Politecnico di Milano

Whole Life Cycle Oriented Temporary Exhibition Design for Sustainability

Student ID:	10621328
	894634
Name:	Bao Jiaqi
Supervisor:	Davide Fassi
Co-Supervisor:	Zhu Xiaocun

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Bao Jiaqi

College of Design,Politecnico Di Milano, Milan, Italy

College of Design and Innovation, Tongji university, Shanghai, China

Abstract: In the digital era, "information" is an important component of social development and progress. People's increasing demands on the quality of information make exhibition activities develop rapidly. There are about 700 temporary exhibitions being hosted in Shanghai each year. Because of the limited time of the exhibition, the waste of exhibitions is turning into a huge problem, which increases the environmental burden seriously. For design colleges, temporary exhibition is an important way of communication and education. The temporary exhibition in design colleges has a subtle influence on future designers. It is necessary to take the temporary exhibitions in design colleges as the experimental touch point for optimizing sustainable design for temporary exhibition.

The main research question addressed in this paper is how to provide effective sustainable design guidance for temporary exhibitions according to Life Cycle Assessment. The main question raises the following research challenges: how to conduct a phased lifecycle assessment of complex and developing events? How can the lifecycle approach be used to make proactive sustainability decisions about design? How to raise public concern about the sustainability of temporary exhibitions?

In this context, according to the literature research on life cycle assessment methods and desktop research and practical investigation of temporary exhibitions, the author divided the complex system of temporary exhibitions into several products from the perspective of life cycle, and developed a characteristic

life cycle assessment method for temporary exhibition. Combined with the summary and data collection of temporary exhibition material to establish a reliable material database. According to the evaluation results of life cycle assessment in two temporary exhibitions which happened in the same site of Tongji University, the author concluded the key units of environmental impact of temporary exhibition. The conclusion provides sustainable decisions for designers in different stages of exhibition design. A common sustainable evaluation is developing through further simplification of the framework, making the sustainable certification be understood and concerned by the public. Therefore, the sustainable exhibition design system oriented to whole life cycle is established, which is composed of the guidance of sustainable exhibition design and the simplified assessment of temporary exhibition, as well as the open data platform for sustainable exhibition. the guidance of sustainable exhibition design is used as the decision-making basis of sustainable design. The practice of sustainable exhibition design needs to be examined by the certification of life cycle assessment. And all the cases could be collected in the open data platform.

The sustainable exhibition design guidance and evaluation is still in the early stage and will be improved in the practice of temporary exhibition in the future. The results of open practices will be collected and summarized, so that the framework will be expanded from shallow and uncontrollable design guidance to an open innovation platform of sustainable design for temporary exhibition. Designers can learn sustainable design from the framework, so as to promote the emergence of new ideas and methods, and achieve sustainable innovation.

Keywords: life cycle assessment, temporary exhibition, sustainable exhibition design, open innovation platform for exhibition design.

Content

Background

1.1 Global environmental crisis

Today, the world is facing an unprecedented environmental crisis, no matter where you live or what social class you are in. (Intergovernmental Panel on Climate Change [IPCC] , 2007 ; World Commission on Environment and Development, 1987). Greenhouse gas emissions, resulting in a catastrophic rise in global climate temperature. It is estimated that the earth has shown a long-term warming trend since the industrial age. The global average surface temperature (GMST) observed by the IPCC for the decade 2006-2015 is about 0.87°C (the lowest value is 0.75°C and the highest value is 0.99°C), which is about 1.0°C higher than the average value of 1850-1900 (pre-industrial). If the increase continues with the current rate, the global temperature is likely to rise by 1.5°C between 2030 and 2052 (IPCC, 2018). The ecosystem of the earth is being destroyed and the biodiversity of the earth is threatened. At the same time, the frequency and severity of natural disasters are increasing (Brophy & Wylie, 2008).

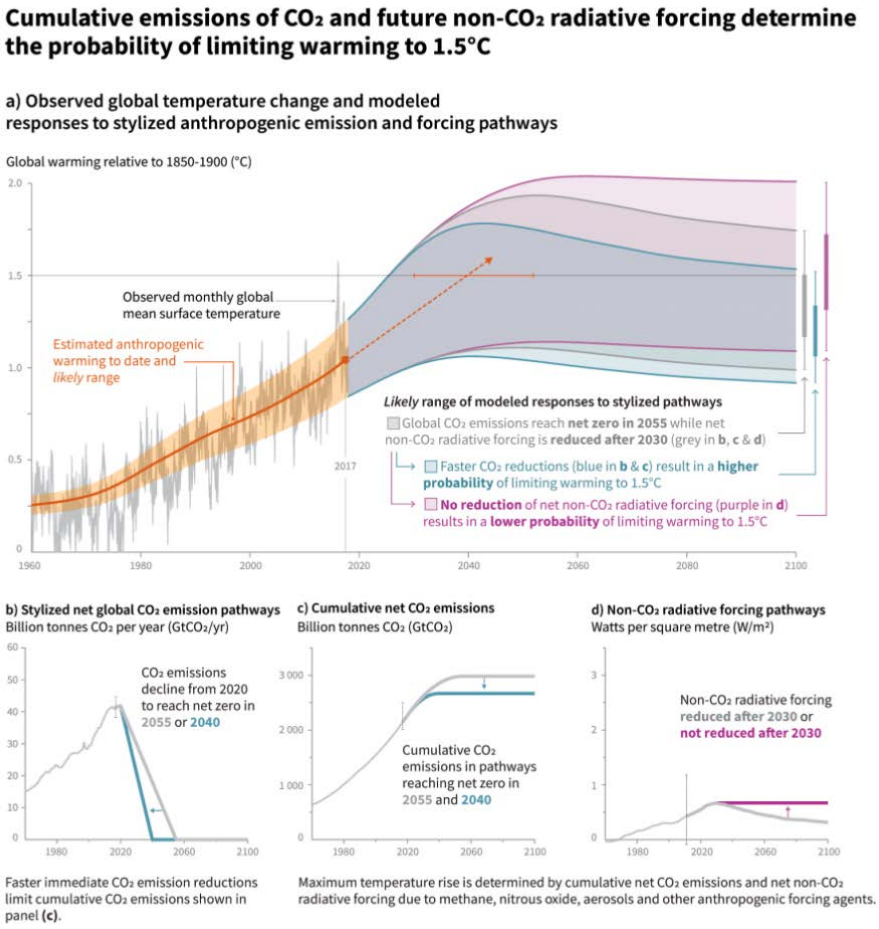

Figure 1: The world is likely to warm by 1.5°C between 2030 and 2052 (resourse: IPCC, 2018)

1.2 Sustainability

1.2.1 Definition of sustainability

Sustainable development has been defined in many ways, but the most frequently quoted definition is from Our Common Future, also known as the Brundtland Report: Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (the World Commission for Environment and Development [WCED], 1987). Carlo Vezzoli and Ezio Manzini gives the following definition for environmental sustainability. The term environmental sustainability refers to systemic conditions where neither on a planetary nor on a regional level do human activities disturb the natural cycles more than planetary resilience allows, and at the same time do not impoverish the natural capital that has to be shared with future generations(Carlo Vezzoli & Ezio Manzini, 2008).

1.2.2 Definition of sustainable design

Different from traditional "material goods" which gives priority to the design of the output, "Sustainable design" builds a "Sustainable solutions" to meet specific needs of consumers through the integration of the "products and service". It emphasizes "achievement" and "benefit" instead of "material products" production consumption. At the same time it aims on reducing resource waste and environmental pollution, and considering improvement of quality of people's life as the ultimate goal (Ezio Manzini, 2001). Therefore, designers are no longer merely entrusting agents, but need to assume more responsibility for changing society and solving problems, and design covers more and more fields.

1.2.3 Life cycle

The whole process of temporary exhibition from production to abandonment is regarded as the whole life cycle process of a complete temporary exhibition.

Life Cycle Assessment (LCA) is a method to evaluate the environmental load associated with the whole Life Cycle system of a product or activity. The assessment covers the entire life of a product, activity, or system, including process of extraction, manufacture, transportation, distribution, use, reuse, maintenance, recovery, and final disposal. Life cycle assessment is an objective approach to assess the environment impact of energy, material and emancipation by identifying and quantifying energy, material and emission. LCA highlights the entire process where a product or activity occurs, and the different ways and degrees each stage’s impact on the environment. Life cycle assessment is not only about the environment, but also about energy and economics.

1.3 Temporary exhibition

1.3.1 Concept of temporary exhibition

Exhibition is a social activity that displays some works or achievements in designated places. Display behavior is a planned and organized high-density information gathering, communication and dissemination activity. The goal of the exhibition is to effectively convey information to target audience and obtain timely feedback. (Wu Aili, 2009) According to the length of the exhibition can be divided into: long-term exhibition (permanent exhibitions about annual terms), medium-term exhibition (exhibitions about 3 months to 12 months) and temporary exhibitions (exhibitions about 2 weeks to 3 months).

1.3.2 Current situation and problems of temporary exhibition industry

Exhibition industry in China is rapidly developing. The number of exhibitions, the size of the venues and other aspects are continually growing. Among them, short-term temporary exhibitions count for more than 80% of the total number of exhibitions.

Data from the China Exhibition Economic Development Report 2018 shows that by the end of 2018, a total of 4,312 exhibitions were held, which was 290 more exhibitions than them in 2017, with a total exhibition area of 146.3 million square meters. In 2018, the development trend in major exhibition cities is positive. Shanghai, Beijing and Guangzhou are the most important exhibition cities in China, ranked as the top three in both the number and area of exhibition, among which Shanghai has the prominent advantage. A total of 741 exhibitions were held in Shanghai, accounting for 19.5 percent of the total number of exhibitions in China. After those short-time period exhibitions, the material waste became a serious problem.

1.4 Research questions

1.4.1 Research subjects

This research focus on temporary exhibitions.

The study was limited to short-term exhibitions ranging from 2 weeks to 3 months with a one-time construction and demolition in indoor spaces, focusing on smaller temporary exhibitions. This study took the temporary exhibition in college of Design and Innovation of Tongji University (D&I) as an example. Since its relocation in 2014, D&I has been holding about 30 temporary exhibitions per year. From the content of the exhibition, the exhibitions of D&I are mainly for knowledge communication and education needs. In addition to designing the curriculum for the students from colleges, there are many participants such as artists, designers and related companies. Exhibitions are generally held in the public spaces of D&I. Due to site restrictions, they are generally small exhibitions and would last only a relatively short period of time, typically no more than one and a half months. The largest-scale temporary exhibition is the graduation exhibition of D&I in mid-June. The exhibition will

occupy all public areas, using an area of about 700 square meters, and the exhibition will last for about 3 weeks. Starting with small-scale knowledge dissemination exhibitions is to conduct a validity check on the characteristic life assessment methods of temporary exhibitions, and provide design schools with a sustainable display design guidance from a full life cycle perspective. A design college's exhibition is not only a disseminator for information, but also an educator for the public. A large part of the design college's exhibition audience is active or future design practitioners. As one of the top design colleges in the world, D&I has the responsibility of designing cutting-edge education and designing to promote social development. There is an unshakable responsibility for the propagation of sustainable ideas and the education of sustainable design. Taking D&I as an example, it is of great significance to propagate sustainable design methods, and to establish sustainable design awareness.

1.4.2 Range of research

First of all, sustainable development covers social, economic and environmental aspects. Ecological sustainability is the foundation of social, economic development and operation. Therefore, this study focuses on the issue of sustainable ecological environment.

The scope of this study includes, but is not limited to the full lifecycle process of events that occur under temporary circumstances: the production phase, the installation phase, the use phase, and the obsolescence phase of temporary exhibitions.

This study focuses on the design phase before temporary exhibitions: how does the information depend on the carrier? How is the carrier displayed in a specific space? How are the material carriers connected? Is it easy to dissemble after the exhibition? Does the disassembly process destroy the exhibit? Can material materials be recycled and reused? Is it possible to control the environmental impact of waste? It need to be considered in advance at the display design stage.

This study uses life cycle assessment methods to quantify the impact of energy, material use and release on the environment by quantifying energy, material use, and environmental emissions at different stages of the temporary exhibition. This will find the key points that have a negative impact on the environment at different stages of the exhibition's life cycle. In the design stage of the pre-exhibition life cycle, corresponding improvement methods are proposed.

1.4.3 Research questions

The core research question in this study is as follows : How to provide effective sustainable design guidance for temporary exhibitions based on life cycle assessment methods? The following research and design difficulties can be raised: how to conduct a life cycle assessment of complex developmental events by phase? How to use the life cycle approach to make defensible decisions for design in advance? How to educate the public about the sustainability of temporary exhibitions?

1.5 Research Method

The main research methods in this paper are life cycle assessment methods and empirical research methods. The author believes that in today's design practice, designers tend to focus on the human experience during products using or activities, while ignoring the environmental impact of the production, installation, use and disposal of products.

Life cycle assessment is a target method to assess and achieve improvements by identifying and quantifying energy, material use and emissions to the environment. With the life cycle assessment method, the impact of the whole process or different stages of a temporary exhibition on the environment could be obtained in terms of different means and degrees.

Empirical research is a research method developed to propose theoretical hypotheses or test theoretical hypotheses. In this study, the biased design decisions resulting from life cycle assessments were validated.

At the same time, this study used the literature research method, through collecting and reading documents and materials, to understand the research situation in this field at this stage, and to seek a blank in the research field. The author is located in Shanghai, the most pioneering city in the domestic exhibition industry. Based on local social research in Shanghai, we could understand the latest developments in the exhibition field in the society, the main problems of today's exhibitions, and summarize the features and future development of current exhibitions, especially temporary exhibitions. In the course of the research, experts from the industry were asked to supervise my research.

1.6 Literature review

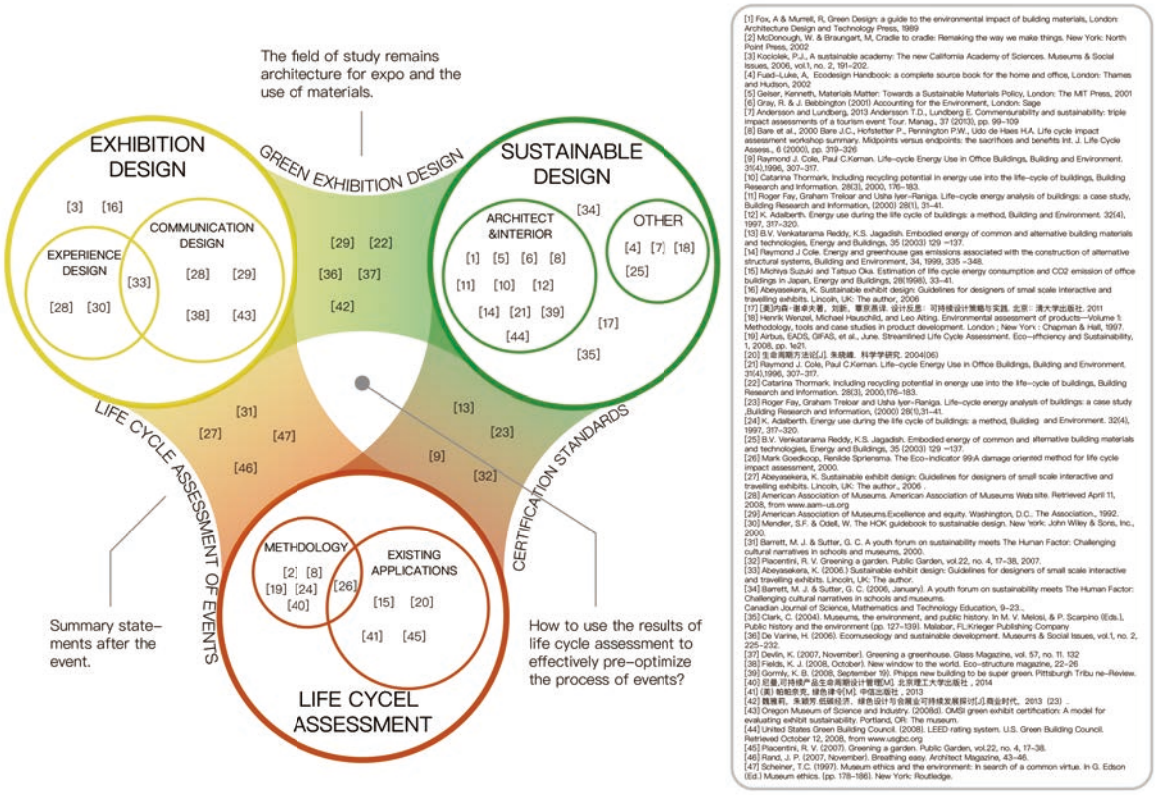

Figure 2: Map of Literatures

At present, as an approach of information propagation, exhibitions need to take the responsibility for raising public green ecological awareness. Sustainable design has been well studied in the architectural and interior areas, but there is still plenty of room in the sustainable design research. Current research is mainly focused on the usage of construction materials for exhibitions. Among those areas using life cycle assessment methods, environmental impact assessments of products and constructions are already commonly considered. At home and abroad, there are also life cycle assessments of the overall events such as the Barcelona Expo and the Shanghai World Expo, but they are summative statements afterwards. How to use the results of the life cycle assessment to effectively optimize the event process in advance is still a gap in the field.

1.7 Framework of research

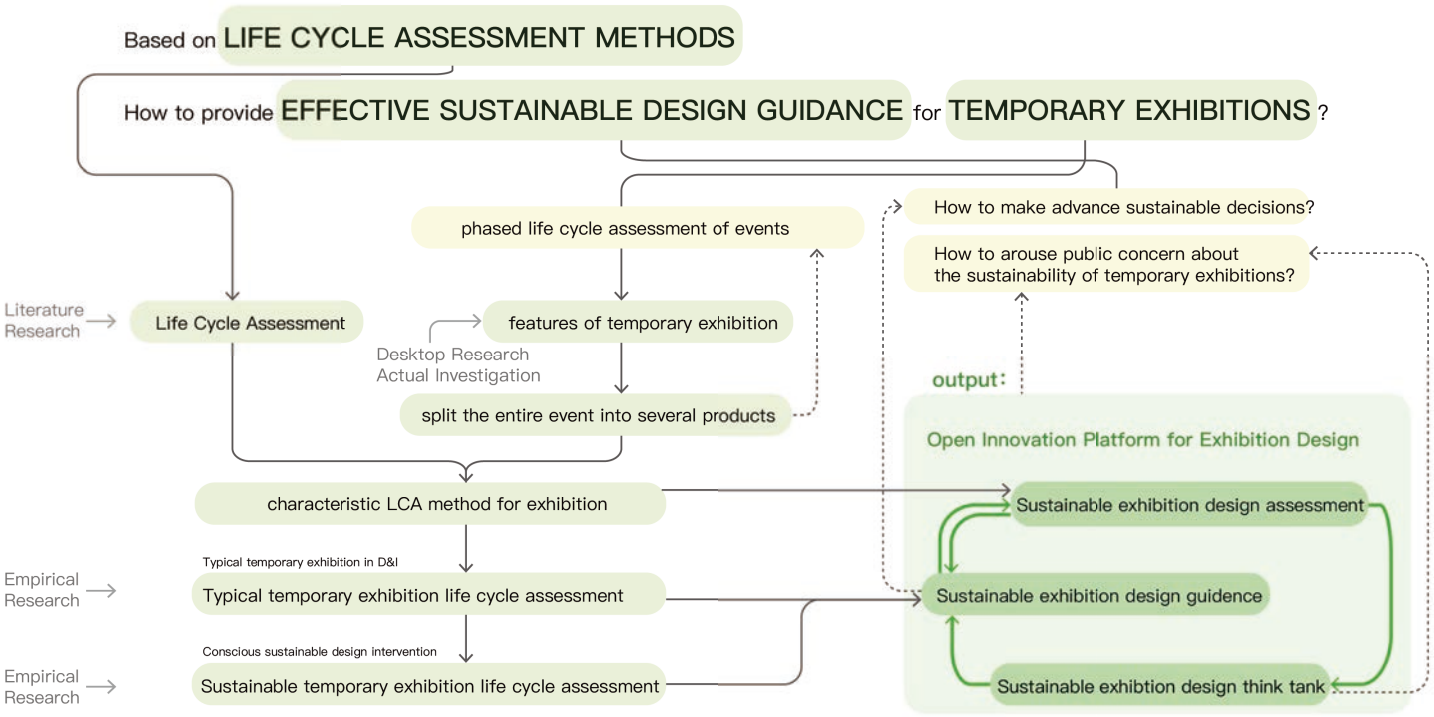

Figure 3: Framework of Research

This chapter forms the basis of research. This research is originated from the environmental problems brought by the emergence of a large number of temporary exhibitions. The sustainable design method is to deal with the common problem of massive waste in the exhibition industry, and the life cycle assessment method can help find the crux of the environmental impact of the exhibition. The author established a design-production-installation-use-disposal life cycle assessment model for the exhibition to evaluate correctly whether the use of the life cycle assessment method is effective for improving the environmental impact of the temporary exhibition. This results in the most important research question in this study: how to provide effective sustainable design guidance for temporary exhibitions based on life cycle assessment methods? In this context, based on the literature research about the life cycle assessment method and the actual on-site research on the temporary exhibition, the author divided the complex system of temporary exhibition into several separate parts from the perspective of life cycle, and formulated a life cycle assessment method for temporary exhibition. Combined with the summary of the temporary exhibition materials and data, a relatively reliable database of physical materials was established. Through empirical research, the author compared the life cycle assessment and evaluated results of two temporary exhibitions conducted by D&I, and then concluded the key elements of the environmental impact of the temporary exhibition's life cycle to provide decision reference for sustainable display design. Based on this, a sustainable design guiding framework is proposed to help designers to continuously monitor different stages of the momentary exhibition during the design stage of the temporary exhibition. Through the

further simplification of the evaluation framework, a universal sustainability assessment standard is established for the temporary exhibitions, and public awareness is raised. This led to the establishment of a sustainable design guide and evaluation system for life-cycle transient exhibitions consisting of a physical materials database, a life-cycle sustainable design guide framework and a simplified temporary exhibition life cycle assessment methodology. Temporary exhibitions' physical materials and exhibition life cycle database could serve as the basis of decision reference for sustainable design guidance. Sustainable design practices require simplified life cycle assessment certification, and sustainable certification practices will continue to be included in the database.

Life cycle assessment

2.1 Basic concepts of life cycle assessment

Life cycle assessment covers the entire life cycle of a product, an activity or a system. Life cycle assessment is used to recognize the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle (ISO 14040, 2006).

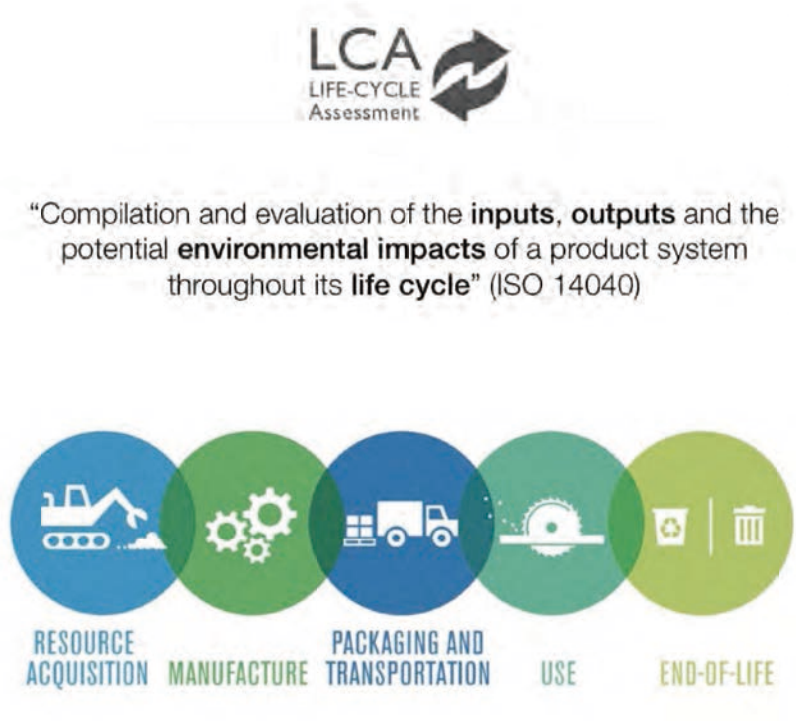

Figure 4：Product Life Cycle (Source: GIGA Green)

2.2 Methodological framework and steps for life cycle assessment

According to the ISO 14040 definition of life cycle assessment, there are four steps, purpose and scope identification, inventory analysis, impact assessment and interpretation of results. The explanation of the interpretation of the life cycle is two-way, and the overall research structure can be continuously adjusted.

(1) Objectives and scope: Firstly, the basic information collection of the product, including the nature, function and production system of the product, to identify the purpose and objectives of the life cycle assessment. Second, determine the system boundary at which the product has to be evaluated. The system boundary is the boundary of the life cycle, which is, the definition of the process from input to output and from start to end. Third, the method of

assigning system input and output. At this stage, in order to ensure the clarity of the process and the integrity of the data collection, detailed system diagrams have to be drawn.

(2) Inventory analysis: analysis of resources, energy inputs, and waste emissions within the entire cycle of the activity. The list is a quantitative data analysis. The focal point of the inventory analysis is to identify the types of data to be collected and collect valid data.

(3) Impact assessment: The impact assessment is to analyze and evaluate based on the combination of the environmental impact types of life cycle assessment and the results of the analysis in the substance list.

(4) Life cycle interpretation: it's to objectively analyze the data and draw conclusions according to the data and findings obtained in the first few steps of the LCA. Due to the difficulty in data collection, usually the assessment results have certain limitations in life. In the interpretation of the cycle, limitations need to be explained and suggestions need to be done to produce a final concluding report. The purpose of life cycle interpretation is to produce well-founded and understandable conclusions through complicated data calculations, and look for potential stages and optimization directions from the data at each stage.

Data calculations in steps 2 and 3 are beyond the ability of non-professionals. It recommends to seek experts or professional software for calculation assistance. Built on the recommendation of Mr. Gong Wanbin, a life cycle assessment expert, this paper used the Chinese version of Simapro calculation software for the 1 meter 1 full life cycle green manufacturing platform for auxiliary calculation. The calculations and results will be shown in Chapter 3 and in the appendix.

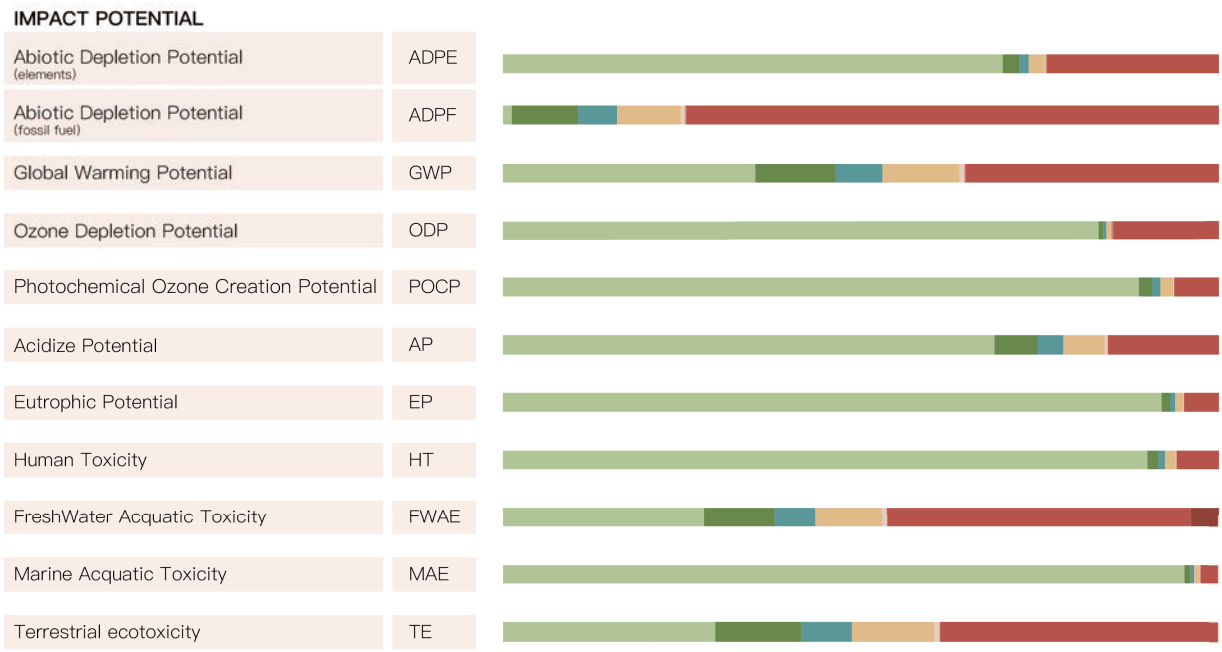

Figure 5: Environmental Impact Types in CML Model

Table 1: Explanation of CML models

Types of environmental impacts in CML models		
Environmental impact types		**Causes and main hazards**
Name	**Abbreviation**	
Abiotic Depletion Potential (element)	ADPE	Abiotic resources
Abiotic Depletion Potential (fossil fuel)	ADPF	Abiotic resources, such as ores, fossil fuels, etc.
Global Warming Potential	GWP	The GWP reflects the mixed effects of greenhouse gases in the atmosphere and the intensity of infrared radiation they emit.
Ozone Depletion Potential	ODP	The F, Br, and C1 atoms produced by the persistent gaseous compounds discharged into the atmosphere are enriched in the stratosphere, which after a certain period of time causes the ozone concentration in the stratosphere to decrease, which results in the enhancement of ultraviolet radiation on the earth's surface and threatens human health.
Photochemical Ozone Creation Potential	POCP	Natural or man-made volatile organic compounds (VOCs) undergo an oxidation reaction in the presence of light and NOx, and photochemical oxides form photochemical smog. Photochemical smog will not only reduce the primary production capacity of aquatic and terrestrial plants, but also affect the respiratory function of humans and animals.
Acidize Potential	AP	Acid gas emissions are washed away and dissolved by rain and snow in the high air to form acid rain, which causes acidification of soil, rivers and lakes, affects fish growth and reproduction, endangers forest and crop growth, erodes buildings and cultural relics, and endangers human health.
Eutrophic Potential	EP	Including water eutrophication and land eutrophication. For aquatic ecology, excessive discharge of nitrogen, phosphorus and other nutrients causes a large number of aquatic organisms, especially algae, to cause a dramatic change in dissolved oxygen concentration and cause water pollution. For terrestrial ecology, excessive nitrogen emissions interfere with the nutritional balance of plants, leading to a decline in plant productivity, which may have an impact on plant communities and biodiversity.
Human Toxicity	HT	Human toxicity refers to health problems caused by human exposure to toxic substances, including acute toxicity, allergies, carcinogenesis, and neurotoxicity. For example: NOX and SOX irritate people's eyes, mucous membranes, trachea, and lungs, causing red eyes, tears, headaches, asthma, and cough, which endanger human health.
Fresh Water Acquatic Toxicity	FWAE	Ecotoxicity mainly refers to the harmful potential of atmospheric pollutants, heavy metals, toxic organics, and inorganics to terrestrial and aquatic plants. Ecotoxicity of toxic substances It depends on their emissions in the ecosystem and their lethality to the environment. The degradation rate of toxic substances will affect the probability of its toxicity to the target organism and its toxic effect. According to different natural ecosystems, ecological toxicity can be divided into terrestrial ecological toxicity, freshwater ecological toxicity and marine ecological toxicity.
Marine Acquatic Toxicity	MAE	
Terrestrial Ecotoxicity	TE	

The results of data calculation by LCA calculation need to be related to the corresponding environmental impact potential value, which is, the process of establishing a model based on the impact type to facilitate the summary of the last results from the same category. The characterization factors could indicate the state of environmental emissions or resource consumption. For global warming, the global warming potential (GWP) of a substance is chosen as a characterization factor. The IPCC uses carbon dioxide as a reference, and the characterization factor converts that the potential impact of other substances to equivalent amount of carbon dioxide. In this paper, the CML ecological impact assessment method only classifies and characterizes the inventory analysis results to obtain different types of environmental impact indices.

2.3 Limitations of life cycle assessment of activities and events

The practice of life cycle assessment of activities and events has been mentioned in the Section 1.7.4. This is the supplemental materials to the complexity of the life cycle assessment for activities and events and the existing methods of operation. Early life cycle assessments are only used to evaluate products. The objectives and scope of the assessment are clear. And the process of product manufacturing is relatively fixed and does not change with the environment or participants. Therefore, life cycle assessment of products is relatively easy. The life cycle assessment of an activity or event is a complex system involving multiple variables such as time, space, participants, material resources used, and energy. According to the author's analysis of the life cycle assessment of existing events, it was found that the data collected in the life cycle assessment of existing events are only the statistical values after the event, which is difficult to reflect the behavior of the environment at different stages of the event. Therefore, it is difficult to produce a decision-making pre-judgment conclusion.

2.4 Limitations of life cycle assessment methods

Although relevant institutions and organizations have widely accepted and understood the life cycle assessment methods, there is still no well-accepted agreement on specific operations, which directly leads to many unavoidable problems in life cycle assessment practice.

First, subjectivity could directly affect the objectivity and completeness of the evaluation. The reason behind is the unclear definition of the academic background, which directly affects the accuracy of the relevant evaluation.

Secondly, the related work of data is a very resource-intensive process. The improper use of resources is likely to lead to inaccurate statistics and analysis of data, thus affecting the validity of life cycle assessment.

Third, in the process of evaluating environmental impacts, due to the unfamiliarity of the relevant principles and mechanisms, it is likely to include subjective factors, resulting in non-unified standard and affecting the effectiveness of the evaluation of the whole life cycle.

Life cycle assessment model for temporary exhibitions and establishment of material database

3.1 Overview of temporary exhibition activities in D&I

As one of the top design colleges in the world, college of Design and Innovation (D&I) in Tongji university has the responsibility of performing cutting-edge education of design and to promote social development. Since its relocation in 2014, D&I has held about 30 temporary exhibitions per year. Exhibitions are generally held in public space of the D&I. Due to site restrictions, they are generally small exhibitions with a relatively short duration, no more than one and a half months. The largest-scale temporary exhibition is the graduation exhibition of the D&I in mid-June. The exhibition will occupy all communal areas, covering an area of about 700 square meters, and the exhibition will last for about one month. The smallest temporary exhibition only occupies one piece in the public area, with an area of about 200 square meters and a short duration, ranging from 3 days to less than a month.

Design school's exhibitions not only have the function of information propagation but also public education. A large part of audiences is future designers or people who work in the design area. There is a real responsibility for the propagation of sustainable ideas and the education of sustainable design. The focus of the sustainable design principle is no longer part just on a specific product, but the whole event.

3.1.1 Problem of exhibitions in D&I

Take the graduation exhibition of D&I as an example. The exhibition uses 15mm thick plywood to make 150 booths, exhibition boxes and showcases of different sizes. Total consumption is 811.58 square meters of plywood, and the total area can be half a circle of 400m playground. The plywood is bonded by chemical substances containing formaldehyde, which may have a negative effect on the indoor air quality during use. More than 600 pieces of paper are printed at one time, about 0.3 tons, which is equivalent to about 6 trees as the original resource. 50 pieces of disposable acrylic protective shells and plastic sheets will be utilized to outdoor printing. These PVC products need to be degraded for more than 100 years after being land filled. This exhibition is just a temporary exhibition of ultra-small scale but has considerable consumption. Each year, only D&I will hold about 30 temporary exhibitions, and Tongji University will hold about 134 temporary exhibitions. As far as the Shanghai area is concerned, there are about 274 temporary exhibitions were held in october. It can be viewed on the national and global perspective that the waste of material resources caused by temporary exhibitions is extremely harsh on the environment and society.

3.1.2 Existing initiatives

In response to this serious material waste phenomenon, D&I has taken corresponding measures.

(1) Recycling measures for exhibits. Starting from the graduation exhibition in 2017, the 106 different sizes of wooden exhibition walls and showcases left after the exhibition was all included in the exhibition cycle system. The size of the exhibition hall and the showcase is not the same. There are 4 different types of exhibition halls and 9 distinct types of showcases to meet the changed display needs of different exhibitions. In order to make the display tools recyclable as much as possible, repair and paint have an obligation to ensure the quality of the exhibition. Under this initiative, the ready-made foundation display carrier wall and showcase could meet the basic needs of the high-definition exhibition of D&I, and shorten the production time as well as the cost. It could increase the efficiency of the exhibition and reduce material waste to a certain extent in the temporary exhibition of D&I.

At the same time, due to the imperfection of the recycling and storage system, it also brings the problem like improper storage. As shown in Figure 4.1 below, due to the large amount of recycled exhibition walls and display cabinets, the lack of internal storage space of the college has caused many public areas to be occupied by display equipment, whether it is right for storage space of the stairs or the lobby. The business public region is filled with idle display equipment. According to the author's measurement, the storage of idle exhibition equipment has occupied about 12% of the public area of the college. It is under a negative influence on the community's daily uses.

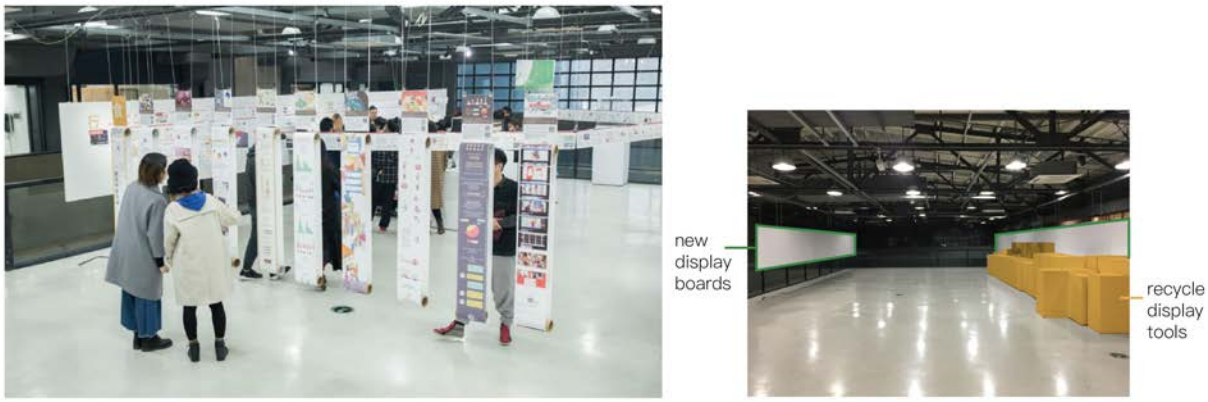

Figure 6: *2nd floor of D&I, display platform*

(2) Add a fixed display interface. In 2018, D&I carried out some targeted transformation for the exhibition platform area on the second floor. The platform on the second floor is a relatively open and transparent platform. When used as a display space, only the top and the ground serve as the basic display interface of the exhibition venue. All other forms of presentation need new construction except for the top hanging display and the ground floor or simple placement. In order to facilitate the display, the college added a hollow iron perforated plate at the boundary of the platform as a fixed display interface for the posting of printed

materials (Figure 3.1). The unique porous structure of the perforated plate also opens the possibilities for further artistic display.

3.2 Design framework of temporary exhibition

The most basic information that the designer receives when designing the temporary exhibition includes the following two aspects: the main content and the spatial information. The first one is the case that the main body of the exhibition, including the theme of the exhibition, the content to be conveyed. The main content of exhibits that can be provided in the form of graphic information, physical objects and other. The second is the spatial information of the exhibition: the space area, space form and restrictions, available time, exhibition time, etc. The content of the exhibition could be conveyed through different senses such as sight, hearing and touch. This study mainly discusses the most common form of transmission: visual transmission. The information conveyed by the visual needs to have the corresponding information carrier, such as print, physical or projection/screen. Commonly used printing plates include paper products, wood boards, pvc sheets, acrylic, glass, mirrors, sheet metal, etc., which can be used as information printing carriers. Flat printing is the most common transient exhibition information transmission method. Even for installation art exhibitions that use the material itself as information, it will make guides and labels for the exhibitions in a flat printing manner to provide visitors with explanations of the exhibits. If physical objects are displayed, the physical objects themselves are informative. Physical exhibitions are usually exhibited in museums or art galleries. The physical exhibitions require attention to the objects themselves. Other design languages and display forms are used as auxiliary objects to express the objects themselves.

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objects themselves. Other design languages and display forms are used as auxiliary objects to express the objects themselves.

At the same time, the information carried needs to be attached to the real space or create space, that is, the installation of the display form. This stage involves the connection between dissimilar materials. Separate connection methods will affect the material recycling during the temporary exhibition processing stage. The inappropriate installation method is also a major factor resulting in the waste of temporary exhibition materials. There are three principal relationships between information carrier and space: First, the information carrier is the surface of the exhibition space itself, which includes the top surface, the sidewall, and the ground. To be specific, the top surface can be used only for the suspension of the information carrier. The sidewall can be used for posting and leaning. And the ground can be used for placing. The second is to use the information carrier to create a new space. That is, to build a new structure. The structure can be subdivided into a frame type and a bulk type according to the form and usage. The frame type is mainly composed of column material. The shape of the support structure is a relatively effortless display method. The bulk type is a relatively solid display method compared with the frame type, such as the exhibition stand and the exhibition wall.

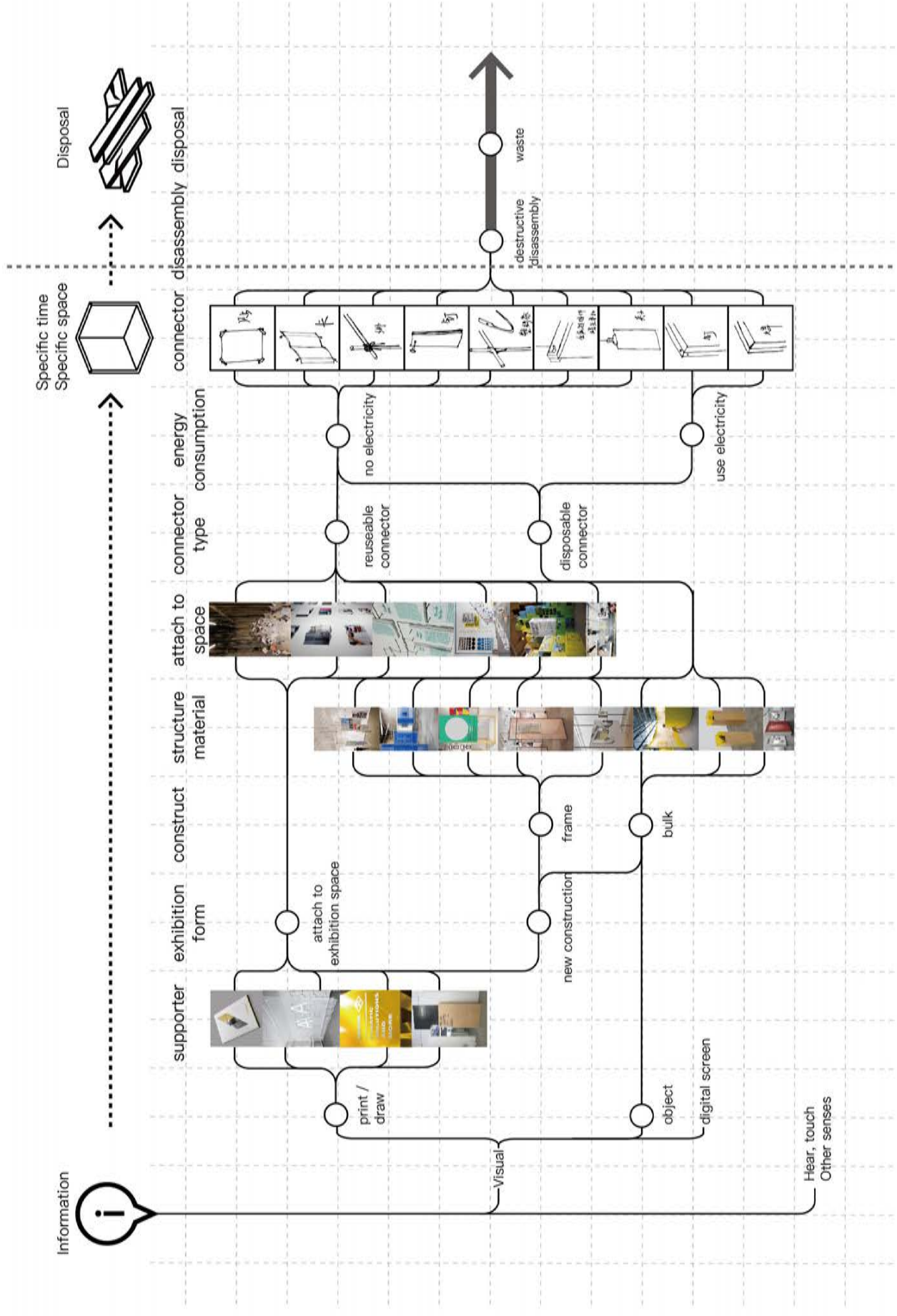

Figure 7: Traditional design process of temporary exhibition

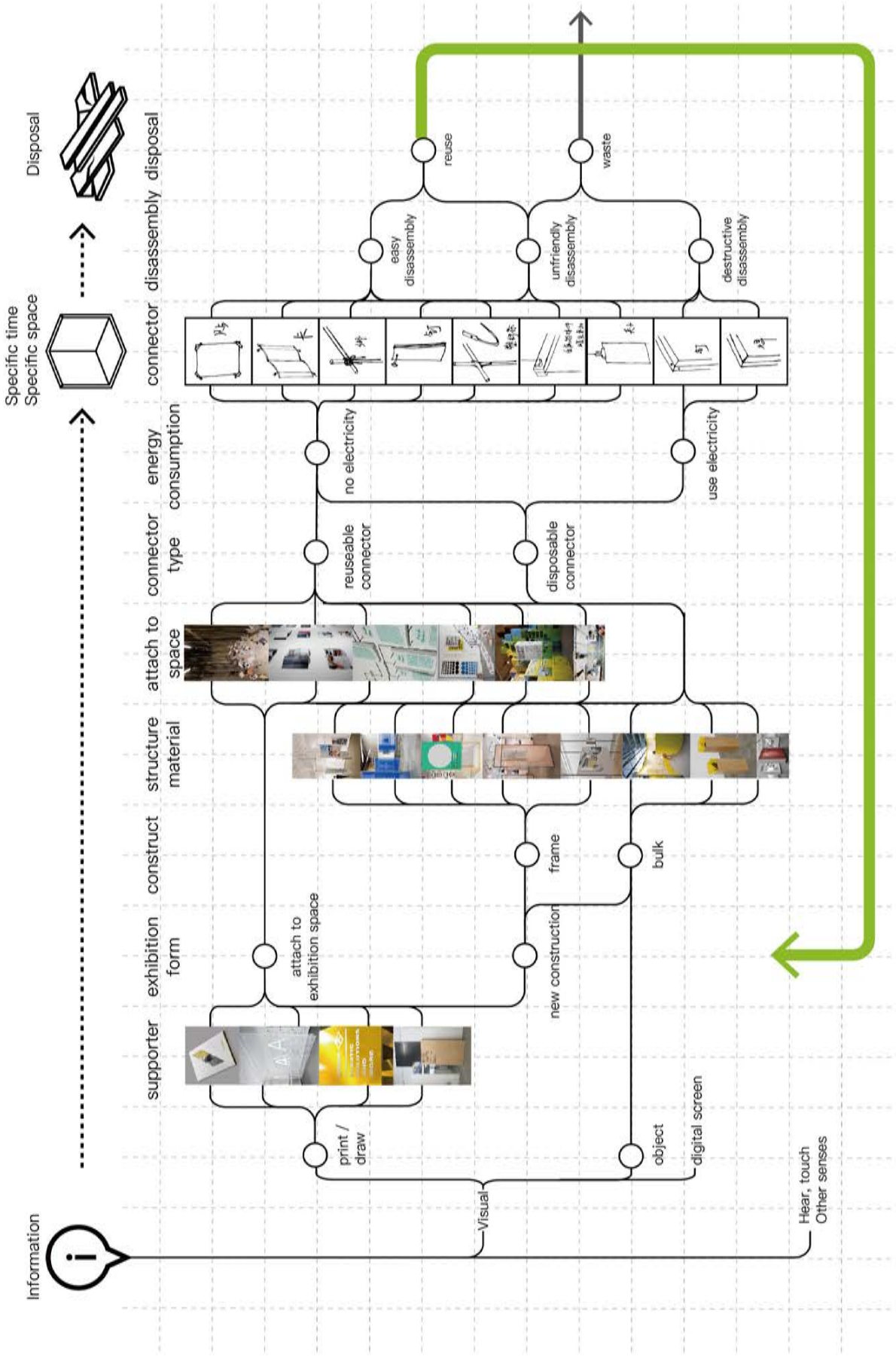

Figure 8: Whole life cycle oriented design process of temporary exhibition

Under the perspective of the entire life cycle, designers are required to pay attention not only to the process of exhibition events but also to how the exhibition ends. The processing stage after the temporary exhibition is the main stage of waste generation, and the choice of disassembly and connection methods is closely related to whether the material or construction can be reused, whether the removal of the connection is easy, whether the disassembly process is time-consuming and labor-intensive, and whether the disassembly process will damage the exhibit or display construction. These all are taken into account in in advance during the design phase.

The definition in the chart explains:

*Frame-type construction: frame type support structure mainly composed of columnar materials, which is a relatively light display method;

Bulk type construction: Bulk type is a more solid display method than the frame type, such as booth, wall and so on.

*Easy to disassemble: It can be quickly removed by hand or using tools within 2 minutes without destroying the disassembly process of the exhibit and construction;

Unfriendly to disassemble: The demolition process can be carried out by hand or using tools with more than 2 minutes without destroying the disassembly process of the exhibit and construction (the long disassemble process is unfriendly design for the high-frequency and quick temporary exhibition. For the construction personnel, even if the life cycle of the material after the disassemble process is longer, the time-consuming labor is still not worthwhile.);

Destructive disassemble: The disassembly process which is easy to damage the exhibits and construction, such as tearing off the adhesive backing, dismantling the wooden keel frame, etc.

*Reuse: Reuse requires that the raw material itself can enter the next use cycle in a relatively good state after being used. There is also a big difference between reuse and recycling; reuse means that after a product's use cycle is over. The product can be put into the next cycle without reprocessing, which means no further consumption. Recycling is also divided into two types: primary recycling and secondary recycling; primary recycling refers to the classification and collection of waste to produce the same type of new products, such as waste paper and recycled paper. Secondary recycling refers to the conversion of waste into other products, such as a plastic bottle for clothing. However, no matter what kind of recycling mode, the process of regenerating materials will generate new energy and material consumption. Reuse advocates extending the life of the product itself to achieve multiple use time, and thus avoids the frequent replacement of the product. Therefore, in this study, the reused mode will be the preferred mode.

The life cycle perspective requires designers to maximize the advantages of temporary display design, so designers need to make overall trade-offs in many aspects, including the generation

of design concepts, the selection of raw materials, construction techniques and display methods, until the end of the display time limit deal with.

Therefore, in the first step, the author proposes a temporary exhibition design framework based on life cycle assessment.

Regardless of whether it is directly attached to the space display or the new construction, the information carrier needs to have a connecting piece for the connection. The installation of the connecting piece is separated into plug-in installation and non-plug-in installation. The connection form is diverse, and when considering the connection mode, it is necessary to consider whether the connecting piece can be recycled. For example, the metal connecting piece of the falling floor, the hole plate type connecting pieces, the long tail clip, etc. are common connecting pieces that can be recycled many times, but the plastic sealing strip, the disposable buckle, etc. Plastic products are relatively easy to damage and are one-time connectors. Normally, after the confirmation of the installation is completed, the design phase of the temporary exhibition is completed (Figure 3.4)

The framework is used in the design phase of a temporary exhibition to guide the designer from the perspective of the entire life cycle assessment. Through the subdivision of each design point, it is possible to find a part to change and change the environmental impact of the entire temporary exhibition life cycle through comparative experiments. To realize the goal of sustainable development, the display design needs to be separated from the life cycle perspective. And by an orderly way to build a new and simple system framework could help better identify and evaluate the impact of activities on the environment at different stages of the design life cycle.

At this stage, the framework remains in the stage of providing designers with comprehensive thinking guidance. The framework is not static. It is an open framework that will be refined and adjusted in the experiment.

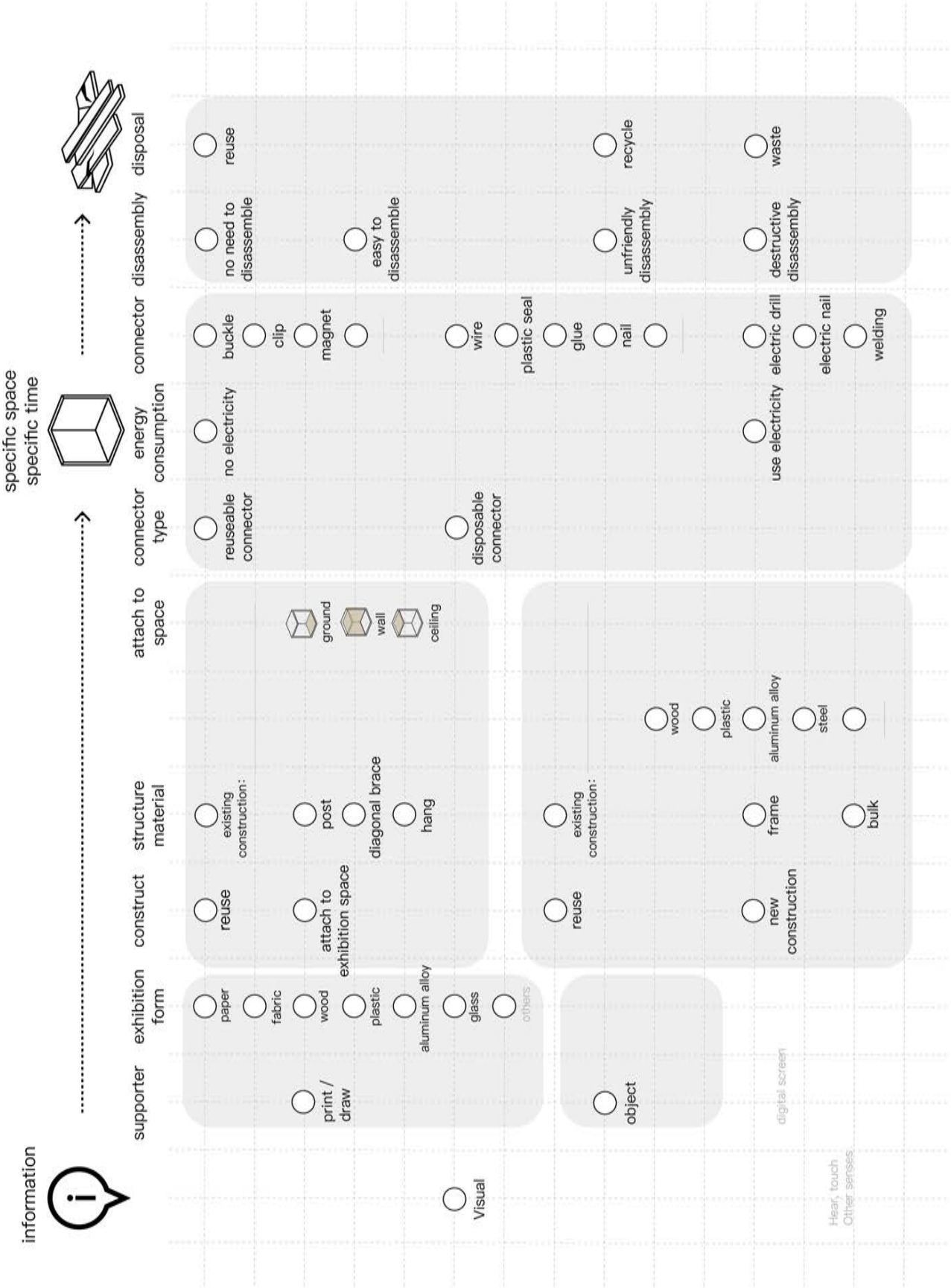

Figure 9: Whole life cycle oriented design framework for exhibition design

3.3 Life cycle assessment for temporary exhibition

The technical framework theory of life cycle assessment outlined in the second chapter is the basis for the selection of the research object and content. The research object of this paper is temporary exhibition. The quick and short-term display behavior determines that the materials, assemble and post-exhibition treatment are not the same as the medium and long-term exhibitions.

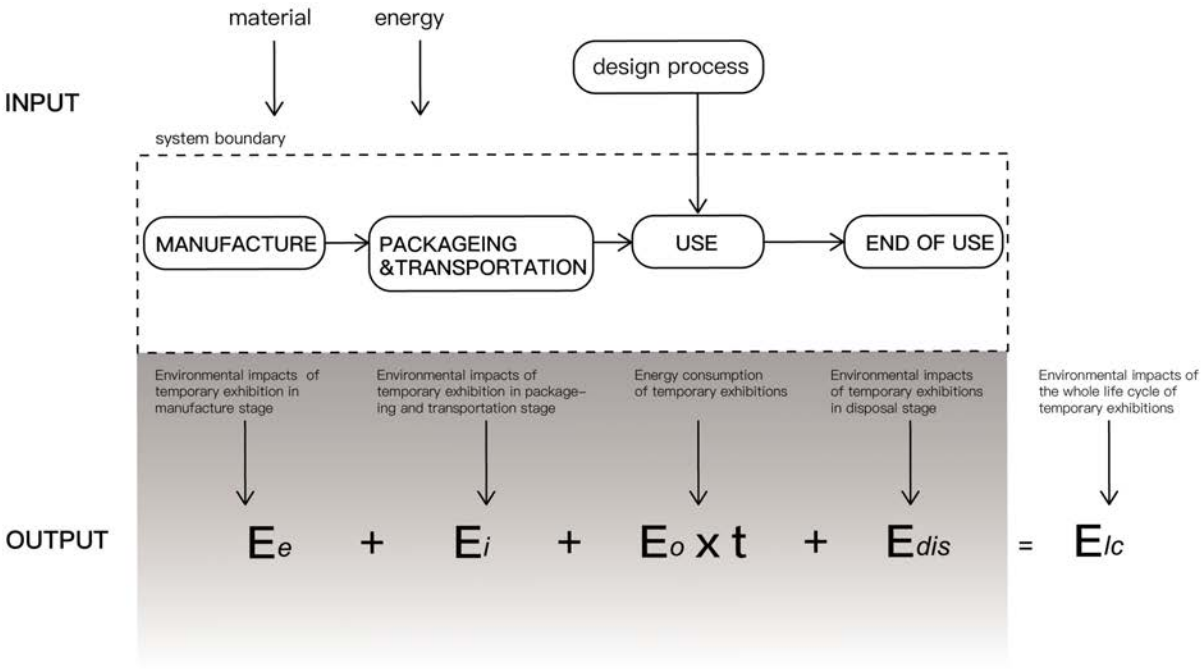

Figure 10: Life cycle assessment system for temporary exhibitions

The scope of the study is not confined to the four phases of the event's development throughout the life cycle of the temporary exhibition: production phase, installation phase, use phase, and waste phase. This study is more concerned about the changes in the environmental impact of temporary interventions during the design phase beforehand.

3.3.1 Characteristic evaluation method for temporary exhibition

When calculating the data related to the raw materials of the exhibition and the unit energy consumption, a large amount of relevant data has to be cited. Therefore, in order to ensure the objectivity of the evaluation of the life cycle of each stage, the subsequent chapters will collect as much authoritative data as possible and refer to the source to ensure the reliability

of the data; but due to the current lack of statistics and research in this area in China, if there is no reference or need to be considered according to the actual situation, this article will take the method of assuming various objective conditions and indicate accordingly.

The entire life cycle of the temporary exhibition has the following stages: design stage, production stage - raw material acquisition and processing, transportation, production, installation stage - material transportation, display installation, use stage - exhibition open operation, exhibition maintenance, exhibit maintenance and abandonment stage - the dismantling, recycling and disposal of the construction.

1) Production stage: The environmental impact of material production, that is, the impact of the materials selected in the temporary exhibition on the environment in terms of its acquisition and processing, transportation and production.

2) Installation stage: During the installation process of the temporary exhibition, it involves the display form of the exhibition and the installation method of different exhibition items. The environmental impact during installation brought by the tools and equipment used.

3) Use stage: The environmental impact of lighting, heating, ventilation, refrigeration and production equipment during the temporary exhibition. The energy consumption caused by the maintenance of the exhibition and equipment is also counted. (Because the energy consumption at this stage is mainly electrical energy, subject to the season, the length of time, and the location of the temporary exhibition. And limited by the current environment, it is difficult to carry out design intervention, so the environmental impact of this part is ignored in this study)

4) Abandonment stage: After the end of the exhibition, the disassembly and disposal of the exhibition equipment is required. The environmental impact generated at this stage includes not only the disassembly action but also the waste disposal process.

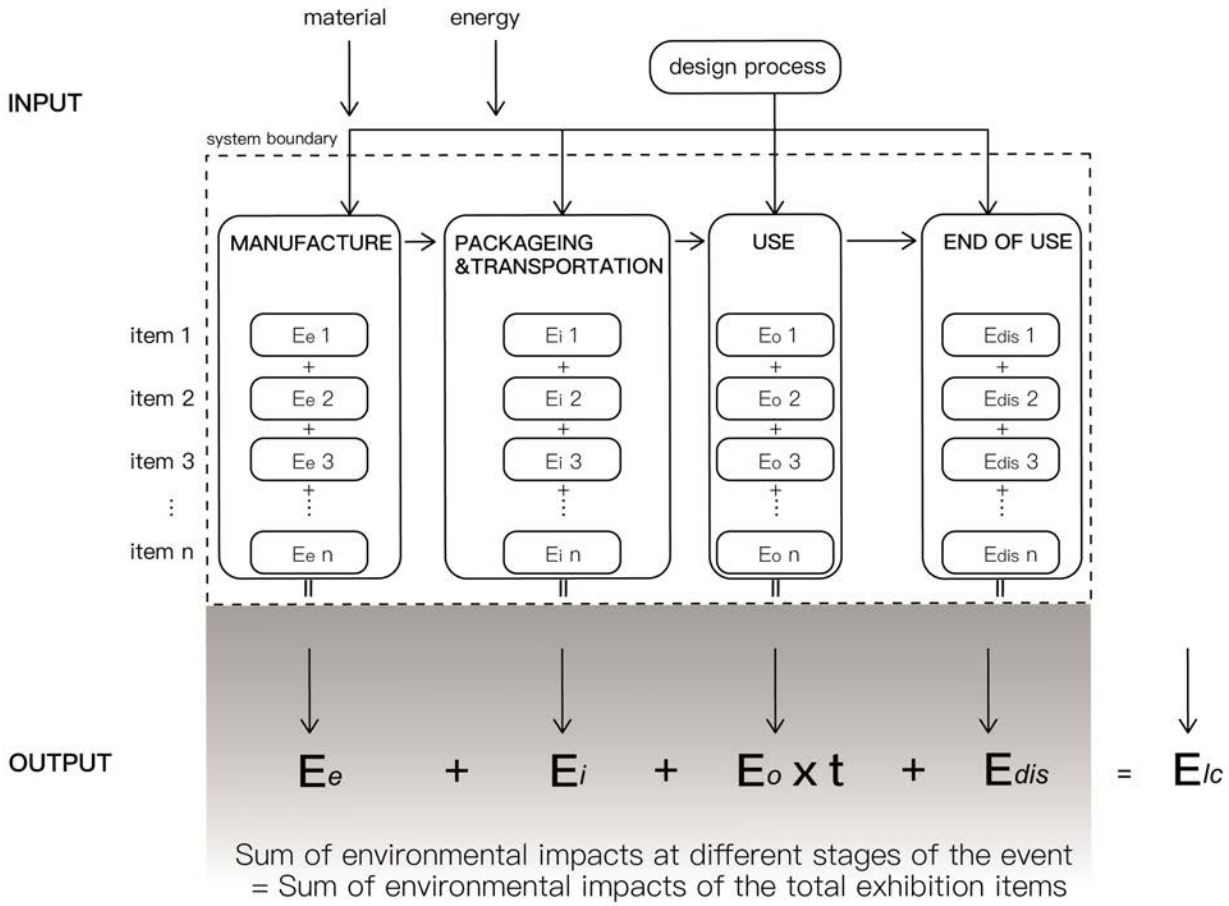

Figure 11: Life cycle assessment framework for temporary exhibitions

The purpose of the life cycle assessment of temporary exhibitions aims to reduce the amount of waste and environmental emissions generated by temporary exhibitions. To achieve this purpose, the optimized usage of material resources and energy throughout the life cycle should be considered for sustainable design during temporary exhibitions. Temporary exhibitions are different from product life cycle assessments. Temporary exhibition is an event with a combination of a large, complex product system and human activities. Owing to the diversity, flexibility, and interactivity of temporary exhibitions, the venue and diverse display formats make it difficult to have a universal approach to life cycle assessment of temporary exhibitions. The statistics of the entire exhibition are messy and costly, and the accuracy of the data canbe ensured. The resulted life cycle assessment of a temporary exhibition will be very abstract, and it is a challenge for designers to find target points for improvement.

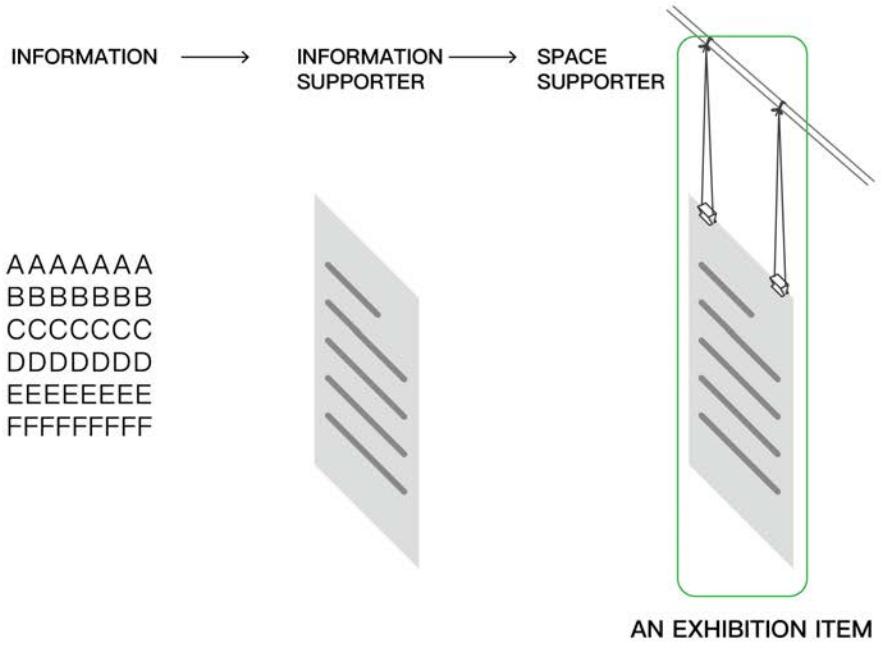

Figure 12: Definition of exhibition items

The main body of the exhibition is “information”. The exhibition is a display space composed of information carriers. The material selection, installation and disposal of individual exhibition items are single elements that cause the overall environmental impact. Therefore, in this study, the author tried to split the whole of the temporary exhibition and regarded the different exhibition items in the temporary exhibition as different individual product parts. The sum of the life cycle assessments of the product's individual products will be the life cycle assessment results of the exhibition. The sustainable design decisions for the display design will also reduce the overall environmental impact of the temporary exhibition.

3.4 Material database of LCA model for temporary exhibitions

The purpose of the life cycle assessment of this study is to derive the basis for the optimization of the temporary exhibition from the preliminary design. The focus of this study is not on the collection of specific data on specific exhibition activities for accurate calculations, but on the use of life cycle assessment principles and results to guide the design phase of the temporary exhibition. In this study, life cycle assessment needs to be prioritized.

Common materials for temporary exhibitions are also commonly used building materials for indoor use. The embodied environment profile of a temporary exhibition is an inevitable impact during the process of the temporary exhibition. It is the sum of the substance consumed during upstream process beforehand and during use. In the life cycle assessment of temporary exhibitions, the consumption of matter is relatively simple and can be tracked and quantified. Therefore, the author quantifies the environmental impact of materials during the temporary exhibition as the basis for predicting the selection of the design process.

In the first part of calculation, due to the different origins of materials, materials manufacturers, and materials production methods, the physical and environmental conditions of temporary exhibitions are difficult to be accurately calculated. As individual materials, we consider the indirect environmental impacts during energy production and direct environmental impacts caused during acquisition, processing and production process of materials.

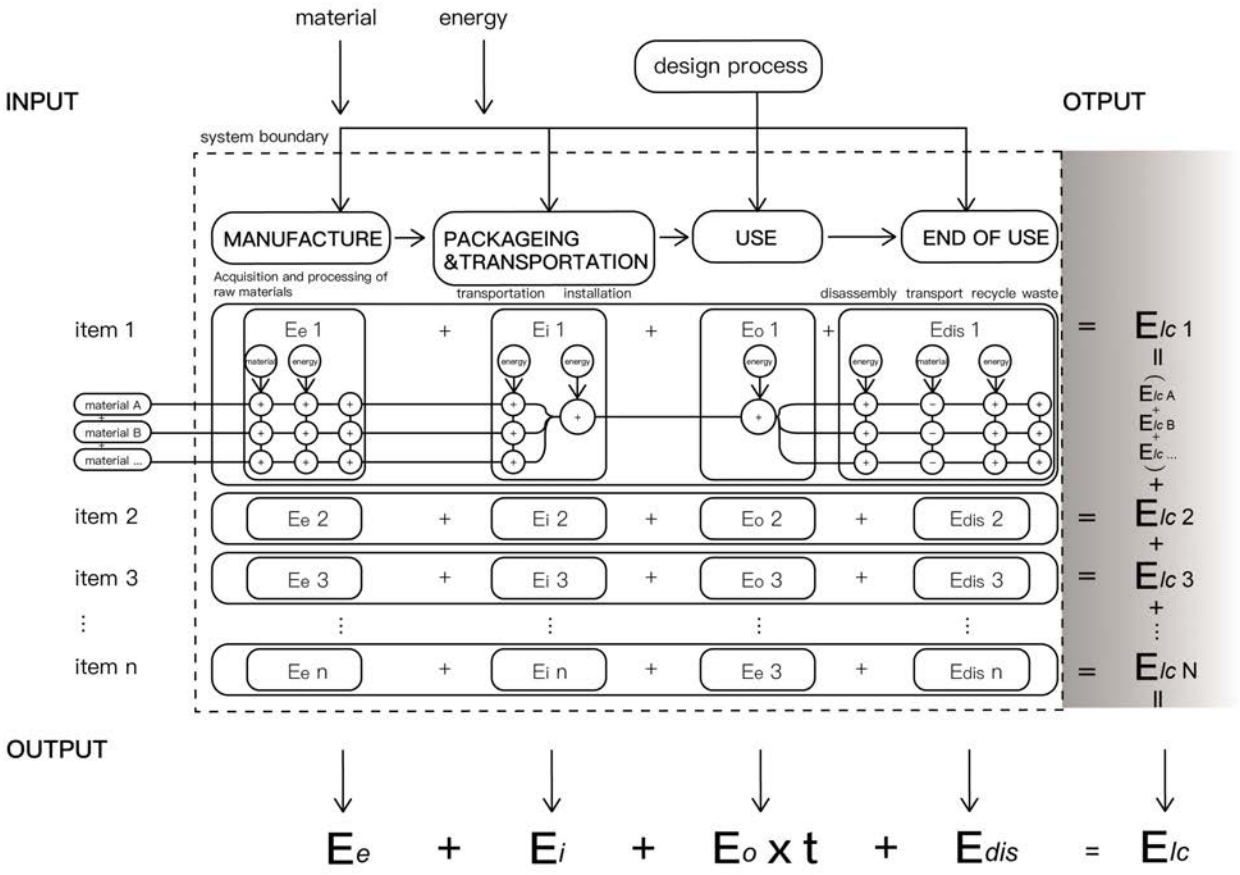

Figure 13: Life cycle assessment of materials for temporary exhibitions

In order to establish a scientific and sustainable design guidance system, the author summarized and evaluated the material life cycle of materials used in temporary exhibitions, and provides quantitative data support for the evaluation framework.

3.4.1 Common materials of temporary exhibitions

The production and use of materials account for the primary parts for energy consumption and environmental pollution, and the materials are the necessary carriers for temporary exhibitions. Therefore, the fundamental meaning of the design is to be used as little material as possible to satisfy the demand as much as possible. Different exhibits correspond to different display forms and materials. The main display mode of the graphic exhibits is flat display, that is, the most important display materials are flat materials: such as paper products, wood boards, pvc sheets, acrylic, glass, mirrors, metal sheets, etc., can be used as a carrier for graphic display. . Information carriers are processed in a variety of ways. According to the processing technology, the graphics and text items are also divided into graphic printing and engraving. The commonly used materials are printing inks or specific materials processing machines and other specific materials, and sometimes some auxiliary materials are involved, such as adhesives.

With the development of the economy and the advancement of technology, new media technologies and virtual reality technologies and interactive experience have become the highlights of temporary exhibitions, creating a new immersion interactive experience for visitors. Exhibition's new technology and equipment could build an interactive experience system. Under normal circumstances, the cost of static exhibitions is much lower than that of interactive exhibitions, but static exhibitions are relatively wasteful. The high-tech equipment is no longer a one-time product. It can uses repeatedly and without serious material waste. The material selection section does not consider electronic devices. As a result, we have classified the main consumables of the temporary exhibition into the following categories: paper, printing ink, plastic, fabric, wood, steel, aluminum alloy, glass, glue and mounting connectors. Since the proportion of glue and mounting connection is less than 5% in the exhibition, it is outside the scope of the list considered.

3.4.2 Common material properties of temporary exhibitions

The environmental impact of the material production phase can be quantified by data collection. The environmental impact of the installation and use phases can be qualitatively estimated based on the quality of the material. (In general, the transportation consumption and installation cost of heavy-weight materials is greater than that of light-weight materials.) The material recovery potential of the waste stage can be predicted based on the material properties, strength, general installation and disassembly methods, and the degree of deformation.

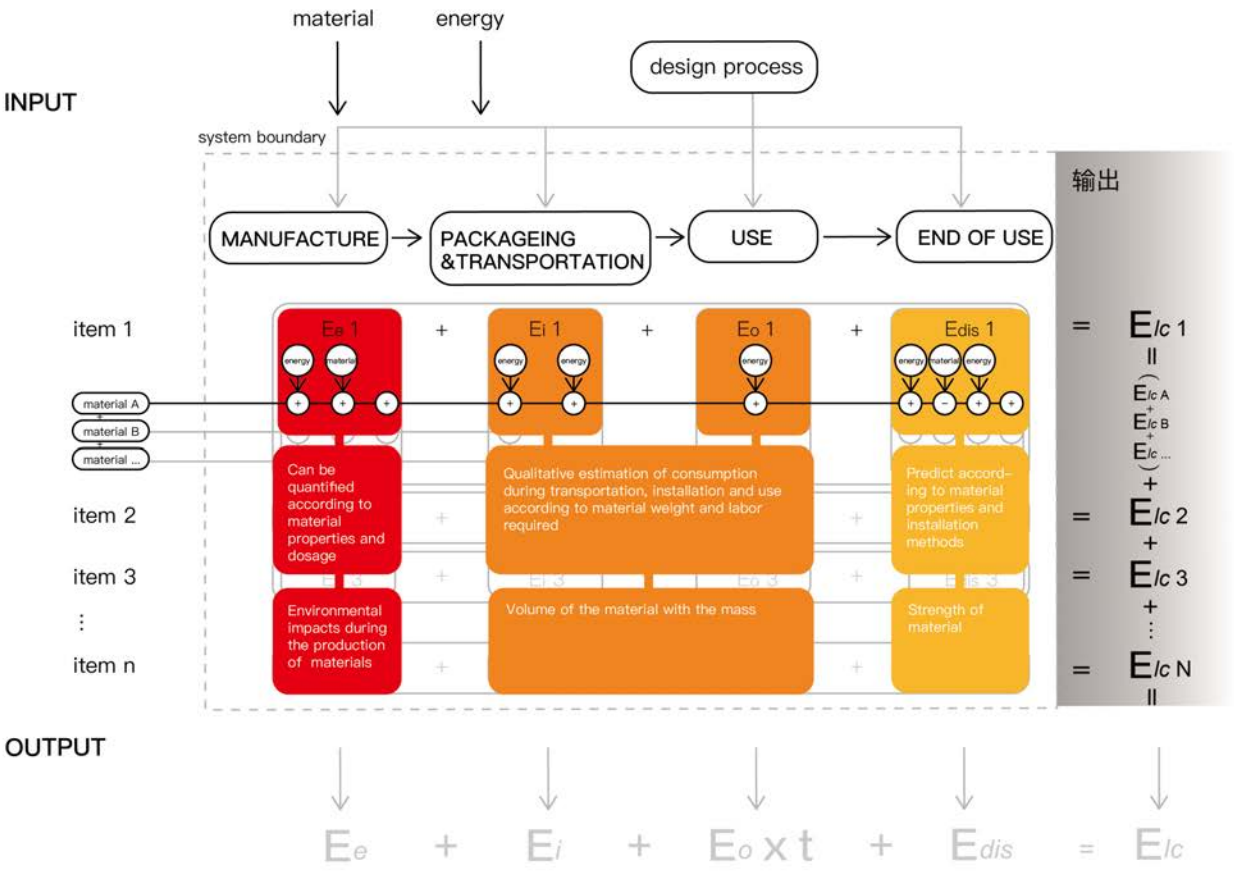

Figure 14: The material properties of temporary exhibitions

According to the life cycle assessment method, the authors calculated the unit cost per kilogram of raw materials and energy consumption, emission accordingly, and calculated them in the life cycle assessment formula. The results obtained are given in *Table 2*.

The life cycle assessment of the material under the unit weight obtained is for reference only for extra overall life cycle evaluations of temporary exhibition. The environmental impact of different materials cannot be compared in parallel under unit weight. Based on the CML (Center of Environmental Science of Leiden University) method developed by the School of Environmental Sciences at Leiden University in the Netherlands, the author obtains standardized values for life cycle assessment, which are used to simplify the value of life cycle assessment and facilitate comparison.

When used as a board, the same size of the board has the same bearing area, and the board of the same nature can be substituted for a better solution based on the environmental impact value of the selected material. In this calculation, taking 1000x1000x5mm plate as an example, the weight of each panel is calculated according to the density, and material evaluation results per unit weight are standardized. From this, the environmental impact of different material under the same bearing area can be calculated.

Table 2: Environmental impact assessment of different materials in same specification

Through the calculation of the data, the influence value of the production stage of each commonly used material, the quality and strength of each material with the same volume are obtained.

Impact category	Normalized value	1000x1000x5mm Sheets						20x20x1000mm Structural materials			
		density x volume = weight						density x volume = weight			
		0.25	0.1	3.6	12.5	10	5.5	0.28kg	0.8kg	0.44kg	3.12kg
		paper	fabric	plastic	glass	wood	aluminum alloy	plastic	wood	aluminum alloy	steel
ADPE	4.78E-09	1.27E-04	2.91E-06	3.48E-07	9.54E-06	4.59E-07	2.12E-06	3.48E-07	4.59E-07	2.12E-06	1.52E-04
ADPF	2.63E-15	1.29E+01	1.22E+02	7.17E+01	2.12E+02	9.53E+00	3.54E+01	7.17E+01	9.53E+00	3.54E+01	1.12E+02
GWP	2.39E-14	1.06E+01	8.04E+00	2.50E+02	1.62E+01	1.08E+00	3.52E+00	2.50E+02	1.08E+00	3.52E+00	1.19E+01
ODP	4.41E-09	1.45E-08	6.74E-09	3.24E-08	1.05E-06	7.80E-09	1.18E-07	3.24E-08	7.80E-09	1.18E-07	2.77E-07
POCP	3.88E-13	4.83E-02	1.39E-03	1.63E-01	3.93E-03	2.17E-04	1.75E-02	1.63E-01	2.17E-04	1.75E-02	2.95E-03
AP	4.23E-13	8.01E-03	2.95E-02	2.79E-02	9.79E-02	5.55E-03	1.83E-02	2.79E-02	5.55E-03	1.83E-02	6.87E-02
EP	5.16E-15	1.11E-03	7.77E-03	3.91E-03	1.12E-02	8.47E-04	1.99E-02	3.91E-03	8.47E-04	1.99E-02	1.37E-02
HT	9.15E-13	6.17E-01	4.75E-01	5.48E+00	3.62E+00	2.21E-01	1.05E+00	5.48E+00	2.21E-01	1.05E+00	7.72E+01
FWAE	2.72E-11	5.24E-01	2.75E-01	6.70E+00	2.71E+00	2.52E-01	1.01E+00	6.70E+00	2.52E-01	1.01E+00	1.56E+01
MAE	4.19E-12	1.92E+03	6.87E+02	7.05E+03	1.42E+04	1.26E+03	4.15E+03	7.05E+03	1.26E+03	4.15E+03	2.39E+04
TE	6.32E-12	5.71E-03	7.76E-04	2.11E-02	4.03E-02	3.6E-03	1.14E-02	2.11E-02	3.60E-03	1.14E-02	1.14E-01
	Sum of normalized values	2.02E-09	2.89E-08	1.07E-07	7.45E-07	5.29E-08	1E-07	8.33E-09	4.23E-09	8E-09	3.14E-07

When used as a support structure, the columnar material of the same specification can be replaced with a better solution according to the environmental influence value of the selected material in the case where the performance and strength are sufficient to meet the support standard. In this calculation, taking the support material of 20x20x1000mm specification as an example, the weight of each material is calculated according to the density, and the material evaluation result per unit weight is standardized. From this, the environmental impact of different material pairs under the same specifications can be calculated.

According to the nature of the material, in the same specification of the supporting structural material, if not considering the strength and hardness of the material, the environmental impacts from the largest to the smallest are wood, plastic pipe, aluminum alloy pipe and steel. The calculation results are shown in *Table 2*.

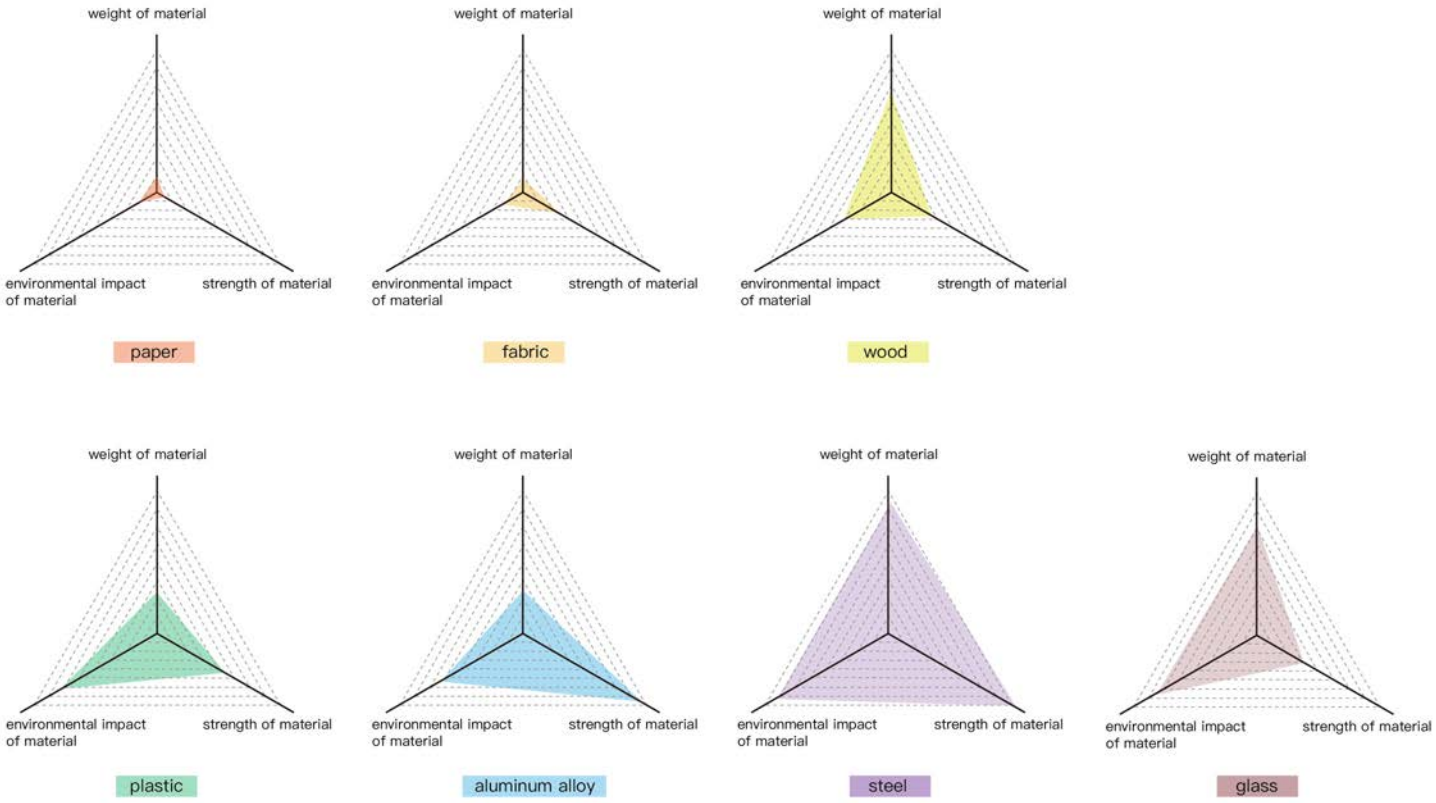

Figure 15: Rose chart of characteristic materials of temporary exhibition

The most ideal material should meet the environmental impact of the production stage, the lighter quality and the stronger material strength.

In this chapter, the author has carried out detailed data collection and detailed calculations to ensure that the life cycle of the common materials for the temporary exhibitions is quantitatively evaluated and calculated as a database for the life-oriented temporary exhibition sustainable design guidance framework. The establishment of the temporary exhibition material database can serve as a scientific basis for designers to select materials. For example, for the use of materials, natural materials are misunderstood at all ecological. The measurement of ecological materials differs from country to country. For instance, for wood, for countries with high forest coverage, wood use is beneficial to the ecological environment (such as Switzerland, Australia, etc.). But for countries with low forest coverage, the use of wood destroys the ecological environment (such as China, Japan, etc.). The use of materials must be built on the current situation. All data in this database are from China. The main context is Shanghai's southeast coastal area centered on Shanghai. If the location of temporary exhibitions is different, the data should be considered as appropriate and reliable.

Sustainable design guidance for temporary exhibition

In the third chapter, the author divided the complex system of temporary exhibition into several products from the perspective of life cycle, and develops a characteristic life cycle assessment method for temporary exhibitions. Combined with the summary of the temporary exhibition materials and data collection, a relatively reliable database of material materials was established to support advance decision-making in the design phase. The basis of advance decision-making should be a large number of experiments and data. Therefore, in this chapter, the author verifies and deepens the relatively naive framework derived from Chapter 3 through empirical research. The framework is not a fixed, deterministic framework with a static conclusion, but a more precise open framework that grows with empirical cases and data.

4.1 Life Cycle Assessment for the "New Retail x New Life" Design Exhibition

The "New Retail X New Life" design exhibition (Figure 4.1) is a temporary exhibition held on the second stage of D&I in early January 2019. The exhibition area is about 200 square meters and lasts for about 20 days. This is a frequent temporary exhibition held at D&I with typical scale. The author uses the "New Retail X New Life" design exhibition as a typical exhibition of D&I to conduct life cycle assessment.

Figure 16: "New Retail x New Life" exhibition

4.1.1 Scoping of the instance

At this stage, “New Retail x New Life” design exhibition is a typical temporary exhibition, which is evaluated and analyzed for life cycle. The main goal of the LCA is to analyze the entire event (i.e. a temporary exhibition with a duration of about 20 days), considering the organization, installation and disposal phases (because the energy consumption during the use phase is mainly electrical energy, and subject to season, duration, and location of the temporary exhibition, it is difficult to design intervention, so the environmental impact of this part is ignored in this study). Another goal is to analyze the impact of different factors on the environment throughout the life cycle, such as energy consumption, material use and waste treatment in the life cycle assessment to find the universality of the temporary exhibition of design and creativity colleges. And propose possible solutions to improve the temporary exhibition design guidance framework based on life cycle assessment.

It should be noted that in the waste phase of the system, only the reuse of waste of the exhibition waste is considered. Since the recycling process brings new material and energy consumption, such as waste paper sorting and recycling for the manufacture of recycled paper, it is not considered.

4.1.2 Inventory analysis

As a design exhibition, the main display content of the exhibition is the results of the students' courses work. The main forms of communication are graphic display and physical display, which are all relatively basic forms of presentation (Figure 4.2).

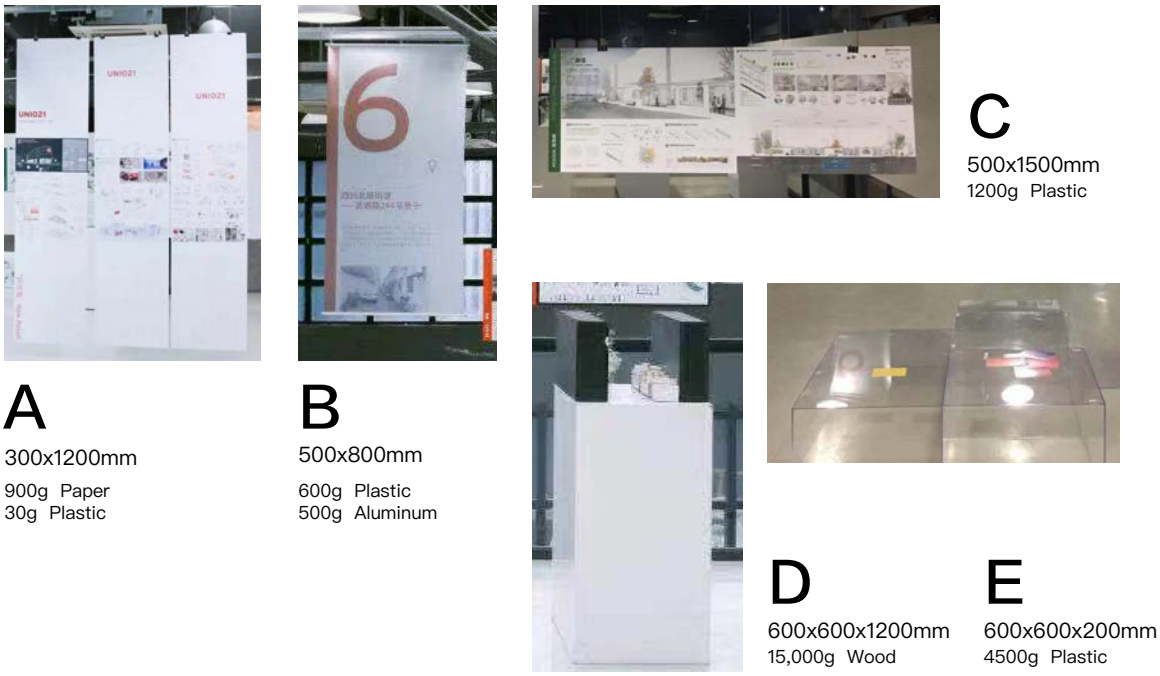

Figure 17: Items of “New Retail x New Life” exhibition

4.1.3 Life Cycle Assessment of basic exhibition items

Taking the exhibition A as an example, the life cycle assessment of the exhibition items of the "New Retail x New Life" design exhibition was carried out.

Combined with the database in the previous chapter, a list of life cycle data for exhibit A is obtained. Lifecycle assessment of Exhibit A was performed using life cycle assessment software Simapro. The following evaluation results were obtained (Figure 4.4).

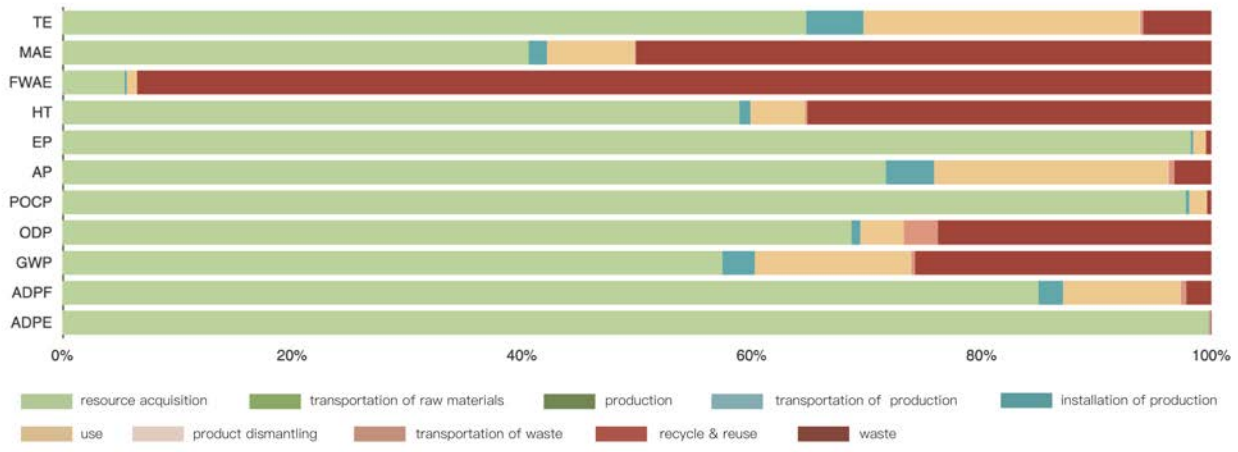

Figure 18: LCA of item A（resource : calculate by Simapro)

From the analysis of the life cycle assessment process of Exhibit A, it is clear to see the degree of influence of the 11 characteristic factors affecting the environment under the CML framework in the different processes of the life cycle of Exhibit A. In the life cycle assessment of Exhibition A, the raw material acquisition and processing stages, product production stage, product installation stage and waste stage have greater impact on the environment.

In the same way, the author conducts life cycle assessment calculations for item B, C, D, and E, and the results are as follows:

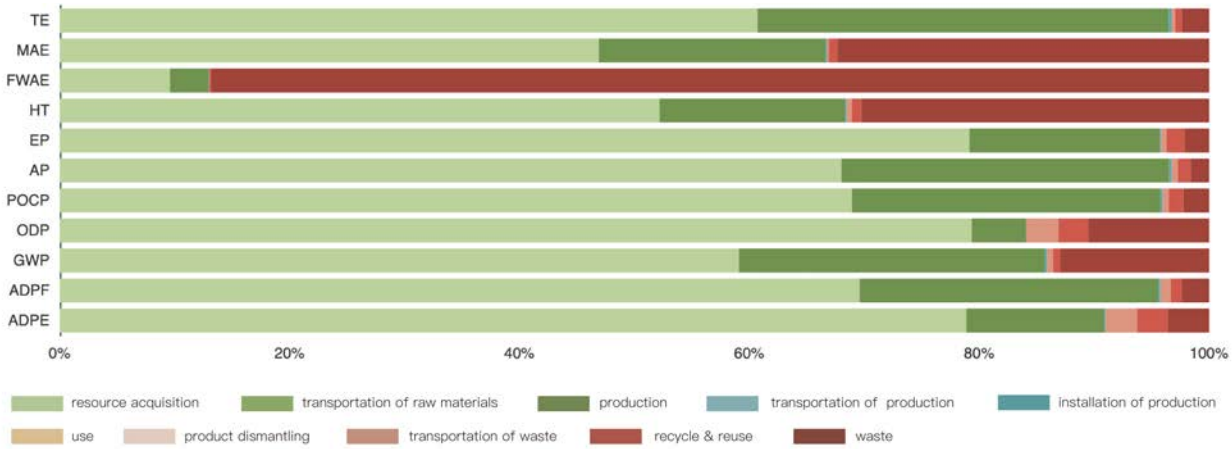

Figure 19: LCA of item B（resource : calculate by Simapro)

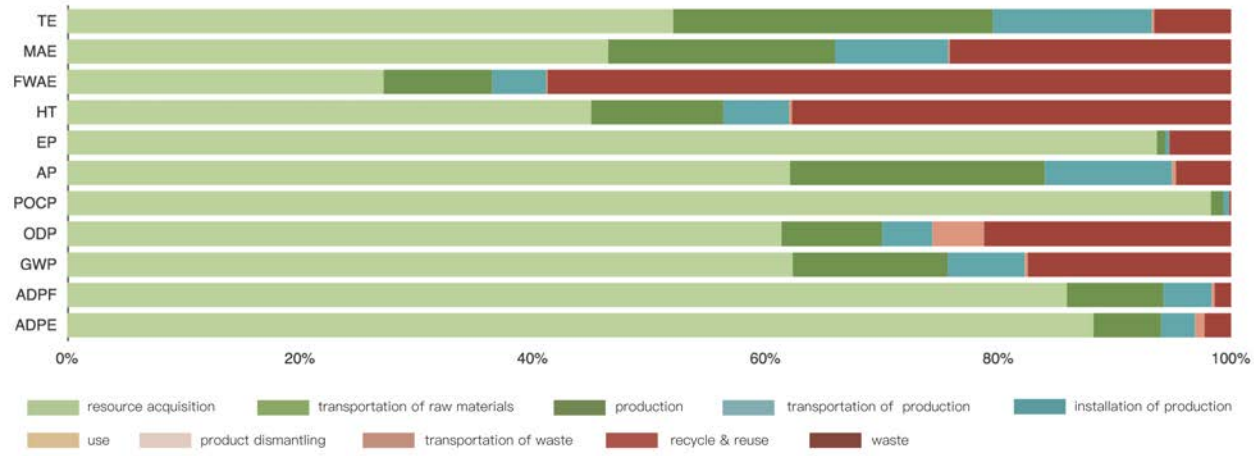

Figure 20: LCA of item C（resource : calculate by Simapro)

The acquisition and processing stages of raw materials is related to the nature of the raw materials themselves. Are they natural or synthetic? Is it a renewable resource or a non-renewable resource that is consumed in one direction? Does too much energy be consumed in the processing of raw materials? Whether it will emit hazardous substances to water bodies, air and land. The nature of the material itself determines the environmental impact ratio of the raw material acquisition and processing stages.

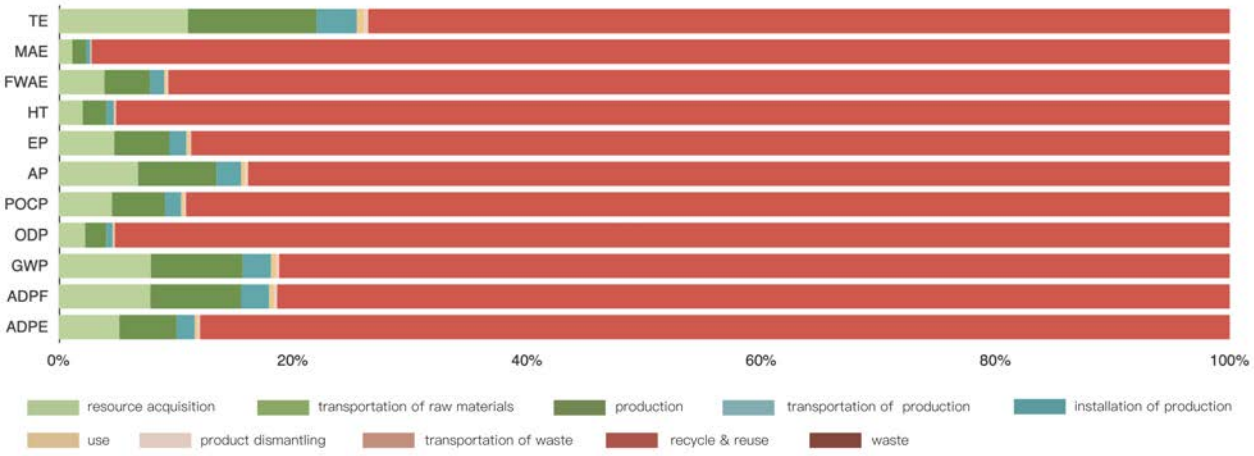

Figure 21: LCA of item D（resource : calculate by Simapro)

As a recyclable display, item D has the most serious impact on the environment during the recycling process. It is worth mentioning that the environmental impact value during the recycling process is negative because negative environmental impacts during other life cycle processes cancel each other. Compared with Exhibit E, which has not been recycled, the environmental impact caused by waste accounts for a large proportion of the life cycle of the entire exhibition. As can be seen, improving recycling and reducing waste is one of the effective ways to improve the environmental impact of temporary exhibitions.

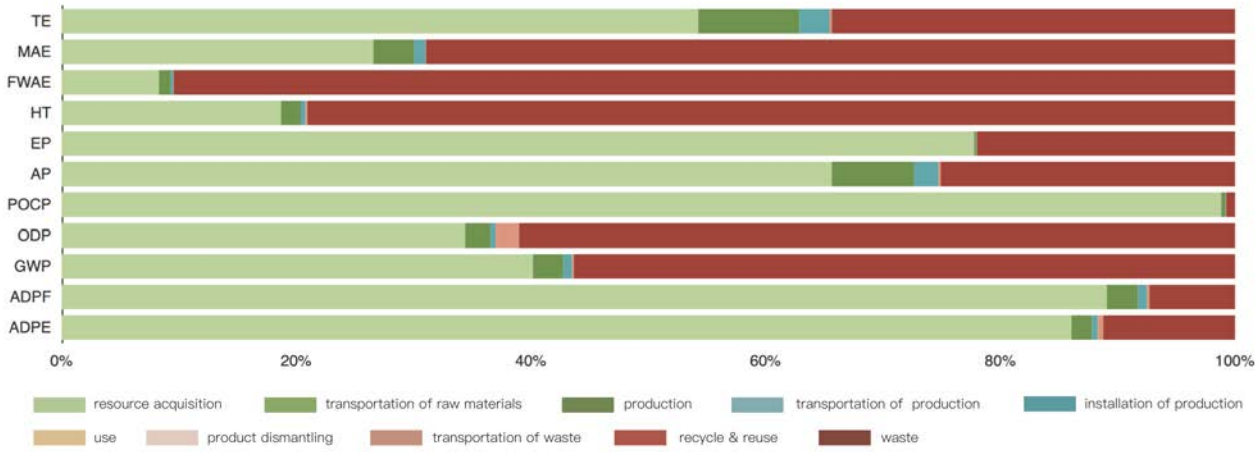

Figure 22: LCA of item E（resource : calculate by Simapro）

Therefore, the author assumes that sustainable design interventions in the raw material acquisition and processing stages, product production stages, product installation stages, and recycling stages will mitigate the environmental impact of temporary exhibitions.

4.2 Life cycle assessment of temporary exhibition taking green design exhibition as an example

4.2.1 Background and opportunity of green design performance

Green design exhibition is an exhibition activity on the theme of green design and sustainable design sponsored by D&I, which provides a stage for sharing perspectives, experiments and methods of sustainable design. As one of the top design schools in the world, D&I is committed to the forefront of design education and promoting social change through design. Sustainable concept and sustainable consciousness need to run through all aspects of design teaching. The green design exhibition serves as a platform for display and communication, allowing sustainable design activities and practices to be seen by the larger community.

In this context, the green design exhibition itself, as a temporary exhibition aimed at spreading the concept of sustainable design, needs to practice the language of sustainable design. Based on the analysis and research on the life cycle assessment of temporary exhibition, the author takes green design exhibition as an example to carry out the practice of sustainable exhibition design, and verifies the hypothesis with the practice results.

4.2.2 Application of sustainable design guidance for exhibition design

The fundamental purpose of this chapter is to provide sustainable design decisions for temporary exhibitions based on life cycle assessment.

The third chapter of this study is based on the results of the life cycle assessment of temporary exhibition, finding the key units that have significant impact on the environment, and tracing back to the corresponding stage of the design. And to help the designers in the design stage of the temporary exhibition, the different stages of the temporary exhibition to conduct sustainable intervention. Besides, it is trying to achieve the green oriented display effect at the same time, and choose the best solution in each stage of the design, to reduce the impact of temporary exhibition on the environment. In this chapter, the author takes the green design exhibition as the practice of sustainable design to carry out conscious sustainable design practice on the guidance framework of sustainable design for the temporary exhibition of the whole life cycle proposed by the author.

The exhibition content of the green design exhibition is mainly a summary of the achievements of the 2018 sustainable design course, which is divided into graphic information according to the form of the exhibition content and presented mainly by printing. The venue for the green design exhibition is the exhibition platform on the 2nd floor of the second phase of tongji university school of design and creativity, with an area of about 200 square meters. The author classifies the information and arranges the space according to the display content, the primary and secondary information to be transmitted and the observation and understanding of the site.

By analyzing the life cycle assessment results of "new retail x new life" exhibition, three key units of the exhibition's impact on the environment can be obtained and corresponding to the process of exhibition design, namely, material use, material selection, installation and recycling.

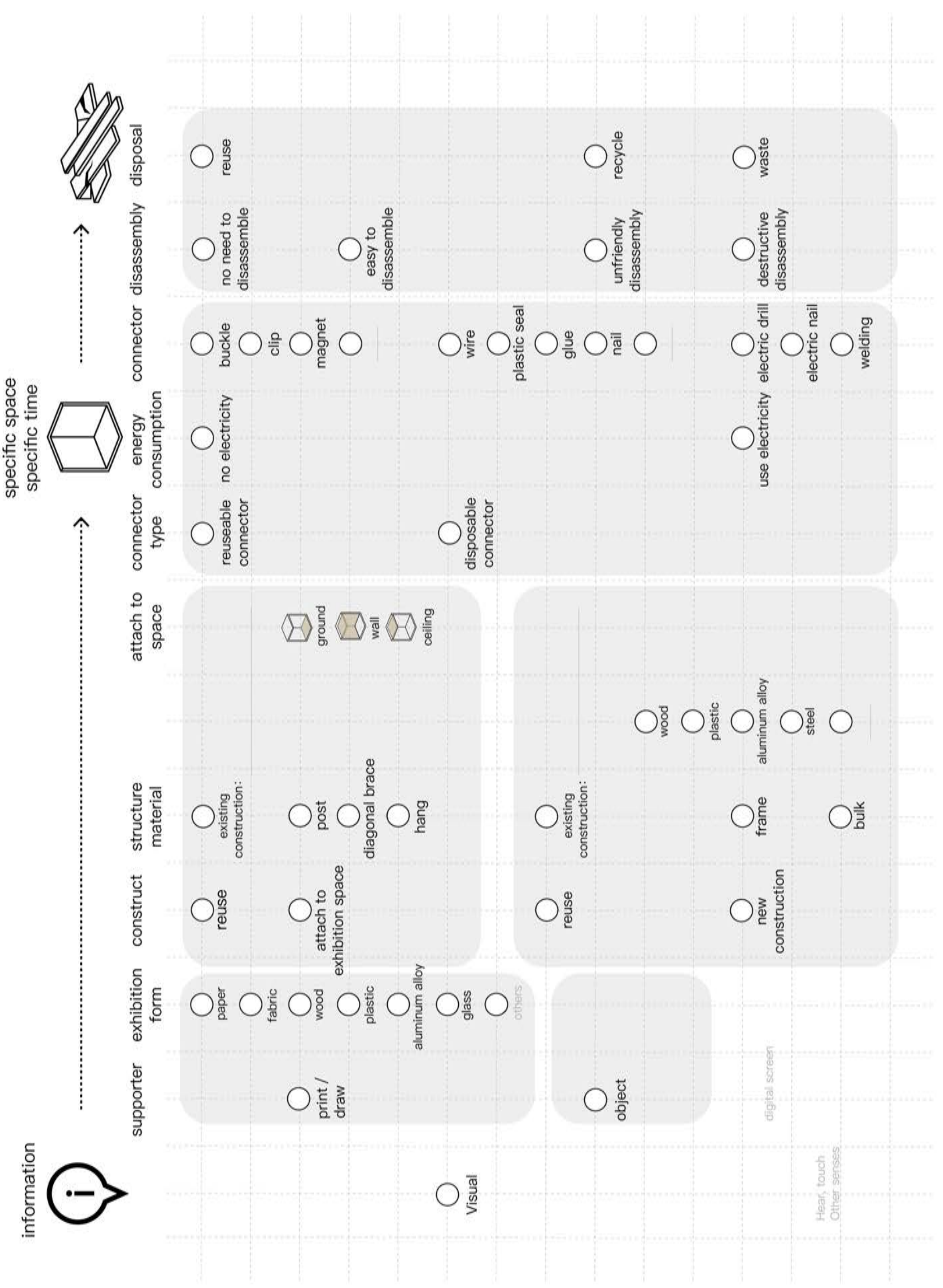

Figure 23: Whole life cycle oriented design framework for exhibition design

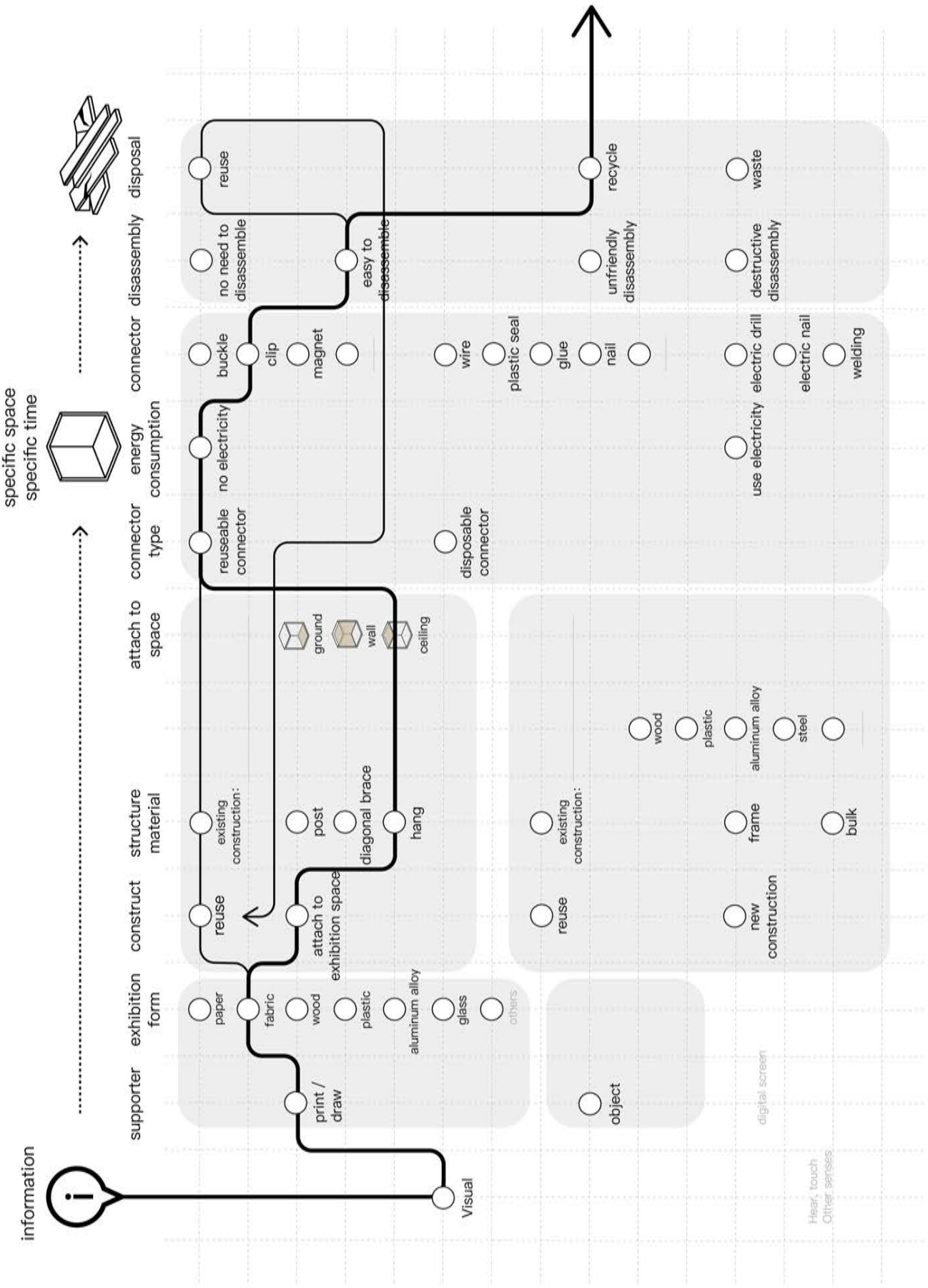

Figure 24: Design decision A guide by whole life cycle oriented design framework

Figure 25: Design Item A

The sustainable design guidance framework lays out the design steps of the exhibition design, and qualitatively compares the impact of design choices on the environment with the assistance of calculation, so as to help designers prioritize the relationship between design and environment from all aspects of the whole life cycle.

The information subject of the exhibition item is graphic and text, so the method of printing is adopted for visual communication. The design concept is to simulate the experience of mobile phone sliding screen in physical space, which requires relatively soft sheet materials. Among the paper products, fabrics and plastic films that meet the requirements, considering the strength of materials and evaluating the impact of materials on the environment, fabric is selected as the printing medium. The simulation of the effect of sliding requires the help of rollers. When selecting the available circular axial objects, the priority should be given to thinking whether there are reusable wastes. For example, the common napkin rolls, coke bottles, etc., because the roller needs a slight weight, to maintain the fabric surface straight, comprehensive examination rate after various forms of waste products, choose a slightly heavier weight print shop paper tube, with cotton thread string roller structure, hanging to the top of the space space structure. In the connection process, there is no use of cement, nails and other destructive connector, all the connections are flexible, very easy to remove and re-use. Only the printed fabric, which cannot be reused in other occasions, can enter the cycle of degradation and recycling.

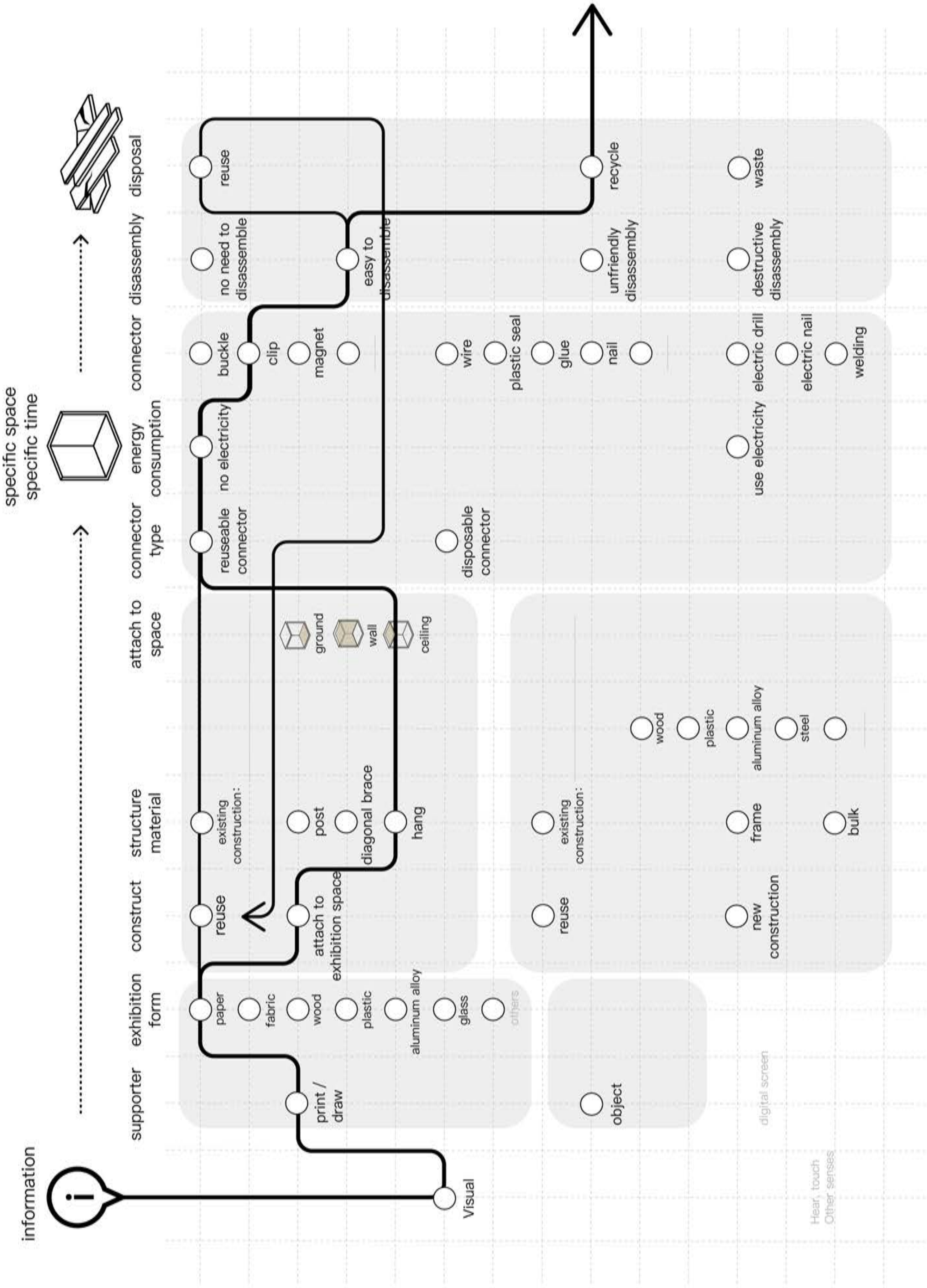

Figure 26: Design decision B guide by whole life cycle oriented design framework

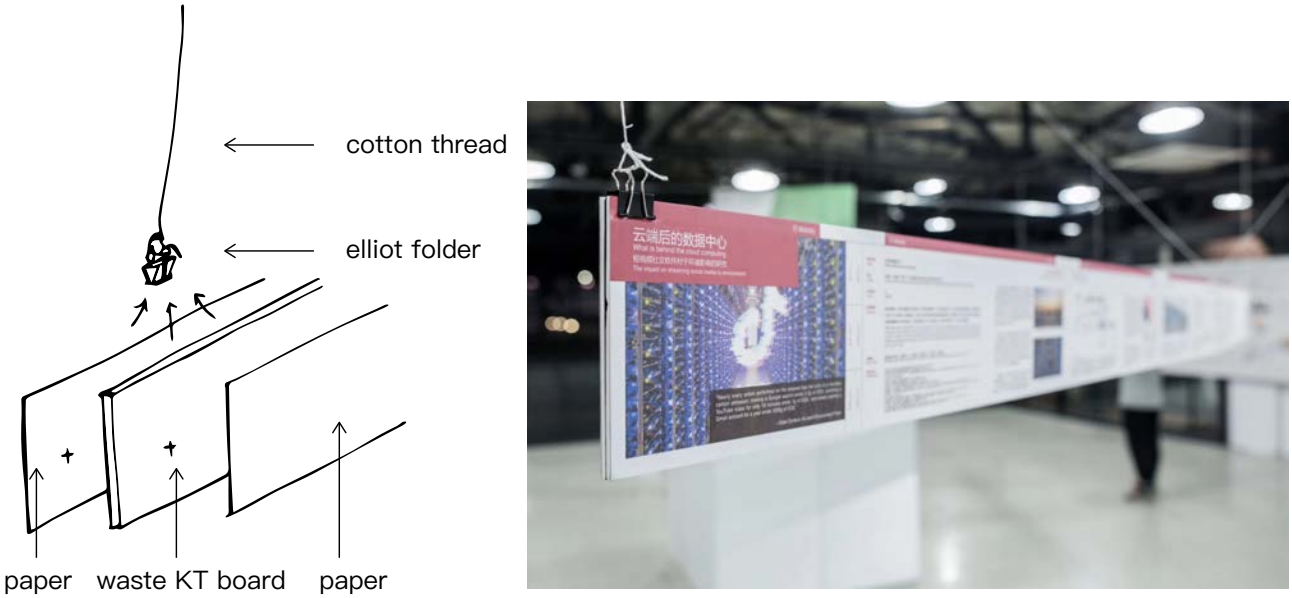

Figure 27: Design Item B

In the center of the space, the author hopes to emphasize the display information. The design concept is a hard board partition at the height of human eyes, hoping to create an immersive reading experience of knowledge maze. Follow the principle of material selection friendly, give priority to the use of waste materials. Green design by the eve of the exhibition activities on the curriculum exhibition activities abandoned many stiff KT board. The author USES the abandoned KT board as the internal framework for display and chooses paper printing. Follow the principle of detachable design, do not use the common cement, but with the help of long tail clip to help paper printed on the surface of KT board. Suspended by cotton thread to the space top structure. During the show's abandonment process, all the joints can be recycled and reused. Only paper printing, because ink adhesion can not be used again, can enter the degradation cycle.

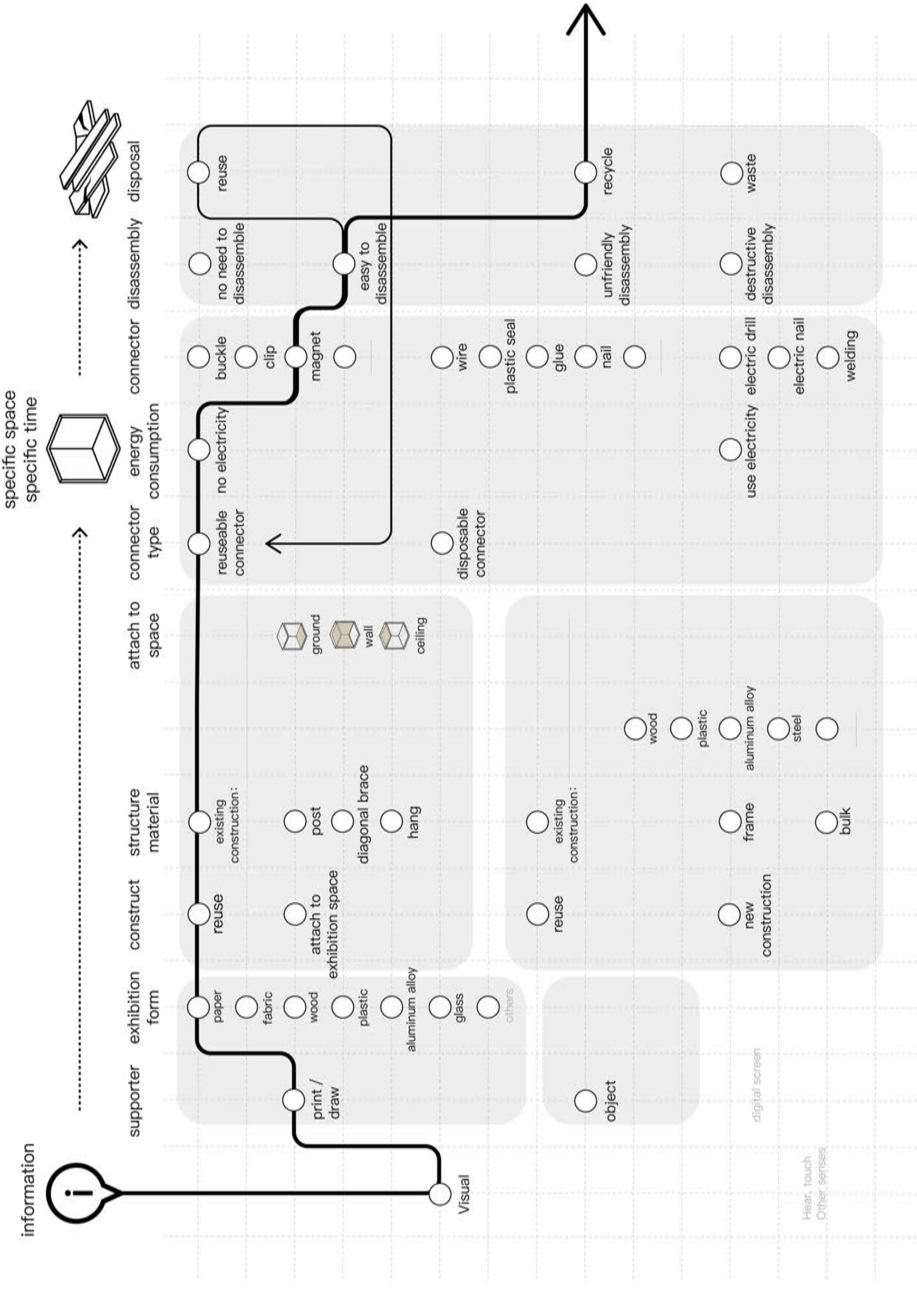

Figure 28: Design decision C guide by whole life cycle oriented design framework

Figure 29: Design Item C

In the practice of this sustainable exhibition, the author starts from the unique properties of materials of different information carriers and different space carriers, follows the principle of material reduction, and tries to make use of the original materials in the space, without unnecessary addition. In accordance with the principle of removable design, do not use hard to disassemble and separate the connection material, as is usually the case, used for paper printing paste cement. In this scheme, the author according to the characteristics of the iron backboard, using magnet to fix the paper, will not cause damage to the paper, easy to remove and recycle.

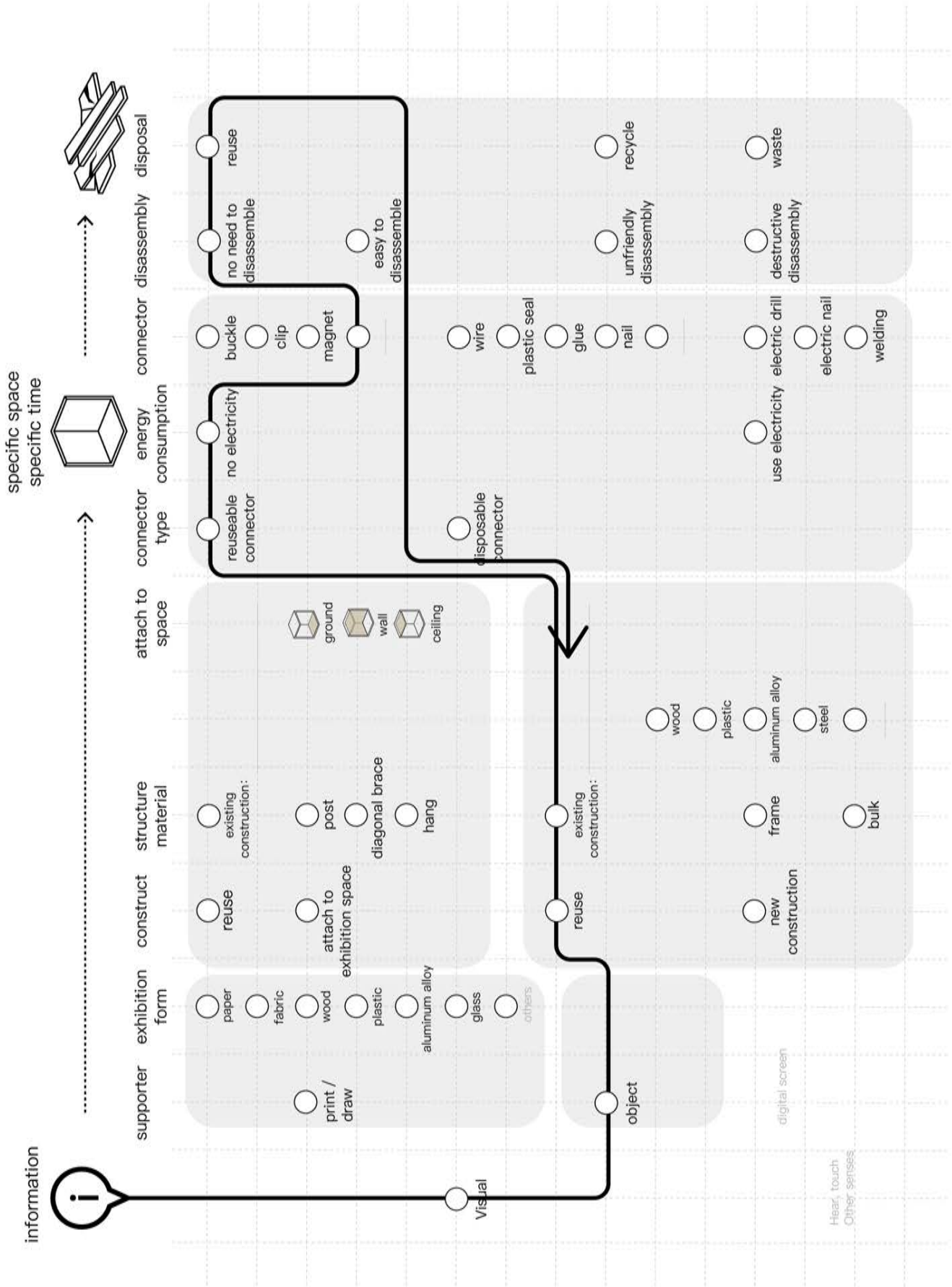

Figure 30: Design decision D guide by whole life cycle oriented design framework

The content of this exhibition involves a small number of exhibits. Following the principle of material selection and friendliness, we have chosen the recycling booth inside the institute of design and creativity, which is ready to use. After the exhibition is over, there is no need to dismantle it. Recycling booths, which do not need to be dismantled and installed, bring great convenience to temporary exhibitions and are beneficial to reduce the environmental hazards of temporary exhibitions. However, there are still some shortcomings, namely the storage problems mentioned above, which need to be solved.

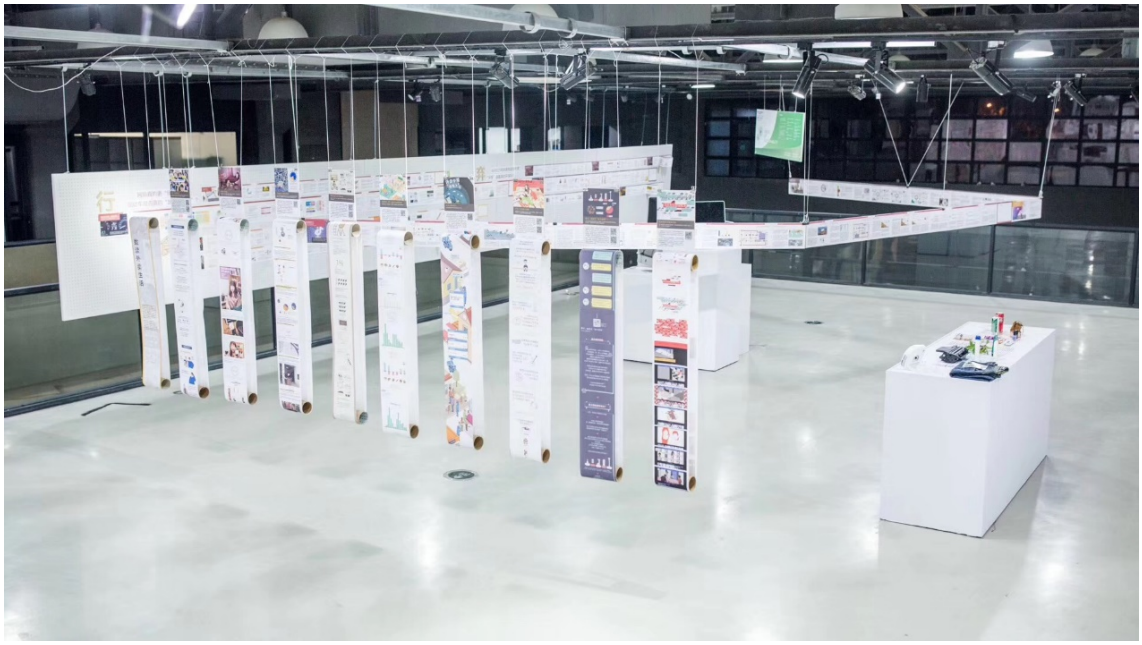

Figure 31: Overview of Green Design Exhibition

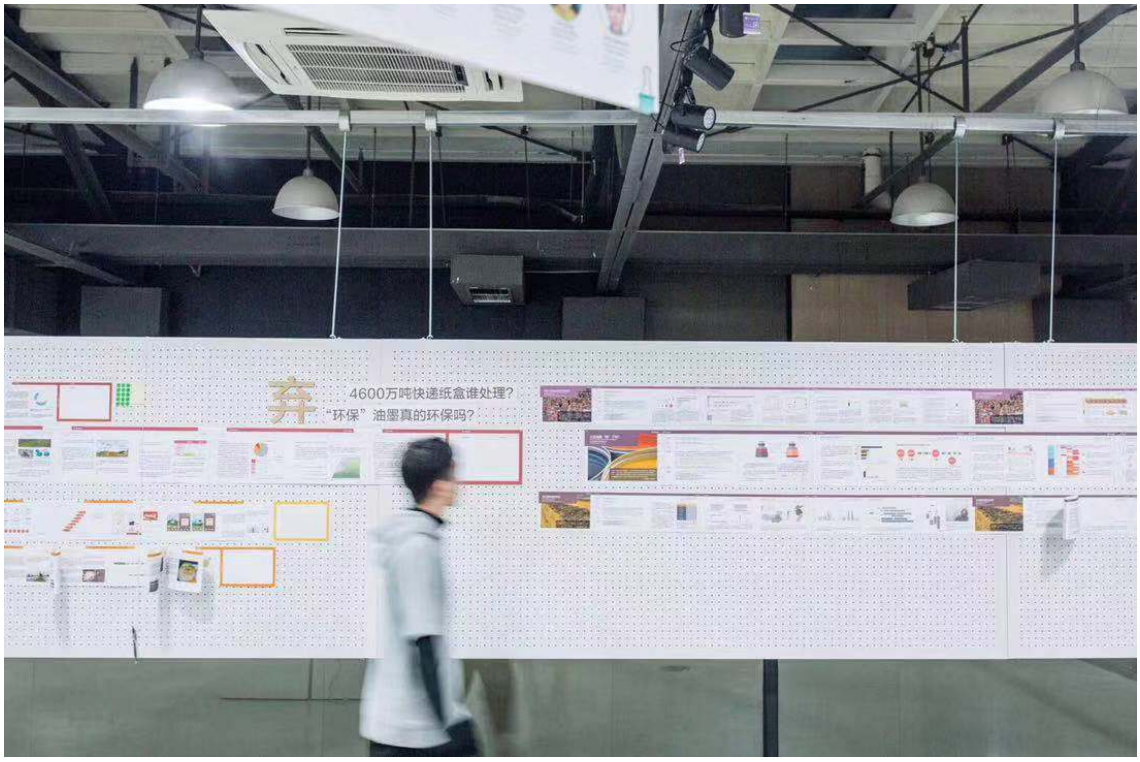

Figure 32: Overview of Green Design Exhibition

4.2.3 Life cycle assessment of green design exhibition items

The author evaluates the life cycle of green design exhibition by using the characteristic life cycle assessment framework and material database calculation results obtained in chapter 3. The purpose is to compare the standardized results of life cycle assessment of green design exhibition activities with the standardized results of life cycle assessment of "new retail x new life" design works exhibition, so as to verify the effectiveness of sustainable design guidance framework for full life cycle temporary exhibitions.

Through simapro software, the author calculated the life cycle assessment results of the green design exhibition:

Table 3: LCA of Green Design Exhibition

Environmental Impact Types		unit	Results of LCA
ADPE	**Abiotic Depletion Potential** (element)	kg Sb eq	5.14E-03
ADPF	**Abiotic Depletion Potential** (fossil fuel)	MJ	9.43E+03
GWP	**Global Warming Potential**	kg CO2 eq	8.24E+02
ODP	**Ozone Depletion Potential**	kg CFC-11 eq	1.03E-05
POCP	**Photochemical Ozone Creation Potential**	kg C2H4 eq	2.03E+00
AP	**Acidize Potential**	kg SO2 eq	3.74E+00
EP	**Eutrophic Potential**	kg (PO4)3- eq	1.10E+01
HT	**Human Toxicity**	kg 1,4-DB eq	1.81E+02
FWAE	**Fresh Water Acquatic Toxicity**	kg 1,4-DB eq	1.64E+02
MAE	**Marine Acquatic Toxicity**	kg 1,4-DB eq	6.81E+05
TE	**Terrestrial Ecotoxicity**	kg 1,4-DB eq	1.67E+00

4.3 Compared to verify

As can be seen from chapter 3, the life cycle assessment results of "new retail x new life" design exhibition are as follows:

Table 4: LCA of "New Retail x New Life" Exhibition

Environmental Impact Types		unit	Results of LCA
ADPE	**Abiotic Depletion Potential** (element)	kg Sb eq	2.94E-04
ADPF	**Abiotic Depletion Potential** (fossil fuel)	MJ	2.65E+03
GWP	**Global Warming Potential**	kg CO2 eq	2.95E+02
ODP	**Ozone Depletion Potential**	kg CFC-11 eq	4.23E-04
POCP	**Photochemical Ozone Creation Potential**	kg C2H4 eq	3.16E-01
AP	**Acidize Potential**	kg SO2 eq	1.41E+00
EP	**Eutrophic Potential**	kg (PO4)3- eq	1.78E+00
HT	**Human Toxicity**	kg 1,4-DB eq	7.14E+01
FWAE	**Fresh Water Acquatic Toxicity**	kg 1,4-DB eq	1.90E+02
MAE	**Marine Acquatic Toxicity**	kg 1,4-DB eq	3.00E+05
TE	**Terrestrial Ecotoxicity**	kg 1,4-DB eq	9.36E+00

Table 5: Comparison LCA results of 2 exhibitions

Environmental Impact Types		unit	Normalized value	Results of LCA		Normalized Results	
				"New Retail xNew Life" Exhibition	Green Design Exhibition	"New Retail xNew Life" Exhibition	Green Design Exhibition
ADPE	**Abiotic Depletion Potential** (element)	kg Sb eq	4.78E-09	5.14E-03	2.94E-04	2.46E-11	1.77E-25
ADPF	**Abiotic Depletion Potential** (fossil fuel)	MJ	2.63E-15	9.43E+03	2.65E+03	2.48E-11	1.63E-18
GWP	**Global Warming Potential**	kg CO2 eq	2.39E-14	8.24E+02	2.95E+02	1.97E-11	1.14E-19
ODP	**Ozone Depletion Potential**	kg CFC-11 eq	4.41E-09	1.03E-05	4.23E-04	4.54E-14	8.73E-31
POCP	**Photochemical Ozone Creation Potential**	kg C2H4 eq	3.88E-13	2.03E+00	3.16E-01	7.88E-13	1.96E-25
AP	**Acidize Potential**	kg SO2 eq	4.23E-13	3.74E+00	1.41E+00	1.58E-12	3.53E-24
EP	**Eutrophic Potential**	kg (PO4)3- eq	5.16E-15	1.10E+01	1.78E+00	5.68E-14	5.73E-27
HT	**Human Toxicity**	kg 1,4-DB eq	9.15E-13	1.81E+02	7.14E+01	1.66E-10	1.96E-18
FWAE	**Fresh Water Acquatic Toxicity**	kg 1,4-DB eq	2.72E-11	1.64E+02	1.90E+02	4.46E-09	3.78E-15
MAE	**Marine Acquatic Toxicity**	kg 1,4-DB eq	4.19E-12	6.81E+05	3.00E+05	2.85E-06	2.44E-06
TE	**Terrestrial Ecotoxicity**	kg 1,4-DB eq	6.32E-12	1.67E+00	9.36E+00	1.06E-11	1.04E-21
						2.86E-06	**2.44E-06**

The calculated results show that the environmental impact of the green design exhibition is 0.85 times that of the "new retail x new life" design exhibition. This proves that, to some extent, the sustainable design guidance framework for the full life cycle temporary exhibition is effective.

4.4 Key process of environmental impact of temporary exhibition

The main purpose of this study is to provide effective sustainable design guidance for temporary exhibitions according to the life cycle assessment method. Find the corresponding design point and intervention point.

4.4.1 Acquisition and processing of raw materials

Firstly, the acquisition of raw materials and the environmental impact of processing stage correspond to the reduction of design materials. When the amount of materials is reduced, the environmental impact will naturally be reduced. How to use the least material to achieve the maximum information carrying capacity, to achieve the best information transmission effect? Is the design initial, the designer needs to pay attention to the problem.

The acquisition and processing stage of raw materials involves the nature of the raw materials themselves, and the corresponding problem of the acquisition of raw materials is the way and way of material acquisition. For example, natural materials can reduce the energy consumption and emissions in the process of raw materials processing, which is a more sustainable choice. Which corresponds to the design of material selection, sustainable consciousness under the intervention of select material, in addition to the use of the material and performance, environmental constraints, criteria and material impact on the environment is also the designer should consider factors, selection of materials shall be non-toxic, non-polluting, easy recovery, recycling reusable or waste biodegradation characteristics. In addition to material selection, the processing stage of materials, also involves the management of materials. On the one hand, reduce the mixing of toxic and non-toxic materials; On the other hand, the products that have reached the life cycle and those that have not have reached the life cycle should be classified and processed consciously. The parts that have not reached the life cycle should be fully recycled and the parts that are not available should be disposed in time to minimize their impact on the environment.

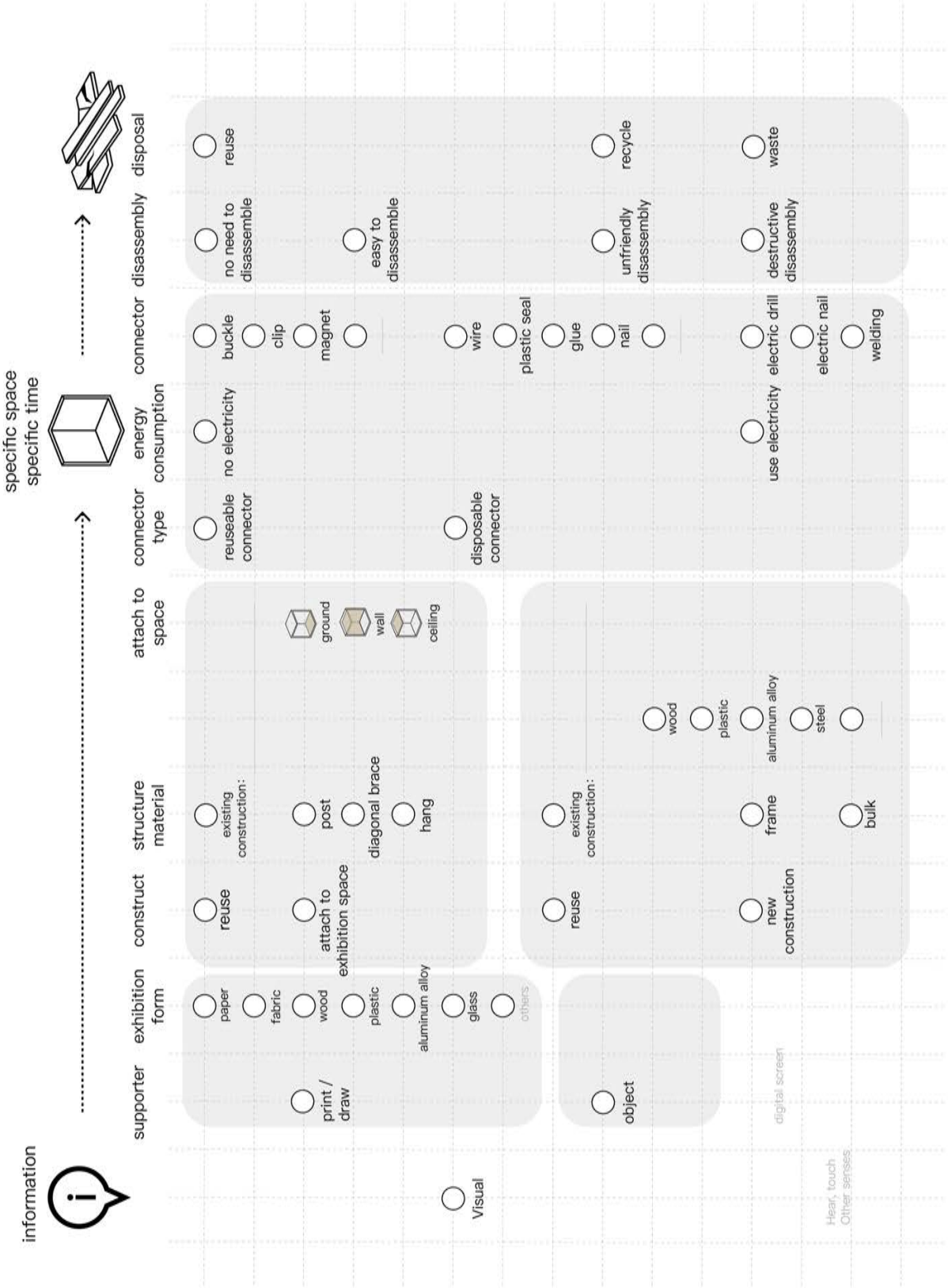

Figure 33: Guide frame for temporary exhibition design based on Life Cycle Assessment

Based on the analysis of the assessment results of the raw material acquisition and processing stage, the guidance framework of the temporary exhibition design based on the life cycle assessment is upgraded.

4.4.1.1 Sustainable Design Guidance: Material Reduction

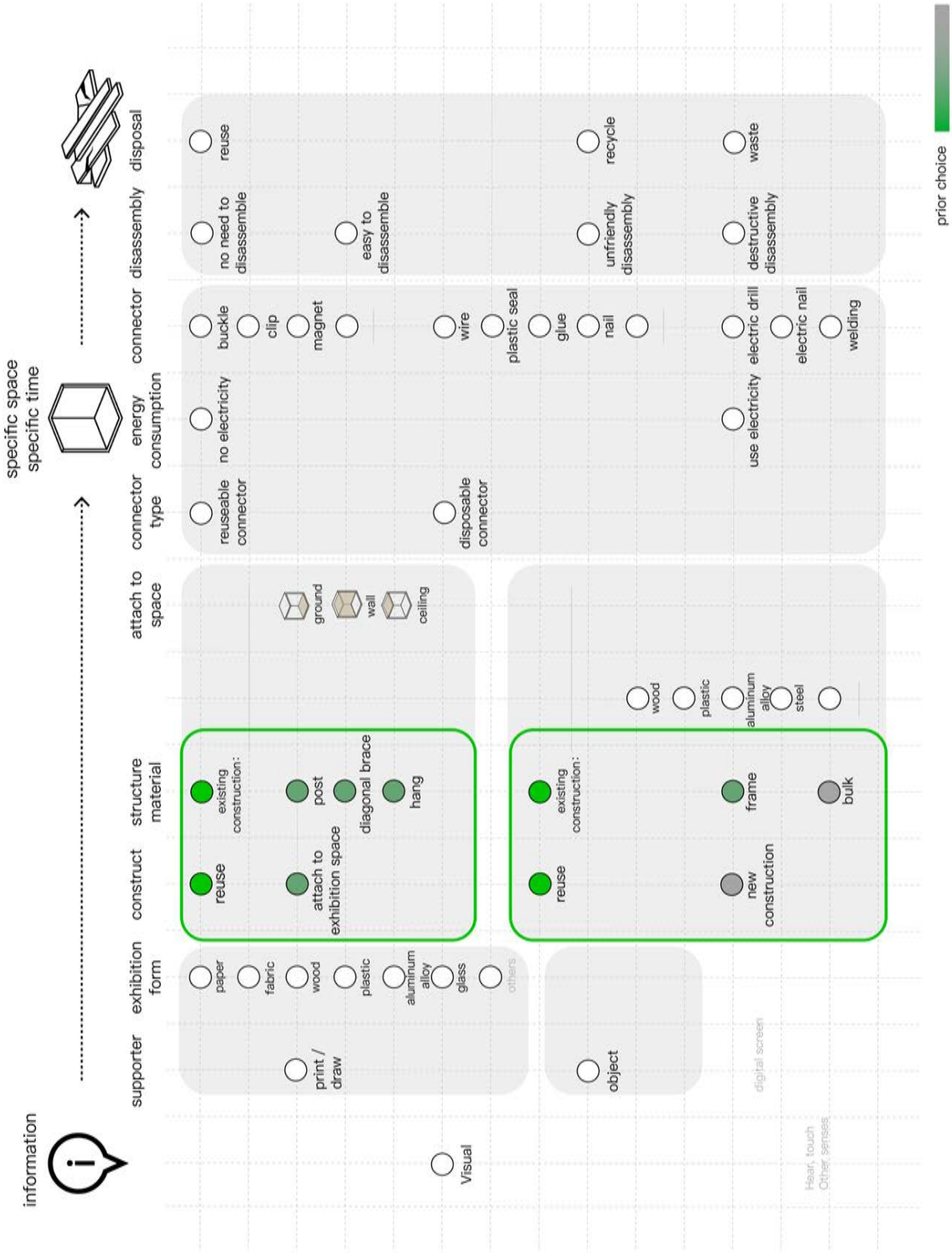

Figure 34: Reduced material guidance

Firstly, the challenge of sustainable display design is put forward: how to achieve the maximum information carrying capacity with the least amount of materials to achieve the best information transmission effect? Secondly, prioritize the selection of links involving material utilization, i.e. exhibition form and construction type:

(1) reuse existing exhibition tools to avoid energy and material consumption caused by new construction.

(2) make the best use of the original spatial interface and structure to make simple and necessary display connections.

(3) during the construction of new construction, the practice of reducing the structural design, that is, through the design of a more reasonable structure, to reduce the types of materials and the use of materials. Therefore, under the premise of displaying function and effect requirements, the structure of simple construction is replaced by the frame type construction, and the block type construction is replaced by the frame type construction, so as to remove the redundant part of the display form as much as possible. The use of functional diversity and complex structure to promote the construction of recycling, reduce resource and energy consumption, reduce waste and other aspects of improvement.

4.4.1.2 Sustainable Design Guidance: Friendly selection

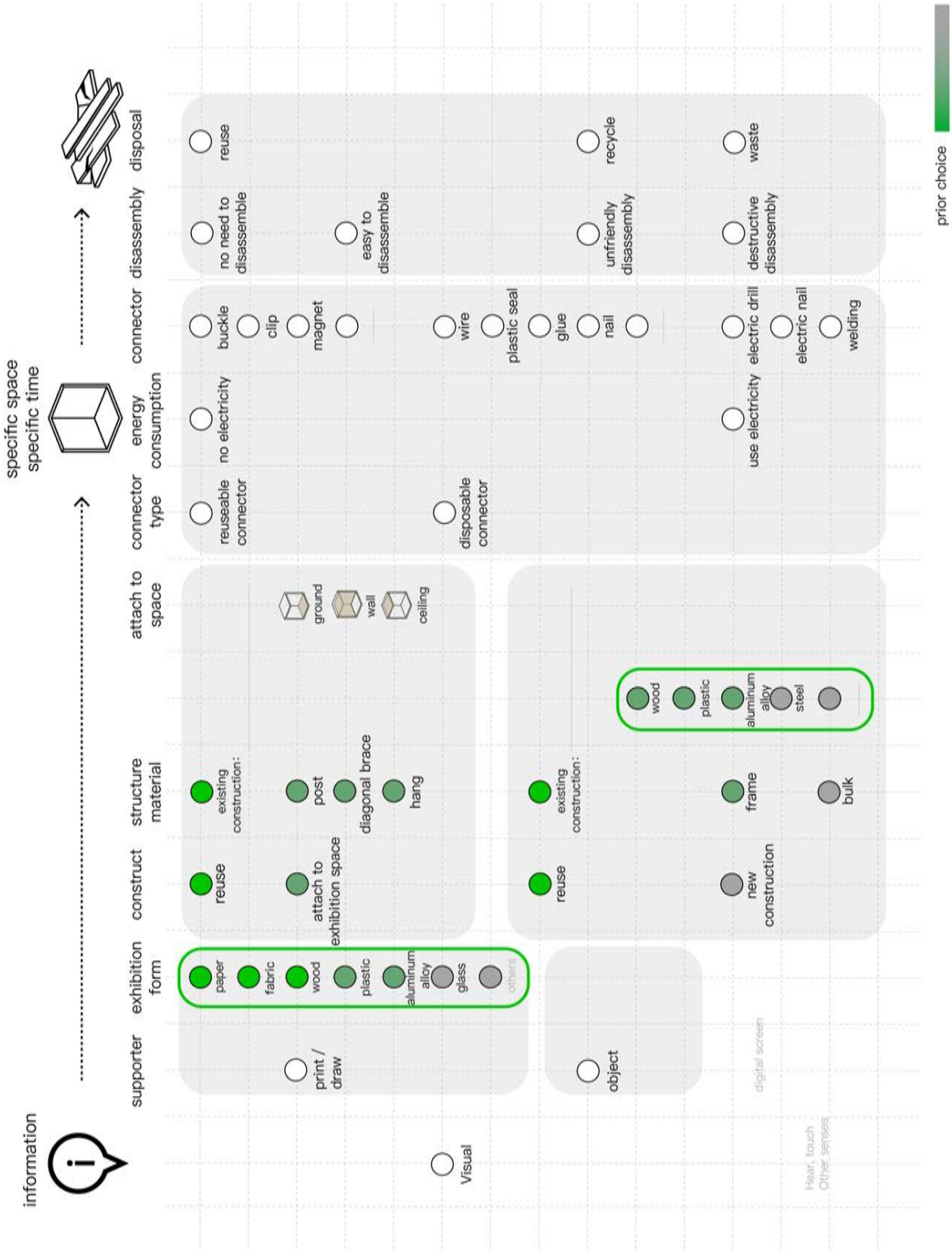

Figure 35: Choose environmental-friendly material guidance

Material selection is one of the most important stages in the sustainable design process of temporary exhibition, which greatly influences the environmental load of exhibition. Materials suitable for sustainable exhibition should meet the dual requirements of basic performance and ecological protection. The premise of material friendly selection is that the material is non-toxic and harmless. When selecting materials, the following principles should be taken into account:

(1) select recycled materials:

The feature of "renewable design" is to replace limited resources with waste and reuse them as design materials, thereby reducing the amount of waste to be disposed. Its biggest advantage is that the selection of materials is not limited, any waste can become a design material.

(2) select materials with low environmental load:

According to the calculation results of the material database in chapter 3, the environmental impact of the application of materials under different circumstances is prioritized.

(3) different materials should be avoided as far as possible.

Different material connections will bring the double difficulty of processing and assembly. At the same time, it also increases the difficulty of dismantling, sorting, recycling and reuse after the exhibition.

4.4.1.3 Sustainable Design Guidance: Designed for Disassembly

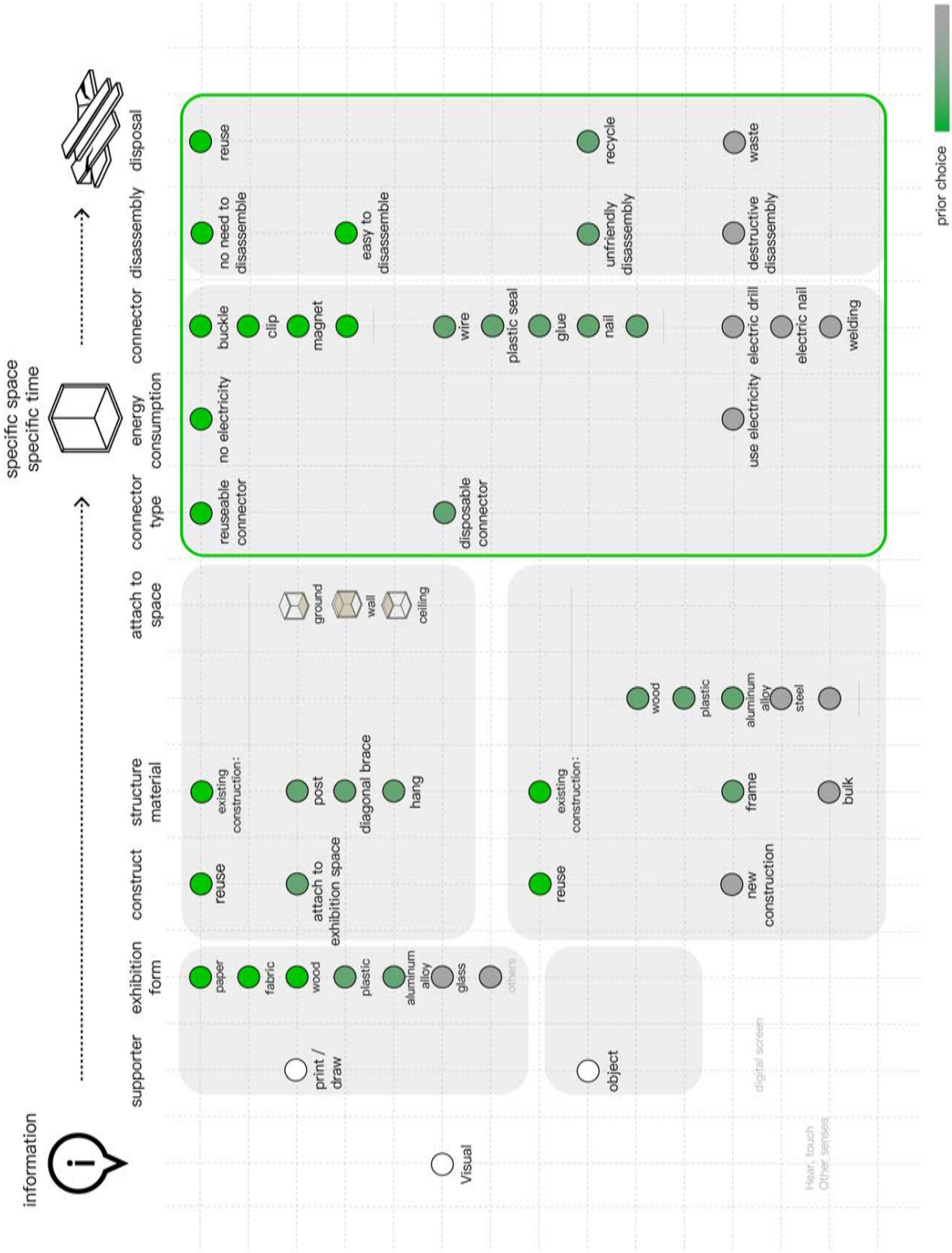

Figure 36: Design for Disassembly guidance

"Design for Disassembly" needs to fully consider the difficulty of product disassembly in the conceptual design stage, aiming to improve the reuse rate of exhibition parts and components through disassembly, and strengthen the recovery of components and materials. The detachable design can be carried out at the whole level or the component level of the exhibition tool, improving the reuse efficiency of manufacturing, recycling, assembly and disassembly. The requirements are as follows:

(1) use recyclable connector. Try to avoid the use of disposable products, such as plastic seals, adhesive and other irreversible installation and connection products. Avoid connection products that are easily damaged, such as nails.

(2) use ready-made simple connector as much as possible to avoid new processing and mold production.

(3) the workload of installation and disassembly should be simplified as much as possible. Refers to the most simple form and structure to form fewer parts when the function is satisfied; Minimize maintenance and recovery effort and reduce technical requirements for maintenance and recovery personnel.

(4) easy disassembly. Means to minimize the secondary processing of parts and components after disassembly, and avoid damaging materials and parts during disassembly and separation. Parts shall be designed to facilitate identification and single, standardized surface treatment, thereby shortening the classification time. Components and tools should be built with internationally standardized hardware to minimize the variety and specifications and achieve faster replacement and disassembly.

Thus, a sustainable design guidance framework based on the full life cycle of temporary exhibitions is obtained. To help the designers in the design stage of the temporary exhibition, the different stages of the temporary exhibition to conduct sustainable intervention. During the installation stage, the connection mode that is easy to be dismantled and recycled is designed for the future. In the waste stage, the reuse and recycling of materials are given priority. Green oriented, trying to achieve the display effect, at the same time, choose the best solution in each stage of the design, to reduce the impact of temporary exhibition on the environment.

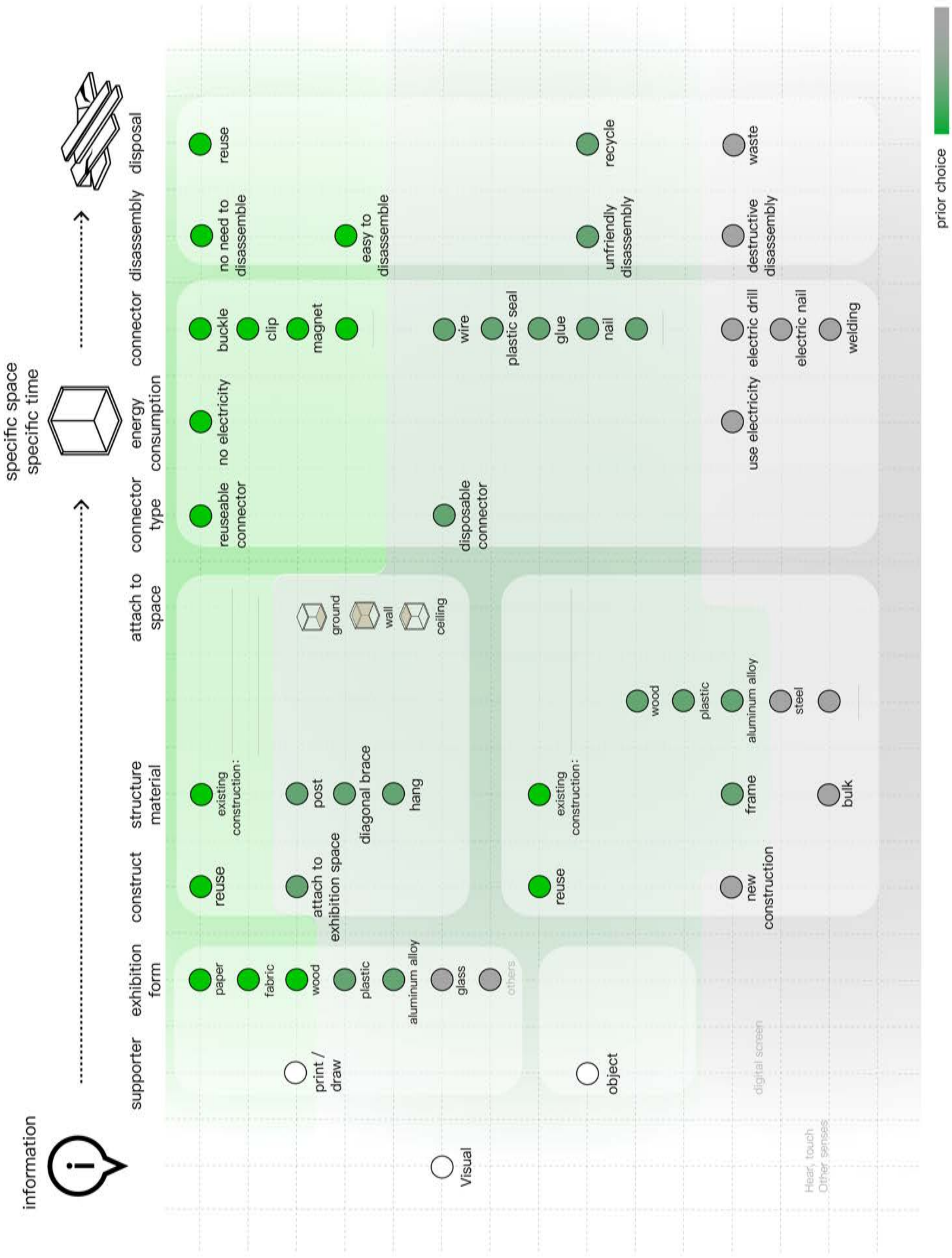

Figure 37: Whole lifecycle oriented sustainable exhibition design framework

Whole lifecycle oriented sustainable exhibition design Assessment

It can be proved from Chapter 4 that the effective nature of whole life cycle oriented sustainable exhibition design framework also proves the three sustainable design principles proposed in this study: reduce material usage, choose environmentally friendly materials and design for disassembly. These three initiatives has positively improved the environmental impact of the temporary exhibition.

This chapter will be based on the research and experimental basis of chapter 3 and chapter 4. Since chapter 4 has proved that the design principles of material reduction, material selection and dismountable design have a positive impact on the sustainability of temporary exhibitions, the author puts the sustainability assessment framework of temporary exhibitions on the implementation efficiency of the design principles.

5.1 Material reduction assessment for temporary exhibition

To reduce the use of new materials is to reduce the consumption of resources, materials and material waste at the source and fundamentally reduce the impact on the environment.

More efficient use of materials, such as structural materials as support can be simplified and replaced by high-quality materials through calculation and optimization design. A typical example in architecture is: hollow brick replaces traditional solid brick as structural support. Analogically, in temporary exhibition, light structure can also be tried to replace heavy structure, such as wood frame instead of wooden exhibition wall, wood instead of metal material and so on.

Reduce the use of additional materials, focusing on how to use waste or recycled materials or existing display tools to further avoid the consumption of new resources and waste generation.

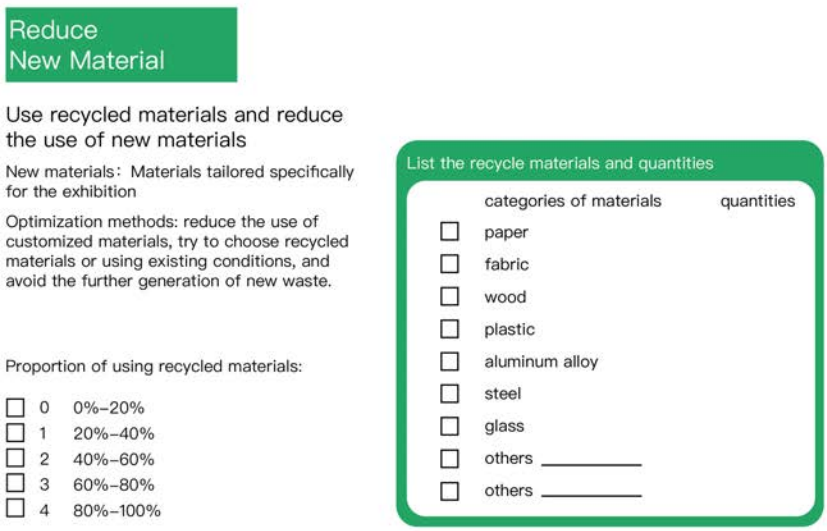

Figure 38: Reducing New material Assessment

In the evaluation framework of material reduction, recycled materials will be used as the evaluation standard. The more recycled materials used in the exhibition, the higher the score of temporary exhibition in material reduction.

5.2 Safety assessment of material selection for temporary exhibitions

The selection of non-toxic and harmless materials is the basis for the friendly selection of materials. The materials used for exhibition construction are common building materials required for temporary construction. Among them, plate materials are essential, and a wide variety of man-made plates are the main source of formaldehyde pollution. Especially in the case of high temperatures in summer, the amount of formaldehyde released increases greatly. In indoor environments with poor gout, the amount of formaldehyde released and the concentration of formaldehyde in indoor air can reach 1.5 times the normal temperature. If non-compliant materials are used, excessive concentrations of formaldehyde will irritate visitors 'eyes and respiratory tract mucous membranes, causing physical discomfort; construction workers' long-term inhalation of excessive concentrations of formaldehyde can cause irreversible chronic respiratory diseases, which can cause cancer.

Solvent-based coatings and interior wall coatings are also commonly used as surface decoration materials for exhibitions and can be applied to the surfaces of wood, metal and other materials. The coating mainly releases benzene, toluene, xylene and formaldehyde. Short-term inhalation of high concentrations of benzene may cause central nervous system irritation. And if construction workers are exposed to a low dose of benzene for a long time, it may lead to aplastic anemia and even leukemia.

It is worth mentioning that, due to the consideration of the cost and durability of the materials used for one-time exhibitions, the most widely distributed and most commonly used products are red list products. There is still a long way to go to change the status quo of the market.

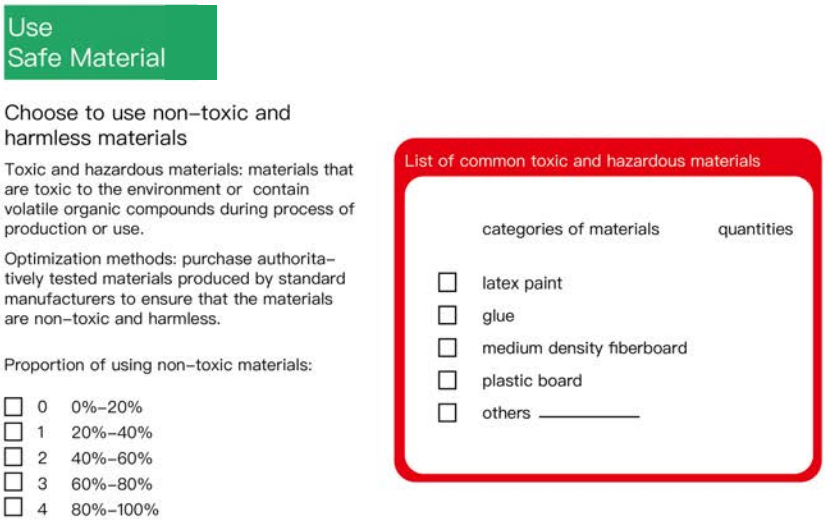

Figure 39: Using Safe Material Assessment

In the evaluation framework of material selection security, non-toxic and harmless materials will be selected as the evaluation criteria. The more authoritatively tested non-toxic and harmless materials from the regular manufacturers account for the total materials used in the exhibition. The temporary exhibitions will be in terms of material selection security. The higher the score.

5.3 Safety assessment of material selection for temporary exhibitions

Natural resources refer to the general term of materials and energy that can be exploited by humans for production and living in nature. Such as water resources, land resources, ore resources, forest resources, animal resources, climate resources, energy resources, etc. These natural resources are divided into renewable resources and non-renewable resources according to whether they can be regenerated. Non-renewable resources such as petroleum, coal, and our resources cannot be regenerated after use, and these resources will one day be depleted; and renewable resources such as forest resources will not be renewable after being severely damaged.

Therefore, reducing the consumption of non-renewable materials is a prerequisite for friendly selection, and depending on the region, different materials are used instead of non-renewable resources. For example, in Europe and the United States, forest resources are abundant, and wood is a suitable substitute for non-renewable resources. In China and Japan, where forest

resources are relatively scarce and wood is severely felled, it is not possible to use wood instead of non-renewable materials takes. Depending on China's national conditions, it is more appropriate to choose bamboo or develop new composite materials as a substitute for non-renewable resources.

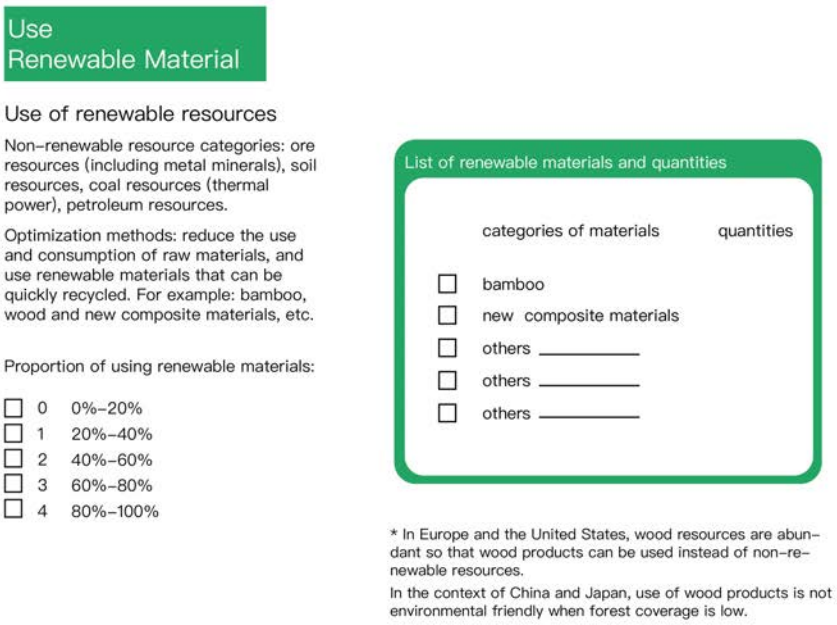

Figure 40: Using Renewable Material Assessment

The material can be selected according to the actual use of the material. Under the temporary short-term construction behavior, under the conditions of indoor construction, the requirements for the strength and durability of the material are depleted, and bamboo and wooden products can be selected for construction. In the case of cyclic display and long-term display, aluminum alloy can be selected for multiple cycles, which has high strength and durability and is not easily deformed, which is suitable for multiple cycles. The development of technology in the secondary aluminum industry has greatly improved the recycling efficiency of aluminum metal, and it is possible to obtain more robust metal products without mining new non-renewable resources.

5.4 Evaluation of the ease of installation of temporary exhibitions

The disassembly time and the degree of material loss after disassembly have a significant impact on the recycling of materials. The evaluation of the degree of easy installation and disassembly requires comprehensive installation and disassembly time and the degree of material loss. The disassembly time of violent disassembly is short, but the material loss after disassembly is large, and it cannot enter the recycling system. Disassembly is also considered invalid in the system. Disassembly is difficult and takes time, but the material loss rate after fine disassembly is small. Although the material can be reused in the recycling system after

disassembly, the inconvenience caused by disassembly will cause inefficient implementation. In reality, Subtle dismantling that requires a lot of time and effort after the exhibition is virtually impossible. In the evaluation system, the most respected is the precise reuse and disassembly behavior that are convenient for installation, quick disassembly and almost no loss.

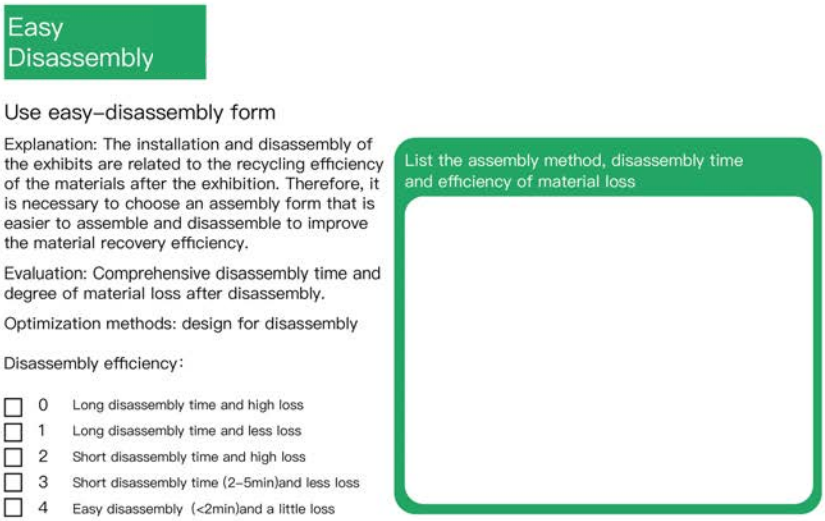

Figure 41: Easy Disassemble Assessment

"Design for disassembly" needs to fully consider the ease of product disassembly at the conceptual design stage, and is aimed at improving the reuse rate of display parts and components through disassembly, and strengthen the recycling of components and materials. The detachable design can be carried out at the overall level of the exhibition or the level of parts and components, improving the reuse efficiency of manufacturing, recycling, assembly and disassembly.

The installation and disassembly process of the temporary exhibition is related to the efficiency of material recycling after the exhibition. For the sustainable design of the temporary exhibition, changing the contacts, that is, the design of the detachable connection structure, most of the current methods are built on the existing connection structure to improve the design. It difficult to completely innovates. The detachable connection structure is summarized and summarized. The mature and typical detachable connection structure is used to design, and the workload of the new design is minimized, that is, based on reasonable inheritance, innovation is carried out to achieve the rationalization of the detachable structure design. It’s helpful to promote the creation of new innovative structures.

5.5 Evaluation of the recycling rate of temporary exhibitions

Recycling reduces the amount of material that enters the waste system, gives the material the value of multiple reuses, and extends the life cycle of the material. Recycling requires that materials remain intact during disassembly. The efficiency of recycling is closely related to the ease of installation and removal. Generally, reasonable material selection and easy installation methods will bring extremely high recycling efficiency. But it also brings a series of storage problems.

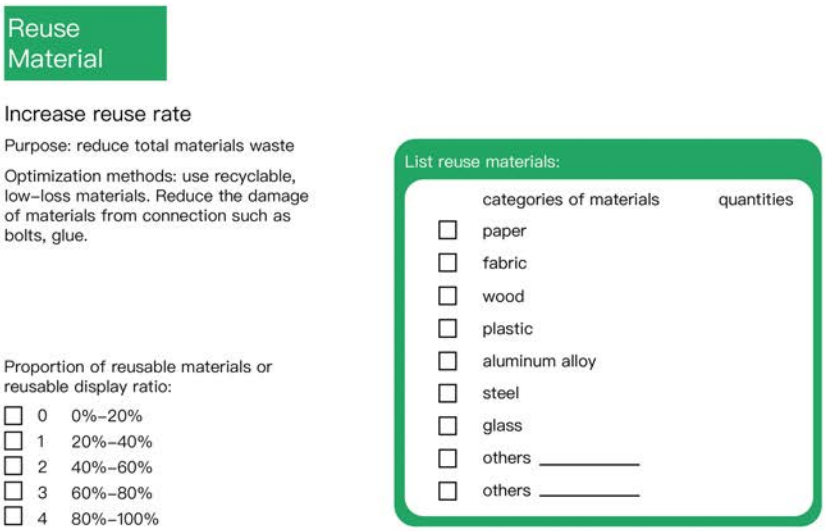

Figure 42: Reusing Material Assessment

Taking D&I as an example, the recycling of exhibits has been started, but the storage of recycled exhibits takes up a lot of public space. In the period when there are few exhibition activities, the circular exhibits are still placed in the corner of the exhibition venue, which has a certain impact on the environment and the efficiency of space utilization.

In the exhibition sustainability assessment framework, the proportion of exhibits that are put into recycling and reused in the total exhibition exhibits is used as the criterion for judging, and the storage of circulating exhibits during idle time is also required.

5.6 A simplified framework for assessing the sustainability of temporary exhibitions

The temporary simplified sustainability assessment framework provides a summary of the three major categories of sustainable design strategies and recycling strategies for temporary exhibitions. Material reduction, material selection friendliness, detachable installation, and effective recycling require designers to make sustainable consideration of exhibition display design from the perspective of the full life cycle. Tracking of recycling efficiency can effectively affect the overall environmental effects of the exhibition. According to the results of the life cycle assessment of the temporary exhibition, find the fundamental units that have

considerable impact on the environment, and trace them back to the corresponding stage of the design.

The simplified framework could help designers to provide sustainable interventions at different stages of the temporary exhibition during the design stage of the temporary exhibition. Adhere to the reduction of materials and the friendly selection of materials. During the installation phase, design a connection method that is easy to disassemble and recycle for the future. In the waste phase, is a priority for the reuse and recycling of materials. The sustainable system strive to choose the optimal solution at each stage of the design while achieving the display effect.

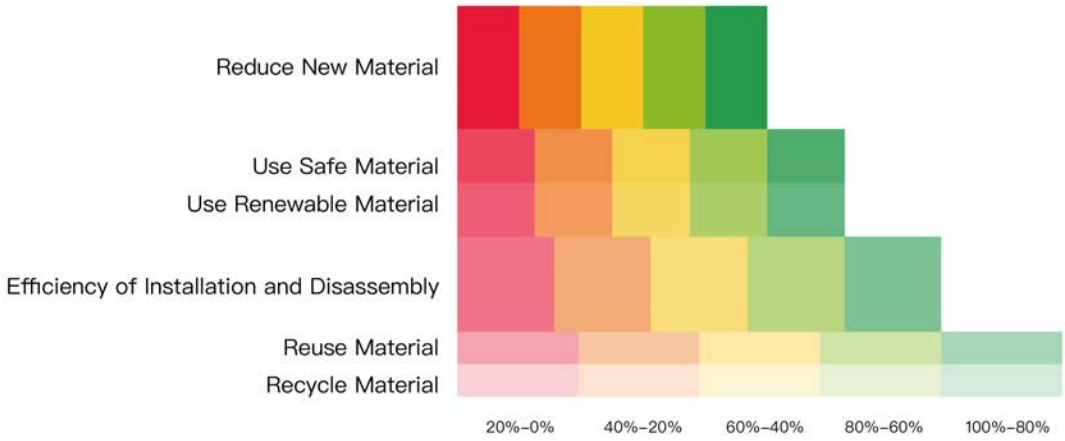

Figure 43: Color Label for whole lifecycle oriented sustainable exhibition design assessment

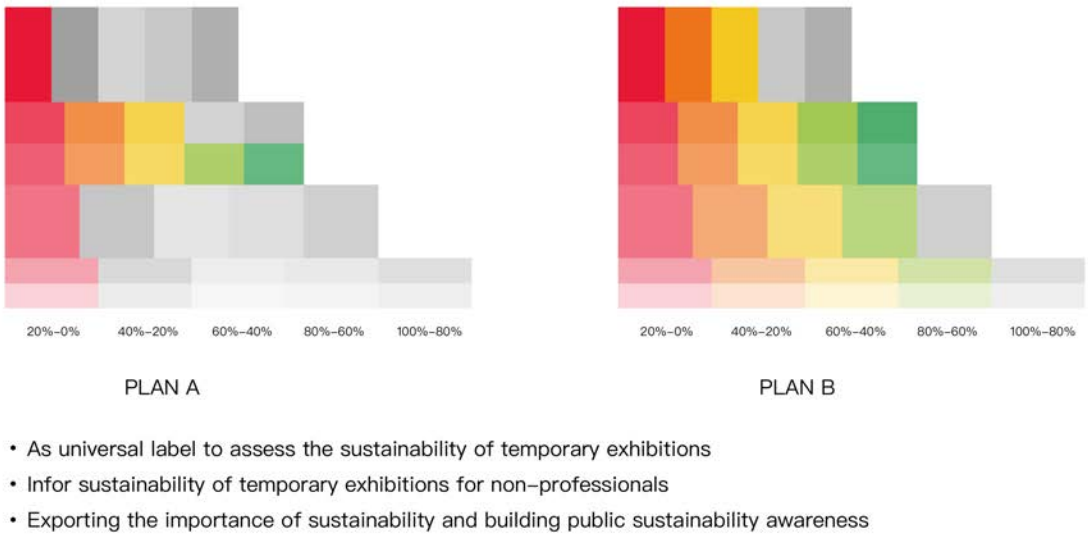

Figure 44: Color Labels of 2 exhibitions

The establishment of a sustainability assessment framework for temporary exhibitions helps non-professional audiences such as visitors and owners to provide simplified assessment criteria for the sustainability of exhibitions. Establish the establishment and impact on the sustainable awareness of the audience and the owners. The audience needs the exhibition to create a sustainable environment for the visitors. The owners need to use the exhibition to demonstrate the corporate social responsibility, thereby urging the industry's upstream and downstream sustainable changes.

Open Innovation Platform and Prospect for Sustainable Design in Temporary Exhibitions

6.1 Open innovation platform for sustainable design for temporary exhibitions throughout the life cycle

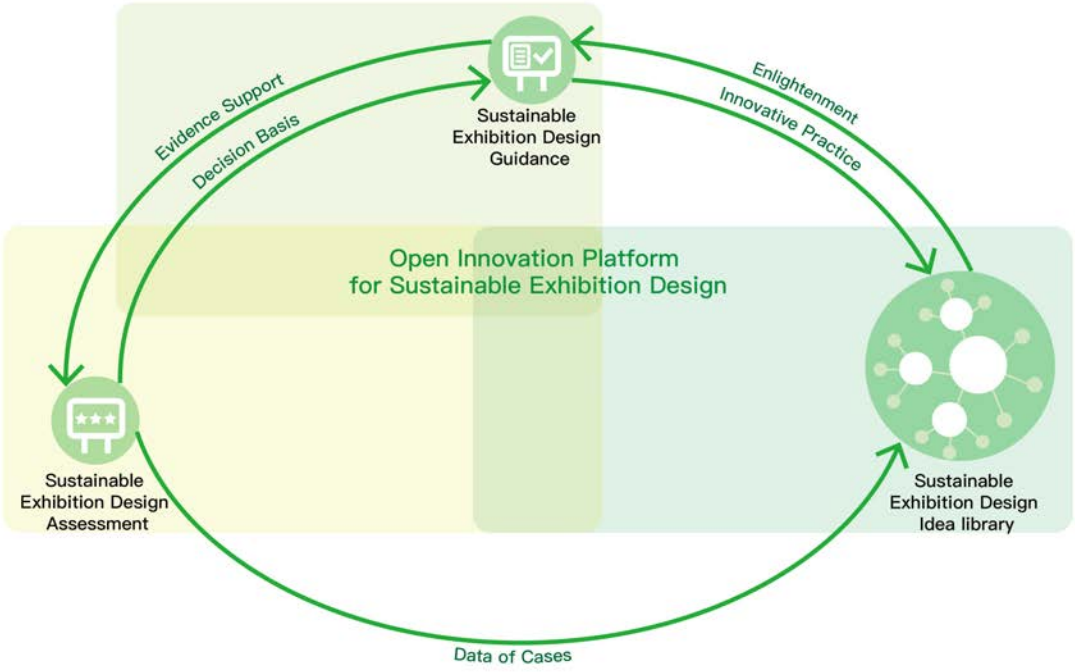

Figure45: An open innovation platform for sustainable design for temporary exhibitions throughout the life cycle

This paper uses the tools of life cycle assessment to evaluate and summarize the life cycle of temporary exhibitions, and proposes a characteristic life cycle assessment framework for the event of temporary exhibitions. Based on the results of the characteristic evaluation of the temporary exhibition, a sustainable guiding framework for the design of the temporary exhibition is proposed. Under the framework of sustainable design guidance, the emergence of new ideas and methods has promoted true sustainable innovation. Sustainable innovation solutions will be assembled to form a sustainable design think tank for temporary exhibitions. The effectiveness of innovative ideas and solutions in think tanks will be tested by the characteristic life cycle assessment of temporary exhibitions. The sustainable display design evaluation framework, guidance framework and think tank interact to form an open innovation platform for sustainable design for temporary exhibitions throughout the life cycle.

6.1.1 Traditional display design process

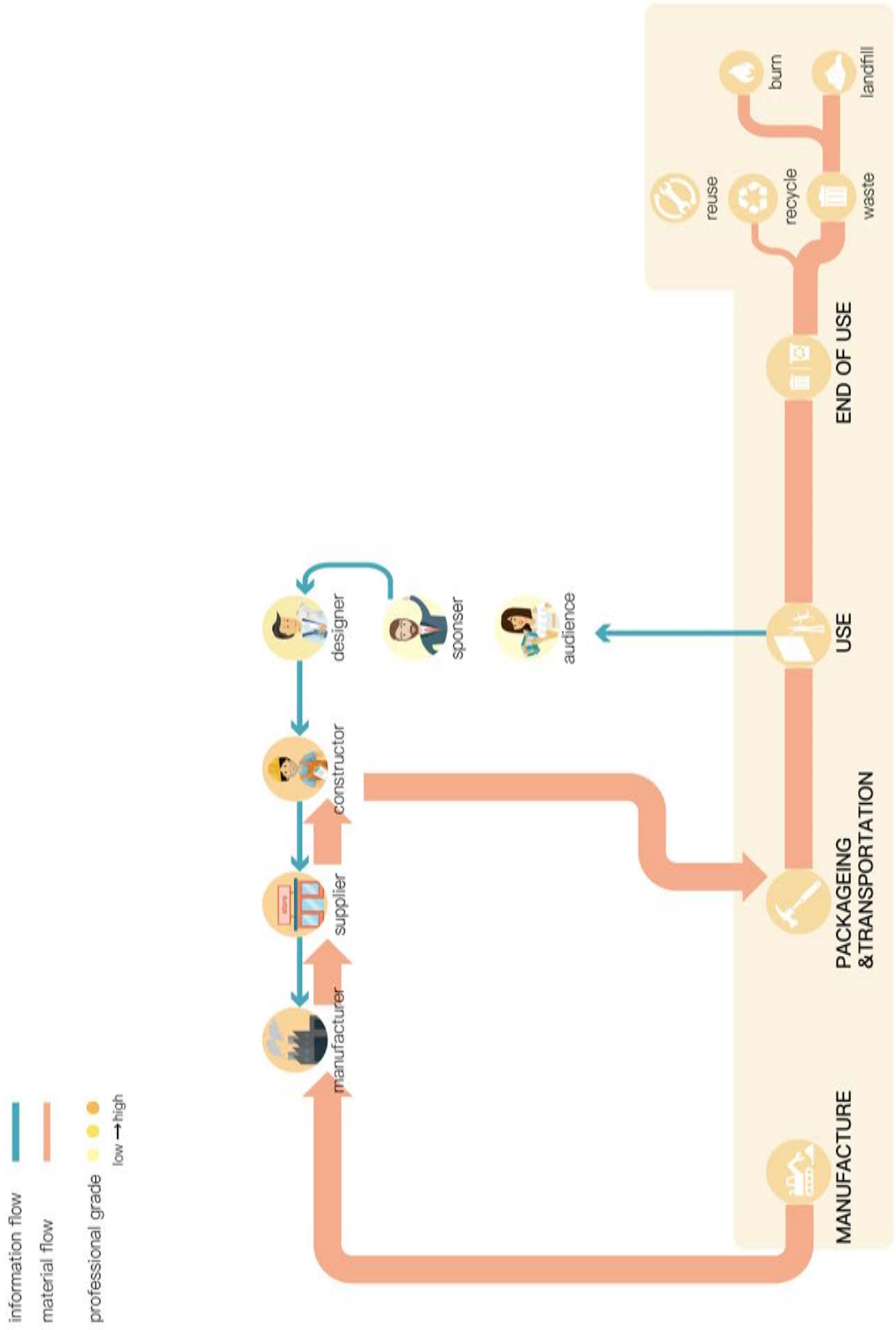

Figure 46: Traditional exhibition system

Under the traditional display design process, the relationship between the stakeholders is only the client and the client, and the information is transmitted in one direction. The owner entrusts the designer with the design, the designer delivers the plan, and contacts the construction party for construction docking. The construction provides material requirements to the supplier, the supplier provides spot materials and orders out-of-stock materials from the manufacturer. Under the traditional design and delivery process, the information is transmitted one-way between stakeholders, and each link is relatively independent. Owners, designers, and constructors, as direct participants in the exhibition, pay more attention to the display form and the effect of the scene during the exhibition. In order to achieve the display effect, the material and manpower investment of the temporary exhibition is huge. Few people pay attention to the waste disposal after the event. Almost all material materials are discarded after the one-time display, which has extremely bad impact on the environment.

6.1.2 Whole life cycle oriented sustainable exhibition design assessment

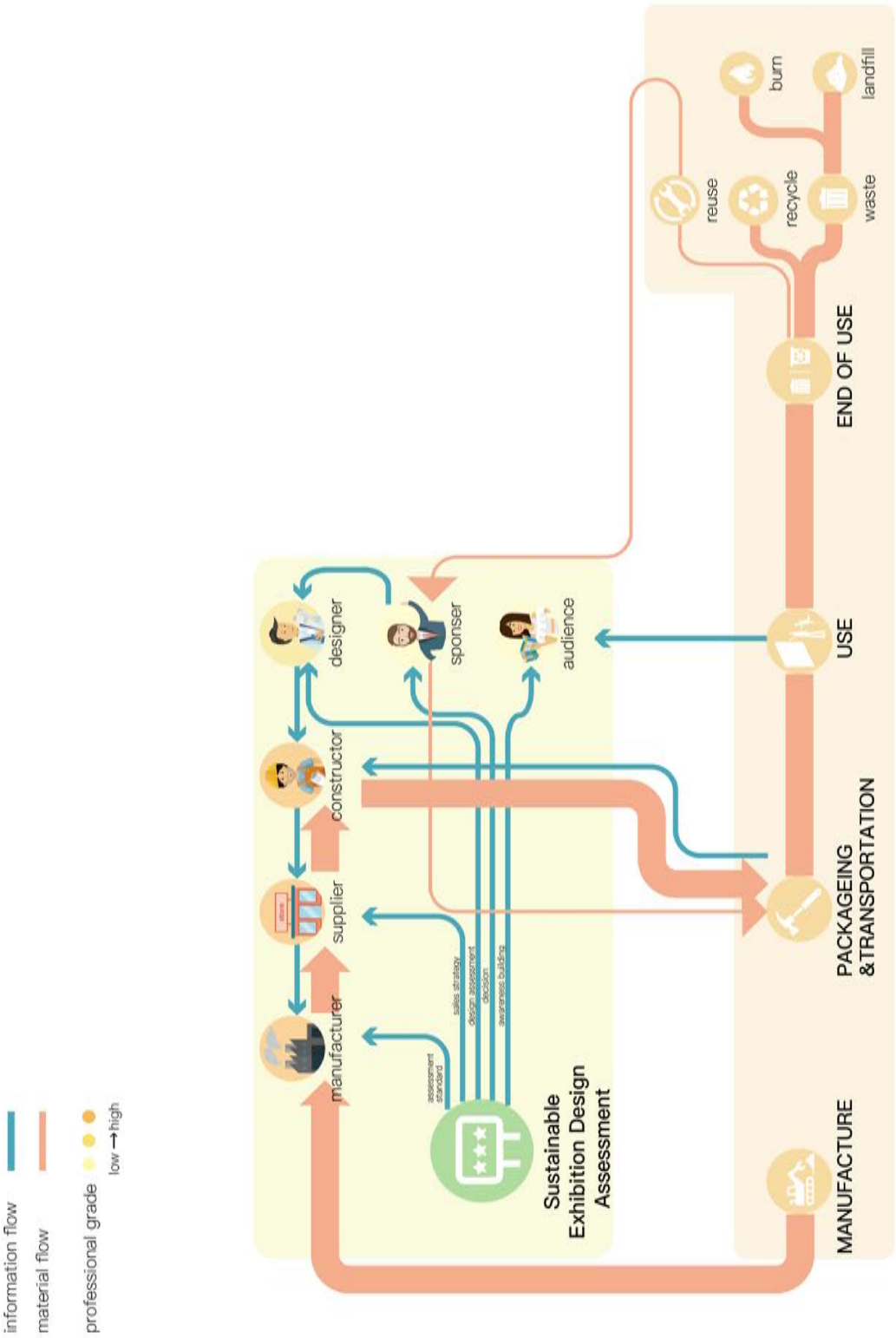

Figure 47: Sustainable Exhibition Design Assessment intervene to temporary exhibition

The first step of the life cycle assessment is to determine the purpose and scope, which provides the judges with a greater degree of freedom. As a result, the current life cycle assessment in many fields is not an assessment from the "cradle" to the "grave". Limited to a certain stage due to lack of information. In order to maintain the integrity of the definition of life cycle assessment, this study defines the process of the temporary exhibition from "cradle" to "product" as the sum of the life cycle assessment of each independent display form in the temporary exhibition in order to simplify the complexity of the overall system. Different display forms bring different degrees of environmental impact. A characteristic life cycle assessment framework for temporary exhibitions has been preliminarily established, and a calculation method with certain universal significance has been given. The life cycle assessment method is a comprehensive, comprehensive, multi-dimensional and systematic method. Its theoretical validity is unquestionable, but the life cycle assessment must be based on a large number of credible data. The data collection process is cumbersome and it is difficult to guarantee the data. Accuracy. In view of this, the author summarizes the common materials of temporary exhibitions, and builds a relatively reliable material and material database for temporary exhibitions based on a large amount of data collection and comparison.

With the support of the sustainable display design evaluation framework, the owner can judge the sustainability of the display design through evaluation tools, the designer can use the evaluation tool to evaluate and optimize the design, and the constructor can consider his own installation method based on the evaluation tool Suppliers can use environmentally friendly evaluation results as marketing strategies, and manufacturers can also develop product evaluation standards based on evaluation tools to promote sustainable product upgrades. As a result, the ecology of the new sustainable display design industry has sprung up. All stakeholders in the industrial chain can use the evaluation tools to introspect and urge the sustainable change of the industry. At the same time, the evaluation framework of the exhibition can be simplified and illustrated. The simple evaluation framework can be used as the evaluation criteria of the exhibition to convey the sustainability level of the exhibition to the audience and promote the establishment of public sustainable awareness.

6.1.3 Whole life cycle oriented sustainable exhibition design guidance

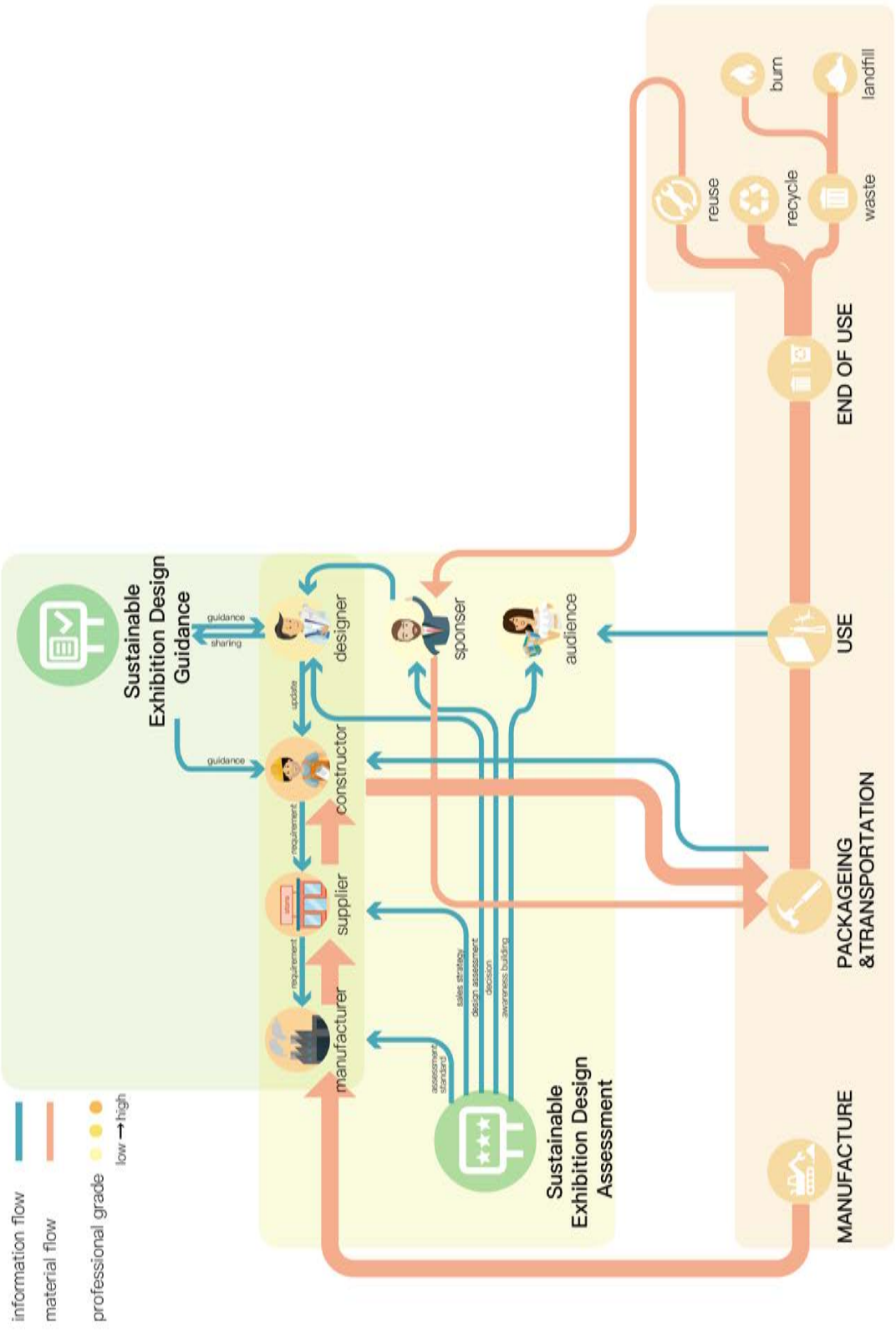

Figure 48: Sustainable Exhibition Design Guidance intervene to temporary exhibition

This study does not stop with the results of the life cycle assessment of temporary exhibitions. The fundamental purpose of this research is to provide sustainable design decisions for temporary exhibitions based on life cycle assessments. Therefore, results-oriented, this research rests on sustainable guidance for the design phase of temporary exhibitions.

Guidance framework for sustainable design of temporary exhibitions based on the entire life cycle:

According to the results of the life cycle assessment of the temporary exhibition, find the key units that have considerable impact on the environment, and trace them back to the corresponding stage of the design.

Help designers to provide sustainable interventions at different stages of the temporary exhibition during the design stage of the temporary exhibition. Adhere to the reduction of materials and the friendly selection of materials. During the installation phase, design a connection method that is easy to disassemble and recycle for the future. In the waste phase, give priority to the reuse and recycling of materials. To be green-oriented, strive to select the optimal solution at all stages of the design while achieving the display effect, and reduce the impact of temporary exhibitions on the environment.

As the establishment of sustainable display design evaluation establishes and influences the sustainable awareness of the audience and the owners, the audience needs the exhibition to create a sustainable environment for the visitors, and the owners need to use the exhibition to demonstrate the corporate social responsibility, thereby urging the industry's upstream and downstream Sustainable change. The change in the sustainable awareness of the audience and owners requires designers to upgrade their designs in response to market demand. The sustainable display design guide came into being. With the intervention of the sustainable display design guide, the designer carried out display design considerations from the perspective of the entire life cycle according to the design guide, and gave guidance to the installation method of the constructor. The change of the installation method promoted the materials. The change in market demand is related to the optimization and upgrading of products, thereby producing and designing environmentally friendly products that meet the requirements of the public, opening up the green display design model for recycling of materials and exhibits, and thus opening a healthy sustainable display design Ecological cycle.

6.1.4 Whole life cycle oriented sustainable exhibition design idea tank

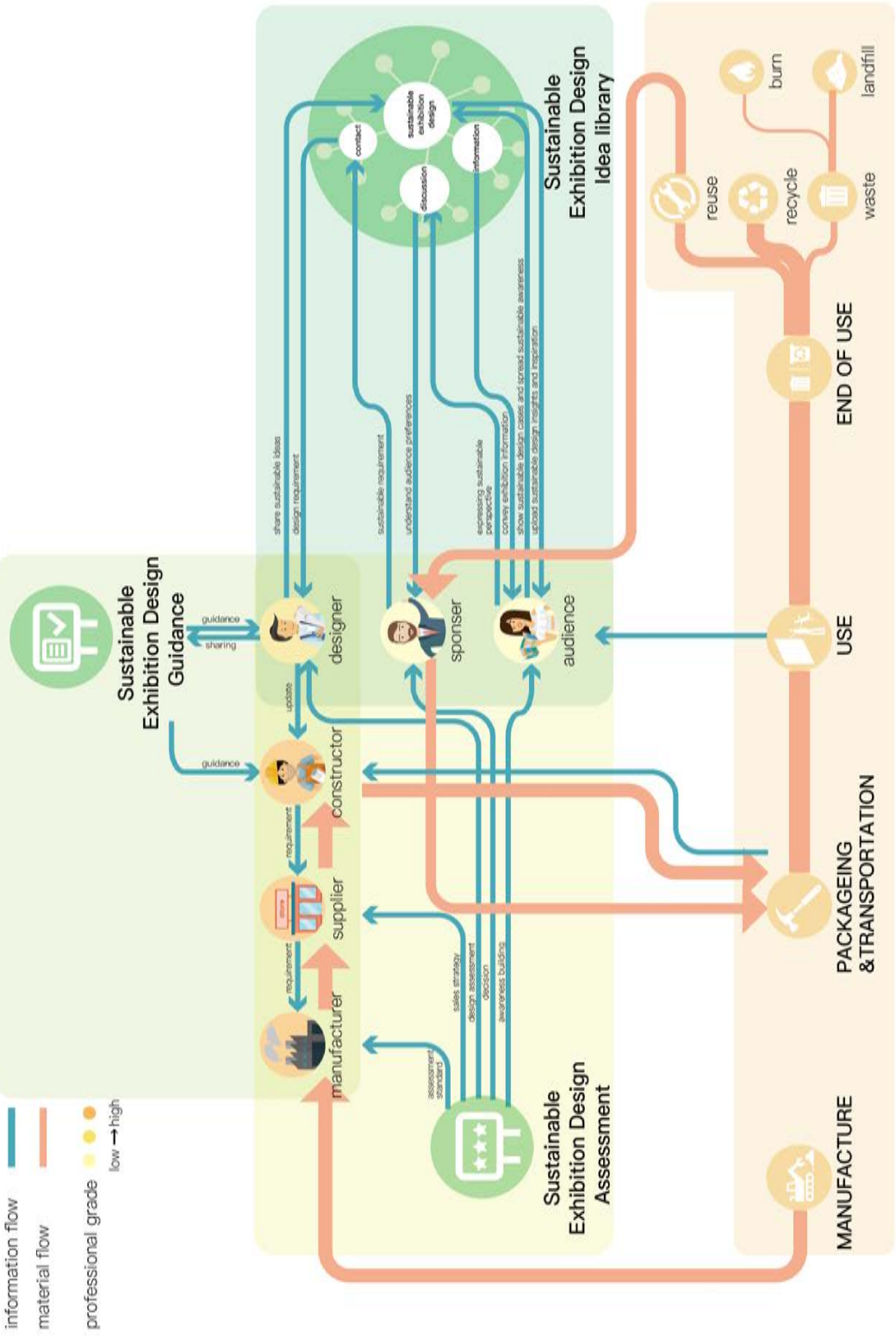

Figure 49: Sustainable Exhibition Design Library intervene to temporary exhibition

The sustainable design guidance framework for temporary exhibitions throughout the life cycle is not static, it is an open design guidance tool. The sustainable practice of each temporary exhibition is a test and supplement to the sustainable design framework of temporary exhibitions. Check if there are any design processes, missing and wrong display materials involved, and help to improve and upgrade the framework. Through the collection and summary of sustainable design guidance and sustainable methods for temporary exhibitions, the framework is expanded from shallow, uncontrollable design guidance to a sustainable design think tank for temporary exhibitions.

Through the data collection and analysis from the sustainable design application to temporary exhibition, an open-source database and idea-inspiring community with temporary exhibition cases could be created. It could further improve the sustainable design tools, and thus realize the real sustainable innovation.

6.1.5 Outlook of exhibition trade

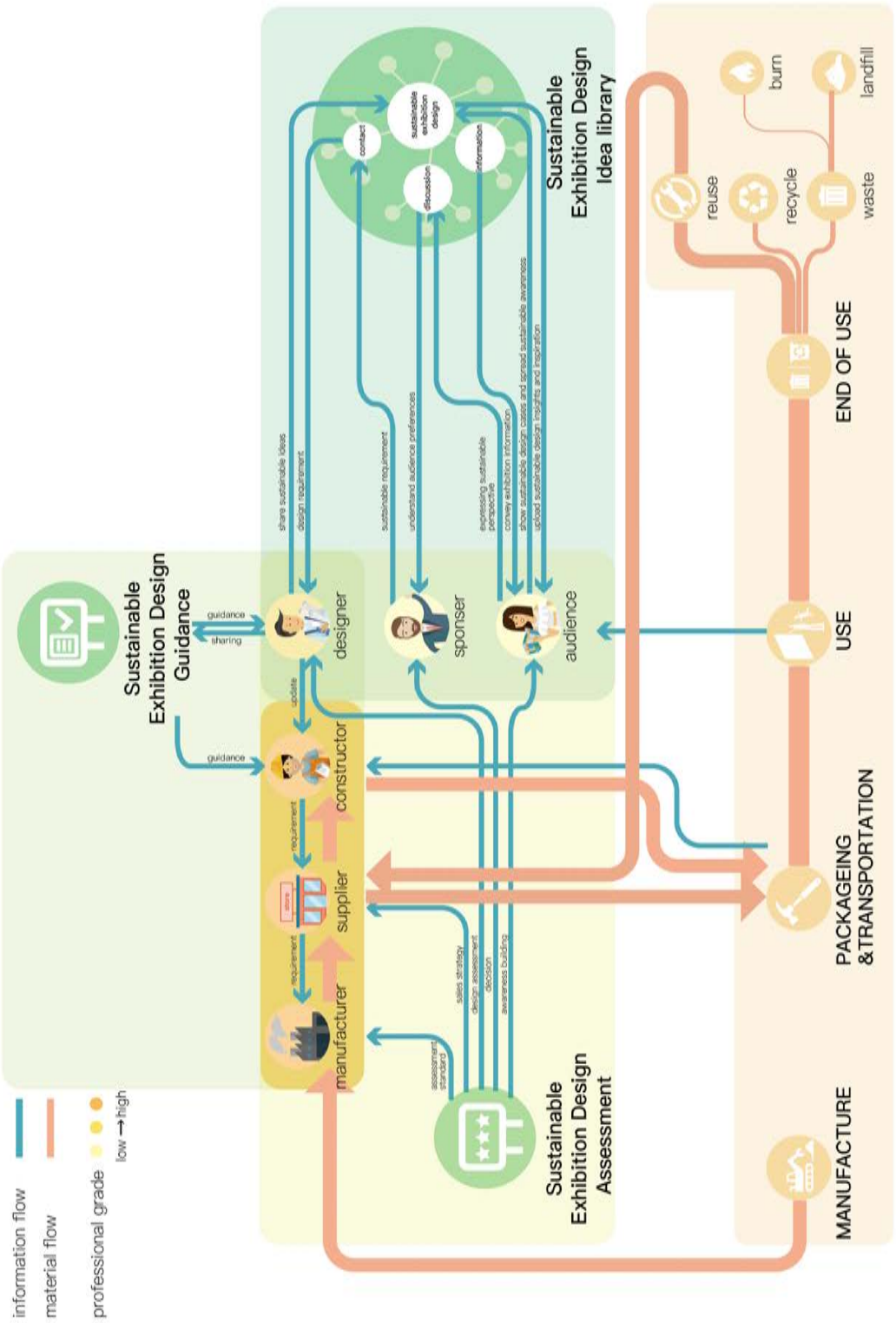

Figure 50: Prospect of a brand new exhibition industry system

Taking a designer as an example, when a designer is doing design, he can qualitatively guide the design process according to the guidance tools for sustainable display design. Under the guidance of the principles of material reduction, friendly selection and detachable design, Targeted sustainable design improvements; after the design is completed, the design can be quantitatively evaluated and inspected based on the evaluation of the sustainable display design; the tested effective sustainable measures can be uploaded to the sustainable display design think tank and accumulated Public wisdom, forming a database and communication platform for sustainable display design.

In the brand-new exhibition design rental system, almost all exhibition materials and tools could be reused in order to realize least amount of cost but most diverse exhibition effects.

6.2 Significance of an open platform for sustainable exhibition design

6.2.1 Optimization of material resources

Different from the sustainable call that is increasing due to the lack of global resources and the deterioration of the ecological environment, the temporary exhibition has entered a vicious development path of serious waste of materials, resources, and time-consuming and labor-intensive construction. This not only becomes a barrier to the development of the exhibition industry, but also affects the positive development of many related industries.

Temporary exhibition activities have a large investment and fast update, and there are a lot of resources and energy waste. Therefore, from the perspective of life cycle in the display design, pay attention to the impact on the environment of each link of the exhibition and the disposal after the disposal stage. Through the intervention of sustainable design methods, the ultimate goal of life cycle research is to improve the environmental impact of the exhibition. How to effectively and reasonably allocate space and resources to achieve the purpose of mitigating environmental impact with optimized strategies and ensure various The material maintains a virtuous cycle during use. Publicizing the improvement process is also an output of a sustainable perspective.

6.2.2 Changes in Design Concepts

As ecological problems become more serious, the sustainability requirements of design and development have been embedded in all aspects of demonstrating practice. The life cycle perspective that emerges at the historic moment is an effective way to assist designers in sustainable conceptual design. The designer analyzes the effectiveness of the exhibition from a life-cycle perspective, and frame a sustainable development system framework, supplemented by the orderly identification and assessment of the environmental impact of the content and services of the exhibition information dissemination, and then it can come again.

During the exhibition, the design resources such as raw materials that have an impact on the environment are identified in stages. Based on the identification results, during the design process, various energy-saving and environmental protection technologies can be used to reduce display costs, improve display effectiveness, and systematically integrate management of various resources to achieve the goal of sustainable development.

As the research continues, the author is trying to explore the possibility of analyzing and improving methods for more specific manifestations. However, the acupuncture improvement of the display process does not have a large influence after all. The fundamental sustainable change of the exhibition display industry requires a macro layout from the perspective of the entire industry chain. In general, through the release of top-down regulations and measures, overall industry control can be achieved, but the establishment of general rules and regulations requires a long time of grinding and experimentation, and it is urgent to continue. From the bottom-up perspective, the author tries to use the designer as the touch point of the industry, and the change of designer design brings the promotion and establishment of the public's sustainable consciousness, starting from the needs of the masses, and promoting the change of the industry.

6.2.3 Establishment of Value Orientation

The display design no longer simply focuses on the design of the creation, but instead begins to discuss the "design strategy". The focus of design is not only on the physical design objects in the traditional intentions of space, materials, colors and functions, but also on The man-made core explores the interrelationship of design, changes in experience, perception, and even consciousness, among display, environment, and values. The exhibition no longer appears as a neutral communication. A responsible sustainable design exhibition conveys a valuable message to visitors, a commitment to the safety of the audience.

6.3 Outlook

Even though this article has achieved corresponding preliminary results in the study of some related directions, there are still many things that need to be deepened in thinking. The task is heavy and the road is long. The sustainable design guidance framework for temporary exhibitions throughout the life cycle is not static, it is an open design guidance tool. The sustainable practice of each temporary exhibition is a test and supplement to the sustainable design framework of temporary exhibitions. Check if there are any design processes, missing and wrong display materials involved, and help to improve and upgrade the framework.

The further work of this research is: through the collection and summary of sustainable design guidance and sustainable methods for temporary exhibitions, the framework is expanded from shallow, uncontrollable design guidance to sustainable design think tanks for temporary exhibitions, designers Sustainable design can be drawn from this framework to promote the emergence of new ideas and methods to achieve true sustainable innovation.

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Figures

Tables

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