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The Impact of Digital Special Effects Technology on China's Film Industrialization - A Case Study of the Wandering Earth Series

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Abstract

With the continuous progress of science and technology, the film industry is rapidly developing in the direction of digitalization and intelligence, thereby the concept of "film industrialization" being also mentioned more and more frequently. The continuous development of digital special effects technology has brought brand new changes to Chinese film industry and became an indispensable part of the modern film production. This study analyzed the impact of the development of digital special effects technology on film industry and the practical experience of Chinese film industrial ization by taking the Wandering Earth series as an example. The industrialization development trend of Chinese films was elaborated in terms of standardization of post-production visual effects process, specialization of production industry standard, and promotion of standardization of film industry. The key founding of this study is that digital special effects technology has not only changed the visual effects of films, but has also profoundly influenced the production mode and market pattern of the film industry. Therefore, we see digital effects technology as both irreplaceable and full of potential in modern film production. In our work, digital special effects play a pivotal role in advancing film industrialization. We anticipate that, as digital effects technology continues to evolve, China will make significant strides in film industrialization, providing robust support for the ongoing growth and prosperity of the market.

Keywords: *Digital Special Effects Technology; Film Industry; Wandering Earth; Film Production.*

1. INTRODUCTION

Nowadays, promoted by new innovative technologies, the film industry is rapidly developing in the direction of digitalization, intelligence, information ization and industrialization. The concept of "film industrialization" has been gradually praised highly by film professionals and widely recognized by audiences. Generally speaking, film industrialization refers to the professionalization, normalization, standardization, process and industrialization of film creation and production [1]. Film and television works are produced in an industrialized way by introducing scientific production management, so as to improve the quality of works and production efficiency, reduce the risks and costs of production, and meet the needs of the market and the

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audience.

Under such a background, with the continuous development and maturity of digital special effects technology, the Chinese film industry has also ushered in a new change. Digital special effects technology has not only changed the visual effects of films, but also profoundly affected the production mode and market pattern of the film industry. For instance, the local science fiction film series Wandering Earth has successfully led the science fiction trend in Chinese cinema with its amazing visual effects, and has also demonstrated the irreplaceability and great potential of digital special effects technology in film production.

The film industrialization levels and modes are different in different countries and regions. At present, the film industry in the United States, Japan and South Korea is more mature. However, the process of film industrialization is not simple. Every step in the process, from screenwriting, shooting, post-production to distribution and publicity, requires all-round standard establishment and scientific planning. In addition, film industrialization also focuses on digital special effects or CG technology. It is a technology that uses computers to produce animation or film works, thereby "achieving the fusion of computer graphics and art"[2]. In actual production, digital special effects technology is mainly divided into two categories, namely, three-dimensional special effects and synthetic special effects. Its early application can be traced back to the 1977 film Star Wars, in which about half of the visual effects shots were processed with computer effects. It was the starting point of Industrial Light and Magic (ILM), which is now the world's most famous special effects production company. It also needs the strong support of perfect system, policy, technology, talent, capital, market and other aspects to improve the overall effect of the work and enlarge the commercial value and market influence of the film through digital special effects.

2. EXPERIMENTS

With a history of more than 100 years, China's film industry was born in 1905. The development of the film industry has gone through four stages: starting, reform, transformation and development. China's film industry began to take off in the 1950s. However, because of backward production technology and low production quality, the film industry developed at a very slow speed. At the beginning of the 21st century, China's film industry began to gradually transform into a market economy, emphasizing market-oriented operation and the integration of industrial chains. At that time, the technology level of Chinese film production was gradually improving and the production cost was constantly decreasing, resulting in the emergence of many excellent film production companies and practitioners. From 2010 to the present, the film industry has undergone a period of rapid development, with the expanding market scale and the accelerating industrialization process.

2.1 Digital Special Effects Technology has Accelerated the Process of China's Film Industrialization

The continuous promotion of film industrialization has far-reaching effects on the development of the film industry. First, it can promote innovation and diversification of films, improve the quality and quantity of films, meet the needs and preferences of different audiences, thus forming a multi-level market structure. Second, it can improve the productivity and cost-effectiveness of films, drive the development of related industries and reduce the waste of resources, so as to promote the development of industrial chain. Third, it can enrich the genre and specialization of film creation, thereby allowing creators to focus more on creation itself and improve the artistic or commercial value of films. Fourth, it can realize systematic management of the film production process and clearly manage the progress of the project online through digital management software, so as to ensure the progress and quality of the work in an orderly and efficient manner. Fifth, it is conducive to

standardizing the film production process, enhancing the stability and reliability of the work, and strengthening the audiences' trust and satisfaction. Sixth, it is conducive to enhancing the global influence and international cooperation ability of films, so as to participate in the competition and exchange in the global film market and promote the diversified development of film distribution.

Many domestic film productions have been recognized and praised highly at home and abroad with the popularization of digital technology and the improvement of film production technology. However, compared with foreign countries' film industries, which have been already quite mature, China's film industrialization is relatively young. First, foreign countries have already established a complete film industry chain from production and distribution to theatrical screening, digital distribution and other systems. In contrast, "China's film industry chain is not complete enough, and there are still many problems in the collaboration and cooperation among various links"[3]. Second, foreign film production technology is mature, with more advanced technology and equipment, and more professional talents and rich experience in scripting, shooting and post-production. In recent years, with the continuous development of China's film industry, the collaboration and cooperation among various production links have become closer, and production technologies and equipment have been updated. Among them, digital special effects technology has also greatly enriched the means of creation and expression of film production, becoming an indispensable and important part of film industrialization. These changes have contributed to the rapid development of China's film industry and have attracted more and more international investment and cooperation

2.2 Digital Special Effects Technology Activated the Chinese Film Industry

The application of various digital special effects technologies under the mature film industry system abroad "brings dazzling visual effects for modeling and scene design, thus forming a powerful sensory impact"[4]. Inspired by this, domestic film practitioners have followed suit and applied special effects technologies into local film creation.

First, digital special effects technology has greatly changed the film production process. It integrates the traditional pre-production, mid-production and post-production stages into the same platform. For instance, the more popular virtual filming technology is the comprehensive use of advanced digital technology means to generate virtual scenes, with the actual actors or objects for interactive shooting. This technology greatly reduces the need to actually build and set up props and scenes. In the meanwhile, it reduces the post-production time and cost. Second, CG technology can produce more realistic and detailed visual effects. Performance face recognition technology is a technology that captures the actor's expressions, movements and other information to generate digital characters in the computer. Another technology such as computer 3D tracking, which has important applications in the production of character animation and digital characters, converts information such as the movement and angle of the live camera into a virtual camera. It makes the camera movement and angle changes of virtual scenes more realistic, thus increasing the film's vie wability and immersion. Based on these technologies, the theme, content, expression and imagination of film creation are expanded. Third, the application of digital special effects technology can create visual elements and shorten the traditional production cycle. The fine modeling, animation, rendering, digital painting scenery and other production means in computer CG technology can be used to create a variety of unique characters, special effects and scenes. And through lighting and material simulation techniques to better render their appearances. By using Houdini, Maya and other computer software, natural physical phenomena, such as water flow, smoke, flame, gas, etc., can be simulated. As can be seen, the application of CG technology to create anthropomorphic scenes and elements can replace expensive physical objects, buildings and special effects props production, thereby

reducing the cost of film production and improving the production efficiency. Fourth, digital special effects technology has promoted the technical development and talent training of the whole film industry. The application of digital special effects technology has also created a demand for related talents. Many higher education institutions and training institutions have offered related professional courses and training programs. It not only promotes the professional development of digital special effects-related technicians, but also injects new vitality and commercial space into the whole industry, which in turn promotes the development and prosperity of the film industry.

Therefore, digital special effects technology transforms imagination and creativity into visual presentation in films by realizing fictional scenes, special effects elements and character performance, thereby making film images more expressive and impactful. It has accelerated the process of film industrialization and made a great contribution to the development of the film industry.

2.3 Practical Experience of China's Film Industrialization From Wandering Earth

There are three types of films have intensive application of digital special effects, they are fantasy films, action films and science fiction films. Among them, science fiction films have the highest requirements for special effects technology, which can test the development level of a country's film industrialization. The successful production of the Wandering Earth series marks a big breakthrough for Chinese science fiction films. However, during the creation process of Wandering Earth, many practical difficulties were encountered, including technical difficulties, time pressure, production costs and story creation. With professionalism and a spirit of exploration, the creative team overcame challenges step by step. For China’s film industrialization, *The Wandering Earth* represents not only a bold experiment but also a landmark achievement

The filming of Wandering Earth is divided into two phases. The first phase began in February 2017 in preparation and ended in September, mainly completing the ground part filming. The second phase took place in April 2018 for the space part filming. The post-production special effects lasted about 10 months from March 2018 to early January 2019. According to the description in the book The Film Production Handbook of Wandering Earth, there are about 2,200 special effects shots in this film, 50% of which are difficult visual effects shots, including a large number of full CG shots and CG doubles [5]. More than half of the special effects shots was produced by domestic special effects companies.

The visual effects of the film Wandering Earth are highly recognized in China. In the digital special effects production of Wandering Earth, a large number of CG technology are combined with live-action shooting. The whole production process has been professionally planned and produced, from the preliminary planning and concept design, to the mid-term 3D modeling, special effects design, and to post-production special effects compositing and scene rendering. In terms of special effects production, the production team used advanced technologies such as dynamic simulation, particle system, fluid simulation, and the creation of various visual effects such as complex scenes and bustling cities. Through the continuous optimization of the production process and standardized management, the production team has not only improved the quality and efficiency of special effects production, but also enhanced the team's innovation and collaboration ability.

2.4 The Visual Presentation of The Digital Special Effects in Wandering Earth

As a film that attaches great importance to visual effects, Wandering Earth strives to build a science fiction narrative and visual system in the local Chinese context and to explore its own industrial process system. The film creates numerous spectacle-like scenes and effects, hoping to fill the gap in the hard science fiction genre

in Chinese films. The innovations in its visual presentation can be summarized as follows.

The first innovation point is the organic fusion of science fiction and reality. The difficulty of science fiction film production lies in transforming never-before-seen scenes and objects described in words in the script into visually-presented content. The story background of Wandering Earth is relatively grand, involving space flight, planetary migration and other science fiction elements. At the same time, it is necessary to be integrated with traditional Chinese culture. Therefore, it requires to explore a Chinese style of science fiction, rather than copying other more successful industrialized models. The production team focuses on the details and realism of the special effects production to make the special effects scenes in the film more realistic and shocking.

The second innovation point is the effective collaboration in post-production. The VFX director prepares for pre-production at the initial creation stage and plans the special effects shots well in advance. PREVIZ previews and detailed dynamic split-screening are used to clarify the content of the shooting. The virtual production is used to improve the collaboration among various types of artists in the pre - and post-team, thus making the film production process more controllable. The film has a large volume of special effects shots, undertaken by 4 post-production visual effects companies (including two foreign companies). The 4 companies subcontract about 20 small and medium-sized companies. The project establishes a detailed creation plan at the beginning and gradually establishes an effective communication and docking mechanism throughout the post-production period, so as to develop the process standards.

With the close cooperation among the various links in the production process and the improved project planning, the film Wandering Earth has made certain achievements in the industrialization process. However, there are still some shortcomings, such as unsound links, inexperienced practitioners, and low level of technology application, resulting in low industrialization efficiency and the need to rely on manpower to finish the workload. It reflects the inadequacy of domestic production technology and resources to meet the demand of mass production of the same film type in the same period, which is a bottleneck faced by film industrialization. The overall level of the domestic film production industry is constantly improving. Many representative works are produced before and after the release of Wandering Earth. 3D animation film Nezha: Birth of the Demon Child ushers in a new era of Chinese animation film from "OEM" to "Rejuvenation". The new mainstream film The Battle at Lake Chang jin adopts advanced technology and standards from scenes, props, costumes to special effects, sound effects and photography, presenting a realistic and shocking war world. The first domestic science fiction comedy film Moon Man learns the successful experience of Wandering Earth and cooperates with domestic visual effects companies to complete nearly 2,000 special effects shots, thereby realizing the "relay" process of domestic science fiction films.

3. DISCUSSION

As the author of the original novel, Liu Ci xin remarked that 'Chinese science fiction films have officially set sail from *The Wandering Earth*.' *The Wandering Earth 2* continues Liu's vision, striving to create a 'future history documentary.' Through the interwoven narratives of three characters, the film combines realistic scenes with science fiction elements, aiming to draw audiences closer through a high degree of realism. Compared to its predecessor, *The Wandering Earth 2* showcases more advanced batch production technology for visual effects and employs refined techniques to manage and control the industrial-scale production of high-volume science fiction content.

3.1 The Standardization of The Visual Effects Production Process

Film industrialization is not about making films into products on a standard assembly line, but about achieving stable output of qualified quality and meeting audience expectations with the help of a scientific and reasonable production process and cycle. Wandering Earth 2 has upgraded the importance of visual effects based on Wandering Earth, with a total of nearly 3,000 visual effects shots and a wide range of effect types covering surface, lunar, underwater and other scenes, of which more than 90% of the visual effects production is done by domestic teams. From script planning to rehearsal production to shooting, the film has been made according to the industrialization process, and its industrialized system construction has injected new vitality into the whole industry.

The effective communication is necessary in producing large-scale visual effects-based films. Faced with a huge amount of information, the production team needs to organize, input, publish, monitor and follow up it. The entire production process can be divided into executable steps, so as to clarify what each step should deliver, when, etc. The automation system is used to ensure the effective operation of the process, so that each department and personnel can do their own job and realize the efficient operation of the production process. And by replacing manual checks with automation, the exchange of data is sped up between different departments and different companies, thereby greatly improving production efficiency. With this system, some specific shots that are not planned can also be alerted, so as to avoid unexpected situations.

Supported by unified data formats and specification requirements, the sequencing of the production process and production standards are also standardized. Before the official filming of Wandering Earth 2, a virtual dynamic preview of the entire film is shot and produced. The digital virtual photography and motion capture technology are used to visualize the entire film under cost-controlled conditions [6]. In the virtual shooting space, the actors perform in motion capture costumes with marker points, and more than a hundred cameras record their motion information and transmit it to the virtual engine, where the transformed actors can be viewed in real time in combination with the scene rendering. Such a convenient way is used to demonstrate the entire film in general, including the number of shots, shot content, light processing, etc.. The production, cinematography and action departments no longer need to go through the complex process of costuming, but are involved in advance during the project preview stage, working together on the structural basics. The director can control the actors' performances, shoot and edit shots on the spot. It also helps the special effects department to anticipate the special effects needs of the shots and prepare them in advance [7].

3.2 The Specialization of The Production Industry Standard

Technology and art are inseparable in the visual effects creation of films. The presentation of the film images is actually a joint creation of the tool developers and the producers [8]. The amount of workload in Wandering Earth 2" has grown geometrically, with as much as three to five times the detail in individual shots of the film compared to its predecessor. For instance, the impressive space station crash scene, which lasts only a few seconds in the film, is a very complex production, and the space station has more than 97 million assets and 30 billion planes. Other visual effects scenes such as the Earth engines, the moon engines, the Ark Space Station, and the Navigator Space Station also require redesigning and upgrading details based on the assets of the previous film, hoping to show sufficient visual space texture and ensure that it conforms to the feature setting of "future history documentary [8].

It is more difficult to "rejuvenate" the human face from the perspective of digital effects technology. Wandering Earth 2 is a science fiction film with a main plot spanning 14 years. In terms of realism, the main actors' faces are bound to change significantly over time. So CG digital ageing technology is used to

"rejuvenate" the main actors' faces in order so as to better immerse the audience in the film's worldview. In the early stage, the visual effects technicians focus their research and development efforts on processing the characters' age changes, capturing the actors' faces through facial capture equipment and artificial intelligence technology, then manually fixing the details and performing fine synthesis to achieve the best visual effects [9].

Moreover, the visual effects pre-production has been optimized with the accumulated experience in Wandering Earth 2. For instance, the underwater scenes in the film have a lot of live shooting and post-production CG needs [10]. Because the flow of liquid and human interaction present a complex dynamic, the filming strives for the realism of the interaction between the water and the actors, laying an important foundation for the post-production. The series of innovations and breakthroughs reflect the important impact of digital special effects technology and industrial thinking on the film industry.

3.3 Promoting the Standardization of The Film Industry

As an art form, the film is most closely linked to science and technology. The film is a combination of science and art. After the practitioners have mastered the corresponding new technology and aesthetics of the film industry, the visual effects elements created with technology can be used to tell stories and convey the emotions of the film. Film technology is constantly updating and developing, and the application of new technologies requires corresponding standards and specifications [11]. It can enable more practitioners to understand and master new technologies faster to establish the standardization of film industry processes, thus improving the quality and efficiency of film production, reducing the risks and costs, and reducing duplication of work and unnecessary delays. Standardization can also promote synergistic cooperation and information sharing among all segments of the film industry, thereby avoiding unnecessary waste of resources and the vicious circle of industrial competition. At the same time, standardization also allows more people to understand and supervise the film production process, improves the transparency and fairness of the film industry, and establishes a more healthy and sustainable film market ecosystem [12].

Currently, the industrialization of the production chain in China's film industry has not yet reached the level of mass production of large scale special effects films like the Wandering Earth series. According to Hollywood experience, large-scale special effects films have always dominated the box office in overseas markets. If the industrialization level of China's films improves significantly, more similar special effects type films can be produced steadily every year and a Hollywood-like mass distribution system can be gradually established. In the future, with the continuous improvement of the film industry level and distribution system, the film industry will grow by leaps and bounds, which will benefit all practitioners in the Chinese film industry chain.

4. CONCLUSION

As we explore the global trend of film industrialization, we see it bringing both new opportunities and significant challenges to the film industry, while offering audiences a richer array of high-quality works. True film industrialization transcends merely showcasing spectacular scenes on the screen; it requires an automated, streamlined system behind the scenes. In our approach, we establish a professional management system that allows specialized personnel to efficiently produce hundreds or even thousands of high-quality shots through industrialized, systematic thinking. We emphasize the importance of rationalization and standardization as foundational elements for the sustainable growth and healthy development of the film industry in China. Our

efforts focus on establishing norms and unified procedures that are essential to advancing the industry's modernization and digital transformation. By adopting these standards, we aim to boost the industry's capacity to produce films of exceptional quality, high efficiency, and substantial market value. Only through rigorous normalization can we drive meaningful progress in the production and reach of Chinese cinema, ensuring its alignment with global industry trends while fulfilling the growing expectations of audiences worldwide.

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