human-machine collaboration. However, China is still in its infancy in these areas, and a wide gap exists between the advanced development level and the actual demand. In addition, a prominent shortage is faced by the digital creative industry in terms of skilled talent, and the cultivation of innovative design talents requires a certain period, which restricts the robust development of the industry.

5 Direction of innovative design development in the digital creative industry

The development trend of the digital creative industry in future can be predicted to be as follows: First, the supply and demand subjects become highly integrated, next physical entities and their digital forms are integrated, and finally, technology, equipment, and cultural creativity become highly integrated. Therefore, it is crucial to rely on China's technological advantages accumulated in AI, 5G, and other technical fields, to accelerate technological breakthroughs in the digital creative industry and overcome equipment shortcomings. Furthermore, China needs to scientifically deploy a digital creative industry innovation system and implement key innovations in the direction of digital cultural creative technology and equipment, digital cultural content, innovative design, and integrated development (Fig. 4)

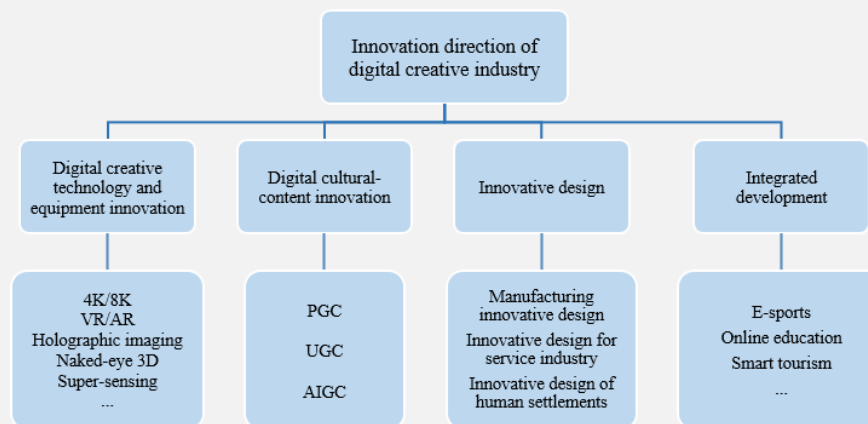


Fig. 4. Content composition of digital creative industry innovation.

5.1 Digital cultural creative technology and equipment

Digital cultural creative technology and equipment is the cornerstone of the prosperity and development of the digital creative industry, and a key factor to ensure the supply of high-quality digital content. AI, big data, Internet of Things, 5G, blockchain and other general-purpose digital technologies accelerate innovation and actively reshape the mode of digital content production, distribution, and consumption. Moreover, the innovative development of related technical equipment such as 4K/8K, VR, AR, holographic imaging, naked-eye 3D, and super-sensing, has created higher requirements for digital content production while providing new formats for digital content presentation and experience. In the future, the digital creative industry is expected to form an emerging business model of “platform/scene + content” and “intellectual property (IP) + technology.” In the process of linking the development of the innovation chain and the industrial chain, platform-based enterprises focusing on content creation and sharing are expected to be prominent. Development will be directed toward big data and AI enterprises that focus on content creation and sharing. These two effectively support the new pattern and new ecology that constitute

the digital creative industry.

5.2 Digital cultural content

In the process of innovation and development of digital cultural content, professionally generated content (PGC), user-generated content (UGC), AI-generated content (AIGC), and other creative methods have been categorized to promote innovations in format. In the near future, PGC will remain an important method to create digital cultural content. For example, the film and television industry has showed steady growth in recent years. Given that China's short video platform is characterized by mobility, interactivity, fragmentation, simple production, and strong visual impact and accords with the needs of Internet socialization and content consumption, UGC-based creation methods will achieve rapid development. Furthermore, in the face of exponentially increasing data such as text, images, sounds, and videos, the new generation of AI technology has demonstrated strong processing and creative capabilities, and AIGC will become an increasingly important content production method. In the future, the integrated application of PGC, UGC, and AIGC will be inevitable in terms of creating digital cultural content. In addition, the use of AI and computer graphics to generate virtual scenes and characters has gradually become the core capability of the film and television network platform. The rapid rise of computer art that combines photos and paintings has also brought forth new growth points for industrial development.

5.3 Innovative design

Innovative design is not only used to solve human/machine/art problems but also used to absorb a variety of new technologies (Internet, big data, AI, etc.) keenly, which can be used to carry out business model innovation and to promote the integration of different cultures. First, in traditional manufacturing, innovative design is used to integrate AI, VR, big data, cloud computing, sensors, and other technologies, with additional sensing functions and intelligent feedback to achieve high levels of human/machine collaboration. Second, it is necessary to focus on promoting the innovative development of the high-tech service industry and knowledge-intensive service industry, encouraging the coordinated and integrated development of the service industry, the Internet, and the Internet of Things, and further enriching the content and format of services. Third, human settlement design services need to expand the use of big data, VR, and other technologies and concepts to achieve innovative development of urban and rural planning, park and architecture design, garden design, and decorative design. Finally, we need to uphold the principle of "enterprise leadership, education enhancement" and accelerate the construction and improvement of the innovative design education system.

5.4 Integrated development

Driven by digital technology, the digital creative industry will break existing industrial boundaries and achieve multidimensional interaction with other industries, thereby providing new momentum for economic and social development [10]. (1) Online education is the integration of technology, data, digital content, and education, which mainly involves the integration of publishing, animation, and toy industries with online education. Through the application of AI technology, a comprehensive and multidimensional teaching application is developed to support personalized online teaching. It is important to note that some online education companies rely on big data for homework, subject, and users, and are expected to grow into data-driven AI companies. (2) E-sports is an important direction for the integration of sports, games, and live broadcasting. Content output is mainly based on game companies, and communication is based on large live broadcast platforms while focusing on long-term cooperation with sports events and sports brands. (3) The "Internet + Tourism" consumption model is gradually emerging, and smart tourism has become an important content of mass consumption entertainment cultural products. Short videos and live broadcasts provide a powerful attracting capability for the tourism industry. The accelerated integration of formats such as film, television, animation, performing arts, cultural creativity, and tourism has enriched the consumer experience of tourists.

6 Suggestions

6.1 Establishing national science and technology major projects for digital creative technology and equipment

To solve the key technical and shortboard problems in the field of digital creative technology and equipment in China, major breakthroughs in the form of major national science and technology projects are required. China

urgently needs to increase R&D support for key technologies, key components, high-end products, innovative applications, software platforms and tools in the field of digital creative technology and equipment. Through the establishment of major special projects, the competitiveness of the digital creative industry will advance into the forefront of the international first square matrix and promote the sustained prosperity and development of China's digital economy.

6.2 Construction of digital creative national engineering research center

The development of the digital creative industry requires collaborative innovation of digital creative technology, equipment, and digital cultural content. Supporting provinces that can contribute to digital content creation and technological equipment innovation, such as Zhejiang Province and Guangdong Province, to organize key universities, scientific research institutions, and leading enterprises to build a digital creative national engineering research center, is recommended. Through the establishment and operation of a national engineering research center, we will improve our national digital creative technology equipment innovation and industrialization support system, enhance the industry's independent innovation capability, and ensure the industry's core competitiveness and development potential.

6.3 Cultivating platform enterprises for digital content creation and knowledge sharing

It is recommended to adopt a market-oriented approach to cultivate a group of platform-based enterprises with digital content creation and knowledge sharing as their main aspects, and encourage the growth of platform enterprises such as online education, knowledge services, short video, live broadcast, audiobooks, and online literature, to improve China's excellent cultural communication ability and international competitiveness. Content platform companies should be encouraged to carry out independent R&D of technologies such as digital creation, audit and supervision, network distribution, and information security, to promote the application and expansion of AI technology.

6.4 Strengthening the cultivation of talents in the digital creative industry

Skilled talents are scarce in the digital creative industry, and the gap between required and available mainstream talents is relatively large. It is recommended to strengthen the localized education of digital creative talents, simultaneously carry out two-way exchange of international talents, and jointly build an innovative design talent system for digital cultural content and digital technology equipment. At the same time, it is recommended to accelerate the implementation of demonstration projects for the construction of first-class digital creative colleges, focusing on the training of comprehensive abilities such as art, culture, science and technology, and commerce to improve the training quality of compound talents. In addition, it is necessary to promote the mechanism of cultivating original talents by encouraging original works, and improving the protection and incentive mechanism afforded to original works. Finally, at the initial stage of creation of digital content works, creators should be provided with certain amount of market-oriented encouragement, and the protection of intellectual property rights should be vigorously strengthened to encourage the creation of works.

6.5 Improving the digital creative industry supervision and service system

We should effectively respond to the development of the situation and appropriately look forward. On one hand, we should demonstrate the establishment of a digital content quality supervision and evaluation mechanism. We should discuss the establishment of a risk assessment agency for dissemination of bad content. We need to improve the copyright and intellectual property protection regulations for digital content and original design and promote the legislative construction for intelligent design and innovative content, to ensure the constructive and orderly development of the digital creative industry. We should further explore the establishment of open source service platforms, a digital creative industry evaluation index system, and an enterprise-based, market-oriented, "production-university-research" collaborative innovation mechanism. Finally, we need to accelerate the construction of a cultural resources big data sharing platform that is applicable to various departments, regions, and industries. By executing the classification and identification of cultural resources, digital collection and management, and the intellectualized processing of multimedia content, we can better support the creative transformation and development of traditional cultural resources.

6.6 Building a digital creative capital with international influence

It is recommended that Beijing, Shanghai, Shenzhen, Hangzhou, and other cities rich in digital creative resources implement the construction of a comprehensive digital creative industry cluster, to promote the integration of digital creativity and the real economy, and to create a digital creative capital that has international influence. Furthermore, it is recommended to expand the application of digital creativity in the fields of convention and exhibition, e-commerce, health care, education services, and tourism and leisure, to accelerate the transformation and integration of sports competitions and performance industries, and to create a batch of high-quality, international, and modern tourism destinations.

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