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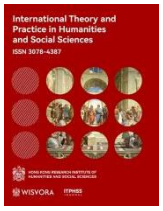

A Synthesis of Science Communication Practices in Auto Museums - Taking Beijing Auto Museum as an Example

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Abstract

As an important carrier of scientific and cultural communication, auto museums play a unique role in public science popularization. This paper takes Beijing Auto Museum as an example to review the practice of science communication in auto museums, and systematically sort out its mode of science communication practice through field research and case study analysis and other research methods. The study focuses on the four dimensions of exhibition communication, academic communication, public education, and cultural creativity, and reveals the innovative path of cross-border integration of contemporary auto museums. In terms of exhibition communication, it builds a dual narrative system of 'science and technology + humanities', and realizes the concrete expression of technical principles through immersive scenarios and interactive exhibits; in terms of academic communication, it relies on the publication of academic research and cooperation in academic exchanges to promote the production and transformation of knowledge; in terms of publicity and education, it develops science popularization activities, communication and publication, innovates the mode of science popularization education for young people by means of digitalization; in terms of cultural creativity, the development of 'theatre+film+radio' joint communication mechanism and cultural creativity venues has enabled the sustainable communication of science and culture. The study found that Beijing Auto Museum has successfully realized the transformation from collection display to value transmission by constructing a science communication system, and its communication paradigm provides operational experience for science and technology museums, which is of great significance in enhancing public scientific literacy and promoting science communication.

1. Introduction

Under the background of the era of deep integration of science and technology innovation and cultural inheritance, museums are experiencing functional transformation as a public cultural space for science communication. Because of its unique industrial civilization attributes and technological innovation characteristics, auto museums show a unique value dimension in the practice of science communication. As the first government-led auto museum in China, Beijing Auto Museum has built up a four-in-one science communication system covering exhibition communication, academic communication, publicity and education, and cultural creativity through more than ten years of

practical exploration, providing a sample for the industry to learn from. Currently, the research on science communication in museums focuses on traditional natural history museums, and the systematic review of science and technology museums is still insufficient. This paper takes Beijing Auto Museum as the research object, and reviews its innovative path of science communication: creating an immersive scientific narrative space in the dimension of exhibition communication, building an innovative platform for research and communication at the level of academic communication, constructing an all-age science popularization matrix in the field of publicity and education, and practicing the transformation of scientific and cultural in the development of cultural creativity. Through the overview of these four core areas, we aim to reveal the composite function of science thematic museums in knowledge production, cultural communication and social education, and provide reference samples for the practice of science communication in museums in the new era.

2. Research Synthesis: Science Narratives and Science Communication

As a bridge connecting professional knowledge and public perception, science narrative emphasizes the reconstruction of scientific knowledge through contextualized and sequential narrative strategies. Under the background of the transformation of contemporary knowledge production and communication paradigm, museums, as public scientific and cultural spaces, are experiencing a profound change from the 'display of objects' to the 'construction of narratives', and an overview of the theory and practice of science communication in museums can provide a reference paradigm for science communication in the museum industry. As the first government-led auto museum in China, Beijing Auto Museum, with its exhibition concept of 'human-car-society' and immersive narrative design, provides a unique sample for observing the localized practice of science narrative theory. By deconstructing its narrative framework and communication path, this study aims to reveal the innovative possibilities of specialized museums in the process of scientific knowledge communication, and then provide empirical support for the application of science communication theory in specific cultural contexts.

2.1 Literature Review

In recent years, with the deepening of the theory of science communication and the expansion of the educational function of museums, the practice of science communication in automobile thematic museums has gradually become a focus of attention in the academic community. Scholars in China and abroad have carried out a series of researches from the dimensions of science communication mechanism and auto museum research, which provide a theoretical foundation for the science communication practice of auto museums.

At the level of science communication theory, a more systematic research system has been formed in the international academic community. Museums and their communities (Sheila Watson, ed. 2007) explores the role of museums in modern societies, pointing out how their role as places of representation, identity and memory can be used for science communication and affect the communities in which they are located. The participatory museum (Nina Simon, 2010) proposes a theory of the 'participatory museum' that emphasizes audience empathy through contextualized narratives, which is a guide to how auto museums can integrate the history of technology with the public's lived experience. Domestically, Science Communication in Contemporary China (Wu Guosheng, 2016) identifies three groups and three modes of science communication in contemporary

China, arguing that the three modes are still in the process of dramatic interaction and integration.

Regarding specialized research on auto museums, from abroad, automobile thematic museums such as the Wolfsburg Volksvagen Auto Museum, and the National Auto Museum of France have respectively conducted research and formed publications based on their own collections, while works such as 'Into the Museum: Classic Cars' (Liu Shuhua trans. 2007) details the production date, engine displacement, number of cylinders, power, acceleration, top speed, and specifications of each classic car. Domestically, Beijing Auto Museum introduced the overview of the museum and carried out research on the collection in the book 'Beijing Auto Museum' (Fanwei ed. 2011), Shanghai Auto Museum expanded the scope of research on domestic auto museums by studying the design concepts, style comparisons, and historical status of the vehicles in the museum's collection from the perspective of transport history in The Legacy of Driving Traces: The History of World Transportation in Auto Museums (Wang yongcheng, 2023).

Through the review of existing studies, the following limitations of current research can be noticed. Firstly, most domestic research focuses on hardware construction and pays insufficient attention to interactive activities and audience feedback mechanisms for science communication. Secondly, there are not enough in-depth case studies of automobile thematic museums in the current research content, especially the exploration of science communication mechanism in government-led museums is limited. In addition, the evaluation of the effects of new technologies such as immersive communication and big data communication is mostly focused on general-purpose museums, and there is a lack of research on the adaptability of the communication of automobile exhibits. These research gaps provide innovative research space for this topic.

2.2 Research Methods and Procedures

This study adopts a multi-dimensional research method to systematically explore the practical path of auto museums in the field of science communication through a combination of theoretical construction and empirical analysis. The main methods include the following three kinds.

Literature research method: Combining a variety of Chinese and English databases, the study systematically searches keywords such as 'science communication in museums' and 'automobile culture communication' to filter relevant literature. It focuses on three aspects: research on the applicability of science communication theories in museums; research on the practice of science communication in auto museums; and cases of the application of integrated media technology in science communication in museums. At the same time, internal literature such as museum manuals and science communication (science education) manuals of Beijing Auto Museum are collected to construct a theoretical analysis framework.

Field research method: A systematic project research was carried out in the Beijing Auto Museum to record the effect of science communication by using participatory observation method, drawing typical visiting paths by using the moving line analysis method, and recording the residence time and interaction frequency of core exhibits. At the same time, special attention was paid to the differences in science communication between the immersive experience area in the Creation Pavilion and the historical narrative area in the Progress Pavilion, as well as the public experience of the cultural and creative venues, and on-site video data and messages from the audience were collected.

Case study method: The special science communication projects of Beijing Auto Museum were selected as the object of in-depth study, such as a series of thematic exhibitions, interactive study activities, 'theatre-video-radio' joint communication mechanism, and virtual reality communication

and other new communication methods. Through case studies of project planning, implementation records and evaluation reports, we studied the logic of the science communication strategy of Beijing Auto Museum. At the same time, it compares the science communication practices of auto museums in China and abroad, such as Mercedes-Benz Museum in Germany and Shanghai Auto Museum, and refines the differentiation features.

2.3 Significance and Value of the Research

Academic innovation value at the theoretical level: Firstly, under the background of the deep integration of contemporary science and culture, museums, as an important carrier of public science communication, have broken through the traditional positioning of 'cultural relics collection and display organization', and transformed themselves into 'knowledge production and communication platforms'. This study focuses on the special type of automobile thematic museums, which fills the gap in the current academic research on the mechanism of science communication in vertical museums. In addition, in the current research on science communication, most of the existing literature focuses on comprehensive or natural science museums, while there is still a gap in the research on automobile thematic museums, which have both industrial and technological attributes as well as social and cultural symbols. Through the interdisciplinary perspective of science communication practice review, this paper constructs a three-dimensional analytical framework of 'scientific narrative - cultural interpretation - public participation', which breaks through the unidirectional limitation of the traditional research on the effect of science communication, and pays special attention to how auto museums can realize the explicit communication of tacit knowledge through the synergistic narratives of material carriers (e.g., classic car models) and intangible carriers (e.g., interactive study). The construction of this research system provides a new methodological reference for the research paradigm of science and technology themed museums.

Practical value of industry development: Beijing Auto Museum, as the first government-led automobile thematic museum in China, is exemplary in its 'five-in-one' (collection, exhibition, education, research, and communication) operation mode. This study provides a replicable template for the industry by systematically analyzing its science communication practices. The study reveals the strategic choices made by professional museums in balancing the authority of knowledge and the popularity of communication, especially in the transformation of science knowledge, and documents the process of science communication through diversified communication mechanisms, immersive forms of expression, and embodied experiential modes, which is of direct guiding value to the industry organizations that are in the process of transformation and upgrading.

3. Exhibition Communication

Exhibition communication is one of the core functions of museums for the public, and is an important path for science communication practice. As a thematic museum with automobile as its theme, Beijing Auto Museum breaks through the one-way display mode of traditional science and technology venues in terms of exhibition communication, and builds up a space for in-depth dialogue between the public and science and culture through the three-dimensional communication system of 'science + culture + education'. A series of exhibitions take the development of the automobile industry over the past hundred years as a vein, and transform abstract science knowledge such as mechanical principles, energy transformation and intelligent driving into perceptible immersive

experiences. This kind of science communication practice using the technological evolution of the industry as a carrier not only enhances the public's scientific literacy, but also fosters the public's awareness of scientific and technological ethics by revealing the interactive relationship between technological innovation and social development, providing a sample for the innovation of the science communication system in the new era. This chapter will use four representative automotive-themed exhibitions in different fields at Beijing Auto Museum as examples to explain in detail the significance of exhibition communication in the practice of science communication.

3.1 Automobiles and History: From Breakthrough to Splendor: Thematic Exhibition on the History of China's Automobile Industry

‘From Breakthrough to Splendor - Thematic Exhibition on the History of China's Automobile Industry’ is a representative thematic exhibition for scientific communication around automobile and history. The exhibition takes time as the main line, and is divided into ‘Starting a prairie fire, groping for the way forward’, ‘Breakout and breakthrough, passionate years’, ‘Focusing on promotion, building a pattern’, ‘Innovation and introduction, joint venture and cooperation’, and ‘From breakthrough to splendor’, which comprehensively review the growth history of China's automobile industry by combining collectibles and images, and interacting with the whole scene, presenting the audience with a long scroll of the history of leapfrog development.

The exhibition space uses dark red as the main spatial tone, supplemented by beige and other visual colors, highlighting the sense of historical gravity and the sense of the times. In terms of the main visual design, the exhibition adopts a number of historical photos to show the historical changes and important events in the course of China's automobile industry. The fluttering flag and automobile elements are used throughout the exhibition, combining aesthetics and storytelling to imply that the spirit of self-improvement of China's automobile industry has always been passed on from generation to generation. The exhibition uses lighting, video, soft curtains, wave boards and other diversified methods to present the exhibits, assisted by changes in the color palette of the exhibition hall, to create a sense of moving through the scenery.

Relying on this representative exhibition, Beijing Auto Museum further planned the special live broadcasts of the exhibition, such as ‘Taking you to the exhibition in spring’, which was viewed by more than ten million people on Xinhua News Agency and other platforms, and reported in depth on the exhibition on Beijing Publishing and Beijing Daily's ‘Automobile Channel’, etc. In this exhibition, Beijing Auto Museum has deeply explored the connotation of the collection, actively linked with the automobile industry, traced and revisited the history of China's booming automobile industry from the perspective of the exhibition, observed and thought about the connection between automobiles and the elements of economy, science and technology, culture and society from the perspective of the development of the automobile society. It promotes the harmonious development of ‘human-vehicle-society-life’ and triggers the public to think about automobile culture.

3.2 Automobiles and Characters: Imprints of China - Characters of the Automobile Industry Exhibition

The ‘Imprint of China - Characters of the Automobile Industry’ exhibition tells the history of the development of China's automobile industry through exhibitions and records the imprints of the characters of China's automobile industry through stories, thus expanding the forms of scientific communication in the automobile museum. The exhibition is divided into three chapters, namely

‘Spirit Inheritors’, ‘Scientific and Technological Innovators’ and ‘Practitioners to the World’, and tells the history of the development of China's automobile industry through a variety of contents, such as exhibits, pictures, images, documents and seals.

Relying on this exhibition, Beijing Auto Museum further cooperated with the Chen Duo Art Creation Studio to create a radio drama related to the content of the exhibition, which tells the important journey of the older generation of automobile people in building China's automobile industry from scratch and from nothing. Through the innovative form of ‘Exhibition + Radio Drama’, Beijing Auto Museum demonstrates the spirit of self-improvement and innovation of the old generation of automobile industry and restores the development of the automobile industry and automobile culture. Through the cooperation of visual and sound communication, the audience felt the important connotation of the development of China's automobile industry in artistic aesthetics. As an extension of the exhibition, Beijing Auto Museum has also launched a series of educational programs, such as the ‘Cloud Listening Automobile Expo’ thematic study sheets and the ‘Racing Carnival’ educational activities, which guide the audience to learn and think independently, and to deeply understand the history of the birth and development of the automobile industry.

The ‘Imprints of China - Characters of Automobile Industry Exhibition’ integrates the cross-border of ‘Exhibition + Radio Drama + Educational Program’ to tell the stories behind the automobile industry characters in a multi-dimensional and three-dimensional way. Under the infiltration of automobile characters and automobile culture, as an independent space for inheriting Chinese automobile culture and scientific culture, Beijing Auto Museum is committed to telling the people and events in the memory of the development of China's automobile industry. Through the exciting stories and memorable characters in the exhibition, the museum demonstrates the enduring spirit of industrial and scientific culture.

3.3 Automobiles and Media: Encountering Automobile Advertising - Pictures on Wheels

Media platform is an important medium for science communication, but the relationship between automobile culture and media communication has not been specially researched and demonstrated before. The theme exhibition ‘Encountering Automobile Advertising - Pictures on Wheels’ at Beijing Auto Museum allows visitors to observe the changes and development of automobiles and automobile society through the unique medium and perspective of automobile advertising. The exhibition is divided into three parts: ‘The Birth and Growth of Automobile Advertising’, ‘Automobile Advertising in China’ and ‘Creativity Changes Life’, showing the history of automobile advertising since its inception, and arousing the resonance of people of different ages to the automobile life they have experienced together in those years, so that they can look back together to feel the influence that automobiles have had on people's lives, and thus arouse their concern and thinking about people, cars, society, the environment and the concept of life.

Differing from the traditional exhibition, the exhibition presents an integrated media exhibition on automobile advertisements through the combination of collection display, electronic exhibition and interactive punch card. The electronic exhibition area adopts retro colors in terms of the main tone, and the content of the exhibition is presented word by word, imitating the effect of typing on a traditional typewriter. At the same time, the electronic exhibition area displayed a diverse range of videos and pictures of automobile advertisements, interspersed excellent domestic and international automobile advertisement design works, and enhanced the display effect with special effects transitions, leading the audience to read the exhibition content while savoring the charm of

automobile advertisements.

In the interactive punch card area of the exhibition, car advertisements from different eras and countries form a punch card culture wall, leading the public to travel back to the era of rapid development of automobile culture. The interactive punch card area also displays the first generation of Chinese family car 'Fiat 126P', the classic 'Volkswagen Jetta', the special car 'HongQi CA770' and the 'Baidu Driverless Robot', as well as the 1960s Automobile magazine. Through these collections, the public can feel the unique charm of advertisements and realize that automobile advertisements not only present cars, but also tell historical stories, convey the brand spirit and reflect the epitome of the times, which influences and records the life of automobiles in a subtle way, and also interprets the century-long journey of automobiles to a certain extent.

3.4 Automobiles and Enterprises: China First Automobile Group Innovation and Entrepreneurship Achievement Exhibition

Co-operation with automobile enterprises is an important practice of Beijing Auto Museum to expand the content of science communication and update the form of science communication. Formerly known as the First Automobile Manufacturing Plant, China First Automobile Group Co. owns independent brands such as HongQi, Jiefang, Bestune and other joint-venture brands such as Volkswagen, Audi, Toyota, Mazda, etc. During the 70 years of development of China's automobile industry, China First Automobile Group has always resonated with China's automobile industry, and its development history and achievements have, to a certain extent, reflected the entrepreneurial history and important moments of China's automobile industry. Against this background, Beijing Auto Museum and China First Automobile Group jointly organized the China First Automobile Group Innovation and Entrepreneurship Achievement Exhibition, expanding the communication content of automobile culture and the form of exhibition.

Based on the precious collections of China First Automobile Group collected by Beijing Auto Museum, the exhibition is divided into chapters of 'Preface', 'Entrepreneurship and Growth', 'Forging the Beginning', 'Courage to Innovate', 'Openness and Co-operation', 'Courage to Stand on the Tide' and 'History of HongQi', etc. It focuses on the major events behind the construction history of China First Automobile Group, and combines with donations of the predecessors of the practitioners of the automobile industry in China and automobile parts, to present more than 70 years' history of China First Automobile Group's magnificent development. The exhibition also tells the story of China First Automobile Group's practice of developing the automobile industry and influencing the development of automobile culture in different periods, while showing the new Chinese automobile industry's progress from the foundation and hard work to reform and innovation.

This exhibition takes China First Automobile Group as the main body of the display, so red is chosen as the theme color of the exhibition, echoing the red color around the collection of classic cars of China's automobile industry in Beijing Auto Museum, and also corresponding to the retro colors of HongQi, Jiefang and other cars. The exhibition area is illuminated with glass showcases displaying vehicle models of FAW Jiefang, FAW HongQi and FAW joint venture brands, supplemented by graphic introductions and multimedia images on the wall, creating a calm and atmospheric atmosphere in the exhibition area and providing important support for the communication of automobile industry culture.

4. Academic Communication

Academic research and academic communication are important ways to ensure that the content and form of science communication are constantly updated. Beijing Auto Museum has always adhered to the concept of 'academic museum', in-depth construction of academic research system, the formation of characteristics of the attraction of academic exchanges, for the museum's high-quality, sustainable development of empowerment. On the one hand, it relies on its collection of resources, digs deep into its connotation value, and focuses on deepening research in the directions of automobile culture, automobile science popularization, exhibition and display, and cultural creativity; on the other hand, it focuses on its core business direction, and carries out diversified academic communication and cultural activities to set up a platform for the exchange of theoretical research on automobile culture and its application in practice, and at the same time, constantly improves the academic content of its business activities, thus promoting the museum's high-quality and sustainable development.

4.1 Academic Research

In order to promote the high-quality communication of science and culture, Beijing Auto Museum has set up an academic organization to carry out special auto culture research and communication, focusing on auto culture, auto science popularization, service standardization and other directions to carry out research. In terms of academic publications, up to now, it has published more than 20 academic monographs, more than 60 academic papers and other articles, such as 'Exploration of the Path of High-Quality Development of Industry Museums - Based on the Practice and Thoughts of Beijing Auto Museum'. In order to build a communication platform for theoretical research and practical application of automobile culture, Beijing Auto Museum hosts the Academic Collection of Automobile Culture Research, which is based on the academic frontier and adheres to the academic standards, and is divided into such sections as frontier exploration, historical research, scientific communication, case study, oral history, international vision, academic information, and so on, and develops the scientific communication of automobile culture in many aspects.

In terms of research on automobile culture, Beijing Auto Museum combines its collections and exhibition resources to carry out research, and publishes the series of 'Automobile Archives Expo' (Including A Brief History of Automobiles, A Brief History of Electric Vehicles, Automobiles and War, Automobile Man of the Year, The World of Luxury Vehicles, Exploration of Motorsports, A Snapshot of Urban Special Purpose Vehicles, Explanation of New Energy Vehicles, and The World of Automobiles and Its Industrial Chain), 'Beijing Auto Museum Exhibition', 'Beijing Auto Museum Collection', and 'From 1949: The Story of Chinese Automobile HongQi', etc., to record the history of the development of the automobile industry and communication of automobile culture.

In terms of service standardization research, as the first national service standardization demonstration unit in the industry of industrial thematic museums and science and technology museums, Beijing Auto Museum has compiled the Beijing Auto Museum Standard Series and the Museum Service Standardization Practice Guidelines, which have become a model epitome of the standardization process in the industry of industrial thematic museums, and led the formulation of the Code of Practice for Museum Services, which has become the first local service standard in the field of Beijing museums. These have made important contributions to the promotion of museum service standardization and the improvement of scientific communication in museums.

4.2 Academic Exchange

In terms of communication, Beijing Auto Museum actively organizes various academic conferences and exchange activities, and promotes academic exchanges and research activities with various units related to the field of science communication. In terms of science popularization forums, Beijing Auto Museum, in cooperation with China Association for International Science and Technology, hosted the first ‘Science and Technology Diplomacy and Automobile Popularization of Science’ forum and senior diplomats' Beijing trip to discuss how to promote the development of the automobile industry through science and technology diplomacy and automobile popularization of science and technology under the new situation. The roundtable forum discussed issues such as promoting mutually beneficial cooperation between China and Europe in science and technology innovation, promoting green and sustainable development in the field of transport, etc. It also exchanged views on promoting the popularization of automotive science among Chinese and foreign youths as well as constructing a multi-level and diversified mechanism for science and technology and humanities exchanges.

With regard to the organization of thematic activities on automobile culture, Beijing Auto Museum, in collaboration with the HuaQi Automobile Culture Foundation, Xinhua News, and the Beijing Wenbo International Curatorial Research Centre, jointly organized a series of thematic activities on automobile culture, ‘From History to the Future’, which brought together senior researchers in the field of automobile to conduct a diversified and in-depth study on the past, present and future of Chinese automobile culture with the theme of ‘Chinese Automobile Culture in a New Era’ on the anniversary of the birth of China's automobile industry every year.

In the planning of thematic symposiums, Beijing Auto Museum and HuaQi Automobile Culture Foundation have successively planned symposiums with a variety of contents and forms, through a series of symposiums and discussions with guests who have experienced, participated in or witnessed the development of China's automobile industry, to communicate China's automobile culture and offer advice and suggestions for the high-quality development of China's automobile industry. Beijing Auto Museum has also taken automobiles as a carrier for dialogue with the world, and has successively carried out automobile culture exchange activities in many countries, committed to building a platform for world automobile culture exchange, using automobiles as a medium of communication, and cooperating with automobile museums and automobile enterprises from all over the world in the form of ‘one-to-many’ and ‘many-to-many’, to explore the transformation and innovation strategies for the development of automobile culture, and to jointly promote the world's automobile culture exchange and mutual understanding.

4.3 Academic Co-operation

Scientific communication is a form of public-oriented communication. As a special communication platform, the museum can expand the scope of its scientific communication through academic cooperation with various types of institutions. In terms of academic cooperation with institutes and associations, Beijing Auto Museum has reached a cooperation agreement with the China Association for International Cooperation in Science and Technology, in which the two sides will follow the cooperation goal of ‘complementary advantages, mutual information, resource sharing, mutual benefit and win-win situation’ to establish a long-term partnership and carry out comprehensive academic cooperation in various fields such as popularization of automotive science and automotive science and technology innovation, so as to join hands in empowering the research of automobile culture and the communication of automobile culture and industrial science.

In terms of academic co-operation with universities and research institutes, Beijing Auto Museum has signed a contract with the School of Materials Science and Engineering of Peking University, and the two sides will work together to form a new pattern of ‘resource sharing and win-win development’ in terms of academic research and exchanges. The two sides have carried out all-round, in-depth and multi-form substantive research co-operation in the directions of automobile industry research, application of new technology scenarios and popularization of new material science, forming synergistic educating synergy, jointly promoting the fusion of scientific and technological innovation and popularization of science, and upgrading the scope and quality of scientific communication and research.

In terms of academic cooperation with automobile professional media, Beijing Auto Museum has signed a contract with China Automobile News and other media cooperation, in which the two sides join hands to carry out all-round, deep-level and multi-form substantive cooperation in the directions of automobile culture research, communication of automobile culture and science and technology, organizing public welfare activities for popularization of science and technology, and development of original automobile themed exhibitions, etc., and continue to push forward the innovation and empowerment, fusion of education and propaganda and cooperation between museums and newspapers, so as to make Chinese automobiles come into the public life better, and jointly promote the high-quality development of China's automobile industry and automobile culture and communication, support the cooperation in scientific communication through academic cooperation.

5. Publicity and Education

In the exploration of science communication system for many years, Beijing Auto Museum has constructed a special science communication system of ‘Car +’ with the theme of ‘Enlightenment of Innovative Wisdom, Constructing Innovative Strength’ by means of co-construction, collaboration and integration, which includes the three major sections of ‘Automobile Culture’, ‘Automobile Science and Technology’ and ‘Automobile Life’ as well as the three major directions of ‘Popular Science Popularization’, ‘Integration of Museums and Schools’ and ‘Innovative and Creative’, which integrates the spirit of science and humanistic ideas. In recent years, in terms of content, Beijing Auto Museum has developed, accumulated and formed a variety of scientific communication services such as courses, study sheets, popular science books, popular science videos, etc. for different audience groups. In terms of form, the museum focuses on thematic tours, supplemented by thematic activities, innovative communication projects, microclasses in exhibits, and the promotion of popular science courses in campuses to continuously enhance the ability of the museum to popularize science and cultural communication.

5.1 Science Popularization Activities

Based on its unique intellectual property (IP) of automobile culture, Beijing Auto Museum actively holds science communication activities on Science Popularization Day every year. In recent years, along with the diversified needs of the public for scientific communication in museums, Beijing Auto Museum has continuously developed scientific communication activities to meet the public's needs. In addition to updating the content and form of activities, it has also recognized the importance of scientific communication, and has been actively applying new media, fusion media and other means of communication to carry out multi-channel communication in an effort to radiate

more widely and benefit more members of the public. At present, based on a series of important nodes of science communication such as the National Science Popularization Day, Beijing Auto Museum has planned and organized a series of science popularization activities called 'Playing in Beijing Auto Museum'. Through the 'Auto Science Show', 'Auto Critics Talk', 'Immersive Visits' and other major activities, the museum carried out science communication.

The 'Auto Science Show' activity transforms the scientific principles related to automobiles into vivid scientific experiments, and through audible, visual and interactive performances, participants can explore the science in automobiles by following the automobile expert Dr Carl and his assistants around the scientific principles in automobiles. By leading the public to participate in scientific experiments such as 'Air Cannon' and blowing ping-pong balls, the activity guides participants to understand science correctly, cultivates their ability to think independently and solve problems by comprehensively applying their knowledge, and then elaborates on the scientific ideas and spirit of science in automobiles.

The 'Auto Critics Talk' activity is carried out in the form of an automobile culture salon, leading the public to understand the first-line knowledge related to automobile racing (such as the equipment required for racing, the composition of the racing team, and participation experiences, etc.), and to further understand the significance behind the sport of automobile racing. In the automobile culture salon activities, participants communicated and interacted with big names around automobile culture and automobile races, which further enriched the practical forms of science communication in the automobile museum.

Beijing Auto Museum also launched the 'Immersive Visit' activity on the National Science Popularization Day, leading participants to visit a number of units exhibiting on the day, so as to experience new science and technology in an immersive way, learn about aerospace, deep-sea exploration, biological environment, and explore the connection between new science and technology and the automobile industry. As a masterpiece of industrialization, the automobile itself is closely related to various industries, and understanding the development and change of science and technology is essential to understanding automobile culture. In addition to on-site visits, the 'Immersive Visits' series of activities were also communicated through short videos and social media platforms, allowing those who were unable to reach the site to learn about automobile culture and science culture through media platforms. A series of science popularization activities integrate automobile culture with various forms of communication through scenario interpretation mode and immersion simulation mode, thus promoting the development and construction of the science communication system.

5.2 Communication and Publication

In terms of communication and publication of automobile science and culture content, Beijing Auto Museum has completed the 'Study of Automotive Science Popularization Content Guide' and other related topics in conjunction with the study of automobile science popularization practices, and has formed a series of communication and publication results on this basis. Focusing on the needs of the public, the communication and publishing products of Beijing Auto Museum have adopted the process of story introduction, questioning, scientific interpretation, etc., and given innovative ways of expression to science and culture, so as to develop a series of popular science communication products in various forms for different groups of audiences, including popular science books and videos, and published popular science books such as 'A Wonderful Journey to the Auto Museum'.

Beijing Auto Museum has also developed a series of popular science study sheets on automobiles, including the 'Wonderful Night of Auto Museum' series, the 'Treasure Hunter' series, and the "Big World of Small Cars" series, etc., which start from the aspects of fun, participation and experience to improve the public's acceptance of communication on automobile culture.

In terms of planning and production of integrated media publications, Beijing Auto Museum has combined the communication characteristics of different media and produced the scientific communication integrated media publication 'The Thousand-Year Mark of the Rut', which combines the functions of a popular science book, a study manual, a model production, and a micro-teaching video. The content covers the rich collection of Beijing Auto Museum and the scientific principles related to automobiles, supplemented by reading and exploring and hands-on assembling sections, guiding participants to learn and think deeply about various kinds of cultural knowledge of automobiles through the comprehensive learning process of deconstruction, inquiring, practicing and summing up to enlighten their scientific thinking.

In terms of the cooperation and distribution of the special issue, Beijing Auto Museum and the Wonderful Museum, the first original museum science education magazine for young people in China, jointly planned the 'Wonderful Museum: Beijing Auto Museum Special Issue', which is themed on the 'past and present life of automobiles', and shows the development of automobiles from various aspects. Among them, 'The Most Practical Vehicles of the Ancients' introduces various practical vehicles created by the ancients for travelling, 'Driving Licence Examination' explains the driving etiquette and traffic law in ancient times, 'When Modern Automobile Meets Modern China' introduces the legend of the earliest batch of Chinese automobiles, 'Breakthroughs from 0 to 1' demonstrates the history of automobile manufacturing, and 'Imagining the Future of Automobile' discusses the features and functions of future automobiles. The publication of the special issue has provided Beijing Auto Museum with a richer form of science communication. In the publication, a number of informative articles written based on the museum's rich collection resources have brought young people a special science communication that is both intellectual and interesting.

5.3 Interactive Study

Currently, popular science plays, scripted tours and other game forms are gradually becoming an important form of science communication in the public. In this context, Beijing Auto Museum has launched a series of immersive scenarios for interactive research and learning activities, such as 'The Thousand-Year Mark of the Rut', 'Searching for the Journey of the Dragon Core', 'The Lost Rearview Mirror', 'The Mystery of the Door', and so on. In the process of experiencing this series of interactive learning activities, participants were able to carefully observe the car exhibits, search for historical archives, conduct immersive experiments, and deeply interact with the character NPCs, taking the role of the protagonist of the story to explore freely in the open game. Through the 'active exploration' of the study scenario, participants can further understand and learn about automobile history and technology, and enjoy a brand new immersive study experience in the museum.

In addition, Beijing Auto Museum also launched the original popular science drama 'Future Driver Through Time and Space' and the 'Time Travel: Journey in Search of the Dragon Core' scripted tour. In the popular science drama 'Future Driver Through Time and Space', Dr Xiaopeng led the research and development of a new type of flying car that carries people's aspirations for the future of technology and life. To open the flying car requires a key (i.e. 'Dragon Core'), which consists of six parts scattered in various corners of Beijing Auto Museum. Participants need to be led by Dr

Xiaopeng's assistant, Mr X, to go to various levels of the museum to perform interactive challenges, and only by successfully completing the challenges can they obtain the 'Dragon Core' and ultimately become the future driver. The 'Time Warp: Journey to Find the Dragon Core' scripted tour further transformed the audience into the protagonist of the story, following Dr Xiaopeng and his partners to collect 'chips' and synthesise the 'Dragon Core' in the exhibition area of Beijing Auto Museum through various forms of games, gate-crashing, driving and other forms, in order to find an excellent future driver for the newly invented flying car.

A series of special interactive learning activities at Beijing Auto Museum integrated science communication into an immersive experience and a storyline that fits the communication of automobile culture. In the course of the 'time-travelling adventure' led by the characters of race car drivers, collectors, explorers, scientists and designers, participants can undoubtedly feel the charm of interactive study, learn about automobiles in an immersive atmosphere, and gain a unique experience of science communication.

6. Cultural Creativity

The cultural and creative activities of Beijing Auto Museum have important demonstrative significance and innovative value to the practice of science communication, which transforms the highly specialized knowledge of automobile science into a perceptible and participatory cultural experience for the general public, and builds a bridge between science and the public. Through immersive exhibitions, interactive installations, thematic studies and other diversified forms, the museum transforms abstract knowledge such as the history of automobile industry development and the principles of new energy technology into figurative narrative scenes. This practice of deep integration of industrial civilization, scientific and technological development and cultural creativity not only enhances the coverage and effectiveness of science communication, but also shapes the ecology of scientific and cultural communication with the museum as the carrier, providing an important reference for the innovation of social education function under the modern science and technology museum system.

6.1 Formation of Diversified Creative Communication Mechanisms

In order to enrich the form of science communication in the museum, Beijing Auto Museum has formed a series of diversified creative communication mechanisms, such as the mechanism of 'Time Travelling Explanation', the mechanism of 'Theatre-Film-Radio' joint communication, as well as virtual reality communication and other new communication methods. Through the creative communication system, the public can learn about specific vehicles and the stories behind them in the diversified immersive scenarios set up by the museum, and obtain a vivid and unforgettable visiting experience.

The 'Time Travelling Explanation' is an immersive scenario based on the industrial and scientific elements in the automobile exhibits of Beijing Automobile Museum. When giving on-site scientific explanations to the public, the interpreters usually wear special costumes and play specific roles. In this way, they lead the public to understand the history of the world's automobiles and the vivid history of their early development. In the case of Mercedes-Benz I, the interpreter is dressed in 19th century European costume and reveals the story behind the world's first car. In addition to Bentz I, the 'Time Travelling Explanation' program includes a number of different characters, as well as the

‘Master's Workshop’, ‘Dr Wonder's Laboratory’ and the ‘Automobile Archives’.

The joint communication mechanism of ‘Theatre-Film-Radio’ uses a variety of platforms and media to communicate science in the museum. In terms of theatre, film and television communication, Beijing Auto Museum has hosted a large-scale popular science drama, ‘Hello, Automobile Man’, which portrays the journey of all the workers in an automobile factory who are dedicated to researching automobile technology. In the production of radio dramas, Beijing Auto Museum has worked with a well-known broadcasting studio to jointly create radio dramas such as ‘Sowing a Seed to the Future - Karl Benz, the Father of Automobile’ and ‘From Scholar to the Backbone of China's Automobile Industry - Rao Bin’. The former tells the story of Karl Benz, the ‘Father of Automobile’, and Mercedes-Benz No.1, pointing out his important contribution in opening up the development course of the automobile era for a hundred years and laying a solid foundation for the change of human transport; the latter tells the story of the old generation of automobile people in building up China's automobile industry, and demonstrates the enterprising spirit of the Chinese automobile people with positive attitude, which makes the audience feel the unique charm of automobile culture in the ups and downs of the storyline.

Beijing Auto Museum also actively expands virtual reality communication and other new communication methods, and has set up projects such as ‘Cloud View Auto Expo’ and ‘Online Exhibition Viewing’ on its official WeChat public number, providing the public with an all-around immersive science and technology experience in the auto museum. Through virtual reality communication, the public can complete an online visit to Beijing Auto Museum by simply touching, turning and clicking on the screen. In order to provide more detailed immersive virtual reality exhibitions and further improve the science communication system, Beijing Auto Museum has also set up the ‘Cloud Car Appreciation’ project online, which makes the public feel as if they are in the interior of Beijing Auto Museum through the application of virtual reality technology, so that they can enjoy the most classic cars in the collection of the museum in close proximity. It can be said that with the support of diversified creative communication mechanisms, Beijing Auto Museum has formed a rich communication matrix, providing important support for the development of the science communication system.

6.2 Establishment of Creative Venues

Museums have special spatial characteristics, and their spatial characteristics also bring about special forms of science communication. In order to realize the extension of the science communication function of the museum, Beijing Auto Museum has set up a series of creative space venues, including the theme post office, the model shop and the automobile culture and life experience hall, which are used as the expansion of the exhibition and science education. Beijing Auto Museum is committed to making the above creative space venues ‘the last exhibition hall of the museum’, so as to realize the cultural and creative attributes of the museum's science communication platform.

The theme post office of Beijing Auto Museum is a unique place integrating automobile history and postal culture, which is not only a post station for delivering letters, but also a space for displaying the glamour elements of the automobile industry and scientific elements. In the theme post office, a series of automobile-themed stamps record the development trajectory of the automobile industry in China and the world, enabling visitors to feel the inheritance and development of automobile culture. After entering the post office, the public can experience the fun

of mailing postcards on-site, selecting postcards printed with classic car models or museum logos to send. The theme post office also displays creative automobile museum cultural and creative products, such as exquisite stationery printed with classic car logos and special car-shaped decorations, each of which is a record of and tribute to automobile culture.

The car model shop is another special creative venue of Beijing Auto Museum, which mainly displays and operates car models. In the whole creative shop, according to the preference of different audience groups for car models, the car model products in the model shop are mainly divided into remote control car models loved by teenagers, middle- and high-end car models loved by car model enthusiasts, and other cost-effective car models. The car model gallery can better fill the blank of the exhibits in the exhibition area of Beijing Auto Museum, and provide visitors with a richer perspective to understand the development of automobiles.

The automobile culture and life experience hall is a comprehensive experience space that combines cultural and creative space, reading space, science popularization space and leisure space. The cultural and creative space is a display space for the cultural and creative products of Beijing Auto Museum, with three-dimensional vehicle display area, digital collection area, interactive experience area, etc., which guides the public to enter the system of science communication through the creative communication of automobile culture; the reading space features automobile books and periodicals, and at the same time, gathers literature, history, and scientific and technological reading materials, and holds thematic reading salons on a regular basis, which guides the public to enter the scientific world; the popular science space regularly launches educational and entertaining automobile-themed popular science courses for specific audience groups with the purpose of communication of scientific knowledge and multiculturalism; the leisure space is equipped with themed catering experiences, such as automobile-themed packages, customized automobile drinks, etc., so as to make the automobile culture integrated into the life in a more vivid way. In a word, on top of meeting the basic needs of the audience, the automobile culture and life experience hall also realizes the satisfaction of the audience's spiritual and cultural needs, and is a multicultural experience platform, which is an extension of the museum's function of science and culture communication.

6.3 Setting up the Speciality Seal House

In order to develop Chinese seal culture and combine the science communication practice of the automobile museum with the unique Chinese culture, Beijing Auto Museum has created a special seal house experience area. The uniqueness of the seal house of Beijing Auto Museum lies in taking the elements of automobile culture as the core and the seal as the carrier, popularizing the excellent traditional Chinese seal culture and better connecting it with modern science and technology, and communicating the automobile culture as well as inheriting and carrying forward the Chinese seal culture.

The seal house of Beijing Auto Museum is divided into four major areas, namely, the theme area of scientific communication, the area of intelligent seal carving experience, the area of cultural collection of seals, and the area of teaching activities. The science communication theme area is designed with a unique immersive wrap-around spatial environment, using cartoon drawings and other rich drawing forms to draw the characteristics of the industrial era, the birth of transport, the development of the world's automobiles, the features of modern new energy vehicles, and mankind's thinking about the future of automobiles on the walls of the theme area, giving the audience an

in-depth experience and an intuitive feeling of industrial science.

The intelligent seal-carving experience area has developed seal design software around the needs of public culture and life, as well as different operation modes of fine engraving machines and a variety of seal materials, visitors can participate in designing and making personalized automotive element seals on the spot after stepping into the experience area, and feel the perfect fusion of traditional skills and modern technology. The area also displays a variety of new printing materials, which are of good texture and represent technological innovation, injecting new vitality into the traditional seal culture.

The cultural collection seal area has developed and designed automobile-related theme seals, covering the classic collection of Beijing Auto Museum car model seals, car logo seals, car character seals, car parts seals and other seals, so that the audience can perceive the automobile culture in the process of stamping and collecting seals, and get a richer experience of science communication by combining the automobile elements of the excellent traditional Chinese seal culture.

In the teaching area, a picture book course on the 'History of Automobile Development in the World', a series of courses on seal culture and related non-heritage courses were held, and professional teachers in the field of science communication were invited to give lectures. In addition to the professional courses, Beijing Auto Museum has also launched more than 600 seals and creative products for the related courses, such as the series of light-sensitive seals for automobile paint, the series of energy-colored seals, the series of glass beads seals, the series of automobile paint seals, the series of seals made of new materials, the series of refrigerator stickers for classic cars in the collection, the series of postcards for classic cars in the collection, the series of stamp albums, and the series of print cards, etc. It can be considered that the seal house of Beijing Auto Museum is an important exploration of the new form of science communication in museums, and in the intertwining of cultural and scientific imprints, the automobile culture can obtain better communication effects.

7. Conclusion and Suggestion

As an important carrier of automobile culture communication in China, Beijing Auto Museum has built a three-dimensional mode of scientific communication through the synergistic practice of four dimensions: exhibition communication, academic communication, publicity and education, and cultural creativity. At the level of exhibition communication, through the exhibition design of 'science and technology + communication + interaction' and the innovative application of interactive experience devices, the museum has realized the concrete presentation of the history of the automobile industry and scientific principles; at the level of academic communication, relying on the platform of academic publications, academic cooperation, industry forums and international exchanges, the museum has promoted the specialized communication of knowledge in the automobile field and cross-boundary fusion; at the level of publicity and education, the museum has reinforced the museum's science popularization activities, communication and publication as well as interactive study and learning as the carriers; in the field of culture and creativity, the museum has extended the communication boundary and industrial value of automobile culture through 'theatre + film + radio' joint communication mechanism, and the setting up of cultural creativity halls and special stamp halls.

For future development, it is suggested that Beijing Auto Museum deepen the practice of science

communication in four aspects: firstly, strengthen the technological empowerment of exhibition and communication, and introduce virtual reality, meta-universe and other digital technologies to enhance the immersive experience; secondly, build an open academic network, and deepen the synergistic innovation with colleges and universities, scientific research institutes, and international organizations; thirdly, expand the system of niche education, and develop differentiated science popularization activities for different audiences such as young people and professional groups; fourthly, promote the process of cultural and creative industrialization, and enhance the market value of derivatives through brand authorization and cross-border co-branding. Through systematic upgrading, the science communication practice of automobile museums represented by Beijing Auto Museum will make a breakthrough in both technological innovation and cultural inheritance, and provide a more exemplary development paradigm for the industry.

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