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Article

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Abstract: As the global aging trend continues to intensify, there will inevitably be more complex and diverse aging problems in the future. There is no doubt that designers have the responsibility to explore the possibilities of the future and solve the problems that will be faced in the future. Based on the Future Cone, the Double Diamond Model and the IDEO Method Cards, this study proposes a new model to guide the design practice of future aging issues in the context of aging. With the aim of validating and refining the framework, an ageing designer workshop was held where participants were asked to imagine, explore and express ideas about future ageing issues. The workshop was used to refine the proposed model. More specifically, the model includes a future concept, a design guidance process based on the Double Diamond Model, and tools that can be applied at all stages of design, which can help designers generate ideas and solutions for future aging problems, and collectively lead society to a more desirable future. Moreover, this study also explores broader directions for the development of the model and provides a reference for continued research on this topic in the future.

Keywords: Double Diamond Model; future studies; future cone; IDEO Method Cards; age-appropriate design

1. Introduction

According to the UN World Population Prospects 2022 report, the proportion of the global population aged 65 and over will increase from 10% in 2022 to 16% in 2050. By then, there will be twice as many people aged 65 and over as the number of children under the age of 5, and the same number as the number of children under the age of 12 [1].Today, 22 countries and territories have more than 20% of their population aged 65 and over. Among them, the problem of aging is particularly prominent in southern and eastern Europe. In Japan, this proportion is 28.4% [2]. In 1999, China entered an ageing society and became the country with the largest elderly population in the world. In the 21st century, China's entry into an aging society is irreversible. Aging will accelerate during the period 2021-2050 [3]. Demographic changes will have a major impact on the future labor, the future consumer markets, the future social security systems, the future health care systems, the future family structures, and the future social culture. Global aging is an extremely complex and important social issue. As the number of older people increases, corresponding economic, social and cultural challenges will become increasingly prominent. According to Leonid Grinin et al., aging will be the most important issue in the future [4]. Faced with the problem of aging, countries should progressively take measures to adapt public programs to the growing aging population, including improving social welfare, optimizing the sustainability of pension systems, and establishing inclusive health care and long-term care systems [5]. In order to accelerate the aging adaptation process, all sectors of society should actively integrate this issue into daily life [4]. For the design industry, aging poses a key challenge. Among them, designers need to re-examine the needs and lifestyles of the elderly, and think about design solutions from a more inclusive and far-sighted perspective.

When it comes to aging design issues, the Double Diamond Model is a useful system concept and framework. The Double Diamond Model was launched in 2004 by the Design Council. By dividing the design process into four phases of Discover, Define, Develop and Deliver, it aims to aid in effective design process management and planning as a standardized methodological process.

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When applied to projects with specific characteristics, it is necessary to enrich the content and form according to the project characteristics to increase its effectiveness [6–10]. By looking to the future, there is a need to further develop the Double Diamond Model to accommodate future design issues.

Based on the above background, the contribution of this study is mainly to develop the Double Diamond Model from the perspective of the future to deal with the aging trend, and to provide solutions and methods for designing an age-appropriate future.

2. Theoretical Background

2.1. Future Studies and Future Cone

2.1.1. Future Studies

Futures studies is the systematic study of possible, probable and preferable futures, including the worldviews and myths that underlie each future [11]. In 1902, the British writer Herbert George Wells proposed the establishment of a "science of future". In 1943, the German political science professor O. Freichtai proposed to establish the same future research as historical research [12]. In 2019, Stuart Candy and Tina Auer suggested that the central challenge for the future lies in "making the invisible visible and tangible [13]. Future studies explore the future of society. Among them, the future cone is a prediction based on future research, which shows different possibilities of the future [14].

2.1.2. Future Cone

In 1993, Clem Bezold first proposed different categories of the future, showing different possibilities of the future. In 2000 Joseph Voros, a foresight analyst at Swinburne University, first started using an early version of the future cone. In 2009, futurist Stuart Candy mentioned the future cone at the Royal College of Art [14], which show four main categories: Possible, Probable, Plausible and Preferable. The present is located at the fixed point of the cone, from which all possible future routes flow.

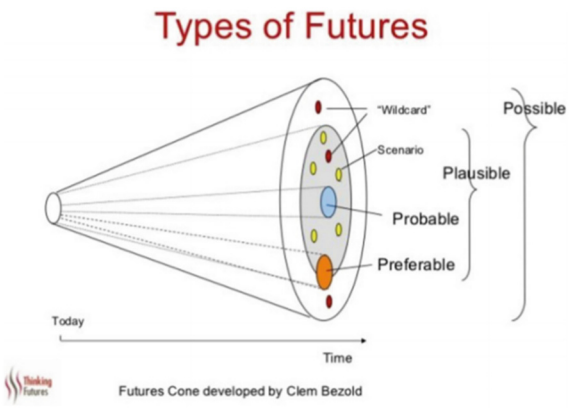

Figure 1. Futures cone by Clem Bezold [Figures - available via license: Creative Commons Attribution-NonCommercial 4.0 International. https://creativecommons.org/licenses/by-nc/4.0/].

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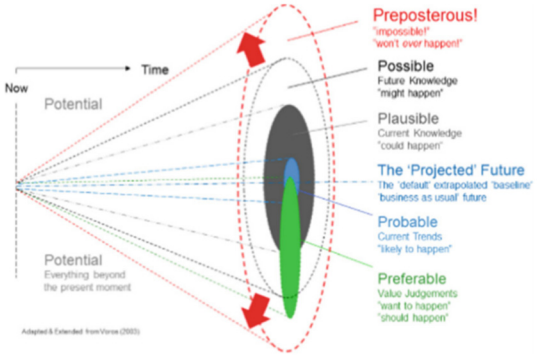

Figure2. Futures cone by Joseph Voros (2017). https://thevoroscope.com/2017/02/24/the-futures-cone-use-and-history/

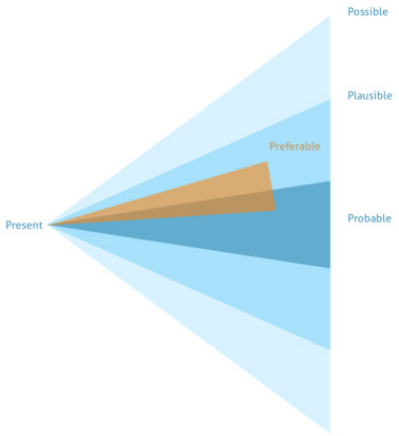

Figure 3. Futures cone by Stuart Candy [Dunne&Raby (2014)]

The concept of the future cone can be explained and established by "three laws of the future": the future is not predetermined; it is unpredictable; and it will be influenced by our current choices [15]. Among them, the preferable future is a better choice for the future derived from value judgments, in which emotion is greater than cognition [16]. Currently, preferable futures are determined by government and industry [17], rather than by users. As such, it lacks designer intervention. Through the combination of the Future Cone and the Double Diamond Model, this study allows people to consider themselves as potential decision makers and designers and move towards a preferable future based on what they deem desirable [15].

2.2. Double Diamond Model

The Double Diamond Model is a design thinking model originally developed by the British Design Council in 2004 [9], with the core principle of identifying the correct problem and finding the corresponding solution [18]. As a standardized approach to the design process [6], it is widely used in product design, interaction design, service design and user experience design. According to the figure below, it can be seen that the Double Diamond Model consists of four phases, namely Discover, Define, Develop and Deliver. Discover refers to exploring problems, gathering insights and user needs, and forming ideas (divergent thinking). Define refers to refining the problem and providing a framework (convergent thinking). Develop refers to creating and exploring solutions (divergent thinking). Deliver refers to testing and evaluation, and eliminating or improving components that do not work (convergent thinking) [19]. In the design process, a linear view is impractical, and design practice is not linear. Sometimes, it may jump from the first to the third. Therefore, the Design Council updated the Double Diamond Model in 2019 [20].

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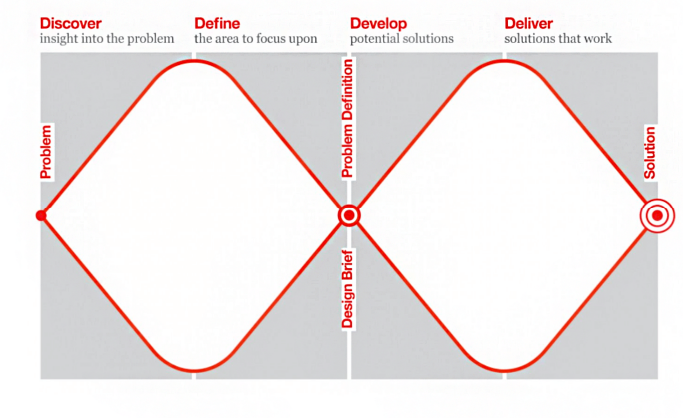

Figure 4. The four stages of the Double Diamond Model (Source: Design Council).

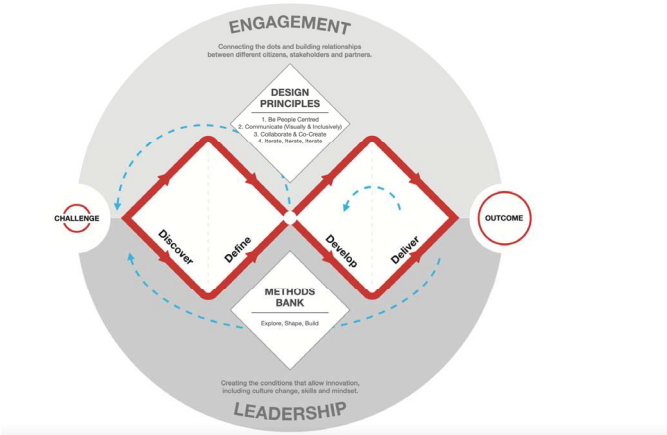

Figure 5. Double Diamond Model 2019 Update (Source: Design Council).

Given that ideal methodological processes are impossible to achieve, it is important to have a flexible infrastructure that responds quickly and appropriately to creative changes in vision and mandate [21]. In exploring the dynamic relationship between digital design and website innovation, Kim Yu-Jin analyzed the workflow and interaction between clients and agents during website development, and modified and extended the Double Diamond Model to accommodate the dynamic and evolving nature of digital content and services [7]. In 2017, Sohaj Singh Brar customized the content of the Double Diamond Model for concrete implementation [8]. According to Ezzat Saad Mahmoud et al., the idea of feedback was introduced into the Double Diamond Model to allow designers to give feedback at any step [9]. As technology advances and calls for sustainability, design thinking frameworks evolve to seek commonality-based change and adapt to subsequent challenges.

In the discovery phase of the Double Diamond Model, an important aspect is divergent thinking, which requires an "open mind" [10]. Since the theme of action in this phase is to generate innovations, designers play a key role in this phase, involving a wide range of perspectives and minimal formalization [6]. Divergent thinking and the flexibility to explore problems are emphasized during the discovery phase of the Double Diamond Model, which is somewhat similar to the exploration of possible futures in the Future Cone. In this regard, designers need to understand user needs and problems through various research methods. In addition, the designer involvement and decision-making awareness are emphasized, which are key elements in the Future Cone that lead to a preferable future. Introducing the concept of the future cone in the discovery phase of the Double Diamond Model helps to explore possibilities from a future perspective, thereby enhancing the foresight and relevance of subsequent designs.

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2.3. IDEO Method Cards

One of the card-based design tools first appeared in 1952 in the House of Cards created by the famous American designers Charles and Ray Eames, which stimulated innovative thinking and enhanced creativity in a fun way. Along with the movement toward the development of systems and design methods in the 1970s, other card sets that aided in creative thinking and problem solving began to emerge. In the 1990s, card-based tools for user-involved design began to emerge, such as the Layout Toolkit to involve employees in workplace design [22]. In the early 2000s, more user-centered card tools were created, the most famous of which was the IDEO Method Cards.

IDEO Method Cards are user-centered design method cards (Figure 6), which provide ways to empathize with users in design projects [22]. The IDEO Method Cards are a deck of 51 cards divided into four categories, namely Learn, Look, Ask, and Try (Figure 8). Each card describes the design approach and a brief story about how and when to use it [23]. As shown in Figure 7, this deck of cards introduces the Behavioral Mapping design tool. It is used by tracking the location and movement of people over time in a space. It is used because the recording of the paths and traffic patterns of occupants in a space helps to define areas of different spatial behavior. Examples of uses of IDEO include tracking visitor paths to help designers identify traffic points, and vacant and underutilized museum lobby areas.

Figure 6. IDEO Method Cards (Source: ideo.com).

Figure 7. Behavioral Mapping (Source: https://zhuanlan.zhihu.com/p/505995801).

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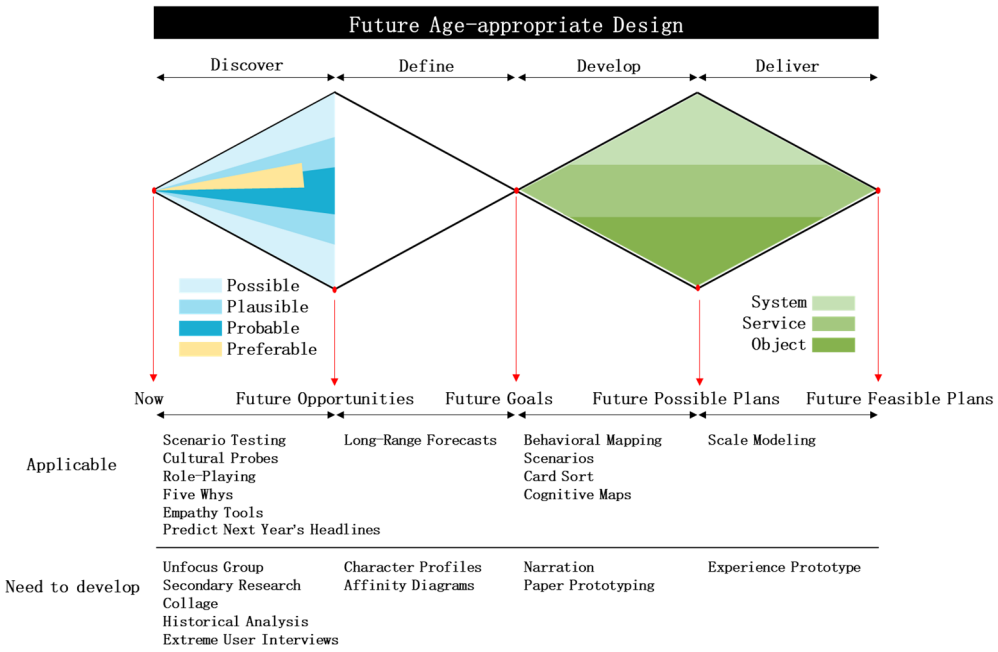

Figure 8. Theoretical Frame Model.

With regard to the design of card sets, Gary Hsieh et al. attempted to place the grouped card sets into the four stages of the Double Diamond Model [24]. In study of Ezzat Saad Mahmoud et al. on the Double Diamond Model, the Double Diamond Model were labeled with different user research methods to clarify the steps of the design process [9]. Based on the Double Diamond Model, Annie Banbury et al. guided dementia caregivers through the co-design process by specifying tasks for each of the four phase [19]. In turn, these tasks can be accomplished using design tools. Thus, the Double Diamond Model specifies the four stages of the design process, and the IDEO Method Cards help us through each phase. Furthermore, design tools enable things that did not exist before, such as introducing desirable changes in the world, and predicting the technical, social, and cultural consequences of design, which is exactly what [25] is needed for a design-oriented consensus future.

2.4. Age-Appropriate Design

The concept of age-appropriate design began in 1974 with the new design concept of barrier-free design proposed by the United Nations Organization. The concept of age-appropriate design is based on the concept of "age-centered design", which aims to design products that suit the physical and psychological needs of the elderly based on their different needs and provide as much convenience as possible for their daily life and travel [26]. With the changing demographic structure and the steady increase in the proportion of elderly people, the issue of aging has gradually become the focus of attention. Under such circumstances, age-appropriate product design has received a lot of attention in many fields. Therefore, it is necessary to pay attention to the special needs of the elderly and design according to their age and physiological function.

In the context of deep aging, many age-appropriate designs have emerged in Japan. Torben Volkmann, Michael Sengpiel, Rita Karam and Nicole Jochems involved the elderly as co-designers in the design, where appropriate speech input types and minimum requirements for conversational agency were explored [27]. Based on participatory design theory, Tsinghua University in China is exploring ways to cooperate with the elderly in design research activities. However, there is currently no guiding framework for age-appropriate design for future aging societies.

According to the BBC, there are already more elderly people in the world than babies and toddlers. Taking China as an example, the aging society began in 1999 [28]. Due to the acceleration of the aging process and unpredictable problems in the future, the current design may present new

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problems in the future. According to a study by the University of the Arts London, the application of design thinking in solving future problems can be divided into Artefact, Artefact and Experience, Systems Behaviour, and Large Scale Systems. Among them, the future society can be regarded as composed of OBJECT, SERVICE and SYSTEM [29]. Thus, future age-appropriate design should be based on systematic service experience design. Through designer intervention, age-appropriate design can be guided. It should be noted that this must have an age-appropriate design tool as the basis.

3. Model

Based on the comprehensive consideration of the above analysis, design context, design management, design goal determination and many other factors, the combination of the Double Diamond Model, the Future Cone and the IDEO Method Card, a new model, shown in the figure below, is proposed to guide design practice activities in the face of future aging issues, which helps to manage the design process, clarify design goals, and solve design problems.

Discover: The Future Cone model is integrated into the Discover phase of the Double Diamond Model, which has a common starting point based on the Now and explores the possibilities of the future. The task of this phase is to understand the future aging trend and the needs of the future aging population, and to identify future opportunities. For example, there is a need to collect and analyze relevant data, trends, and changes to discover various possibilities for the future, followed by initial assessment and screening. Interviews with older adults, their family members, healthcare professionals and other relevant stakeholders are also required to understand related needs, expectations and challenges. Define: The tasks of this phase are to define future goals and vision, ensure that the research question has future value, and clarify the subsequent design process. For example, there is a need to summarize information and data from the discovery phase and identify key challenges and opportunities for research. Additionally, a target user group needs to be defined and a problem statement needs to be developed. Develop: In this stage, the task of the designers is to explore possible future plans and to compare, refine and optimize them. For example, there is a need to use creative thinking tools and methodologies to develop innovative solutions, and to test and improve solutions, thereby ensuring that they meet the needs and expectations of older adults. Deliver: This phase focuses on evaluating and filtering plans to converge on future viable plans. There is a need to ascertain whether they solve the problems defined in the Define phase, and whether the solutions to the problems help designers facilitate the development of a more desirable future for society. For example, the feasibility and effectiveness of the final solution needs to be determined, an implementation and monitoring plan needs to be developed, and the solution needs to be implemented to provide better services for the elderly and ensure its sustainable effect. In view of the fact that the solution to the aging problem in the future will be dominated by system design and service design, the solution should emphasize the importance of system experience and service design, so as to ensure that a complete, comprehensive and systematic solution can be provided in the end.

In the design process described above in the Double Diamond perspective, each stage faces different tasks and goals. The value of design tools is to assist in these tasks. When building new design models, the specificity of the topic of aging in the future means that not all IDEO Method Cards are applicable to this topic. Therefore, the team analyzed 51 IDEO Method Cards and selected the ones applicable to this topic. Discover phase contains Scenario Testing, Cultural Probes, Role-Playing, Empathy Tools, Unfocus Group, Five Whys, Predict Next Year's Headlines, Secondary Research, Historical Analysis, Extreme User Interviews. Define phase contains Long-Range Forecasts, Affinity Diagrams, Character Profiles. Develop phase contains Behavioral Mapping, Scale Modeling, Scenarios, Narration, Paper Prototyping, Card Sort, Cognitive Maps, Collage. Deliver phase contains Experience Prototype, Scale Modeling. These cards were incorporated into a new design model, which helps design teams apply creative thinking techniques and approaches when addressing issues of aging. Besides that, it was found that some tools are not quite suitable for this topic and need some development. The tools are grouped into two tiers, tools

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that are applicable and tools that need improvement. For example, since Long-Range Cast is a predictive tool for the future, it is perfectly applicable. However, the form of paper prototyping may change with the future development of digital virtualization. It should be noted that these inferences are based on team experience only. In order to verify the veracity and accuracy, a designer workshop was conducted to discuss the applicability and classification of IDEO Method Cards, which not only refined the model, but also deepened the understanding on how to apply different design method cards at different stages.

4. Workshop

4.1. Workshop Design and Materials

This exploratory workshop lasted 180 min and consisted of three steps: workshop introduction, interaction and discussion, and semi-structured interviews in small groups to collect rich descriptive data. The content and materials of the seminars are primarily designed and directed by the research team (two faculty members and three graduate students). Materials for the workshop included some tables and chairs, IDEO Method Cards, coloured pens, A4 paper, 20 neutral pens and sticky notes. The oral presentations and interactive scenes of the participants were recorded by audio and video equipment.

4.2. Participants

There are 13 participants in the workshop, all of them have design background and are engaged in or interested in the field of aging design. A total of 2 professors and 3 professional designers have relatively senior design experience and design education background, 6 graduate students have 2-3 years of advanced design experience, and 2 college students represent designers who have just entered the industry. All participants were Chinese, and aged between 19 and 61. In terms of gender, there are 5 males and 8 females.

Table 1. Workshop participants information.

Participants	Discipline	Areas	Sex	Age	Occupation	Aging Design/Research Experience
S1	Design	Products Design Services Design Interaction Design	Male	58	Professor	33years
S2	Design	Products Design Services Design	Femal e	61	Professor	35years
S3	Design	Visual Design Public Facilities Digital Product	Male	43	Designer	1year
S4	Design	Digital Product	Male	48	Designer	23years
S5	Design	Smart Products	Male	42	Designer	2years
J1	Design	Age-appropriate Design of the Interface	Femal e	25	Postgraduate students	3years
J2	Design	HMI	Male	27	Postgraduate students	3years
J3	Design	Age-appropriate Design Visual Design	Femal e	27	Postgraduate students	3years
J4	Design	Experience Design Co-Design	Femal e	25	Postgraduate students	2years

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J5	Design	Co-Design Service Design	Female	26	Postgraduate students	3years
J6	Design	Interaction design User Interface Design	Female	30	Postgraduate students	3years
J7	Design	Smart Wearable	Female	19	Undergraduate students	0year
J8	Design	Assisted Aging Products	Female	20	Undergraduate students	0year

4.3. Workshop Procedures

As shown in Figure 9, this workshop has the following three steps. The specific description is as follows.

Figure 9. Workshop Flow.

(1) Short Introduction

This phase lasted 30 min. Firstly, the facilitator introduced himself and described the entire workshop process and time spent. Secondly, questionnaires were distributed to understand the basic situation of each participant, as well as their experience and opinions on the Double Diamond Model, IDEO Method Cards, etc. Refreshing their memory helps to understand the theory and participate in subsequent discussions. Afterwards, the facilitator introduced the participants to Future Studies, Future Cone, the Double Diamond Model, the New Model and the IDEO Method Cards. The relevant paper materials and 4-5 IDEO Method Cards each were provided (see the appendix for card numbers). Finally, a question-and-answer session for the participants took place.

(2) Discussion and Interaction

This phase lasted 90 min. First, participants were guided through a vision of travel and entertainment experiences in 2050 to stimulate their imaginations of future scenarios. Secondly, the participants were asked to consider from a designer's perspective how to identify possible problems in future scenarios and whether the cards they had would contribute to the design practice process. The cards they can be categorized as usable, to be verified, or discarded. Finally, participants in the interactive session were asked to place their cards in the appropriate places on the model. It is worth noting that some participants indicated in the discussion and interaction that many of the cards need to be expanded to accommodate future issues of aging. Therefore, an "extended" category was added to the original three tiers. The final results are shown in Figure 10.

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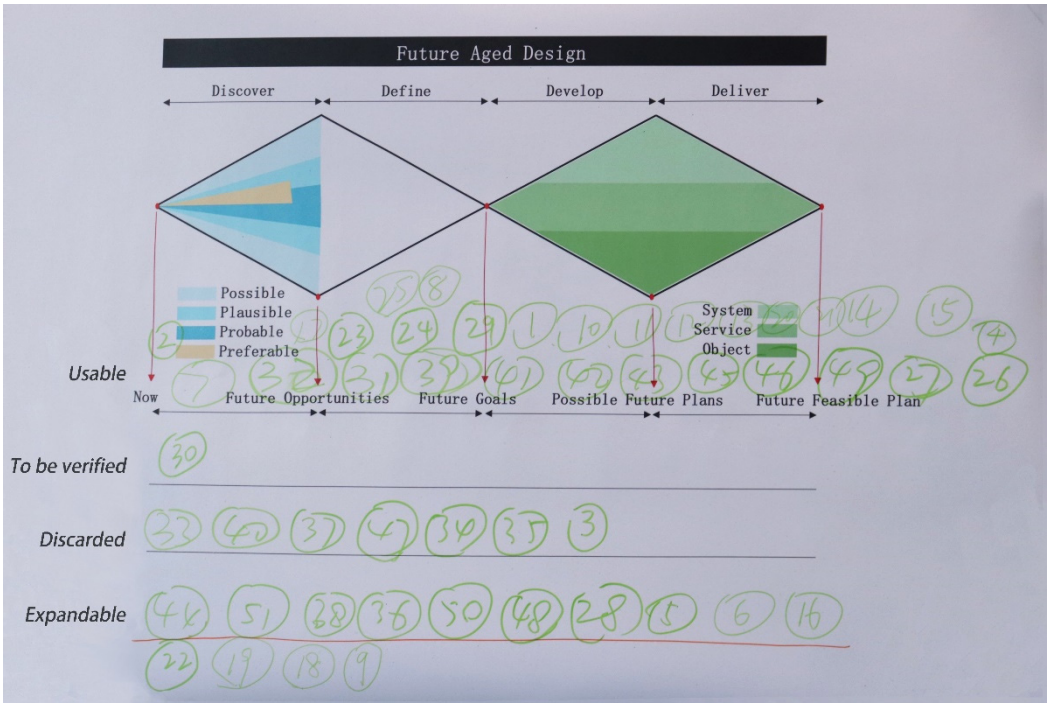

Figure 10. Results of participants' classification of cards.

(3) Interview

This phase lasted 60 min. After the interactive session, the participants were divided into two groups for semi-structured interviews, one group of five older and more experienced designers and the other group of the eight students. On the one hand, broader and more in-depth interviews were conducted on the points raised by the participants during the discussion and interactive sessions. On the other hand, participants were asked to discuss their thoughts on the factors influencing card usefulness and related suggestions for improvement.

4.4. Data Collection and Analysis

The workshop research used qualitative methods. The main source of data was the presentations made by participants throughout the course of the workshop. In subsequent analysis, the research team recorded all audio files verbatim and sifted through the raw information to identify meaningful sentences and hidden meanings. Finally, the data was crawled and classified.

5. Discussion

To validate and refine the theoretical model presented in Section 3 of this study, participants' views on how to categorize and rank the IDEO Method Cards were collated. It is worth noting that the 'Informance' cards were classified as 'to be verified' during the interactive session (Figure 10). In the follow-up interview, participant J2 felt that the tool was limited because objective constraints made it difficult for us to be realistic users. In other words, it can break the limits and let the designer play the user's behaviour as much as possible. In such cases, informal tools can become useful. Given that how to break the limit is a problem that must be considered in the future, this tool is still classified as "to be expanded".

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Table 2. Selected views of the IDEO Method Cards hierarchy and phasing

Description Examples	Categories
S3：Still-Photo Survey is useful, as Xiaomi's behavioural analysis lab uses it to analyse how different people, of different ages, interact with different UI interfaces.	Cards usable
J6：Ergonomics is well developed and is used in product design and space design to check that spaces are reasonable and comfortable.	
S1：Narration falls into the category of observation and questioning and can lead older people to state their needs, even though it is difficult for them to say what they really need.	Cards to be expanded
S2：Historical Analysis should be a study of the history of people, the way they behave. But because the way a 90-year-old behaves would be so different from a 60-year-old, the entry point for research needs to change.	
S2：Cross-Cultural Comparisons refers not only to the cultural differences between East and West, but also to the differences in the cultures embraced by different age groups.	
S1：Paper Prototyping can be made to interact in a quick way, but how to involve older people is a direction that needs to be investigated.	
J2：Informance as a tool has limitations of its own. For example, for elderly people who are not frontline or rural and who do not understand Mandarin, designers are not able to perform user behaviour authentically.	
J5：Long-Range Forecasts of prospects and future business focus in itself implies a crossover of disciplines and a fusion of knowledge, and I think it is expandable.	
J3：Opportunities can be found by using Role-Playing and Empathy Tools to imagine what the person wants now.	
S2：Word-Concept Association can only do conceptual things, they don't work for practical products like ageing.	Cards discard
S4：The sample we follow, track, and accompany in the future cannot be determined, and thus Shadowing as such is invalid.	
J3：In the first stage, you can use role-playing, empathy cards, which are analytical and observational methods, to imagine possible problems and needs.	Identify the purpose of the card and place it in the different stages
J1：You can start by clustering the cards to clarify what the tools in this category can help you achieve before placing them in the appropriate stage.	

By collating and analyzing the views and marks of the participants in the interactive session (Figure 10), the theoretical model shown in Figure 11 is finally obtained. In addition, participant S1 stated in the interview session that "if we want to do future design, the second phase is not necessarily about system service experience products. It would limit our thinking, so how about changing the edge of the latter auger to a dashed line." Based on this, the original model was improved accordingly to represent more possibilities in the future. At the same time, this also verifies the openness and evolution of the Double Diamond Model [7,10].

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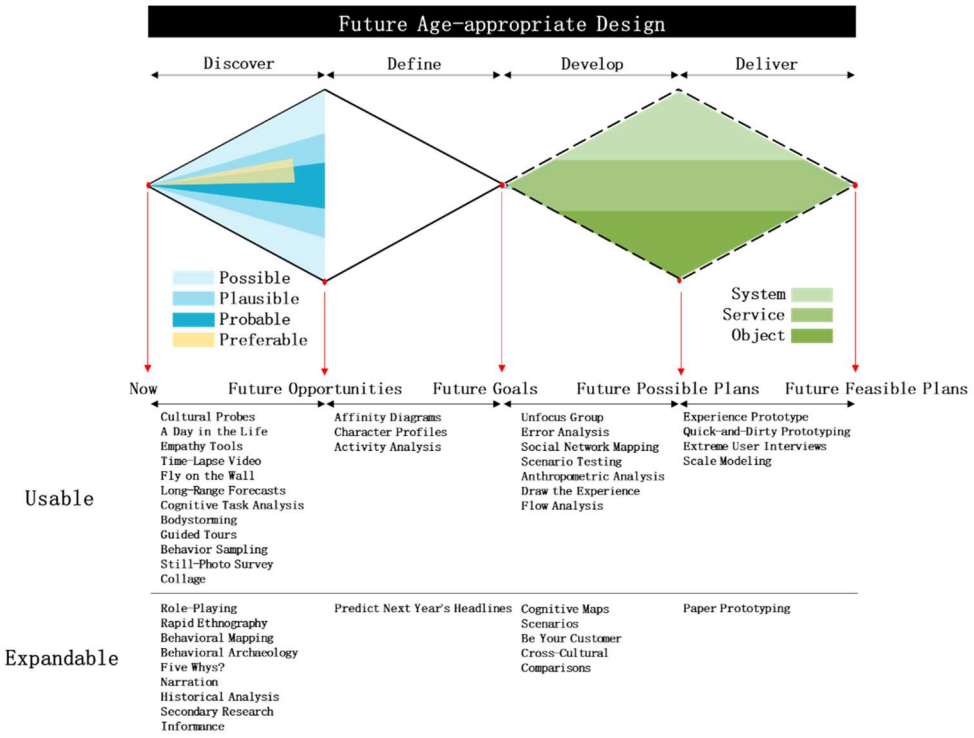

Figure 11. The Refined Model.

Among other things, participants were instructed to explore the factors that affect the usefulness of the cards in the face of future aging, and the reasons why many cards become ineffective or ineffective. Relevant ideas and data were collated and analyzed.

Table 3. Exploration of the factors affecting the utility of IDEO Method Cards

Description Examples	Opinions	Categories
S1：The broad, cross-sectional group of older people requires consideration of various elements such as different populations, different countries and different geographic regions.	Elements such as the need to consider different countries and different regions	Differences in the older population
S5：The environment can have a physical and psychological impact, so designing for different geographical areas such as urban and rural people can be different.	Significant variability in older people from different environmental backgrounds	
J1：Different individuals have different levels of acceptance of the tools.	Different levels of acceptance of tools by older people	
S2：Narration, for example, makes it difficult for older people to say what they really need.	The card method does not suit the characteristics of older people	Cards cannot adequately study the elderly
S4：Role-Playing, for example, is difficult to simulate the psychology and mentality of older people.	Cards struggle to provide real insight into the needs of older people	
J4：The design approach itself needs to be validated over time.	Card tools also need time to prove	Cards need time to validate
J2：The future itself is diffuse and the toolkit should be as evolving as the	Card tools should evolve over time	

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future, rather than judging now whether it will work in the future.		
J2：It is more effective at the stage of problem identification, but at the stage of solution we cannot predict whether it will work in the future.	It is not possible to determine whether the tool will play a corresponding role in the future	
S2：Using existing tools and design thinking to gain insight into the future is limiting and should be explored in a more open way.	The tools and thinking are now too limited	Limitations of existing design thinking and tools
S3：Some tools can only consider the product or the space, for the future it is not possible to consider the design from a system perspective.	Existing tools do not allow for a comprehensive view of future designs	
S1：The future is inherently unknowable and therefore our predictions of it are always limited.	Our predictions for the future are limited	Designers struggle to predict the future
S3：It is not possible to think of future conditions in terms of current social patterns, which may be completely different.	The shape of society in the present is not the same as the shape of society in the future	
J2：The impact of technological developments is so difficult to assess that it is difficult to evaluate it or circumvent it in advance.	Difficult to assess the future of technology	
J4：These card methods are based on research into the problems of the status quo, and we have difficulty in gaining insight into the cultural characteristics and user profiles decades later.	The cultural profile and user profile of the future will change	Times have changed for users
J3：The mindset or needs of users will change over time or with technology.	User mindsets and needs change over time	
J2：The perceptions of people from different times and backgrounds are different. The perceptions of people nowadays form a fixed path dependency and it may be difficult to cut through the future perspective to generate ideas.	Different perceptions in different times and backgrounds	
J5：People are becoming more aware.	Human consciousness advances	
J5：Smart bodies will intervene in future user research, when we may only need to study individual cases.	Smart body interventions will influence our decisions	Developments in technology, policy, culture and other factors will all affect user research
J5：Political policies may influence developments such as technology.	Political policies can have an impact	
J7：People from different cultures will accept tools differently, for example, the differences between Eastern and Western cultures and the cultural differences between the present and the future.	Cultural backgrounds have an impact on how people are received	

According to the above analysis, it can be found that there are various factors affecting the usefulness of cards in this study. In the topic of aging, the aging population spans a large range and

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a wide range of groups. Therefore, it is necessary to consider differences in the acceptance of IDEO Method Cards by older people from different cultural backgrounds, ages and geographical areas. In addition, some cards do not conform to the characteristics of the elderly, such as narration, or do not allow the spiritual experience of the elderly, such as role-playing. These cards do not help designers adequately study aging populations. For future questions, participants felt that the cards themselves needed to be time-tested. In addition, it is difficult to judge whether existing cards are suitable for future design problems. It has to be admitted that the existing design tools and design thinking are limited to a certain extent and cannot help designers to think comprehensively about the future. With the development of the times, user characteristics and user needs will be affected to a certain extent. In addition, the development of factors such as technology and culture will also have an impact on user research.

Based on the refined model, many tool cards were classified as "needing expansion". During the course of the workshop, many participants suggested that the IDEO toolkit needs to be extended to better accommodate future aging issues. Therefore, suggestions from participants on how to improve or expand the toolkit are collated and analyzed.

Table 4. Suggestions for expansion of the card.

Description Examples	Opinions	Categories
S1：Redevelop the IDEO card by thinking in terms of a double diamond and redesign it.	Research IDEO Method Cards with the Double Diamond	Overall improvement toolkit
S2：For the future, it is important to improve the card as a whole.	Overall improvements to the card	
J6：Give the cards all a sustainable view to expand a future dimension and keep adding to them when they are applied in the future.	Expanding the dimensions of the future to make it sustainable	
J1：This can be done by clustering them, clarifying the effectiveness and purpose of each category, and then improving each of these categories separately.	Cluster first then analyse how to improve	Cluster first then analyse and improve
J2：Pre-clustering is important and some of the methods may be very relevant for the elderly, and these can be summarised first and then developed in relation to future concepts.	Improvements to methods suitable for ageing studies after clustering them	
J6：The IDEO Method Cards themselves are divided into four main categories, each of which can be improved.	Improvements to each of the four categories of IDEO	
J1：Since it is aimed at the elderly, the cards should also be adapted for ageing.	Age-appropriate retrofit	Improvements based on geriatric cognition
J2：The improvement of the method must be based on a contemporary approach, which has a lot to do with the various aspects of older people's perceptions, and the improvement of the method will only be effective if	Improvements based on elderly perceptions	

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their perceptions reach the appropriate level.		
J1：In combination with other disciplines, the cards can be supplemented by other knowledge when a problem cannot be fully studied.	Combined with knowledge from other subjects	Interdisciplinary
J5：Forecasting the future from a historical perspective, in conjunction with economic cycles or cyclical changes in other areas.	Combining knowledge of history, economics, etc.	
J4：Standing up for the future requires us to think in a business sense and to consider all aspects of the economy, politics, culture and technology.	Integrating a business mindset that considers economics, politics, culture, technology, etc.	Combining multiple elements of science, technology, culture and society
J3：More technological elements can be incorporated, such as the use of different devices to experience different states of being.	Incorporating more technology	

Based on collation and analysis of the data, participants made various suggestions on how to develop and improve the toolkit. Participants S1, S2 and J6 felt that the toolkit as a whole needs to be improved. S1 suggested that toolkits can be explored in a discrete fashion using the double diamond model. J6 suggested that the toolkit needs to be given a future dimension so that it can be improved at a future point in time, which contributes to the achievement of sustainability goals. Some participants felt that the toolkits could be grouped according to the characteristics of each category and improved, for example by classifying and analyzing them according to each of IDEO's original four categories or according to the role of the tools. According to participants J1 and J2, since this research falls within the field of design for aging, it was necessary to adapt the toolkit to the perceptions of older people. In addition, some participants felt that the fusion of knowledge across disciplines was a good way to expand the toolkit. Integration with other disciplines helps fill gaps in existing tools. Undoubtedly, the combination of technological, cultural and social factors is a development which in the future will lead to increasingly complex problems and require a more integrated and holistic approach to problems. Therefore, design tools need to be able to predict the technical, social and cultural consequences of design in order to introduce desired changes into the world [26].

6. Conclusions

Aging is a very complex and challenging topic for designers. This study proposes a new theoretical model in the context of aging, which combines the exploration of the future in the theory of the future cone, the strengths of the double diamond model to manage the design process, and the strengths of the IDEO Method Cards as a design aid. This model aims to help designers cope with the social pressure brought by aging in advance, and provides certain value for the development of design thinking and the guidance of design practice.

Undeniably, there are some limitations of this study. First, this study only considered how well IDEO Method Cards fit the model. Due to the variety of design tools and methods, more diverse auxiliary tools are needed to deal with future problems. Secondly, the participants of this workshop are all Chinese designers. Despite their broad horizons, the limitations imposed by a single cultural background are unavoidable. Finally, this study focuses on the formulation and improvement of the theoretical framework without the support of actual cases. Therefore, no further improvements can be made on this basis at this stage. During the workshop and the later data collation process, the

designer was open to the development of the Double Diamond Model and IDEO Method Cards as a proposition for future exploration, and wanted to think outside the box. Section 4 explains in detail possible development directions, such as helping design tools adapt to future changes by integrating multidisciplinary knowledge.

In summary, there is a need to involve people from a wider range of cultural backgrounds and conduct practical activities to test and refine models. Furthermore, more groundbreaking attempts favor the development of design tools like IDEO.

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Appendix A. IDEO Method Cards Number

1.Scenario Testing, 2.Anthropometric Analysis, 3.Personal Inventory, 4.Cultural Probes, 5.Role-Playing, 6.Rapid Ethnography, 7.Extreme User Interviews, 8.A Day in the Life, 9.Behavioral Mapping, 10.Experience Prototype, 11.Quick-and-Dirty Prototyping, 12.Empathy Tools, 13.Scale Modeling, 14.Draw the Experience, 15.Unfocus Group, 16.Behavioral Archaeology, 17.Time-Lapse Video, 18.Five Whys?, 19.Scenarios, 20.Fly on the Wall, 21.Error Analysis, 22.Predict Next Year's Headlines, 23.Character Profiles, 24.Flow Analysis, 25.Cognitive Task Analysis, 26.Bodystorming, 27.Guided Tours, 28.Secondary Research, 29.Long-Range Forecasts, 30.Informance, 31.Behavior Sampling, 32.Surveys & Questionnaires, 33.Shadowing, 34.Competitive Product Survey, 35.Try It Yourself, 36.Narration, 37.Word-Concept Association, 38.Paper Prototyping, 39.Still-Photo Survey, 40.Camera Journal, 41.Collage, 42.Affinity Diagrams, 43.Card Sort, 44.Historical Analysis, 45.Conceptual Landscape, 46.Activity Analysis, 47.Foreign Correspondents, 48.Cognitive Maps, 49.Social Network Mapping, 50.Be Your Customer, 51.Cross-Cultural Comparisons.

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