

A THEORETICAL MODELING OF DIGITAL WORLD HISTORY: PREMISES, PARADIGM, AND SCIENTIFIC DATA STRATEGY

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ABSTRACT

Digital World History is a new expression of world history (or maybe "a new method for world history expression") and a paradigm of world history description, study, and application by virtual informatization and recovery. It is also a comprehensive systematic study through dynamic marks, integrated description, and retrieval of human society evolution and its causality dependant on the theory and methodology of digitization information. It aims at breaking the limitation of diachronic language attributed to the process of history cognition, summation, and recovery, addressing a possible scheme to fuse historical factors in relation to changing history, dynamically applying a multiplicity of results so that the discipline of world history can meet the needs of the information-equipped society of the 21st century. In this article, the author uses theoretical modelling methods, resulting in a blueprint of the quality issue, namely the Digital World History premise, and a paradigm for setting the foundation and scientific data strategy as a basis for its necessity.

Keywords: Histories, World history, Paradigm, Information technology, Scientific data

1 INTRODUCTION

At the end of the 20th century, the rapidly developing field of information technology not only made the acquisition, storage, and management of information move to an unprecedented high level but also permeated into human life, transformed human social activities, and promoted a revolution that is constantly creating breakthroughs in human thought.

This new world needs a new historiography, or as L.S. Stavrianos (1998) wrote, "Namely, a new world requires a correspondingly new historical approach." Such omnipresent change brought about by information technology that changes each passing day is dynamically constructing the coming information society. It is also creating conditions for achieving a new world history paradigm with an information visual angle of space-time blending in its real meaning and reflecting dynamic changes. The world history paradigm from an information visual angle can be also called "the Digital World History." This article provides an explanation with the requisite arguments, definition of the paradigm, and scientific data strategies.

2 PREREQUISITE: INFORMATION, SOCIAL SPACE-TIME, AND ATTRIBUTE OF WORLD HISTORY DISCIPLINE

The first prerequisite, *information processing and transmitting*, is the basic form of movement in human society. It has already been verified by natural science research that information processing and transmission is one form

of the basic natural biosystem movements. The biosystem depends on this information processing function to exist and be prosperous in the world. This attribute determines the existence of the human society as well.

In human society, besides preserving its own existence and the information on which the society depends, human beings trace and record a large number of their own activities to pass on to their offspring, though recording unconsciously and bequeathing passively. In this way, the next generation can share in the experiences of their forefathers and draw lessons from them. So this recording and understanding, in essence, is a kind of information processing.

The second prerequisite, *the record and cognition of human history*, is restricted by the information processing pattern. History, in the meaning of its objective, can be described as mankind's multi-dimensional activity orbit in "four-dimensional space-time" (i.e. the linkage of three-dimensional space and time). Here, so-called "three-dimensional space" generally means longitude, latitude, and altitude (degree of depth) on the earth; and the "time link" consists of the past, present, and future – the three pieces of basic time form. For example, Athens, Greece during the Aegean civilization, which belongs to ancient history's heyday, can be described on its dynamic space-time: about 23°43' E longitude, about 37°58' N latitude, 156 meters above sea level (at the Acropolis), in the period of the 5th century B.C. Regarding this four-dimensional space-time point as the centre, it involves and spreads to the whole eastern Mediterranean area. (Figure 1)

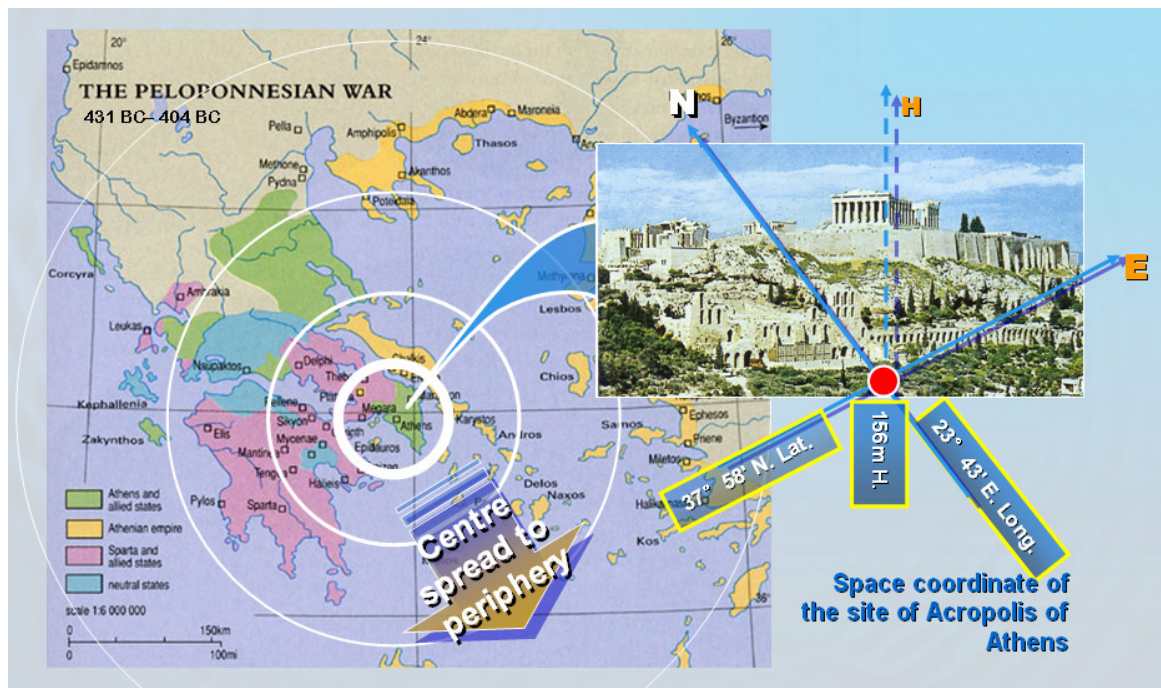


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However, during the developing stage when the society was low in engineering technology information, people had to confine the record of their own activities to a one or two-dimensional record. For instance, narration by

oral or character methods, where the record is transmitted via either oral or written language, has the words and phrases arranged sequentially, in which diachronic time differences exist one after another. Therefore, this method belongs to one-dimension pointing to single properties. However, when a figure's point, line, and color are described in the narration, the narration has a two-dimensional property. The two dimensions can only record one item or, in one respect, the contents of human activity within one unit of time, so they are single-directional and diachronic.

With the progress of society, the retention method that records human activity also change. First, the invention and popularization of printing help to record, paint, and narrate history on a physical medium all at the same time. The mixed retention of information with excellent pictures and texts makes the two-dimensional attribute of painted history a remedy for the weakness in the expression of simple characters, in the sense of the space-position of human activity.

The invention and progress of recording technology has caused airwaves to become a media type. Fleeting oral history (not really a written record) can be solidified and excellently preserved by voice with all emotions in their natural state. After sound, film was invented and implemented, and taking a photograph became a preferred retention method. Film does not only merely give an oral account of history but also paints it and documents narrated historical information. Through time, the technology of showing many static pictures sequentially though time almost records and reproduces human activity during a particular space-time event. ("Almost" means that a subjective choice is made by film-makers and later editors of the objective realities, using montage tactics and skilled lens deployment.)

Truly, the space that can be shown in sound films is extremely limited, and there are essential differences between the films and true four-dimensional human activity in the real world. In fact, the real space-time of human activity should be multi-dimensional, which can be described simply as four-dimensional because of mathematical and physical advances. For this reason, even if film has broken through the limitation of historical information retained in the one and two-dimensional forms of the past, it can only be regarded as a faked three-dimensional or faked four-dimensional form.

To some extent, human subjective impressions of the perimeter of multidimensional space-time can be acquired through slow unconscious or conscious experiences. However, human beings still constantly have to face the question during the development process of how to correctly state, describe, and transmit multidimensional space-time in objective reality. This is also the same problem that classical geometry (since the 4th century), analytic geometry (since the 17th century), modern geometry (since the 19th century) and special relativity (since the early 20th century) have tried to solve. The existence of such gradual progress, in fact, has already directly restricted the form of human process information, restricting it indirectly in the particular information processing of human records, statements, and cognition of history.

The third prerequisite, *the whole world history discipline*, has unique information attributes. For historiography, it is particularly important to break through the single-directional limitations that appeared in the one or two dimensions used when traditional history narrates past human activity because it was dominated by the world history discipline's characteristics.

The discipline of world history has several objective characteristics. In space, world history should not be a

simple connected history about nations or territories. Instead it should be a crisscrossing and organically-integrated history mixing together the range of global experience. It seems as if today, world history developed with the evolution of human society. Actually, that is not true. As humans trace the processing of historiography, it is difficult for us to find that the phenomenon that narrated human activities from a broad view point has not existed since its foundation. Such integration came from ancient times. A great amount of evidence in from ancient historical research suggests that a human might first take himself as the perceptive center and then extend to the whole world. Just because of this feature in epistemology, human cognition of integrity was confined to a limited space-time. For example, the ancient Greeks regarded the eastern Mediterranean as the whole meaning of "World" (Thucydides, 2004). Thucydides set the concept of "world" at the beginning of his work *History of the Peloponnesian War*, in which it is not difficult to see that his world was just the area approximately in the center of the Greek peninsula. His east- most location was not further than Asia Minor, which was mentioned in Homer; the farthest south was Egypt, and the farthest west the middle region around the Mediterranean area from which pirate ships arrived. So also Thucydides, who lived in the era of 5th Century B.C., had a narrow view of human evolution, which is considered naive by modern people. He reached his conclusions merely from his knowledge and experience. That is, Thucydides (2004) would write "in the history ... even the whole human history ... there had not been any other great times" before the times of Peloponnesian War! Thucydides could not or was not capable of realizing that another world, China, existed in the remote Orient at the same time.

Just as the ancient Greeks, the Chinese who lived before the Han dynasty, in "Xi Yu" - the west territory in China today, also considered the area where they lived to be the center of the world, and they believed the places outside of their region to be the margins of the world. Thus our Chinese ancestors correspondingly made respective epithets for the people who lived in those margins, calling them "Bei Di" (北狄), "Nan Man" (南蛮), "Dong Yi" (东夷), and "Xi Rong" (西戎). Confucius's *Spring and Autumn* was considered to be a description of "the world history" in Chinese minds at that time.

It is certain that with the frequent communications among different world regions, the human subjective cognitive radius was constantly extended, and the understanding of the size of the world also progressively expanded. The ancient Romans' understanding of the world's size must have surpassed that of the ancient Greeks; also the Mongolian of the 13th and 14th centuries in the Christian era must have had a greater understanding of the world's size than the Eastern European peoples at that time. Not until Columbus opened up new navigation routes could European understanding of the world's size finally expand. Since A.D. 1500, the world space view in the modern meaning has fully taken shape.

As we turn the angle of investigating world history attributes from space to time, it is quite easy for us to find that world history should not be the story of one nationality or have the simple linear continuity of a temporal yardstick of only one nation or related nations in one area. It is also not a mechanical temporal advance side by side with only one nation or a small group of related nations in one area. Because different people in different regions are unable to evolve without restriction by different natures and different environmental factors, even world history cannot avoid disparate development laws. Its internal historical process also demonstrates undeniable differences in time, multi-track, complicated patterns of gradual progress.

Once these objective characteristics of world history have been analyzed by information science, the information attributes of history reveal that plural associations and multi-dimensional assembling of information

occurs naturally. "Multi-combinations of information" means that world history deals with combinations of natural, political, economic, military, scientific and technical, cultural, and social elements. These varieties of information influence and impact each other. Without considering and using this multiplicity, the research loses its integral nature and simply deals with a *specialized* history track. Further, "information distribution in multi-access" means that no matter what kind of information is involved, it can exist in different countries or areas at the same or different times. It is necessary to consider and pay attention to different countries or areas in which information represents historical changes. For world history, it is more important to collect this information to make a clear distinction between what is specialized and what is global. According to this, we could do organic thinking and judge all historical changes of human social development using the global point of view. If we lose the pathway to multi-access information distribution on a global scale, world history is just very easy to slough off as regional or country history or simple concatenations thereof. "Information multi-dimensional aggregation" refers to any kind of historical information that is suitable for studying from both space and time perceptions and their own coordinates in history. Multi-dimensional information in historical space-time leads to assembling numerous multi-dimensional messages, which just become reflections on the intricate aspects of information organization existing and developing in real world history.

Yet, from the angle of historiography's development, world history, especially general history, is quite different from the objective features and information attributes of world history itself. *The General History of the World* by ZHOU Yiliang and WU Yujin, published in 1960s, is a representative Chinese example, which broke down all of world history into a stylistic format without considering the space-time dimensions. This case does not exist only in China. Other examples of this popular style of world history can be found throughout the world. Examples are *The General History of World* by the USSR Academy of Sciences in the ex-Soviet Union era, *The New Cambridge Modern History* by the Cambridge University Press, and even some well-known historical works by the French Annals School. *The General History of the World* by the ex-Soviet Union Academy of Science was one representative of non-integrated construction, which could be seen from its contents. *The Cambridge General History* was divided into three parts: ancient history, medieval history, and modern history, in which country history, regional history, and subject history were alternatively narrated. Its style can be seen in *The Cambridge Ancient History* (Cambridge University Press, Second edition) or *The New Cambridge Modern History* (Cambridge University Press). In the works of the French Annals School such as *LA MEDITERRANEE at le monde mediterraneen a l'epoque de Philippe II*, Fernand Braudel described Mediterranean history even though he wished to reveal the whole historical process.

Even so, it was not a mistake made by world history historians, but the diachronic restriction of depiction by human language (Figure 2). Some historians have noticed this problem and attempted to overcome it. For instance, Braudel (1996) vividly explained the integration of geographic history as the association from one time step to another in a vertical direction with the horizontal association at each step. Arnold Toynbee (1976), a British historian, tried to describe it as the trick of throwing tiny balls into the sky at the same time, which made each regional history bounce and fall, so as to coordinate the contradictions between unity and divisions and made an effort to integrate world history from the angle of the history of civilization. L.S. Stavrianos, an American historian, even brought forward the concept of Global History and attempted to establish a fitted style and a system for solving the problem at its root (In order to draw the whole picture of "global history" more precisely, Stavrianos revised his famous work *A Global History* seven times before he died.). These cases of advances in the subject remind us that world history with new informational functionality should present new schemes, which are new models and epistemologies far from the traditional ones.

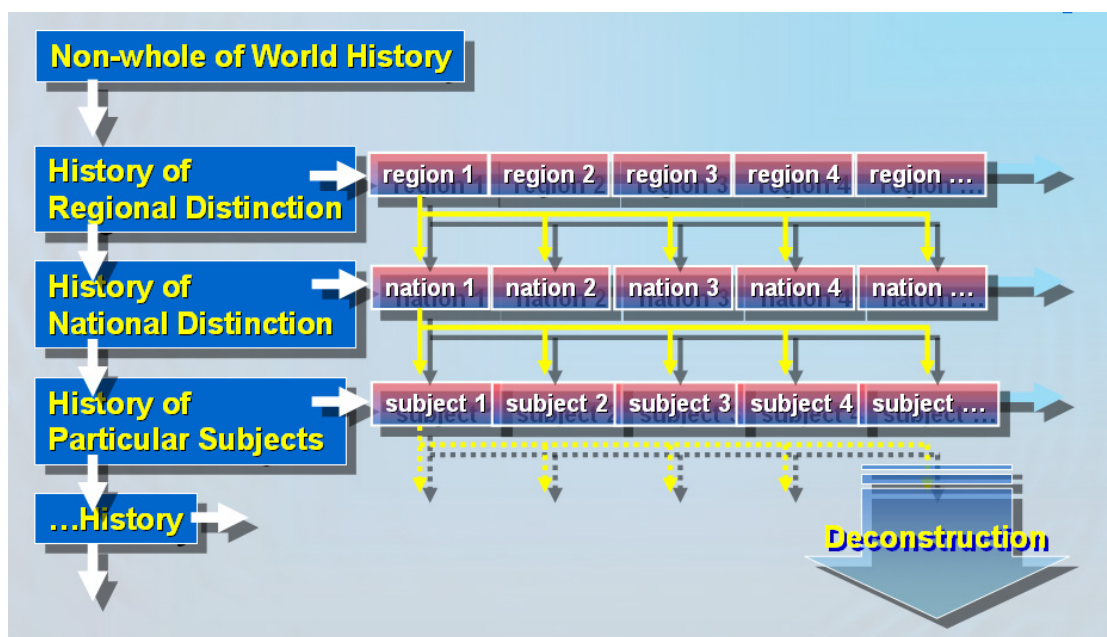


Figure 2. The deconstructive phenomena of lack of unity in the historical discipline. Historical roots: the diachronic quality of natural language, a restriction to the retrieval of space-time in historical narration.

3 PARADIGM DEFINITION: CONCEPT, FRAMEWORK ELEMENTS, AND METHODOLOGICAL PRINCIPLE

This account provides explanations of the concepts, framework elements, and methodological principles of digital world history on the basis of the definition of the paradigm for combining information technology. Digital World History is not numeric history but an organic combination of digital history and informational historiography research.

The definition of Digital World History is that it is a brand new paradigm that studies world history on a specific information technology platform from an information angle. This paradigm gives a dynamic character and integrated description and retrieves on a global scale the historical evolution of human society and its relevant causality. This view requires that achievements can be used in integration, depending on the theory and methodology of digitization and informatization. Digitizing is a combined technical process that codes and transmits with 0 and 1. It includes two aspects: describing messages with a numeric code and using this numeric code to transfer information, such as traditional words, sounds, and images in a variety of virtual signals, into informational data that can be measured, controlled, and further processed. This informational data can also be duplicated and transmitted without limit in a non-distorted manner. Informatization refers to a new productive force and pattern marked with the capacity for intelligent information processing owned by makers of social wealth on the basis of cultivating and developing techniques of computer information processing in association with the transmission of information capacity. It is also an historical process that changes all aspects of human life into a state of advanced intelligence based on the principle of historical research. It aims to associate and fuse factors in the changing history as well as the results of all sorts of historical research in order to meet the needs of an information-equipped society in the 21st century.

Following this definition, the framework of Digital World History consists of the elements in Figure 3.

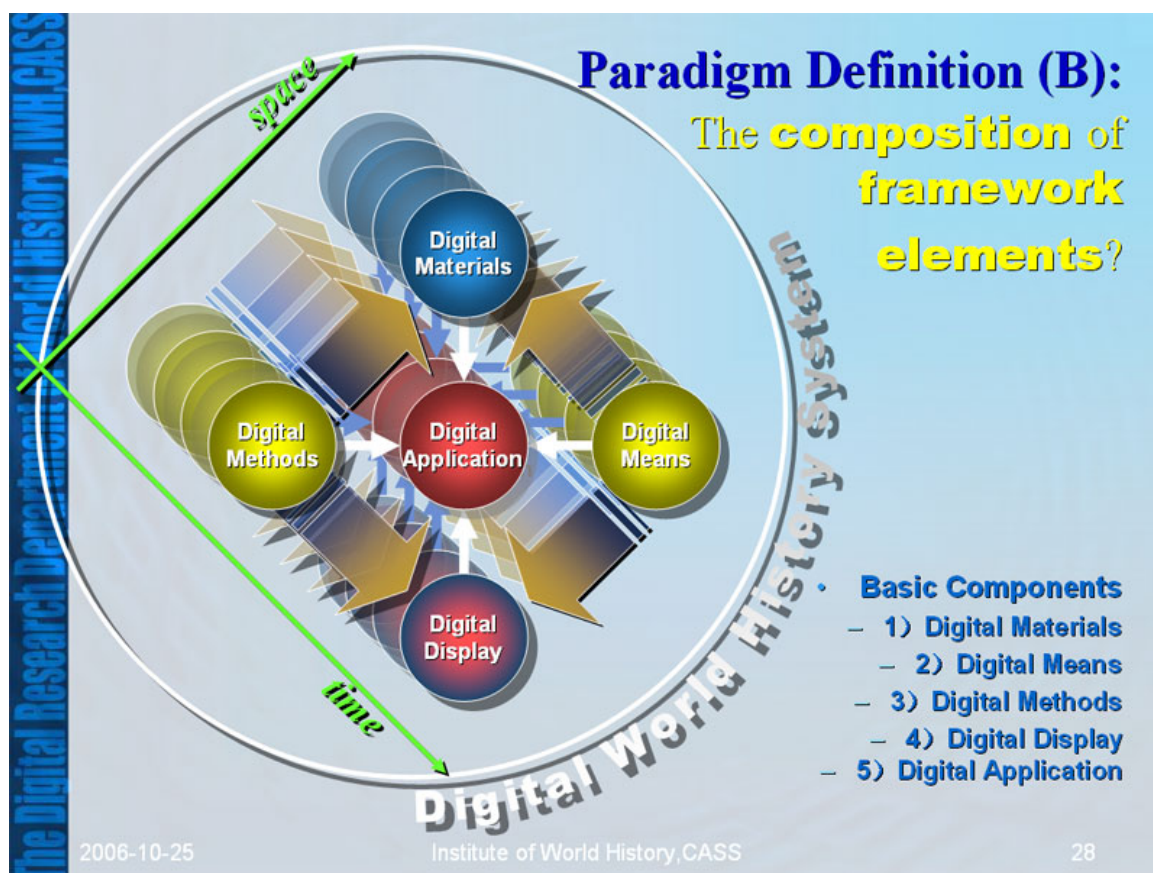


Figure 3. The relationships among the important components of the paradigm.

1. **Digital materials.** Digital Materials are the various digitalized historical materials accepted into the categories of Digital World History. They are broad enough to include all the resources obtained directly or indirectly in the process of historical cognition. In terms of information theory, all the exposed and hidden information, found in any place or transferred in any way, can be categorized as historical materials (Topolski, 1976). These include relics of human activity, archive and file literature, records of sages, various biographies, diaries or notes, pictures and graphs, voice records, and research achievements in other fields, which could be applied to world history research. Braudel has not merely discussed these broad historical materials, and he also has approved their non-negligible value through his research achievements. Braudel (1996) points out valuable materials which could be used in world history research include passages, biographies, books, publications, and investigative reports. Some of these are the purely historical resources, while others are from other scientific fields, such as ethnology, geography, botany, geology, and technology, which are as important as history itself. After the digitalizing process, these materials become digitalized research materials with certain information technology standards that are stored in the computer system.

2. **Digital Method.** The Digital method has two connotations: on the one hand, it refers to the acquisition method of digital materials; on the other hand, it refers to various digital methods that analyze and annotate the theories in digital world history's research methodology. From the first meaning, acquisition of digital material

depends on the application of digital technology. This involves two kinds of procedures. The first procedure is a narrowly-defined digital course, i.e. information can be manually typed into the computer and digital pictures. Scanned documents and OCR results can also be entered. This turns the material into editable digital files in the computer systems. The second kind of procedure is the database process; i. e. after the creation of the digital file in the first procedure, the file is set up according to database technical specifications and becomes a professional scientific database meeting the demands of digital world history.

The second connotation of the digital method is much more complicated. When working with historical data, analysis and annotation methods in digitization include statistical approaches and mathematical modeling as well as information theory, control theory, and general system theory, and even the quantization theory. All are suitable for drawing lessons from other disciplines and, in fact, can be absorbed by the methodological category of digital world history relying on the corresponding information-based application's technology platform. For example, describing or revealing the historical evolutionary relationship between the earth's environmental changes and human social development needs the introduction of a systematic theory. Implementing this kind of analysis through GIS technology is a digitized concrete application of a method in the field of digital world history. The digital method combines outward phenomena and inner thoughts using digital means and discovering similarities and relationships in these coincident meanings.

3. **Digital Means.** As is demonstrated in the micro research and macroscopic construction of digital world history, the whole process begins with collecting, ordering, differentiating, and analyzing historical data. Next, researchers must suppose, propose, analyze, and prove until the conclusion or ultimate aim has been obtained. The overall process is analyzed or expressed by using digitization in part or as a whole. Digital means also include two aspects: one is technical support and hardware and software, such as computers, network platforms, scientific databases, analyzed software, data collections, state software, etc. The other is digital theory, including modeling of historical courses and situations (mathematical modeling, 3D modeling, etc.), historical documents and data time sequence analysis, the GIS of superimposed historical space-time analysis, using Virtual Reality to reconstruct and restore history in a factual manner, etc. Digital world history must be open enough to adjust or expand research in the use of digital means in selected research objects, fields, and propositions.

4. **Digital Display.** Digital display means that every level of historical data and all achievements of world history studies are stored in the Digital World History framework. Digital display is determined by the above mentioned digital means. If the historical data or achievements need to exist in the form of digital text, it must be ensured that the research results stored in the scientific databases be in editable text. In this way, these research results can better facilitate hypertext indexing, chains, dynamic transfers, and intelligent full-text searches. If the material needs to be displayed graphically, CAD or 3DS MAX technology must be used to model two-dimensional or three-dimensional figures according to demand. Finally if the result needs to be augmented by sound or motion picture, or if the historical data is originally an audio or video file, there must be more complicated multimedia technology to store and edit these media types, also according to the demand.

There must be a whole set of digital standards and methods to connect and annotate every level of historical data and results and the relationships between them, for example, finding the rational association of each research result on world history by using the systematic theory; discovering the rational cause and effect connection among each achievement and feedback relationships using cybernetics; figuring out how to display and describe all kinds of historical data or quantitative relationships in world history research through analytical counting;

and excavating and valuing historical data and predicting key elements that might model all of the research results, according to mathematical modeling methods. Certainly, world historical data research and display of digitalized results still depend on making rational choices in terms of applicability for the informationization technological platform.

5. Digital Application. Digital Application refers to the transfer modes at every stage and level of the results obtained by studying, constructing, and employing digital world history. The chief transfer objects undoubtedly pertain to the historiography content, which is expressed in digitization. The transfer approach basically is realized through networks. Whether these transfers could achieve the anticipated application purpose or not depends on the choice of the technological platform of informationization mentioned above.

According to the above-mentioned definitions and framework elements, the methodological principles of digital world history can be summarized as: 1) Building and constructing a system to collect resources with indispensable history and associated components of the digital world, which follows the principle of systematic theory and theoretical guidelines for four-dimensional space-time; 2) In the course of study, to provide and judge the related degrees of partiality and entirety of digital world history, which follows the principle of the organic whole; to judge the boundaries which outline many factors of history's gradual progress from quantitative change to qualitative change, which follows the principle of combining quantitative analysis with qualitative analysis; 3) After constructing the model of digital world history, how to transfer the context, which follows the principle of dynamic retrieval and comparability; 4) The introduction and secondary development of the digitized informatizational technology in the digital world history, which follows the principles of creation sharing, exchange, expansion, etc.

Finally, digital application is a definition of the concept, framework elements, and methodological principles concerned with various aspects of theory construction in digital world history, including research ideas and visual viewpoints, research thinking and methods, and research means and expressions. It also relates to concrete planning and design.

4 SCIENTIFIC DATA STRATEGY: TECHNOLOGY ASPECTS, POLICY ASPECTS, AND INTEGRATION OF THE SYSTEM'S FRAME

The definition of premise and normal form, in fact, has offered the basis for scientific data strategies in digital world history research. The scientific data strategy has directly influenced the possibility of the whole idea of digital world history becoming a future reality.

The scientific data strategy of digital world history is divided into two aspects: the technological scheme and the policy environment scheme. The technological scheme involves three levels: a digitizing scheme of original ecological information resources in world history research, a database scheme of digital information resources, and a network scheme of system construction with a database foundation.

The digitizing scheme makes use of the idea that the function of digital resources is to operate or portray text-type or multi-media type resources (figures, pictures, audios, videos, etc.) of multi-dimensional displays, and that there are objective distinctions among these resources. The different types of digitization resources, to some extent, are distinguished on the basis of different uses. Digital world history resources actually have

already included these types, so the corresponding scientific data tactics are more complicated than a single type of digital resource. In the rest of this paper, we no longer go into concrete technological details.

The database scheme should meet the requirements of the informationization platform to support the whole digital world history system as it responds to the purpose of the world history knowledge system and its research. For this reason, as the integration of exclusive scientific databases on digital world history, the database scheme should at least be divided into the following types as illustrated in Figure 4.

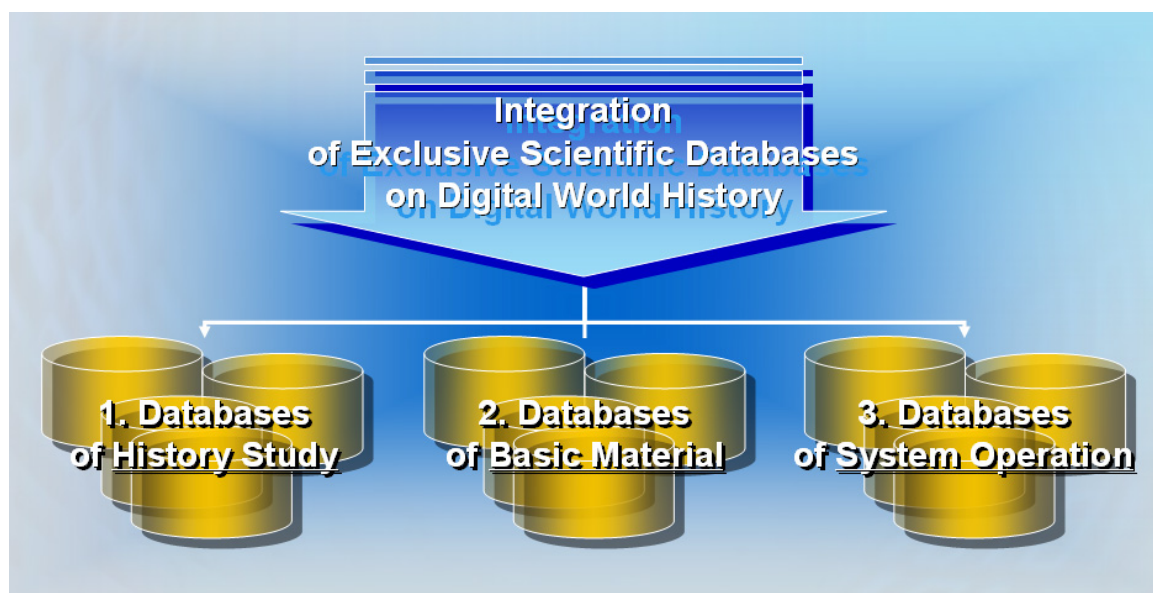


Figure 4. Scientific data strategy: Technological scheme aspect – Databases

1. *The Databases of History Study* are mainly used to give a structure to the storage of various historical data and research results at different stages during world history research, so the information can be transferred to digital world history. These databases include: 1) sub-databases of historical materials - according to the category of historical data, using special topic classification; 2) sub-databases of research achievements - according to the category of research results, using special topic classification as well; 3) sub-databases of indices with relevant key elements, etc. For the application subject of digital world history, the historian or person who consults and draws lessons from it, the historical data and phased results that are contained in the first two sub-databases are the application objects of digital world history, that is, the targets.

2. *The Database of Basic Materials* is mainly used for storing all the complementary materials from nature, society, and other fields during world history research in order to get a comparative reference system in digital world history. It includes: 1) sub-databases of the natural environment and resources; 2) sub-databases of natural scientific achievements; 3) sub-databases of social environment and resources (non-historical); 4) sub-databases of social scientific achievements (non-historical); 5) sub-databases of indices with relevant key elements, etc. The various resources contained in these sub-databases are also the application targets of digital world history.

3. *The Database of The Basic Operating System* is mainly used for normal running of the open platform of informatization technology on which digital world history depends. The set-up of this sub-database relies on technical standards from relevant information technology platforms.

The network of system construction using the database foundation is determined by how informatization technology applies to the digital world history system. These applications involve the following aspects, illustrated in Figure 5.

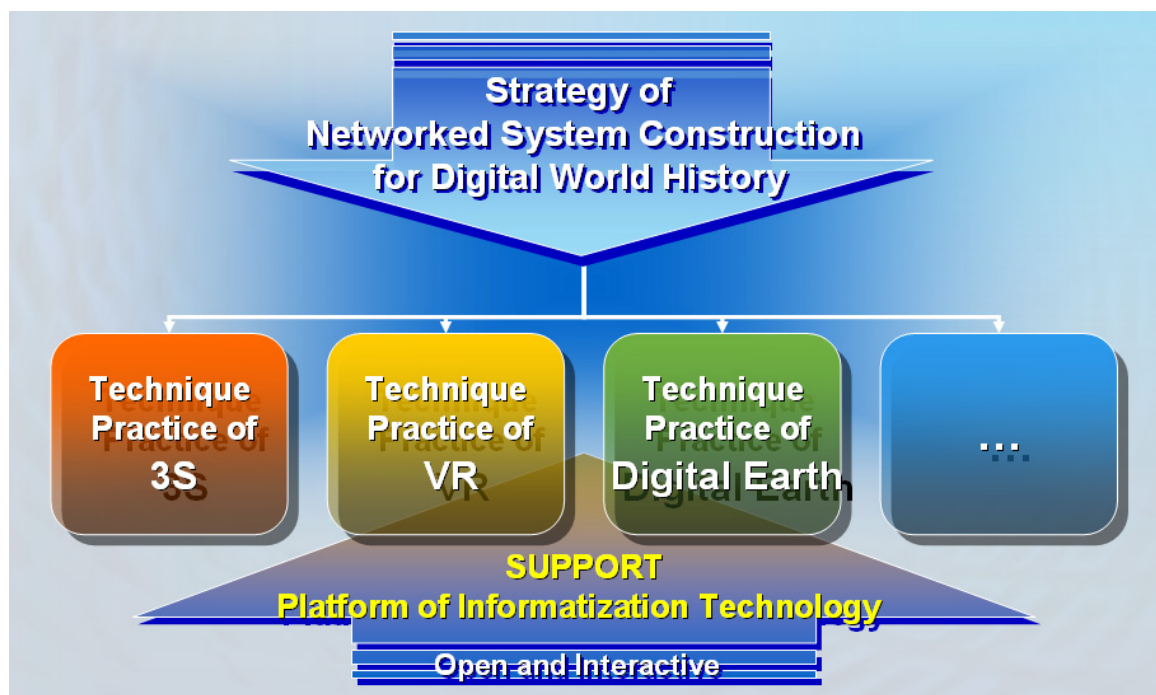


Figure 5. Scientific data strategy: Technological scheme aspect – Networks

1. *Application of "3S" technology* includes: remote sensing technology (RS), geographic information system (GIS), global positioning system (GPS), etc. This has predominantly real-time, high speed, high precision capability to combine the information acquisition process with the applications. It also provides a convenient integrating function of informatizational processing by providing timing of the adjustment to natural environmental information and processing and displaying overlapping content on the basis of timing. (Gregory, 2002)

2. *Application of "VR" (virtual reality) technology* includes virtual applications in the real environment and virtual applications in the virtual environment. This makes good use of these two technologies in digital world history by facilitating recovery of corresponding historical elements and relationships that are closely related with human survival and development. It also vividly facilitates the reproduction of fictitious historical processes.

3. *Application of the "Digital Earth" technology* is virtually further integration of the more high-tech aspects of the first two items of technology. The digital earth gathers the achievements of all informatization application technology. It is a type of virtual global system realized using the multi-resolving and dynamic dimensions of the immensity of data in the embedded geographical coordinate system: 1) The distributed global database system built and managed by different countries and organizations on the basis of the global high-speed network; 2) Earth photographs by high-resolution satellites; 3) Virtual reality technology for high intelligence man-machine conversations; 4) Interactive operational techniques; 5) Metadata, etc. (Gore, 1998).

For digital world history, the digital earth can be very useful in achieving multi-layer and multi-resolving

displays, intelligent searches, and transferring comprehensive comparative analyses and super emulation dynamics in the four-dimensions of space-time. It also creates a virtual "stage" for the historian to recover and reproduce human historical evolution. On the "stage," the construction purpose of digital world history can be realized through the superimposing technology of the GIS and other high technologies.

Scientific data strategy on the environment aspects of policy in digital world history embodies a concentrated reflection on how to settle the problem of data sharing, data safety, and intellectual property rights, and protection of digitized works and products. (Figure 6)

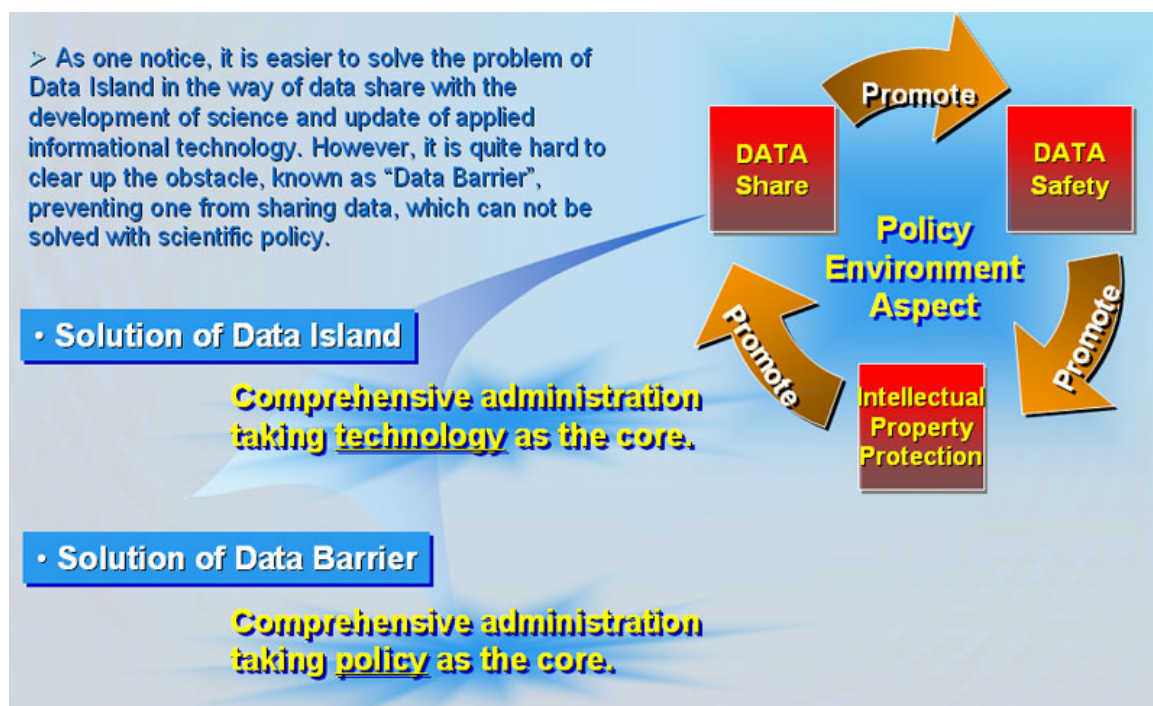


Figure 6. Solving the Data Island and Data Barrier, emphasis points will be different to some extent.

Data sharing and data safety are two aspects of mutually restricting, promoting, and owning the dialectical relationship of these information-based objects in data applications. If there is no open omni-directional data sharing across the span of geographical and physical demarcation, putting the theoretical model of digital world history into effect will face an insurmountable obstacle. Likewise, it is impossible to reach satisfactory results with data sharing in the whole system of digital world history without some data safety solution that can be used with all types of data access. Therefore, when considering data sharing, putting forward a rational and feasible scientific data safety scheme is very important.

The world has accepted the essentiality and value of data sharing. While not going into details, it is necessary to point out that it is easy to solve the problem of the Data Islands through data sharing with the development of science and updating of applied informational technology. For this is merely a problem stemming from skills in the technological category that are "non-standard", "non-isomorphism," "non-unified platform," "non-open interface," "non-network interconnection," etc.

However, it is quite hard to clear up the obstacle known as "Data Barrier", which prevents data sharing and cannot be solved by scientific policy. The problem of the "Data Barrier" comes mostly from people and society, that is, the issues of ideas, policies, and profit distribution, similar to a difference in viewpoints among

individuals, a difference in interests among departments, organizations and regions; differences in state policies among countries, "national benefits difference", "safe precaution and restraining differences", etc. Elimination of the "Data Barrier" needs support from national authorities for scientific data sharing at the domestic level. To remove the barriers in sharing international scientific data not only needs the support of national governments but also must have common understanding, coordination, and cooperation from international and governmental levels among all countries in the framework of international organizations. In view of this, as digital world history is related to historical and realistic resource data from many countries and regions, the formulation of detailed rules and regulations for sharing data in the strategy of scientific data can solve the problem of the "Data Island" and also take note of the "Data Barrier" in a non-technological manner.

As for the protection of intellectual property rights of digitized works and products, this should be one of the "game rules" followed strictly during sharing of data, so as to respect inventors and owners of data sources for their creation and wisdom, as well as the researchers authorized to use this property. For this reason the protection of intellectual property rights of digital world history can be divided into two issues: the protection of original data sources and systems and the developed models of digital world history. Consulting the relevant laws and regulations, there should be a consideration of the issues and a listing of the detailed practical rules for applying scientific data to a digital world history scientific data strategy.

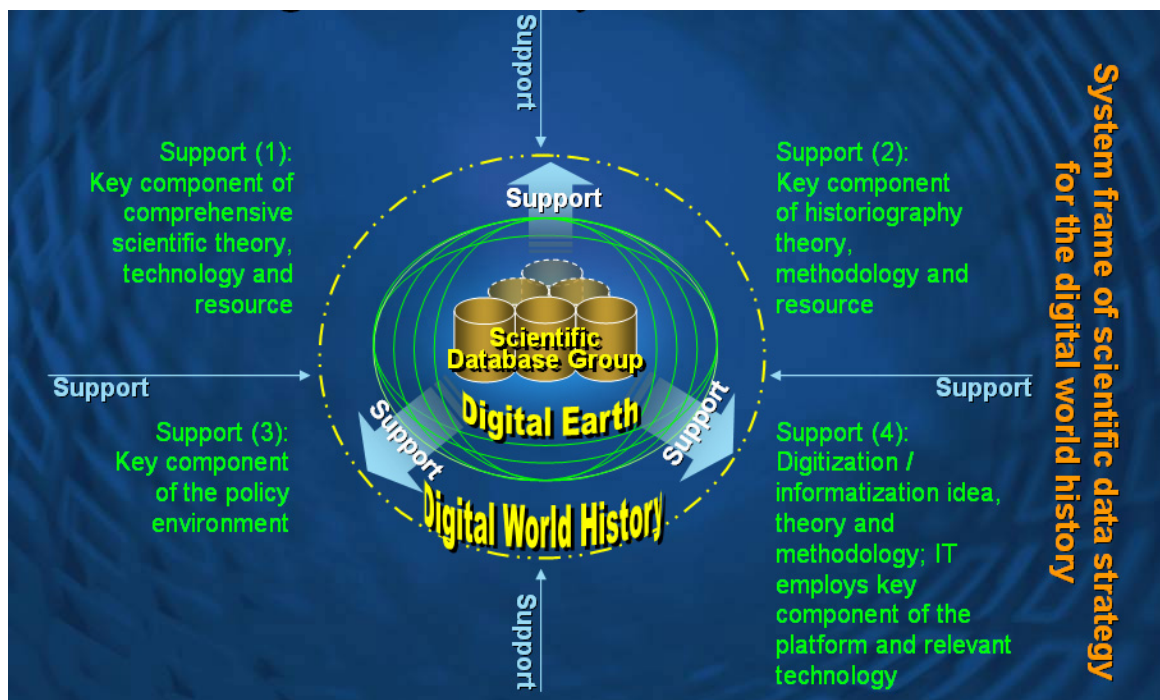


Figure 7. Scientific data strategy: Integration of system framework

Apart from the differences between the technological schemes and policy environment in the scientific data strategy of digital world history, it is necessary to integrate many reference elements from systematic theory, which can be developed into a practical systematic framework that reflects appropriately the relationships among the elements. As suggested in Figure 7, first, the scientific database in the center of the framework is made up of the basic metadatabases on which the digital world history relies. Second, the digital global system is supported by the scientific databases that surround the central area of the framework. Third, above the digital globe is digital world history. Finally, the construction of digital world history needs the complete support of the ideas, general theories, methodologies, technologies, and correlated information resources in the system. These

consist of four types of knowledge: 1) non-historiography (refers to subjects in natural science, social science, and engineering); 2) historiography; 3) policy environment (laws and regulations, etc.); and 4) digitization, informationization, and IT applications.

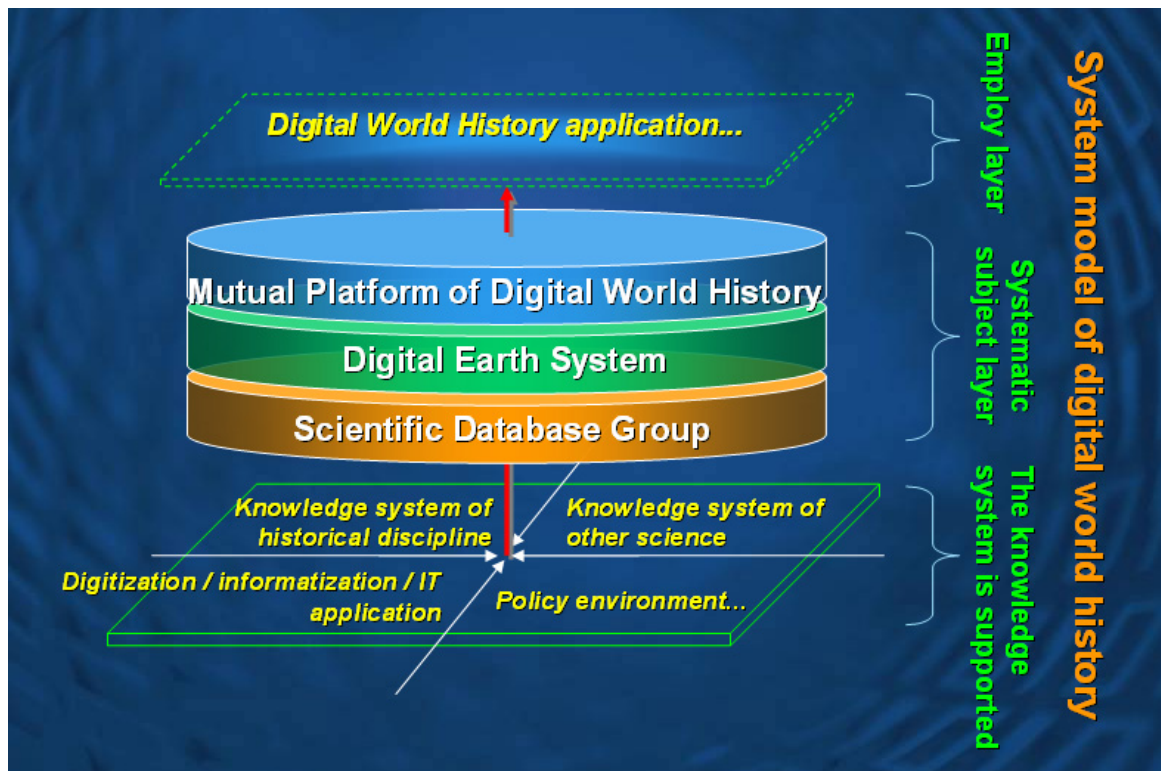


Figure 8. Scientific data strategy: Integration of system framework - system model of digital world history.

The system's models can be obtained as suggested in Figure 8, with structural plans for digital world history based on the framework of the scientific data strategy. Among them, the group of scientific databases at the bottom of the main system is an indispensable foundation supporting the normal operation of mutual platforms of digital earth system and digital world history. The digital earth system not only locates the spatial coordinates for digital world history but also transfers access to the data resources of relevant basic information. Besides that, the mutual platform of digital world history supports the use by the scientific database groups, and more importantly, it also realizes the dynamic integration of space-time between digitized human society and relevant ecological environments consisting of historical and realistic elements by the corresponding relationships it makes with the digital earth. (Figure 9) The detailed scheme for systemic models of digital world history is not included in our discussion.



Figure 9. Scientific data strategy: Integration of system framework - Digital World History System sketch constructed by the paradigm and approach.

In brief, we can conclude from the structural framework and systemic models discussed that constructing digital world history is a quite complex and rigorous task.

5 EPILOGUE: PERSPECTIVES ON THE RELEVANT APPLICATION

As suggested above, both rapidly changing informatization applications and their relevant theories, if brought into the historical research field, will make revolutionary changes to the research and application of world history. Because it is an intact system consisting of the respective advantages and capacities of the historians' intelligence, information resources, and technical application, digital world history can be applied to many other fields, as follows:

1. **Study.** Digital world history, characterized by its multi-dimensional and dynamic visualization and extension, will not only effectively promote and modernize historical research but also offer to other fields the convenience of the achievements in historical research and the relevant historical resources.

2. **Education.** By using the applications of digitization and informatization for traditional history, digital world history will make an impact on cognition, remembering, and recounting, which bring a lifelike educational popularization of history into the field of education.

3. **Decision.** Making all human historical processes in fields throughout the world can be served when they are brought into the digital world history manner of analysis and comparison, making decisions by using the dynamic platform of multi-dimension and multi-resolutions. These decision-making methods can be applied to personal paperwork, office management, or market operation consultation, as well policy construction by

governments and international organizations. Especially in international politics, diplomacy, military, economic, and global conversations, digital world history's decision-making is a valuable reference to meet the needs of a changing and evolving world.

4. **Entertainment.** The system of digital world history, characterized by its various integrated historical and current information, the capacity to simulate historical changes in multi-dimensions of space-time, as well as its information retrieval and transfer in a handy and visual way, makes it possible to apply historical resources accurately in the popular culture, such as in film, television, theatre, and video games.

In the field of cognition, the function of digital world history is large but difficult to assess. From the general theory of knowledge, the paradigm of digital world history, combined with the technology of informatization application represented by the digitized earth, will provide an effective new approach to eliminate the problems caused by primitive informational processing. From historical ontology, the application of this approach might accelerate the whole research process of tracing, annotating, and recovering history. Also, it could overcome past restrictions caused by languages differences, so as to step into a new period with a dynamic emersion of space-time in dimensions integrated by synchronism and diachronism.

In a word, it is not difficult to foresee that the actual application of the digital world history paradigm and system will make the old historiography one of the optimal modes for serving the developing high-speed modern human society both entirely and almost ideally, in the new world of the 21st century constituted by the globalization age and information society.

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