

Article

Research on the Integrative and Iterative Architecture Design Mechanism of Chinese Culture and Green Technology

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Abstract

Aiming at the weakness of “two kinds of thinking; lack of integration” between Chinese culture and green technology in the field of urban and rural construction, as well as the high-quality construction needs of China’s new urbanization, using system thinking, genetic factors, and iteration theory, the components of genetic and variation factors and the integrative and iterative mechanisms of Chinese culture and green technology were studied. Chinese culture is rich in humanistic and green science and technology feelings of “reciprocity between heaven and mankind” and “matching nature”, believing that the ways of science and technology is inherently consistent with the ways of nature and man. Chinese culture endorses green science and technology with humanity and soul, and green science and technology promote the evolution and rebirth of Chinese culture. The genetic factors of Chinese culture and the variation factors of green science and technology constitute the inheritance and renewal system of integration, the unity of opposites, and the coordination of conflicts between them, deducing the integrated architectural design mechanism in which science and technology are “culturized” and culture is “technologized”. The iterative mechanism of mathematical operation is the logical thinking of architectural design in the repeated feedback process of cultural and scientific spatial graphics. It approximates the design thinking law of design conditions and requirements through a cyclic iterative scaling operation and can use computer-aided iterative design. According to the function, level, and structural relationship between Chinese culture space graphics and green science and technology space graphics, the iterative mechanism of collocation accumulation is the iterative design law of level accumulation and optimized collocation. There are two kinds of deduction paths, forward and reverse fusion, in the iteration–fusion design mechanism, which form the integration and iteration logic of mutual carrier and object.

Keywords: Chinese culture; green science and technology; integrative–iterative architecture design mechanism; genetic and variation factors; humanistic green science and technology



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1. Introduction

Progress in scientific and technological fields has brought multiple shocks to mankind, demonstrating great power and influence, and promoting rapid changes in the production and lifestyle of human society, as well as the rapid enhancement of economic development, which undoubtedly reflects the positive effect of the first productive force. However,

science and technology are also a double-edged sword, triggering the loss of cultural outlook, increasing ecological imbalance, environmental pollution, confusion of values, and other negative effects, causing a global ecological and environmental crisis regarding the survival and development of mankind. For this reason, mankind has improved the science and technology unnatural self-repair factor and upgraded to natural ecological green technology, but there is still no fundamental solution to the problem of science and technology working with human culture, the root cause of which lies in the separation of science and the humanities, technology and art, or even antagonism, which has also led to the lack of deep integration of Chinese culture and green technology, and has become the main bottleneck of development in the field of urban and rural construction in China. In response to the above problems, the Decision of the Central Committee of the Communist Party of China on Further Comprehensively Deepening Reform and Promoting Chinese Modernization, adopted at the Third Plenary Session of the 20th CPC Central Committee, explicitly proposed “exploring an effective mechanism for the fusion of culture and science and technology, and accelerating the development of new cultural business forms” and “calling for the construction of a new ecology for the fusion of culture and science and technology development”. In January 2025, the State Council’s “Several Economic Policies on Promoting the High-Quality Development of Culture” put forward core measures such as “in-depth integration of scientific and technological innovation and culture” and “synergistic development of green science and technology and culture”, emphasizing that “science and technology provide the basis for the development of Chinese culture and the development of Chinese culture”. The State Council’s “Several Economic Policies on Promoting the High-Quality Development of Culture” in January put forward core measures such as “deep integration of scientific and technological innovation with culture” and “synergistic development of green technology and culture”, emphasizing that “science and technology casts the soul of culture, and culture empowers science and technology”. In this context, we explore the deep integration of Chinese culture and green science and technology and carry out research on the architectural design mechanism of the integration and iteration of the two.

Scholars at home and abroad in different fields, such as anthropology, history, sociology, philosophy of science and technology, and architecture, have carried out research studies related to the integration of culture and science and technology in terms of their origins and development, interrelationships, fusion of separation, characteristics of performance, etc., have achieved much more, and they have formed a consensus that “science and technology are the source of cultural inheritance and innovation, and culture guides the development of science and technology”. A consensus has been formed that “science and technology are the source of cultural inheritance and innovation, and culture guides the soul of scientific and technological development”.

The research related to the integration and development of the two can be summarized in the following five stages: (1) A combination of primitive society culture and simple technology obscurantism—culture, science and technology, and human beings [1]; (2) The interactive development between ancient culture and science and technology—culture, science, and technology mingling, and marriage between natural science, humanities, and the arts [2], with fusion between the city and architecture, and the art of culture, science, and technology; (3) Cultural conflict and imbalance between Western modern science and technology—with the West in the “mechanical reproduction” era, the prevalence of the cult of technology, the human spirit placed in vain [3], science and technology, a vein of unique exploration; however, China has a modern architecture of modern science and technology for selective absorption and creative transformation, showing the Chinese culture and modern science and technology, demonstrating both the conflict and the fusion of the

steering wheel [4]; (4) the stage of conflict and integration of modern culture and science and technology, with the culture and technology imbalance further aggravated, modern science and technology gathered to change the continuation of hundreds of years of urban architecture and historical and cultural environments, and which has led to a thousand cities, and caused serious damage to the natural environment and ecological crisis. Under these circumstances, the world has been prompted to reflect on the relationship between culture and science and technology, and human beings have been rethinking the integration of culture and science and technology, re-examining scientific and technological innovations with the goal of improving the human environment [5], and shifting from conflict to the integration of culture and science and technology; (5) In the stage of development of the deep integration of contemporary science and technology and culture, we should give science and technology a deep humanistic understanding and humanistic care, strengthen the reawakening of the scientific humanistic spirit in the contemporary era [6], and deeply excavate cultural genetic factors and scientific and technological variation factors in order to continue the culture and integrate the technology [7], and reconstruct the mechanism of integration of “architecture—human—environment” [8].

However, the current research still exists in favor of green science and technology or in Chinese culture, the “two kinds of thinking; lack of integration” of the soft underbelly, the exploration of the integration theory and methodology of the two, in-depth integration of the theory and innovation of the research related to the results of the relatively few. This leads to a lack of deep knowledge of the integration mechanism in Chinese culture and green science and technology, and the key technologies and methods of green integration technology or methodology and the integration of key technologies and methods of research is insufficient. In addition, the theoretical research on the integration of culture and science and technology and iterative design at home and abroad mainly focuses on mathematical iteration, iterative thinking theory, and method research [9], and has only a small amount of involvement in the fields of art and design, such as the use of genetic factor theory iterative design in train modeling [10], but the theoretical depth needs to be expanded.

In view of the above deficiencies, it is proposed to start from the scientific problem of what kind of internal mechanism and development and evolutionary law the integration of Chinese culture and green technology in the field of urban and rural construction follows, to carry out the research on the internal mechanism of integration and the iterative mechanism, and to explore the integrative–iterative architecture design mechanism of Chinese culture and green technology by combining systematic thinking, the theory of iterative design, the traditional Chinese construction theory system, and the theory and methods of green and low-carbon building design.

2. Relevant Concepts

2.1. Chinese Culture and Its Humanistic Green View of Science and Technology

Chinese culture is all the cultural achievements created by the people of all ethnic groups in the course of their production and living practices on the vast expanse of land, including not only material culture such as the Forbidden City, the Great Wall, the Four Great Inventions, and porcelain, but also spiritual culture such as the philosophical thinking, humanistic spirit, technological art, and the ideology of construction that characterizes the Chinese people. It is mainly “a cultural form reflecting the unique style of the Chinese nation and reflecting the distinctive characteristics of pluralism and unity, with Han Confucianism as the dominant culture and on the basis of the integration of the cultural elements of other ethnic minorities” [11].

2.1.1. Harmonious Scientific and Technological Concepts of the Chinese Culture of “Reciprocity Between Heaven and Mankind” and “Forgetfulness of Things and Self”

Since its inception, Chinese culture has emphasized the harmony of humans and their scientific and technological ideas with nature, and despite the low level of technology in ancient times, the green and natural attributes of traditional science and technology are particularly prominent. Chinese classics such as the *Analects of Confucius*, *Mencius*, *Xunzi*, the *Dadai Ritual*, the *Xiaodai Ritual*, the *Zhou Ritual*, and the *Guanzi* all record the cultural systems developed by our forebears to harmonize human beings (including scientific and technological ideas) with nature, which were explicitly incorporated into the ancient normative system of “rites”. The Chinese culture’s harmonious scientific and technological concept of “the mutual benefit of heaven and mankind” is not an abstract idea but is realized through concrete systems and technical practices. The *Zhou Rites—Earth Officials* stipulates that “the law of soil suitability” guides agricultural cultivation, and crops are selected according to the nature of the soil, which is highly consistent with the principle of “suitable land and suitable seeds” of modern ecological agriculture. Archaeological discoveries have confirmed that about 5000 years ago, the water conservancy system of the ancient city of Liangzhu realized flood control and irrigation through 11 dikes, the design precision of which demonstrated the ancient people’s precise mastery of the laws of nature and proved the historical effectiveness of green technology. *Mencius* stated “not against the agricultural time, grain cannot win the food; several birds do not enter the stagnant water, fish and turtles cannot win the food; axe catty in time into the mountains and forests, wood cannot win the use of wood. Grain and fish and turtles cannot win the food, wood cannot win the use, is to make the people to raise life and death without regrets. Nourish life and death without regret, the beginning of the King’s Way”; “into the sometimes, take the degree, use the section” [12], which proves the degree, section and balance, restraint, order of the Chinese culture, and the concept of the natural harmony of science and technology.

The core of culture lies in its values, with the core value of Chinese culture being “reciprocity between heaven and mankind”. This embodies the harmonious unity of humanity, scientific and technological wisdom, and nature, representing an integration rather than splitting the conflict between man and nature, science and technology. It advocates a symbiotic relationship between science, technology, and nature, striving to achieve a realm where “I and the world are one, oblivious to separation”. The fundamental problem of modern Western science and technology are that science and technology conquer nature and neglect human nature, which triggers the crisis of ecological imbalance and loss of human nature. In order to solve this crisis, Western scholars have proposed incorporating the Chinese cultural ideas to redirect the value target of contemporary science and technology from the conquest of nature to the closeness of nature. In other words, green science and technology embody only one of the basic connotations of the harmonious values of Chinese culture, which advocates for a “reciprocity between heaven and mankind”. Green technology is only one of the basic connotations of the Chinese culture’s value of “mutual harmony between heaven and mankind”, and the other basic connotation is humanistic science and technology.

2.1.2. The Humanistic Green Technology Concept of “The Virtue of Man and Nature” in Chinese Culture

Chinese culture is not only rich in green scientific and technological thinking but is also full of humanistic scientific and technological care. Drawing upon the extensive history of its agricultural civilization and the harmonious coexistence between mankind and nature, Chinese culture has profoundly influenced the evolution and application of science and technology, while adhering to the universal principles of nature: to reign as the

steward of heaven and earth, to be esteemed for nurturing, to thrive by embracing these laws, and to falter by defying them [13].

On the one hand, green technological values are reflected in the fields of agriculture, engineering, and forest vegetation in ancient times. Agricultural cultivation science and technology are applied to the cultivation of rice, wheat, citrus, and other crops, so as to provide sufficient food and clothing without excessive demand for natural resources, and to realize the sustainable development of green agriculture. Engineering science and technology are applied to the creation of river and canal water conservancy, cities and buildings, making full use of the natural topography, landforms and water veins, water potential, multiplying the situation, and self-flowing water diversions. This ensures the interdependence of functions such as embankments, water diversions, flood relief, sand drainage, flow control, as well as planting trees on both sides of embankment to prevent erosion, thereby forming a harmonious symbiosis of the green technology system. Forestry technology focuses on afforestation, the degree of orderly planting and felling, including the strategic felling of trees on the south side of mountains in winter, then on the north side of mountains in summer, etc., which demonstrates the green technological wisdom of the integration of man and nature. For example, at the place-making level of Huizhou courtyard, under the influence of the natural environment and the Taoist concept of “Taoism Laws of Nature”, Huizhou dwellings follow the geomancy environmental principle of “pillowed by the mountains, surrounded by water, and facing the screen”, focusing on the mountain and water environment. The Huizhou folk houses follow the principle of the geomancy environment, with an emphasis on the mountain and water environment. Most of the grouping places are characterized by the scientific and technological layout of being surrounded by water and mountains, and the natural water system is transformed through the construction of canals, water outlets, ponds, etc., which create a large number of humanistic landscapes to meet the needs of daily life and fire prevention [14].

On the other hand, Chinese culture gives natural landscape, everything in the world, and science and technology a human nature, so that “people and pine, bamboo, plum, orchid and chrysanthemum than virtue” fully embodies the Chinese culture of human culture and nature and humanities and science and technology ideas. Confucius expresses landscape as a virtuous concept: The wise delight in rivers’ flow, the virtuous in mountains’ glow, as well as people, technology, and jade as virtuous ideas: Jade, the gentleman of virtue: warm and moist and zephyr, benevolence; chestnut and reasoning, knowledge; firm and unyielding, righteousness [15]. Laozi landscape morality: goodness is like water; virtue is like a valley. In Chinese culture, since ancient times, plants are personalized as ideas: pine, bamboo, plum are subject to anthropomorphism as “three cold friends”. Plum, orchid, bamboo, chrysanthemum are compared to the “Four Gentlemen”, and are seen as an interpretation of human nature and humanities and science and technology thinking, people, science and technology and nature and can be compared to each other, scientific and technological ideas, methods and nature, society, and completely consistent, affinity and integration, infected with each other, fully demonstrating the humanization of nature and scientific and technological thinking.

The towering mountains are the image of the “Benevolent One” in Chinese culture, and the flowing water is the style of the “Wise One”. The beautifully carved jade and its craftsmanship is the reputation of the “Virtuous One”, and the tenacious plants are the embodiment of the “Courageous One”. Since its inception, Chinese culture has injected humanistic attributes and the concept of harmonious coexistence with nature into the ethics of green science and technology, laying the philosophical foundation of contemporary humanistic green science and technology and guiding the correct development direction of contemporary science and technology ethics.

2.2. Green Technology and Its Chinese Cultural Development Concept

Green science and technology are the survival system, lifestyle, and corresponding science and technology that can promote the survival and development of human beings. It is also the ecologization of science and technology. It is to view the development of science and technology from the holistic viewpoint of ecology, to separate science and technology from the world as a whole, to put it back into the organic whole of ‘human-society-nature’, to apply the viewpoint of ecology and ecological thinking into progress in scientific and technological fields, and to put forward the goal of ecological protection and ecological construction, which mainly includes the change in scientific values, scientific worldview, and scientific outlook [16]. Green science and technology encompass scientific and technological fields such as environmental pollution control, ecological practical technology, green production processes, green products, green new materials, and new energy, as well as scientific and technological concepts related to major issues in the development of nature and society, with the goal of ecology, low carbon, energy saving, and environmental protection, which is conducive to saving resource consumption, reducing environmental pollution, and advancing the coupled development of socioeconomic systems and environmental sustainability.

2.2.1. Green Technology Continues to Renew Chinese Cultural Heritage

Scientific and technological progress is a key factor in promoting social and cultural change [17], and also promotes the inheritance and renewal of Chinese culture, while green technology promotes the ecological harmony and sustainable development of Chinese culture due to its ecological suitability. On the one hand, green science and technology have given new life and new interest to Chinese culture and have become the core driving force to promote changes in the inheritance elements of Chinese culture, as well as the power source of innovation and development. On the other hand, green technology has profoundly influenced the inheritance carriers of Chinese culture, breaking through the restrictions of traditional carriers, promoting the living inheritance and technological sharing of Chinese culture, as well as diversified forms of existence. It has enabled the permanent preservation, inheritance, and dynamic updating of scientific and technological data such as the gene pool, database, and resource base of Chinese culture. In addition, green technology has expanded the scope of Chinese cultural inheritance space and innovation, broadened the scope of creative transformation and development, concentrated and integrated Chinese cultural resources, and generated diversified forms of dissemination, production, and organization. It uses scientific and technological means to assist in the exploration and tracing of Chinese culture to reveal its origin, formation, and development, thereby promoting its inheritance, development, and continuous innovation.

The “square” pattern of the “square form” of the city has been the main feature of city construction in the Chinese plains for thousands of years and is unique in the world’s urban civilization. Xiongan New Area design, for example, has as its core location an innovative layout of the center of the square city, and not only continues the “square nine miles”, “square hundred paces”, and other traditional spatial genes, but also constructs a 5 min, 10 min, and 15 min living circle through modern spatial organization modes, such as dense road networks and small-scale neighborhoods, which has realized the reimagining and revitalizing of China’s excellent traditional cultural through dual-path innovation [7].

2.2.2. Green Technology Expands the Spatial Boundaries and Forms of Communication of Chinese Culture

Green technology has broken through the geographical space, scene limitations, and one-way communication of Chinese culture. First of all, it has greatly changed the form

of existence and spatial boundaries of Chinese culture, breaking the previous centralized existence of physical objects, graphics, audio, and video, transforming Chinese cultural collections, canonical books, paintings and calligraphy, and art into virtual and diverse forms of existence. The Dunhuang Mogao Grottoes digitization project, for example, where Dunhuang Research Institute has completed the digital image acquisition of 289 of the 492 caves in the Mogao Grottoes, 45 color sculptures, 140 caves, and 7 large sites to achieve a three-dimensional reconstruction. Through high-precision 3D scanning and AI repair technology, there has been a 1:1 restoration of 45 caves' mural details and the world's first "digital Dunhuang" cloud platform has been built, to achieve an average daily visit of more than 100,000 people (2023 data), compared with the entity itself improving the visitor efficiency by 300%.

Secondly, green technology has extended the material space boundary of Chinese culture, breaking through the material space on which the cultural material space, cultural scenes, and cultural relics exist, expanding to the network virtual space or digital link space. This has promoted lightweight and interactive forms of communication such as virtual anchors, digital studios, and live streaming studios without real scenes, deriving the efficient and intelligent digital media culture, and broadening the forms, depth, and breadth of Chinese culture dissemination in an comprehensive and three-dimensional way. In contrast to the British Museum's one-way data strategy of opening up only 20% of its collections, China builds a new paradigm of "symbiosis between reality and reality" in cultural dissemination through interactive virtual exhibition halls and blockchain authentication technology, so that Chinese culture breaks through the physical boundaries and realizes "living inheritance" and "no limit to inheritance" in the digital space.

Thirdly, green technology has further extended the mode of Chinese cultural exchange, giving rise to VR, 5G, AR, and cross-media cultural platforms. It has achieved the organic fusion and complementary advantages of digital media and traditional media, breaking the one-way interaction mode between Chinese culture and the public. It has opened up a two-way interaction and interactive experience between Chinese culture and audiences, as well as a long-distance, high-precision, and low-cost means of Chinese cultural exchange, and extending its breadth and depth. Relying on 5G+AR technology, the Palace Museum has created a "digital cultural relic library" and opened 83,000 pieces of high-definition images of cultural relics. Users can interactively experience the etiquette of Ming and Qing Dynasty costumes through virtual wear, and the number of registered users worldwide has exceeded 50 million, expanding the radius of cultural dissemination by 200 times compared with that of traditional exhibitions.

Above all, green is the background color of Chinese culture, containing a long history of Chinese culture and harmony of values, "everything is a reason" [18], with people and human science and technology existing in the same place between heaven and earth. This is a space where natural things with the flow of science and technology are by no means beyond the natural, and the way of science and technology is inherently consistent with the way of man and nature. Therefore, the view of science and technology in Chinese culture is essentially a humanistic green science and technology concept, in which the humanities, science, and technology are integrated and promote each other. Chinese culture has endowed green science and technology with a humanistic essence and soul, while green science and technology has promoted the development and rebirth of Chinese culture.

3. Logical Relationship

Chinese culture and green technology each constitute a complex system, which can be divided into two levels: "Tao" and "tools". The study of the "Tao" of Chinese culture carries the ideas, spirit, and concepts, and the "tools" of Chinese culture presents specific forms of

expression. Similarly, it explores the ideas, laws, and concepts of eco-science contained in the “Tao” of green science and technology, as well as the external technological forms of eco-science “tools”. Accordingly, we will study the constituent elements, logical correlation, and architectural design law of Chinese culture and green technology. Due to the slow and orderly development of science and technology in ancient times, and under the influence of the philosophical thought of “unity of heaven and mankind”, Chinese culture and science and technology have been closely integrated, and the two are intertwined and intermingled, and have developed side by side, maintaining their own basic characteristics, forming a relatively stable Chinese cultural core (genetic factor), which is also inherited and continued. Green science and technology, as the main external variation factor of Chinese culture, has promoted the renewal and development of Chinese culture.

3.1. Chinese Cultural Components and Genetic Factors

Chinese culture is a whole with specific functions composed of multiple elements that interact with each other, depend on each other, and have relationships with the cultural environment [19]. The “Tao” is the ideology, spirit, and value of Chinese culture, and is the core of the culture. “Ware” is the carrier and concrete expression of Chinese culture, including material carriers such as books, instruments, and buildings, as well as non-material carriers such as language, music, and art. Taking traditional architecture as an example, the wooden structure system of ancient Chinese architecture embodies the combination of “Tao” and “tools” in Chinese culture. From the level of “Tao”, it means that traditional Chinese architectural thought reflects the Confucian idea of “keeping the middle ground” and the Taoist concept of “unity of heaven and mankind”; this is manifested in the symmetrical and balanced spatial layout and facade form, which embodies the order of etiquette, mediocrity, and harmony. From the level of “tools”, it refers to the traditional Chinese architectural design methods and techniques, adopting the axis control design method and mortise-and-tenon structure technology, with stable structure and high seismic resistance, which not only reflects the high level of ancient architectural technology, but also avoids the over-processing and wastage of architectural materials, as well as being practical and durable.

The core of Chinese culture is the spirit of thought, values, and ways of thinking, which is the essential kernel that distinguishes it from other cultures. Categorized according to the core logic of “Taoism” and “instrumentality”, Chinese culture mainly consists of philosophical ideas such as Confucianism, Buddhism, and Taoism, humanistic spirit of humanism and ritual order, geomancy concepts of yin and yang, the Five Elements and the phases of life, as well as the aesthetics of literature such as poetry, songs, music, chess, calligraphy and painting, astronomy, and the geography of the dividing field and the nine states, the craftsmanship of paper making and printing and construction techniques, Chinese medicine of the balance of yin and yang and harmony, opera music of carrying the Tao through opera and transforming people through opera, clothing, and food of color, smell, and taste, as well as the traditional architecture of the law of nature and unity of harmony.

Based on the classification of the Chinese cultural kernel, we further study the essence of Chinese culture and the wisdom of building in the field of urban and rural construction, by taking the essence and removing the dross. We screen the components of Chinese culture that are closely related to this field, which are mainly categorized as philosophical thought, humanistic spirit, concept of geomancy, craftsmanship, and traditional architecture, forming the first level of the main components and kernel of Chinese culture. According to the Mendelian theory of genetic factors, the kernel of culture is the genetic factor of traditional culture that is passed on from generation to generation. Accordingly,

the deeper connotations of Chinese culture are explored, and the second level of genetic factors are synthesized and refined. First, Chinese philosophical thought includes Taoist thought of “unity of heaven and mankind”, Confucianism thought of “keeping the middle ground”, and Buddhist thought of “carrying the way with the building”. Secondly, the humanistic spirit includes the harmonious concept of “people-oriented”, the ethical concept of “ritual order”, and the aesthetic concept of “the image outside the image”. Thirdly, the concept of geomancy includes the systematic concept of geomancy and geography, the complementary concept of yin and yang, and the concept of the flow of birth and death of the five elements. Fourth, the spirit of craftsmanship includes the unique construction techniques, the legal standardization of the unity of skills, and the spirit of craftsmanship that is uniquely refined. Fifthly, traditional architecture includes the group layout of the axial courtyard, the rigid and flexible wooden architecture, and the landscape garden of the world in a pot (Figure 1(1)).

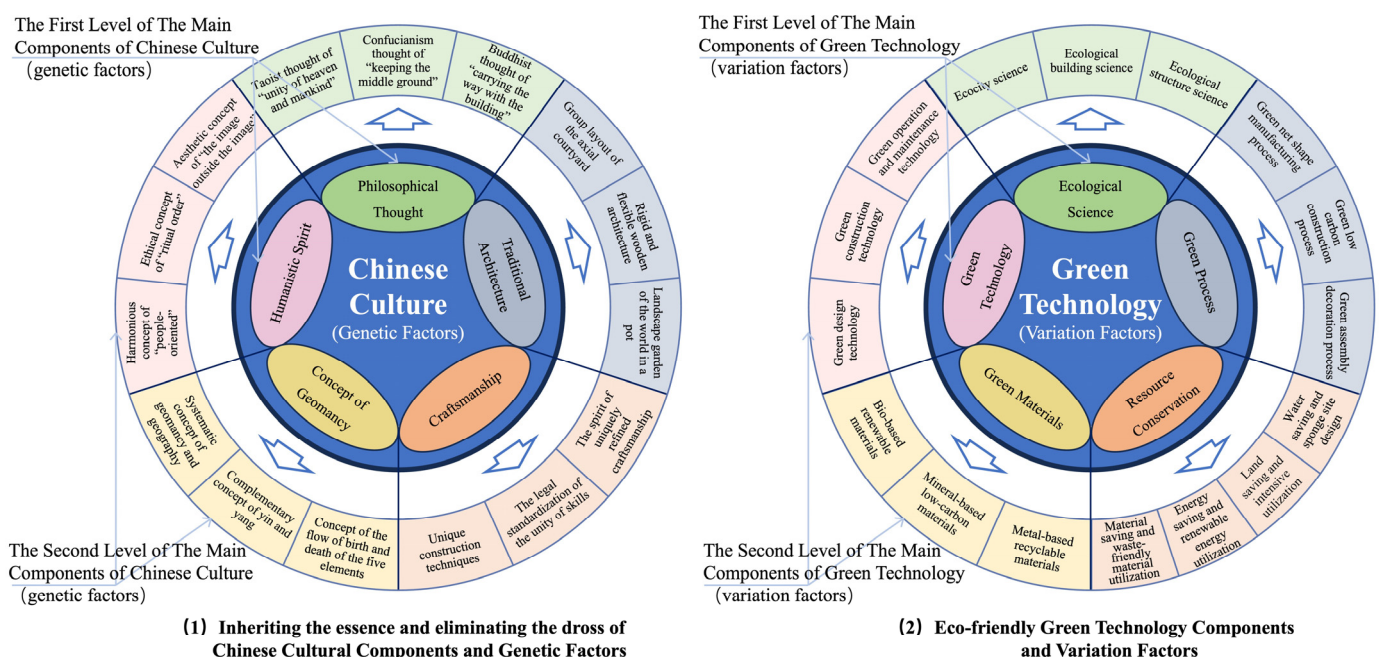


Figure 1. Research on components, genetic factors, and variation factors of Chinese cultural and green technology in the field of urban and rural construction.

The genetic factors of Chinese culture are passed on from generation to generation through technological carriers and spatial practices. The circular layout and use of materials in Fujian Tulou reflects the systematic idea of “unity of heaven and man”. The Dong Ethnic Village Cultural Center in Guizhou uses mortise-and-tenon craftsmanship and a drum tower design to combine modern functional needs with the inheritance of ethnic skills. Chongqing Hongyadong Cultural Scenic Spot builds footstools on the hillside, utilizing the difference in terrain to form commercial and viewing spaces, and preserving the original cliffs and vegetation. The Qing Dynasty royal garden is based on Kunming Lake and Wanshoushan Mountain, modeled after the West Lake in Hangzhou, with buildings built on the mountains and alongside the water, reflecting the Confucian view of landscape of “The wise delight in rivers’ flow, the virtuous in mountains’ glow”.

3.2. Green Technology Components and Variation Factors

Green science and technology refers to science and technology that enables human beings to obtain the greatest material and spiritual life satisfaction with the least carbon emissions and minimal disturbance to the natural environment. It is also a variation fac-

tor that promotes the sustainable development of nature, economy, society, and Chinese culture. Green science and technology in the field of urban and rural construction mainly consists of five categories, including ecological science, green technology, green materials, resource conservation, and green processes, which constitute the variation factors of dynamic transmutation at the first level. Based on the first level of variation factors, the second level of variation factors are identified. First, ecological science includes the ecocity science of natural harmony, ecological building science of heat, sound, and light synergy, and ecological structural science of interaction between mechanics and space. Secondly, green technology includes green design technology adapted to the terrain and climate, integrated and innovative green construction technology, and energy-efficient equipment with green operation and maintenance technology. Third, green materials include bio-based renewable materials, mineral-based harmless low-carbon materials, and metal-based recyclable materials. Fourth, resource conservation includes material savings and waste-friendly material utilization, energy savings and renewable energy utilization, land savings and intensive land utilization, and water savings and sponge site design. Fifth, the green process includes green net shape manufacturing processes, green low carbon construction processes, and green assembly decoration processes (Figure 1(2)).

The green technology variant factor realizes the renewal of the architectural heritage through green materials, green technology, and green construction. As a renewable green building material, bamboo and its composite processing technology have advantages of fast growth, high strength, and corrosion resistance, which not only reduces the dependence on traditional building materials, but also reduces the carbon emissions of the building. Bamboo has been widely used in the building walls and indoor decorative partition walls and partition components. In addition, the new mortise-and-tenon technology makes the connection between the blocks convenient and comfortable, realizing free assembly, and solving the problem of inconvenient disassembly and difficult recycling after connection and fixings between wall components under the current traditional mortar, adhesive, and other connection methods [20]. The mortise-and-tenon construction realizes high-efficiency, assembly-type green construction.

3.3. The Logical Connection Between Chinese Culture and Green Technology's Unity of Opposites

Chinese culture is a kind of historical memory of national and social identity with its own values and ethical consensus literacy, while green technology is scientific knowledge built on physical principles and logical thinking. Culture and science and technology are two core elements in design, both of which constrain and promote each other, forming a pair of contradictions [21]. The interaction between Chinese culture and green technology is not a one-way influence, but a dialectical and unified relationship. The renovation of Beijing Ju'er Hutong has preserved the historical and cultural heritage of the hutong courtyard space, while incorporating passive green energy-saving technology to significantly reduce building energy consumption. This aligns with Mendel's genetic theory of the law of cultural evolution: the cultural kernel, such as the "spatial texture", can be continued through the "variation" in green technology, rather than the "mutation" of green technology, which is not a contradiction in terms [22]. This model is also recognized in the international academic community, with Frederick Steiner pointing out that the "adaptive wisdom" of Chinese culture provides a paradigm for global sustainable design. On the one hand, green technology has promoted the transformation and renewal of Chinese culture, acting as a factor of mutation to push it forward, passing on its cultural core and replacing its backward components. On the other hand, Chinese culture has promoted the natural and human nature of green technology, reflecting on the regional, humanistic, and value-based objectives of green technology, correcting the unnatural and inhuman factors of green

technology, promoting the harmony of green technology with nature, society, and culture, and manifesting its life way of benefiting and enjoying life. Therefore, Chinese culture and green science and technology constitute an interdependent and mutually influential unity of opposites.

According to the Mendelian theory of genetic factors, biological traits are determined by genetic factors. On the one hand, genetic factors of the parent generation are copied to the offspring to ensure that they will not be eliminated by natural selection, i.e., the inheritance of organisms. On the other hand, the genes (the core of the Chinese culture), in addition to inheriting themselves, will also be subject to interference by the external environmental factors (green technology), which will lead to mutations [23]. Therefore, the core of Chinese culture is the genetic factor of traditional culture, which is inherited and relatively stable, while green technology is the variation factor of Chinese culture, which is innovative and dynamic.

Green science and technology constantly break through the development trend and expression of Chinese culture, promoting the technological expression, declaration, experience, and dissemination of Chinese culture, and enhancing the Chinese culture of sensory enjoyment and cultural tourism, resulting in a deeply related cultural and technological forms. Chinese culture has a profound impact on the value objectives and soul direction of green science and technology, promoting the harmonious development of green science and technology and human society, as well as the ultimate value objectives of science and technology of humanism [24], thereby achieving the goal of green science and technology in culture. Green science and technology catalyze the evolution of Chinese culture, Chinese culture leads the orientation of green science and technology, both aim to achieve humanities green technology. Chinese culture is the “soul” of green science and technology, inheriting humanistic values. Green technology is the “newborn” of Chinese culture, the driving force of cultural innovation and development. The two form a logical correlation which is characterized by the unity of opposites, conflict, and synergy.

4. Methodology

4.1. Research Method

The integrative–iterative architecture design mechanism is cross-rooted in system science, mathematical iteration, and genetic factor theory, comprehensively considering the main influencing factors and elements such as Chinese culture, green technology, site environment, social demand, and economic aesthetics, adopting the methods of multi-scale transformation integration, iterative deduction, genetic factor deduction, etc., so as to establish the integrative–iterative mechanism of Chinese culture and green technology in the main body, content, form, space, etc., which includes the integrative architectural design mechanism and the iterative architectural design mechanism.

The traditional Chinese construction wisdom contains the thinking logics of “one inheritance and one variation”, and culture and science and technology show the attributes of heredity and mutation, respectively. Based on the theory of heredity and variation factors and the theory of system synergy, we study the first and second level inheritance elements, corresponding design methods, and main technologies of each constituent element (genetic factors) of Chinese culture (Figure 2, left), as well as the first and second level innovation elements, corresponding design methods, and main technologies of each constituent element (variation factors) of green science and technology (Figure 2, right), so as to explore the interdependence and unity of Chinese culture and green technology, and analyze how green technology extends Chinese culture and gives new life and interest to the logic of deduction. We also analyze the translational logic of how Chinese culture grasps the moral, ethical direction, and cultural characteristics of green technology development, and reveal

the architectural design mechanism of multi-level integration, inheritance, and innovation of Chinese culture and green science and technology (Figure 2). In addition, we analyze how science and technology can be formed through the two types of integration mechanisms, in which science and technology are “culturized” and culture is “technologized” in the process of convergence and integration.

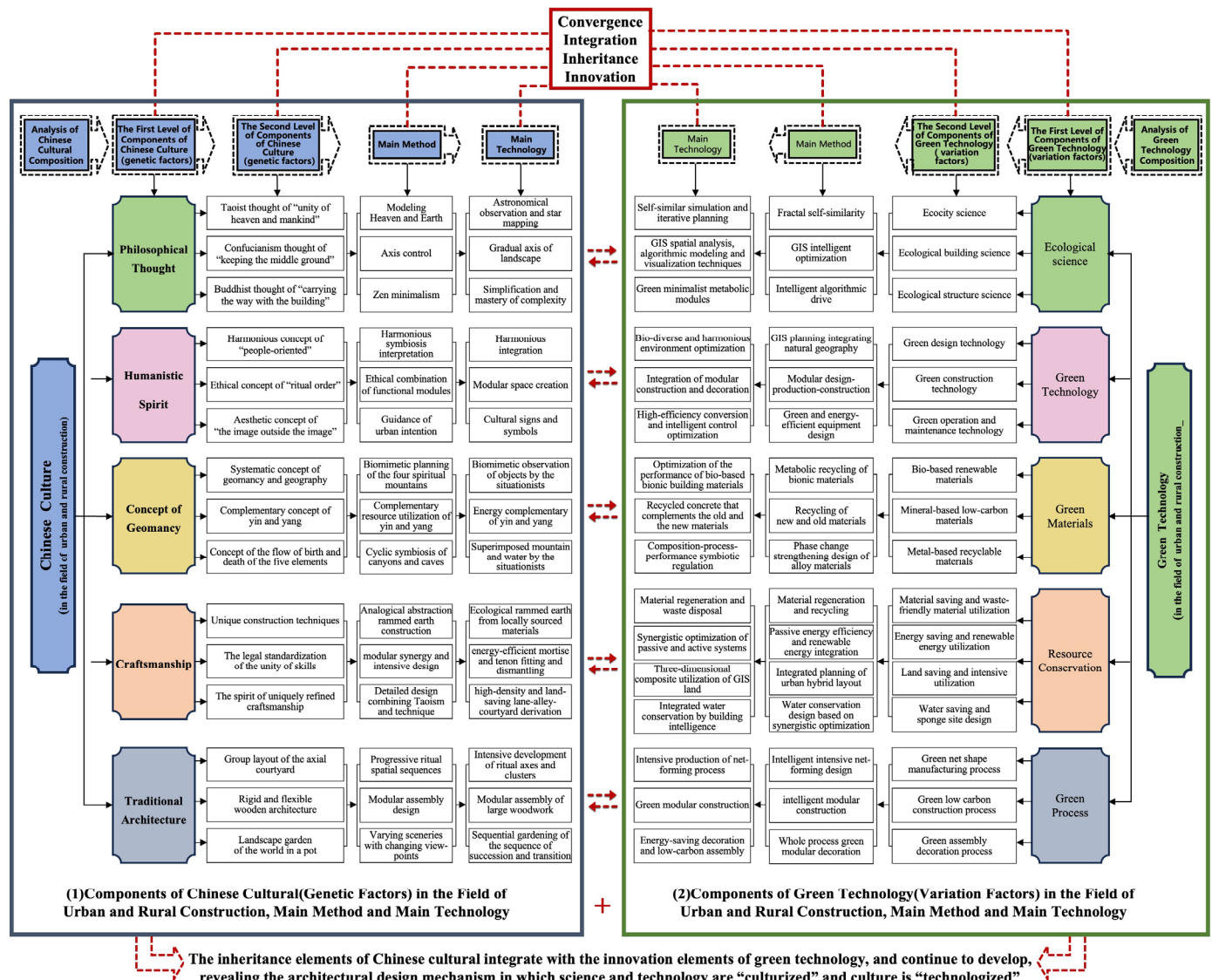


Figure 2. Deductive diagram of architectural design mechanism of Chinese culture and green technology inheritance and innovation elements and integration in the field of urban and rural construction.

4.2. Modeling

Culture and science and technology are essentially derived from human experience, wisdom, and knowledge. Culture takes society as its object and devotes itself to transforming people with “literature”, with a greater emphasis more on value rationality. Science and technology take nature as their object and are committed to mastering things with “technology”, with a greater emphasis on instrumental rationality. Every fusion of Chinese culture and green science and technology is like the combination of deuterium and tritium to produce nuclear fusion, demonstrating remarkable power, thereby promoting social, economic, and cultural innovation.

4.2.1. Genetic and Mutagenic Integration Systems

In the process of historical and cultural evolution, from the level of “Tao”, the genetic factors that maintain the basic characteristics of Chinese culture can be summarized as philosophical thinking, humanism, geomantic concepts, craftsmanship, and traditional architecture, and other major components and the genetic core. The process of cultural evolution is primarily influenced by external environmental factors such as social systems, science and technology, and ideological movements [24], of which the most central variation factor is science and technology. Contemporary science and technology have improved their unnatural attributes and evolved into green technology that is friendly to the natural environment, which can be summarized as ecological sciences, green technology, green materials, resource conservation, and green processes as the main constituent elements and the outer kernel of the variation.

From the “tool” level, both Chinese culture and green technology are presented in the form of “method” and “technique”. The “method” is the main design method, and the “technique” is the construction technology. The “method” and “technique” of Chinese culture cover the following five main aspects. (1) Philosophical thinking includes the main design methods such as modeling heaven and earth, axis control, and Zen minimalism, as well as the main construction techniques such as astronomical observation and star mapping, gradual axes of landscape, simplification, and mastery of complexity and natural authenticity. (2) The humanistic spirit includes the main design methods such as harmonious symbiosis interpretation, ethical combination of functional modules, and guidance of urban intention, as well as the main construction techniques such as harmonious integration, modular space creation, and cultural signs and symbols. (3) The concept of geomancy includes the main design methods such as biomimetic planning of the four spiritual mountains, complementary resource utilization of yin and yang, and cyclic symbiosis of canyons and caves, as well as the main construction techniques such as biomimetic observation of objects by the situationists, energy conservation, complementarity of yin and yang, and superimposed mountain and water management by the situationists. (4) The spirit of craftsmanship includes the main design methods such as analogical abstract rammed earth construction, modular synergy, and intensive design, and detailed design combining Taoism and technique, as well as the main construction techniques such as ecological rammed earth from locally sourced materials, energy-efficient mortise-and-tenon fitting and dismantling, and the high-density and land-saving lane-alley-courtyard derivation. (5) Traditional architectural ideas include the main design methods such as progressive ritual spatial sequences, modular assembly design, and varying sceneries with changing view-points, as well as the main construction techniques such as the intensive development of ritual axes and clusters, the modular assembly of large woodwork, and the sequential gardening of the sequence of succession and transition.

The “methods” and “techniques” of green science and technology include the following five aspects. (1) Eco-science includes the main design methods such as fractal self-similarity, GIS intelligent optimization, and intelligent algorithmic drive, as well as the main construction techniques such as self-similar simulation and iterative planning, GIS spatial analysis, algorithmic modeling, and visualization techniques, and green minimalist metabolic modules. (2) Green technologies include the main design methods such as GIS planning integrating natural geography, modular design–production–construction, green and energy-efficient equipment design, as well as the main construction techniques such as bio-diverse and harmonious environment optimization, integration of modular construction and decoration, and high-efficiency conversion and intelligent control optimization. (3) Green materials include the main design methods such as metabolic recycling of bionic materials, recycling of new and old materials, phase change strengthening design

of alloy materials, as well as the main construction techniques such as optimization of the performance of bio-based bionic building materials, recycled concrete that complements the new and old materials, and composition–process–performance symbiotic regulation. (4) Resource conservation includes the main design methods such as material regeneration and recycling, passive energy efficiency and renewable energy integration, integrated planning of urban hybrid layout, and water conservation design based on synergistic optimization, as well as the main construction techniques such as material regeneration and waste disposal, synergistic optimization of passive and active systems, three-dimensional composite utilization of GIS land, and integrated water conservation by building intelligence. (5) Green processes include the main design methods such as intelligent intensive net-forming design, intelligent modular construction, and whole process green modular decoration, as well as the main construction techniques such as intensive production of net-forming process, green modular construction, and energy-saving decoration and low-carbon assembly.

From the two levels of “Tao” and “tools”, Chinese culture and green technology form a subsystem of genetic factors for the inheritance and continuity of the inner core of Chinese culture (Figure 2(1)) and a subsystem of variation factors for the renewal and transmutation of the outer core of Chinese culture (Figure 2(2)). The genetic factor subsystem and the variation factor subsystem jointly construct the inheritance and innovation systems of the convergence and integration of Chinese culture and green science and technology, which implies the logic of the inheritance and renewal of “one inheritance and one variation”, which is the unification of the two and promotes the development and evolution of the integration systems of Chinese culture and green science and technology.

4.2.2. Chinese Culture and Green Technology Iterative Model

Iterative architectural design mechanism is a design logic constructed by using mathematical iteration theory and multi-scale transformation iteration method, based on the interaction between genetic factors of Chinese cultural essence and variation factors of green technology innovation, and constructed by mathematical operation and cumulative iteration logic. First, the initial spatial pattern of the architectural cultural spatial pattern or scientific and technological spatial pattern is extracted in combination with the functional requirements of the building as the initial value of other functional spaces derived from mathematical operations or cumulative iteration, which can be the multiple initial spatial patterns of the inheritance or updating factors. Second, determine the similarity and proportionality between the iterative derived space according to usage requirements, or establish a simple linear iterative function system, such as the mathematical operation iterative function in Figure 3, to build the iterative or cumulative geometric relationship logic. Third, the initial spatial pattern is directly scaled and accumulated, or input into the iterative relational function, to obtain a corresponding output result, i.e., the spatial pattern required by the design conditions, and the results obtained from each operation or accumulation iteration as the initial value of the next design iteration. According to this loop operation, a series of design space graphics that are close to the design conditions and requirements can be obtained by performing the same iterative operation steps. Finally, functional space graphics obtained by operation or cumulative iterative operation are arranged and combined according to functional, structural, and modeling art requirements to generate the overall shape of the architectural space. The iterative architectural design mechanism can be divided into the mathematical iteration mechanism and cumulative iteration mechanism.

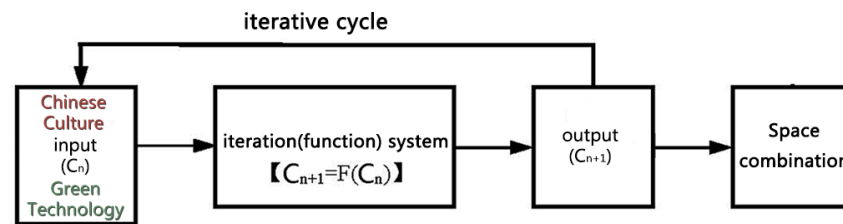


Figure 3. The first iteration: a study of the iterative principle of mathematical operations (complex operations are parameterized and iterated by a computer).

5. Discussion and Results

5.1. Architectural Design Mechanisms for the Intersection and Integration of Chinese Culture and Green Technology

Based on the theory of integration systems and synergy systems of genetic and mutagenic factors, the constituent elements of Chinese culture (genetic factors) and green science and technology (variation factors) are interdependent, mutually constrained, and mutually coordinated, together forming an architectural design mechanism of dynamic integration and development. Chinese culture is a living stream, embodying a broad-minded spirit. Rooted in China, it organically integrates with green technology, thereby simulating its innovative vitality. Green science and technology are a rushing spring with the qualities of pioneering and innovation, based on the effectiveness of human nature, pouring into the Chinese culture to activate the sentiment of life. Between Chinese philosophical thinking and ecological science, humanism and green technology, technology and art and green materials, astronomy and geography and resource conservation, and traditional architecture and green technology, these genetic and variation factors, as well as other elements of the two, are not only opposing and conflicting but also synergistic and unifying, and in the midst of opposition and unity. They are blended together, forming the architectural design mechanism of multi-level fusion, inheritance, and innovation of Chinese culture and green technology. This mechanism of convergence and integration that are inseparable ultimately fuses to form harmonious ecological science, humanistic green technology, humanistic green materials, natural environmental protection and conservation, green building technology, etc., to continue to innovate the principles and methods of architectural design.

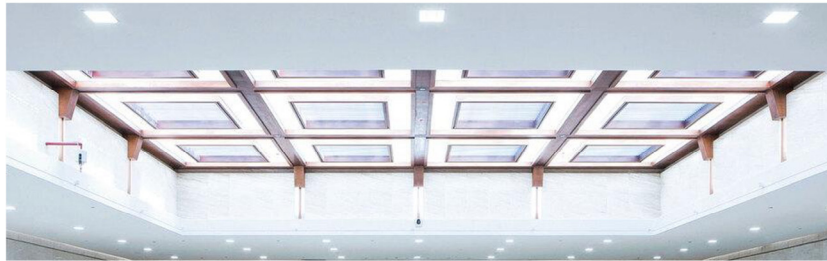
Take the Old Great Hall and History Hall of the Nanjing Museum as examples. First, the Old Great Hall of the Nanjing Museum was built in 1936. It is a hall modeled after the Liao and Song styles and is rich in Chinese culture and history. Second, the expanded History Hall preserves and inherits historical and cultural spaces and genetic factors, including a model of the courtyard culture and the axial ritual order of honor and subordination. Third, the roof form of the History Hall incorporates the genetic elements of the Chinese nine-square grid culture, while the form of the skylight canopy in the atrium is derived from the caisson form of traditional Chinese architecture. The building materials incorporate a green steel structure and photovoltaic panel technology, replacing the traditional Chinese architectural wood structure to express cultural intention, forming a lightweight steel structural space that is rich in traditional Chinese cultural elements and integrates green technology. Fourth, the detailed decoration on the exterior of the History Hall echoes the colors of the Old Great Hall, and its form is derived from traditional Chinese patterns (Figure 4).



a. Facade of the Old Hall of the Nanjing Museum



c. Exterior decoration of the History Museum



b. The atrium skylight canopy in the traditional Chinese caisson style



d. Detailed decorations with traditional Chinese patterns of History Museum

Figure 4. The embodiment of Chinese traditional culture in the Old Great Hall and History Hall of the Nanjing Museum (adapted from the following references: [25]).

The integrative mechanism of Chinese culture and green technology is shown in two major development patterns. Traditional Chinese architecture and culture have gained innovative performance and progress after being continuously injected into green technology, while green technology has gained the soul of Chinese humanism and environmental history and culture after being integrated into Chinese cultural heritage, as illustrated in Figure 5. On the one hand, Chinese culture grasps the ethical and cultural characteristics of green technology development. The humanistic spirit of traditional Chinese culture, such as “the reciprocity of heaven and man” and “natural humanity”, as well as traditional architectural spatial patterns, proportions, and scales, facade modeling, and regional cultural characteristics, are integrated into green technology and its urban environment and architectural space at multiple levels. This gives a soul to green technology and its urban and architectural space helps green technology to benefit the construction of the human environment. Green technology is no longer a cold tool, but rather a warm humanistic green technology by integrating Chinese culture.

On the other hand, Chinese culture has been extended and revitalized with a new vitality and charm through green technology. Green technology, with its advanced, innovative, and driving nature, shapes and empowers Chinese culture, and promotes its renewal and transmutation in terms of content, form, structure, and dissemination. Through its continuous integration with green technology, Chinese culture achieves leapfrog development. In short, the genetic factors of Chinese culture and the variation factors of green science and technology are interdependent and in conflict and synergy with each other, forming the architectural design mechanism and development law in which science and technology are “culturized” and culture is “technologized” in the process of convergence, integration, and unification.

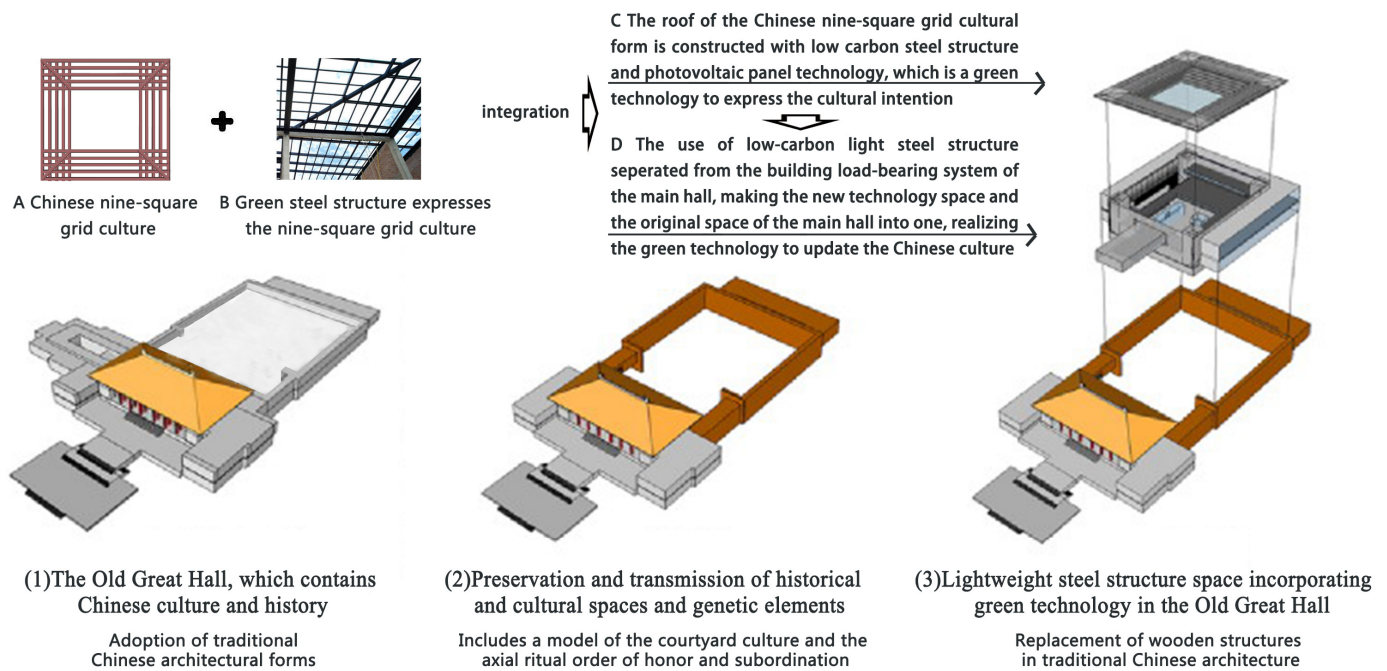


Figure 5. Schematic diagram of architectural design mechanisms for integration of Chinese culture and green technology.

5.2. Architectural Design Mechanisms for the Iteration of Chinese Culture and Green Technology

5.2.1. Type I Iterative Architectural Design Mechanism for Mathematical Operations

The iterative mechanism of mathematical operations is the logical thinking of architectural design through a repetitive feedback process and applies the design principle of approximating the design conditions and requirements through cyclic iterative operations, which can be utilized for computer-aided design. First, according to the design conditions and functional requirements, to refine the Chinese cultural characteristics of the basic unit graphics of architectural space, or rich in Chinese culture, green technology space graphics, as the initial graphics of iterative operations (Figure 6a).

Second, analyze the proportional relationship between the functional spatial pattern of the building and the initial graphic, so as to determine the scaling ratio, or (with the help of computer-aided design) to determine a simple linear mathematical iterative function formula. For example, $C_{n+1} = F(C_n)$, the independent variable C as the initial value of the architectural design graphics, typically representing Chinese cultural symbols, architectural space graphics rich in Chinese culture (genetic factors), or green technology structural space (variation factors) and other geometric shapes. These are constrained by architectural function and technology constraints, with the iterative function generally being a simple one-dimensional function scaling relationship, as shown in Figure 3.

Third, based on the design conditions, determine the basic graphic of architectural functional space (initial value) C_0 , iterate the initial cultural graphic to the above iterative function among the demonstration case in accordance with 0.8 times the scaling relationship, i.e., among the $C_{n+1} = 0.8(C_n)$, and output the C_1 spatial graphic (Figure 6b).

Fourth, based on the iterative logic of mathematical operations, the result obtained by iteration C_1 graphics are used as the input value for the next design iteration, thereby generating C_2 space graphics. This process is repeated for the implementation of the operation steps, ultimately producing a series of Chinese culture space graphics that meet different functional requirements (Figure 6b–h).

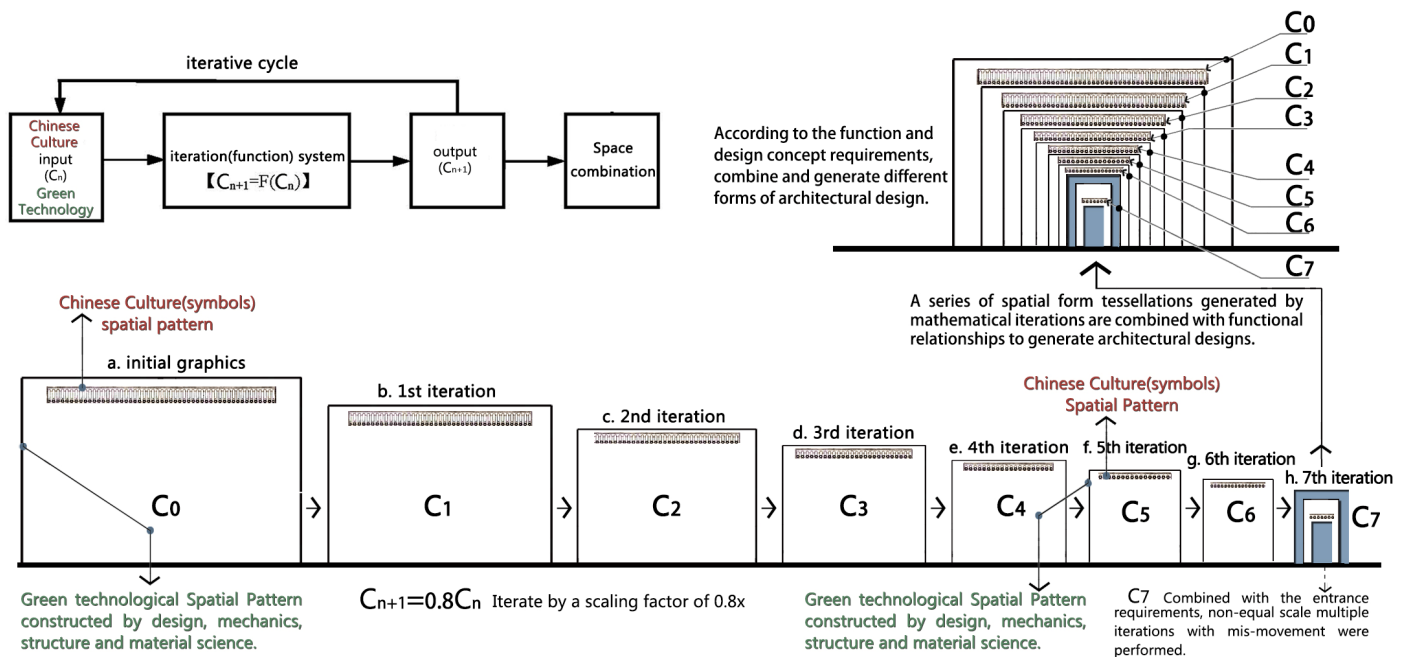


Figure 6. The first class of mathematical operations iterative architectural design logic deduction. C0 indicates the initial graphics of iterative operations. C1 graphics represent the result of the first iteration. C2 represents the result of the second iteration, and so on, with C7 representing the result of the seventh iteration. The red text in the image represents Chinese culture spatial pattern. The green text represents green technological spatial pattern.

Fifth, the space graphics formed of Chinese culture symbols and green technology can be iterated separately or combined and iterated together, based on functional, transportation, structural, and aesthetic requirements, multi-level, multi-path iterations of the Chinese culture space and green technology space. Through the architectural space permutation and combination of building space, the iterative generation of the architectural design diagram in the upper right corner of Figure 6 is formed.

5.2.2. Type II Collocation Accumulation Iterative Architectural Design Mechanism

The mathematical operation iteration mechanism is the space graphics design of Chinese culture and green technology, which follows the principle of mathematical proportional function cycle iteration logic, and integrates mathematical iteration theory into design and artistic thinking. Based on the characteristics of the design discipline, the space graphics collocation accumulation iterative mechanism is deduced [9]. The difference between the two is that mathematical iteration is based on a prior understanding of the general situation of the results, and then through iteration to approximate the functional, styling, aesthetic, economic, other requirements, and the results of the architectural design. While the collocation accumulation iterative mechanism is not clear about the final result, it borrows the logic of multiple correlation and random collocation and repeatedly accumulates the spatial patterns of cultural genetic factors and scientific and technological variation factors. As a result, it determines the unknown spatial form design result during the process of cumulative iteration and deduction.

The collocation accumulation iterative architectural design mechanism is the iterative logic and thinking of Chinese culture genetic factor space graphics and green technology variant factor, based on the function, traffic, and structural relationships step by step, via optimization of the collocation. The accumulation of the iterative mechanism, as shown in Figure 7, with the designer's conceptualization of the manuscript cultural graphics collage to the 3D male-body green technology material space graphics placed on top of

the completion of the first collocation of accumulative iterations (Figure 7(3)). The same principle of printing out the 3D female-body green material space graphics is again as a collage accumulative to the first cumulative graphics, forming the second cumulative iteration (Figure 7(5)), and so on. According to the required design conditions multi-level and multi-cycle accumulative iteration can be performed.

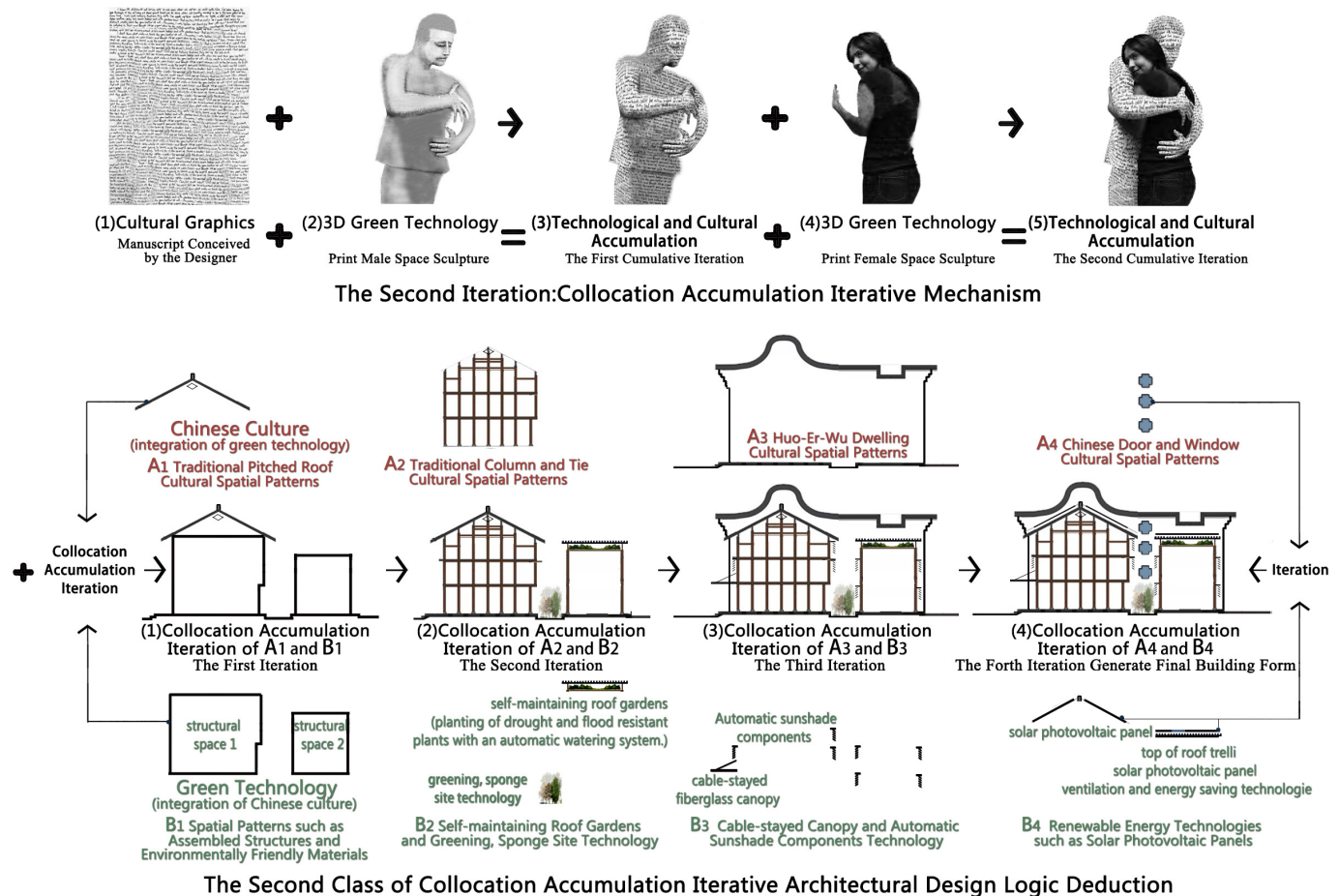


Figure 7. Collocation accumulation iterative mechanism and architectural design logic. The red text contains diverse elements of Chinese cultural spatial patterns. The green text contains green technology spatial patterns and specific green technologies.

Collocation accumulation iterative architectural design follows the above cumulative iterative mechanism, as shown in the lower part of Figure 7. At the beginning, the historical, cultural, and regional spatial characteristics of the construction site, as well as the structural science and green technology characteristics are analyzed, then the genetic factor spatial patterns of Chinese cultural characteristics (Figure 7A1–A4) and the variant factor spatial patterns of the green technology (Figure 7B1–B4) are extracted from them. Secondly, the spatial patterns of Chinese cultural characteristics and green technology spatial patterns extracted above are combined or added together to form the first cumulative iteration spatial pattern, such as the cumulative iteration graphs of A1 and B1 in Figure 7. Third, based on the spatial pattern formed by the first accumulative iteration, the green technology structural space or spatial pattern rich in Chinese cultural elements, is subjected to cumulative iteration again to obtain the spatial pattern of the second accumulative iteration, such as the accumulative iteration of A2 and B2 in Figure 7. Fourth, based on design requirements, cultural, genetic, or scientific and technological variation factors of space graphics can also continue to accumulate, either through overall accumulative or local cumulative iteration, to obtain A3 and B3 in Figure 7 which shows the cumulative iteration.

By comparing the design of the cycle of accumulative iteration results, space morphology that meets the design conditions for architectural spatial forms can be obtained. The space graphics of A4 and B4 in Figure 7 are the result of accumulative iteration. Figure 7 deduces the logic and process of collocation accumulative iteration between the Chinese cultural spatial pattern and green technology spatial pattern.

5.3. Results

The goal of the integration and iteration of Chinese culture and green science and technology is to achieve humanistic green science and technology thought and its architectural design law, together forming the architectural design mechanism and integrative path in which science and technology are “culturized” and culture is “technologized” in the process of integration, iteration, and unification.

5.3.1. Mutual Carriers and Objects Integrative—Iterative Path

The integration of Chinese culture and green science and technology follows the logical law of water–milk blending or cyclic iteration, with the two being the carrier and object of each other, showing two types of integrative–iterative paths: first, carrier and then object, and first, object and then carrier. First, integrating and iterating science and technology as the object with culture as the carrier (Figure 8(a)), using the path in which culture is “technologized”; thereby, the green science and technology (object) can be fully integrated into the Chinese cultural (carrier) core, form, structure, and dissemination at all levels, reflecting a Chinese cultural space experience with green science and technology characteristics.

The second is to integrate and iterate the culture as an object with science and technology as the carrier (Figure 8(b)), using the path in which science and technology are “culturized”, to integrate Chinese philosophical thought, humanistic spirit, and traditional architectural essence (object) into green technology (carrier) and its urban environment and architectural space at multiple levels, showing a green technology habitat characterized by the Chinese humanistic spirit. The two integrative paths are each other’s first and last, each other’s carrier and object. Regardless of which integrative–iterative path is ultimately taken, both lead to the architectural design logic thinking of Chinese humanities green science and technology.

5.3.2. Multi-Level Integrative—Iterative Path

Chinese culture is multi-level, which can be divided into material culture level and spiritual culture level. The former is the carrier and specific expression of Chinese culture, while the latter is the cultural core of Chinese culture, such as ideology, spirit, and values. Each level can also be divided into sub-levels and further sub-levels. Similarly, green science and technology can also be divided into different levels. Figure 8(1) and (2) show two levels of genetic factors in Chinese culture and two levels of variant factors in green science and technology in the field of urban and rural construction, respectively. Multi-level determines the multi-level intermingling path between the two.

The multi-level integrative—iterative path of Chinese culture and green technology also reflects the corresponding structural hierarchy. Macroscopically, the five main genetic factors of the first level of Chinese culture which contains philosophical thought, humanistic spirit, concept of geomancy, craftsmanship, and traditional architecture, and the five main variants of the first level of green technology which contains ecological science, green technology, green materials, resource conservation, and green processes, can be integratively and iteratively designed at the same level and with multiple paths (Figure 8(3)).

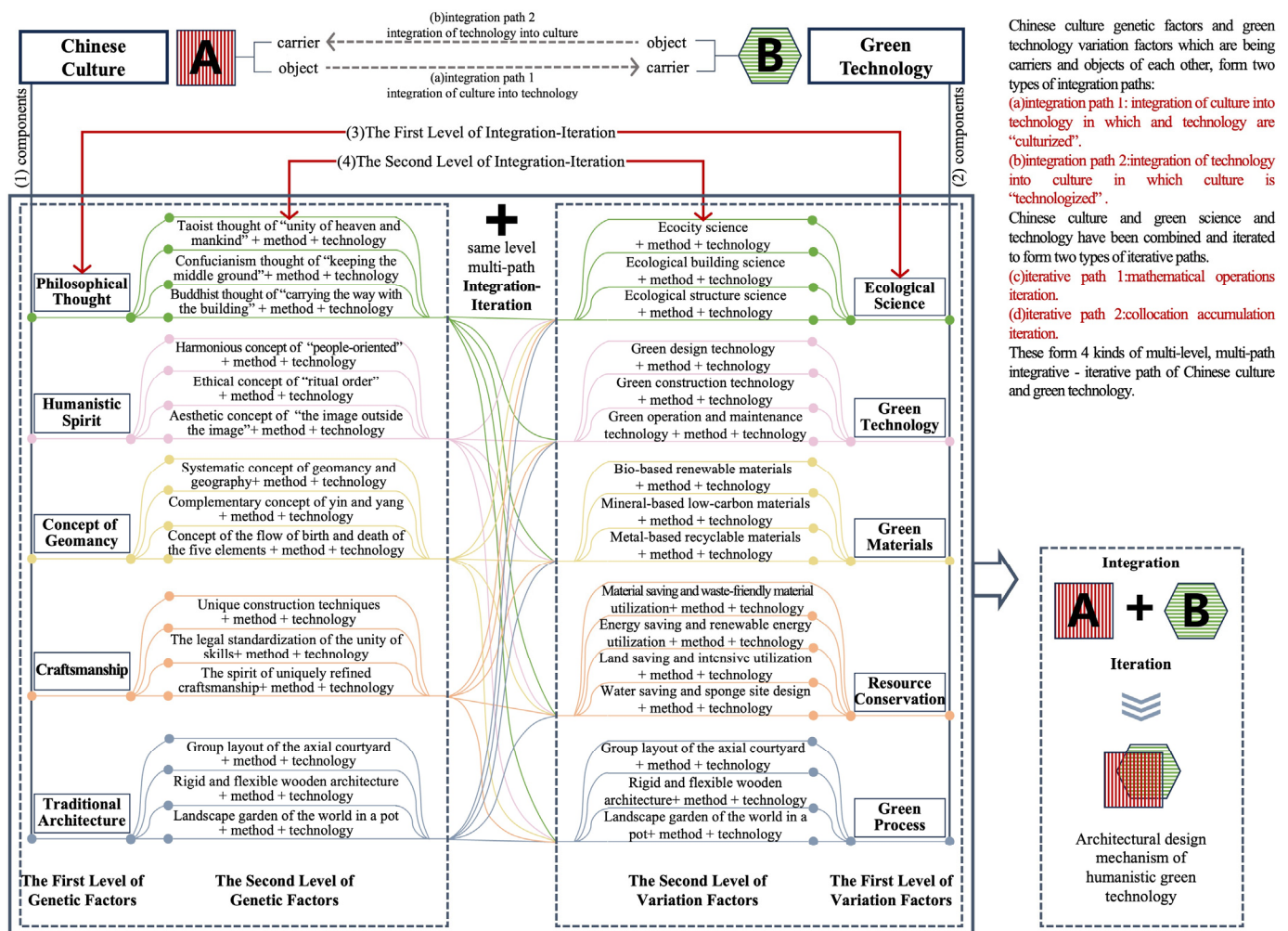


Figure 8. Multi-path integrative-iterative architectural design logic path of Chinese culture and green technology. The colored lines in the figure indicate that genetic factors at the first and second levels of Chinese culture can be integrated and iterated with any variation factor at the same level of green technology, thereby forming multi-path integration and iteration paths at the same level.

Mesoscopically, the five genetic factors of the first level of Chinese culture can be further divided to form the second level of cultural genetic factors. Similarly, the five variation factors of the first level of green technology can be further divided to form the second level of technology variation factors. There is a same-level, multi-path integrative-iterative design between the second-level genetic and variant factors of culture and science and technology (Figure 8(4)).

Microscopically, the same hierarchical, multi-path integrative path exists between Chinese culture and green science and technology at the third, or even deeper level, or between the micro-cultural space and the micro-scientific and technological space. Therefore, the multi-level, multi-path integration-iteration of culture and science and technology ultimately forms the humanistic green technology design logic that are inseparable (Figure 8, right).

5.4. Practical Applications and Limitations

The convergence and integration of Chinese culture and green technology has been reflected in today's architectural design practice. For example, the Chinese Pavilion at the 2010 Shanghai World Expo demonstrated the integration of green technology by combining plastic arts and passive technology [21]. The frame form of the China Pavilion ingeniously

combines traditional Chinese architectural components with passive green shading technology, creating a layer-by-layer overhanging self-shading architectural art form. At the same time, the elevated ground floor enhances the natural ventilation effect, and the top floor is paved with solar photovoltaic panels, realizing energy conservation and renewable energy utilization (Figure 9a). The China Pavilion frame and air-conditioning system are designed in an integrated manner, and Chinese seal elements are incorporated into the design of the air-conditioning ventilation holes, transforming the Chinese seal symbols into practical ventilation structures (Figure 9b). In addition, the China Pavilion adopts the green technology of a sponge site to improve the building environment through eco-roofing, and the roof adopts the rainwater collection system to realize the rainwater used for the air-conditioning recharge of the project, the watering of the green landscape, and the flushing of the garage (Figure 9c). The China Pavilion skillfully combines architectural space and modeling art rich in regional cultural elements with passive green technology, solving the problem of passive key green technology such as spatial modeling design that fully integrates topography and climate, lighting and ventilation, shading, and heat insulation.



Figure 9. Green technology integration of plastic art and passive technology in the Chinese Pavilion (adapted from the following references: [21]).

In architectural design research on the integration of Chinese culture and green technology, it is necessary to clarify the structural boundaries of its scope of application. The core evaluation system for functional and technically oriented building types (e.g., standardized housing, modern industrial plants, etc.) focuses on spatial efficiency, engineering specifications, and technical indicators, while cultural inheritance is usually listed as a non-essential dimension. The design logic of these building types is more inclined to solve practical needs rather than cultural expression, so the findings of related studies have limited applicability to these types of buildings.

6. Conclusions

Chinese culture is not only rich in the green science and technology thought of “reciprocity between heaven and mankind”, but also full of the humanistic science and technology care of “matching nature”. Green technology continues to renew and spread the evolution of Chinese culture. The way of science and technology and the way of heaven and man are internally consistent. Chinese culture gives green technology humanity and soul, while green technology promotes the evolution and renewal of Chinese culture. Philosophical thought, humanistic spirit, concept of geomancy, craftsmanship, and traditional architecture of Chinese culture form the genetic factors that are passed on from one generation to the next, while ecological science, green technology, green materials, resource conservation, and green processes of green technology form the dynamic transmutation of the variation factors. They jointly construct the interseptive and integrative system for the

inheritance and renewal of the Chinese culture and green science and technology. The multi-level integrated architectural design mechanism deduced by oppositional unity, the conflict and synergy of the two, is essentially the architectural design mechanism and development law in which science and technology are “culturized” and culture is “technologized”.

The iterative architectural design is rooted in the interaction between the genetic factor of Chinese culture and the variation factors of green technology innovation, mathematical operation, and cumulative iterative logical thinking. The iterative mechanism of mathematical operations is the logical thinking of architectural design through a repetitive feedback process and applies the design thinking that approaches the design conditions and requirements through cyclic iterative operations, iterating the Chinese culture space and green technology space in multiple levels and paths, and computer-assisted iterative design can be utilized. The iterative mechanism is an iterative idea and method to optimize the integration of Chinese culture genetic factor space graphics and green science and technology variation factor space graphics according to the functional, hierarchical, and structural relationships of level-by-level accumulation. In the process of the convergence and integration of Chinese culture and green science and technology, there are two kinds of logical deduction processes: forward and reverse integration, forming the integrative–iterative path as mutual carriers and objects in multi-levels and multi-paths.

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