

Article

Exploring the Future Design Approach to Ageing Based on the Double Diamond Model

Xiaochun Wang, Zihan Huang *, Tongfei Xu, Yuting Li and Xiangang Qin

School of Digital Media and Design Art, Beijing University of Posts and Telecommunications, Beijing 100876, China; wangxc2000@bupt.edu.cn (X.W.); fionaxu@bupt.edu.cn (T.X.); simi@bupt.edu.cn (Y.L.); qinxiangang@bupt.edu.cn (X.Q.)

* Correspondence: huangzihan@bupt.edu.cn

Abstract: As the global trend of aging continues to intensify, there will inevitably be more complex and diverse aging-related problems. Designers have a responsibility to explore the possible outcomes of the future and solve the ageing-related 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, in which participants were asked to imagine, explore and express ideas about future ageing-related issues. The workshop was used to refine the proposed model. 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 to generate ideas and solutions for future aging problems, as well as collectively lead society toward a more desirable future. Moreover, this study explores broader directions for the development of the model and provides a reference for continued research into this topic in the future.

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



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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 2050, 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, in 22 countries and territories, more than 20% of the population is aged 65 and over. Among these countries, the problem of aging is particularly prominent in Southern and Eastern Europe. In Japan, this proportion is 28.4% [2]. In 1999, China became both an ageing society and the country with the largest elderly population in the world. In the 21st century, China's status as 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 markets, consumer markets, social security systems, healthcare systems, family structures, and 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 facing societies in the future [4]. Faced with the problem of aging, countries should progressively take measures to adapt public programs to suit the growing aging population, including improving social welfare, optimizing the sustainability of pension systems, and establishing inclusive healthcare 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

these challenges, designers need to re-examine the needs and lifestyles of the elderly and develop 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 the four phases of Discover, Define, Develop and Deliver, it aims to improve effective design process management and planning via a standardized methodological process. When applied to projects with specific characteristics, it is necessary to enrich the content and form according to the project's 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, this paper will, firstly, start from the perspectives of the literature to investigate the possibility of integrating the Double Diamond Model into other theories. Secondly, we will propose a new theoretical model as the core contribution of this study, as well as validate and improve the model by organizing a workshop. Finally, we will summarize the innovations and limitations of this study. The main contribution of this study is the systematic presentation of a complete theoretical model that can provide solutions and methods in the field of future age-appropriate design.

2. Theoretical Background

2.1. Future Studies and the Future Cone

2.1.1. Future Studies

Futures studies involves 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 future research as a form of 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 the methods used, the Future Cone is a prediction based on future research, which shows different possible outcomes of the future [14].

2.1.2. Future Cone

Figure 1 shows the evolution of the Future Cone model. In 1993, Clem Bezold first proposed different categories of the future, showing different possible outcomes of the future. In 2000, Joseph Voros, who is a foresight analyst working at Swinburne University, first started using an early version of the Future Cone. In 2009, the futurist Stuart Candy mentioned the Future Cone at the Royal College of Art [14], dividing it into 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 emanate.

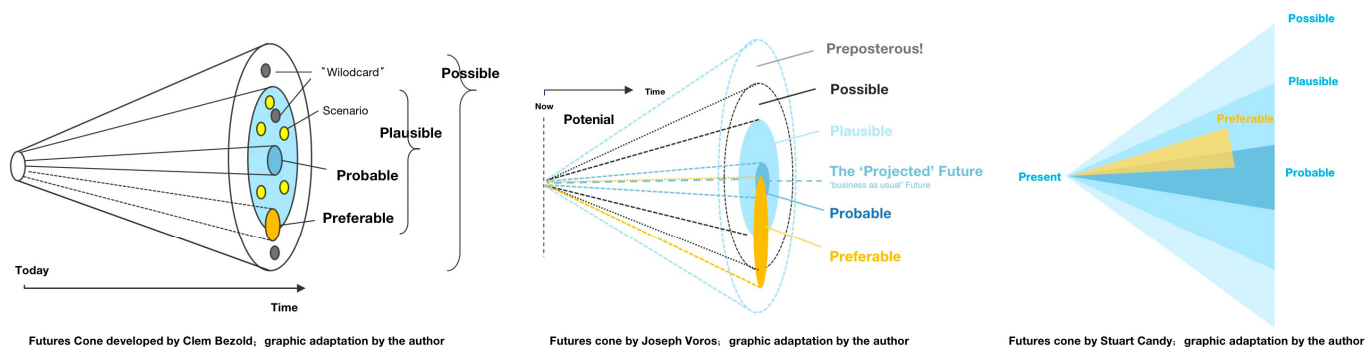


Figure 1. Evolution of the Future Cone (graphic adaptation by the author).

The concept of the Future Cone can be explained and established by “three laws of the future”: the future is not pre-determined; it is unpredictable; and it will be influenced

by our current choices [15]. Among these potential outcomes, the preferable future is a better choice for the future that is 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 individuals. As such, they lack 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 to be 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 its core principle being identifying the correct problem and finding the corresponding solution [18]. As a standardized approach to the design process, it is meant to be generic throughout most design projects [6]. The Double Diamond Model consists of four phases, namely Discover, Define, Develop and Deliver. Discover refers to exploring problems, gathering insights and understanding user needs, and forming ideas (divergent thinking). Define refers to refining the problem and providing a framework to resolve it (convergent thinking). Develop refers to creating and exploring solutions (divergent thinking). Deliver refers to testing and evaluation, as well as 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 stage to the third stage. Therefore, the Design Council updated the Double Diamond Model in 2019 to reflect this fact [20].

Given that ideal methodological processes are impossible to achieve, it is important to have 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, modifying and extending 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 to suit 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 arise, 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, which involves 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 via the Future Cone. In this regard, designers need to understand users’ needs and problems through various research methods. In addition, the designer’s 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 researchers to explore possible outcomes from a future perspective, thereby enhancing the foresight and relevance of subsequent designs.

2.3. IDEO Method Cards

One of the earliest examples of card-based design tools is The House of Cards created in 1952 by the American designers Charles and Ray Eames. It was designed to stimulate innovative thinking and increase creativity in a playful way. Along with the movement toward the development of systems and design methods in the 1970s, other card sets that aided 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, which involves employees in workplace design [22]. In the early 2000s, more user-centered card tools were

created, including the IDEO Methods Cards, which are the best-known design tool cards and are widely used by designers.

IDEO Method Cards are user-centered design method cards that provide ways to empathize with users during design projects [22]. IDEO Method Cards are rich in methods, being diverse and comprehensive, to help designers to inspire creativity in all aspects and stages of design. There are 51 cards, which divided into four categories, namely Learn, Look, Ask and Try. Each card describes the design approach and a brief story about how and when to use it [23]. For example, the design tool 'Behavioral Mapping' is used to track the location and movement of people over time in a space. It is used because recording 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 to identify traffic points, as well as vacant and underutilized museum lobby areas.

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 by Ezzat Saad Mahmoud et al. regarding the Double Diamond Model, the Double Diamond Model was labeled with different user research methods to clarify the steps in 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 phases [19]. In turn, these tasks could 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 to complete each phase. Furthermore, design tools create things that did not exist before, such as introducing desirable changes in the world, and predict the technical, social and cultural consequences of design, which is exactly what is needed to create a design-oriented and consensus-based future [25].

2.4. Age-Appropriate Design

The concept of age-appropriate design began in 1974, with the new design concept of barrier-free design being 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 in their daily lives 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 products according to their age and physiological function.

In the context of deep aging, many age-appropriate designs have emerged in Japan. Torben Volkman, Michael Sengpiel, Rita Karam and Nicole Jochems used the elderly as co-designers in the design process, in which appropriate speech input types and minimum requirements for conversational agency were explored [27]. Based on participatory design theory, Tsinghua University, China, is exploring ways to cooperate with the elderly during design research activities. However, there is currently no guiding framework for age-appropriate design that specifically considers 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 that may emerge in the future, the current design may present new problems in the future. According to a study by the University of the Arts London, the application of design thinking to solve future problems can be divided into Artefact, Artefact and Experience, Systems Behavior, and Large Scale Systems components. Among these components, 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 process must use an age-appropriate design tool as its 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, which is a new model, as shown in Figure 2, is proposed to guide design practice activities in the face of future aging issues, which may help to manage the design process, clarify design goals and solve design problems.

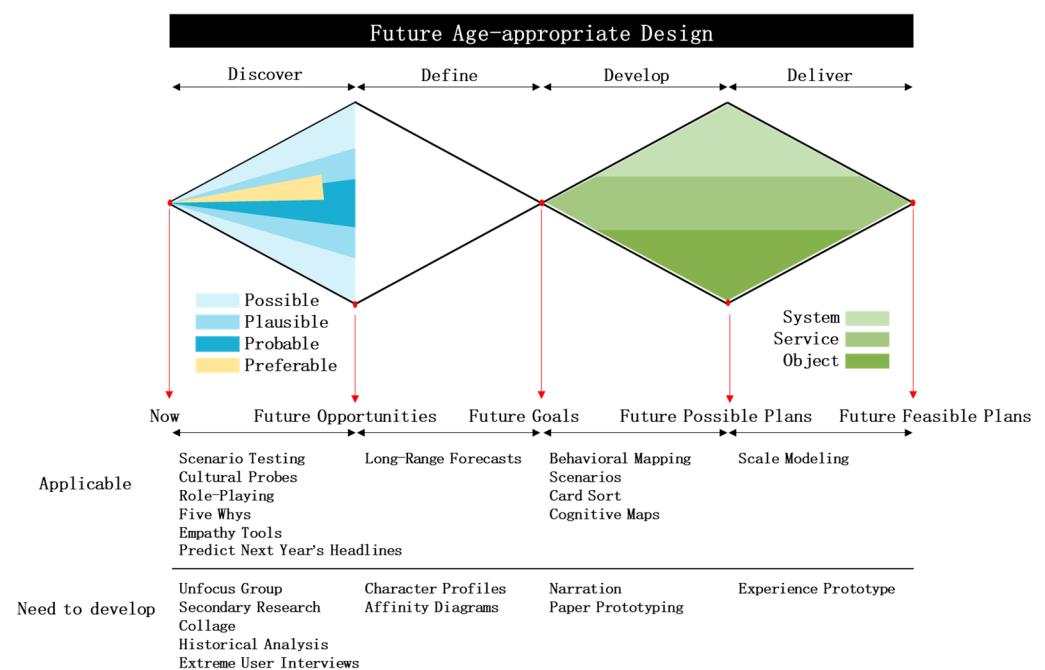


Figure 2. Theoretical Frame Model.

In the Discover stage, the Future Cone is essentially a divergent thinking model, which emphasizes the divergence of different possible outcomes at set points along the timeline and guides designers to use a systematic approach to thinking at the future time level. The Future Cone model is, therefore, integrated into the Discover phase of the Double Diamond Model, which has a common starting point based on the present and explores the possible outcomes of the future. The task of this phase is to understand future aging trends and the needs of the future aging population, as well as to identify future opportunities. For example, there is a need to collect and analyze relevant data, trends and changes to discover various possible outcomes of 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. In the Define stage, the main tasks 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 derived during 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. In the Develop stage, the main task of the designers is to explore possible future plans and compare, refine and optimize them. For example, there is a need to use creative thinking tools and methodologies to develop innovative solutions, as well as to test and improve solutions, thereby ensuring that they meet the needs and expectations of older adults. The Deliver phase focuses on evaluating and filtering plans to combine them into 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 to 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 issues, the solution should emphasize the importance of system experience and service design, ensuring that a complete, comprehensive and systematic solution can be provided.

In the design process described above based on 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 those applicable to this topic. The Discover phase contains Scenario Testing, Cultural Probes, Role-Playing, Empathy Tools, Unfocus Group, Five Whys, Predict Next Year's Headlines, Secondary Research, Historical Analysis, and Extreme User Interviews. The Define phase contains Long-Range Forecasts, Affinity Diagrams, and Character Profiles. The Develop phase contains Behavioral Mapping, Scale Modeling, Scenarios, Narration, Paper Prototyping, Card Sort, Cognitive Maps, and Collage. The Deliver phase contains Experience Prototype and Scale Modeling. These cards were incorporated into a new design model, which helped design teams to apply creative thinking techniques and approaches when addressing issues related to aging. Moreover, it was found that some tools were not quite suitable for this topic and needed further development. The tools were grouped into two tiers: tools that were applicable and tools that needed improvement. For example, since Long-Range Cast is a tool used to predict the future, it was perfectly applicable. However, the form of paper prototyping may change with the future development of digital virtualization. It should be noted that these inferences were only based on team experience. In order to verify their veracity and accuracy, a designer workshop was conducted to discuss the applicability and classification of IDEO Method Cards, which helped us to refine the model.

4. Workshop

The aim of this workshop was to combine the ideas of as many people as possible to accurately integrate the IDEO Method Cards into the theoretical frame model, including their classification and phasing. In addition, it aimed to inspire designers to think diversely, and we aimed to draw good suggestions from them. The flowchart with information about activities carried out in the workshop is shown in Figure 3.

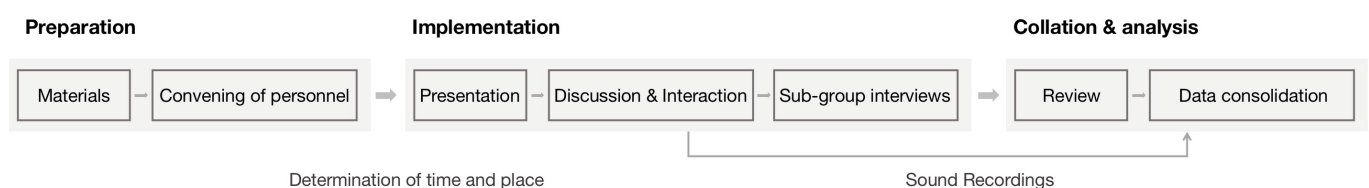


Figure 3. Flowchart of workshop activities.

4.1. Workshop Design and Materials

This exploratory workshop was held on 14 June 2023, and it 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 were primarily designed and directed by the research team (two faculty members and three graduate students). Materials used in the workshop included some tables and chairs, IDEO Method Cards, colored pens, A4 paper, 20 neutral pens and sticky notes. The oral presentations and interactive scenes involving the participants were recorded using audio and video equipment.

4.2. Participants

As shown in Table 1, there were 13 participants in the workshop, all of whom had a design background and were engaged or interested in the field of aging design. A total of 2 professors and 3 professional designers had relatively senior design experience and design education backgrounds, 6 graduate students had 2–3 years of advanced design experience, and 2 college students represented designers who had just entered the industry. All participants were Chinese and aged between 19 and 61. In terms of gender, there were 5 males and 8 females.

Table 1. Workshop participants information.

Participants	Discipline	Areas	Sex	Age	Occupation	Aging Design/ Research Experience
S1	Design	Product Design Service Design Interaction Design	Male	58	Professor	33 years
S2	Design	Product Design Service Design	Female	61	Professor	35 years
S3	Design	Visual Design Public Facilities Digital Products	Male	43	Designer	1 year
S4	Design	Digital Products	Male	48	Designer	23 years
S5	Design	Smart Products	Male	42	Designer	2 years
J1	Design	Age-Appropriate Design of the Interface	Female	25	Postgraduate Students	3 years
J2	Design	Human–Machine Interface Design	Male	27	Postgraduate Students	3 years
J3	Design	Age-Appropriate Design Visual Design	Female	27	Postgraduate Students	3 years
J4	Design	Experience Design Co-Design	Female	25	Postgraduate Students	2 years
J5	Design	Co-Design Service Design	Female	26	Postgraduate Students	3 years
J6	Design	Interaction design User Interface Design	Female	30	Postgraduate students	3 years
J7	Design	Smart Wearable	Female	19	Undergraduate students	0 year
J8	Design	Assisted Aging Products	Female	20	Undergraduate students	0 year

4.3. Workshop Procedures

As shown in Figure 4, this workshop had three steps. The specific description is as follows.

(1) Short Introduction

This phase lasted 30 min. Firstly, the facilitator introduced himself and described the entire workshop process and timeframe. Secondly, questionnaires were distributed to understand the basic situation of each participant, as well as their experience and opinions regarding the Double Diamond Model, IDEO Method Cards, etc. Refreshing their memories helped them to understand the theory and participate in subsequent discussions. Afterwards, the facilitator introduced the participants to Future Studies, the Future Cone, the Double Diamond Model, the New Model and the IDEO Method Cards. The relevant paper materials and 4–5 IDEO Method Cards were provided to each participant (see the

Appendix A for card numbers). Finally, a question-and-answer session involving the participants took place.

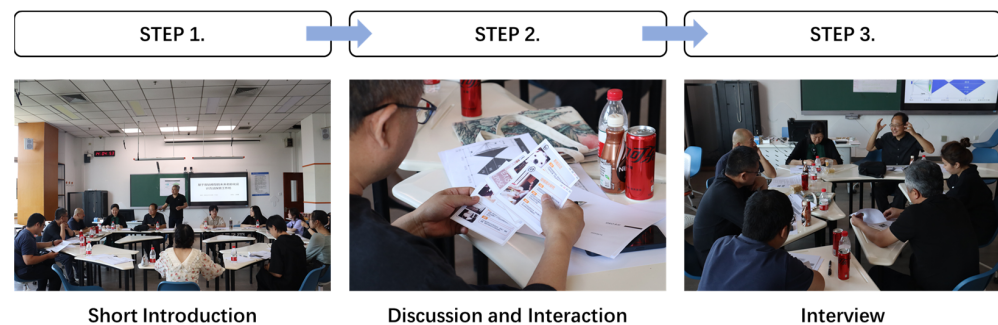


Figure 4. Workshop flow.

(2) Discussion and Interaction

This phase lasted 90 min. Firstly, participants were guided through a prediction of travel and entertainment experiences in 2050 to stimulate their imaginations regarding 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 could then be categorized as usable, to be verified, or to be 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 related to aging. Therefore, an "extended" category was added to the original three tiers. The final results are shown in Figure 5.

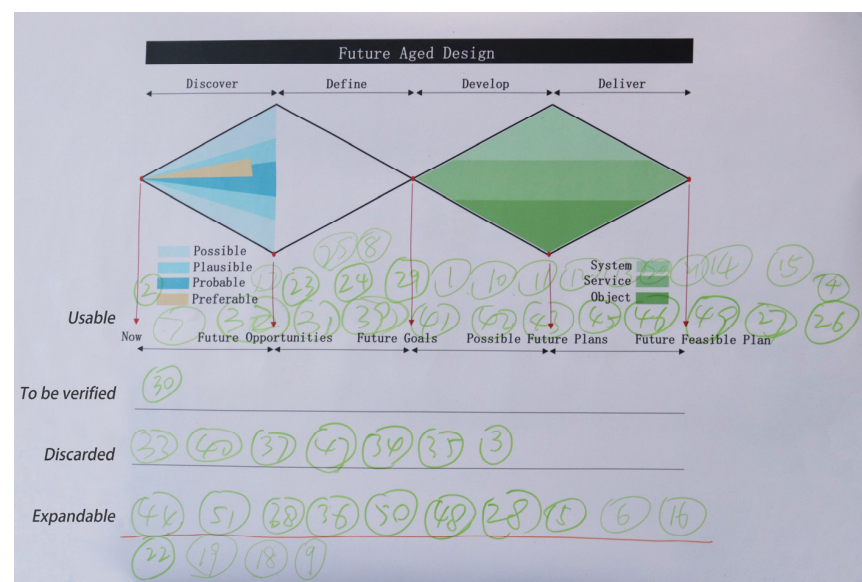


Figure 5. Results of participants' classification of cards.

(3) Interview

This phase lasted 60 min. After the interactive session, the participants were divided into two groups for semi-structured interviews: one group included five older and more experienced designers, and the other group included the eight students. On one hand, broader and more in-depth interviews were conducted regarding the points raised by the participants during the discussion and interaction sessions. On the other hand, participants were asked to discuss their thoughts regarding the factors influencing cards' 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 were crawled and classified. Based on the results and data, it is clear that the workshop met its intended objectives. Not only did it refine the theoretical model, but it also explored the reasons and suggestions influencing the designers' ideas.

5. Discussion

As shown in Table 2, 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, as shown in Figure 5. In the follow-up interview, participant J2 felt that the tool was limited because objective constraints made it difficult for us to behave like realistic users. In other words, we should break the limits and allow the designer to influence the user's behavior as much as possible. In such cases, informal tools can become useful. Given that the way in which to break the limit is a problem that must be considered in the future, this tool is still classified as needing "to be expanded".

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

Description Examples	Categories
S3: Still-Photo Survey is useful, as Xiaomi's behavioral analysis lab uses it to analyze how different people, who are of different ages, interact with different User Interfaces.	Cards usable
J6: Ergonomics is well developed and used in product design and space design to confirm 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, i.e., the way they behave. But because the way a 90-year-old person behaves would be so different to that of a 60-year-old, the entry point for research needs to change.	
S2: Cross-Cultural Comparisons refer not only to the cultural differences between the East and the 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 the way 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 based in frontline or rural locations and who do not understand Mandarin, designers are not able to authentically perform user behavior.	
J5: Long-Range Forecasts of the prospects and future business focus in itself imply a crossover of disciplines and a fusion of knowledge, and I think that it is expandable.	
J3: Opportunities can be found using Role-Playing and Empathy Tools to imagine what the person currently wants.	Cards to be discarded
S2: Word–Concept Association can only perform conceptual tasks, but it does not work for practical products, like ageing.	
S4: The sample that we follow, track, and accompany in the future cannot be determined, and, thus, Shadowing as such is invalid.	Identify the purpose of the card and place it in the different stages
J3: In the first stage, you can use role-playing with empathy cards, which are analytical and observational methods, to imagine possible problems and needs.	
J1: You can start by clustering the cards to clarify what the tools in this category can help you to achieve, before placing them in the appropriate stage.	

By collating and analyzing the views and marks of the participants in the interactive session, the theoretical model shown in Figure 6 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 statement, the original model was improved accordingly to represent more possible outcome of the future. At the same time, this approach verifies the openness and evolution of the Double Diamond Model [7,10].

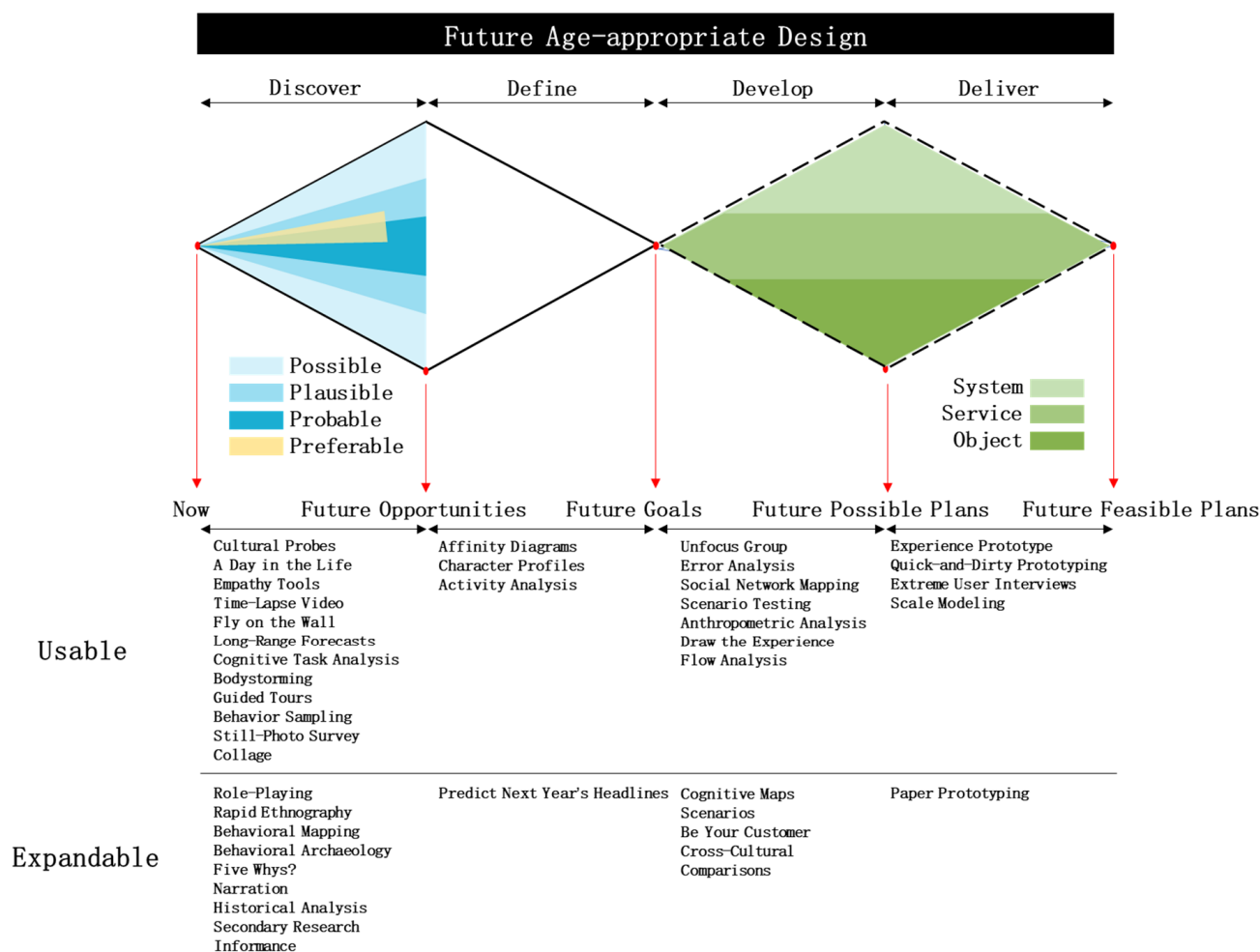


Figure 6. The Refined Model.

As shown in Figure 7, significant differences were found between the numbers of IDEO method cards that were categorized into the four categories ($\chi^2 = 34.25$, $p < 0.01$). Among the 51 IDEO method cards, 29 were categorized as Usable, 14 were categorized as Expandable, 7 were categorized as Discarded, and only 1 was categorized as To be verified (see Figure 5). The results indicate that most IDEO Method Cards were not specifically developed for future design, but they can still be categorized as Usable or Expandable as approaches to future design. In contrast, seven cards were discarded. Therefore, this study will now examine the factors that influence the utility of IDEO Methods Cards and the directions in which they could be expanded.

As shown in Table 3, participants were instructed to explore the factors that affect the usefulness of the cards in the face of future aging, as well as the reasons why many cards become ineffective. Relevant ideas and data were collated and analyzed.

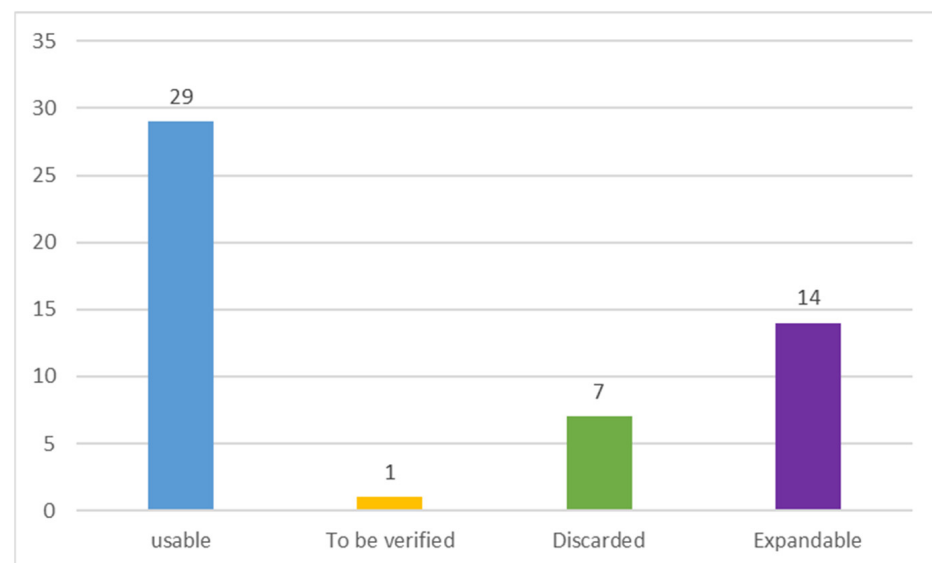


Figure 7. Number of cards in each of the four categories.

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

Description Examples	Opinions	Categories
S1: The broad and 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 should be considered.	Differences within the older population
S5: The environment can have a physical and psychological impact, meaning that solutions designed for different geographical populations, 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 explain 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 their validity.	Cards need time to be validated
J2: The future itself is diffuse, and we should evolve the toolkit as the future changes, rather than judging now whether it will work in the future.	Card tools should evolve over time.	
J2: It is more effective at the stage of problem identification, but at this 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 about the future is limiting, and the future should be explored in a more open way.	The current tools and thinking are too limited.	Limitations of existing design thinking and tools
S3: Some tools can only consider the product or the space, and 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.	

Table 3. Cont.

Description Examples	Opinions	Categories
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 impacts of technological developments are so difficult to assess that it is difficult to evaluate or circumvent them 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 will have difficulty gaining insights about the cultural characteristics and user profiles of individuals from decades in the future.	The cultural profile and user profile of the future will change.	Times have changed for users
J3: The mindsets 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 their future perspectives to generate ideas.	Different perceptions based on different times and backgrounds	
J5: People are becoming more aware.	Human consciousness advancements	Developments in technology, policy, culture and other factors will all affect user research
J5: Smart bodies will intervene in future user research, while we may only need to study individual cases.	Smart body interventions will influence our decisions.	
J5: Political policies may influence developments in areas 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 may impact tool acceptance.	Cultural backgrounds have an impact on how people are received.	

According to the above analysis, it was found that there were various factors that affected the usefulness of cards in this study. On the topic of aging, an aging population spans a large range and 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 allow the spiritual experience of the elderly, such as role-playing. These cards do not help designers to 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 acknowledged 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 these times, user characteristics and user needs will be affected to some extent. In addition, the development of factors such as technology and culture will have an impact on user research.

Based on the model, many cards were classified as “Expandable”. During the course of the workshop, many participants suggested that the toolkit needs to be extended to better accommodate future aging issues. Therefore, we extracted the relevant high word frequencies from the participants’ perspectives, as shown in Figure 8. Based on the results, it was found that participants have multiple perspectives regarding how to improve the toolkit. Words such as “expansion, improve, cluster, cognitive, culture”, etc., were repeatedly mentioned.

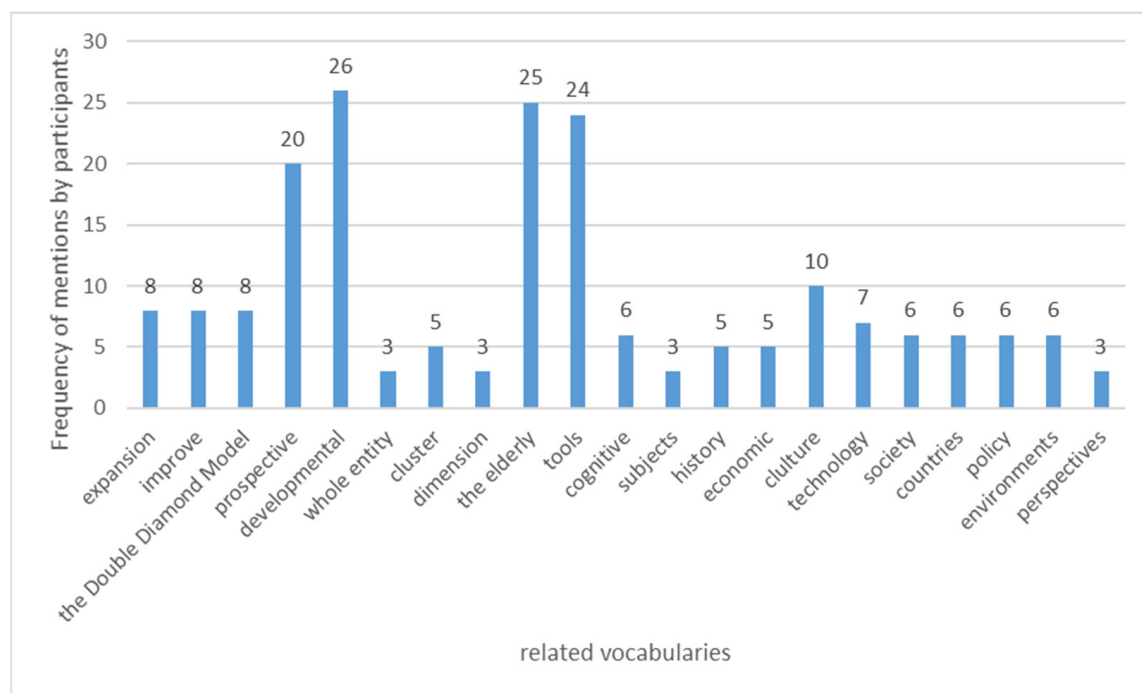


Figure 8. Related high frequency vocabularies statistics.

As shown in Table 4, we, therefore, explored the descriptions associated with high-frequency words and consolidated and analyzed participants' suggestions regarding how to improve the toolkit.

Table 4. Examples of participants' suggestions for cards expansion.

Description Examples	Opinions	Categories
S1: Redevelop the IDEO card by thinking in terms of a double diamond and redesigning it.	Research IDEO Method Cards with the Double Diamond Method	Overall improvement toolkit
S2: In the future, it is important to improve the card model as a whole.	Overall improvements to the card	
J6: Give all of the cards 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: An improvement can be made by clustering the cards, clarifying the effectiveness and purpose of each category, and separately improving each of these categories.	Cluster before analyzing and improving	Cluster before analyzing and improving
J2: Pre-clustering is important, and some of the methods may be very relevant for the elderly, which can be first summarized and then developed in relation to future concepts.	Improve methods suitable for ageing studies after performing clustering	
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	Improvements based on geriatric cognition
J1: Since they are aimed at the elderly, the cards should also be adapted to ageing-related issues.	Age-appropriate retrofit	
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 their perceptions reach the appropriate level.	Improvements based on elderly people's perceptions	

Table 4. Cont.

Description Examples	Opinions	Categories
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, should occur.	Combining knowledge of history, economics, etc.	
J4: Protecting the future requires us to think in a business sense and 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 allow us to experience different states of being.	Incorporating more technologies	

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 needed to be improved. Participant S1 suggested that toolkits could be explored in a discrete fashion using the Double Diamond Model. Participant J6 suggested that the toolkit needs to be given a future dimension to ensure 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, such as 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 fit 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 to fill gaps in existing tools. Undoubtedly, the combination of technological, cultural and social factors is a development that, in the future, will lead to increasingly complex problems that will require a more integrated and holistic approach. 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 aims to help designers cope in advance with the social pressure brought by aging. For example, we can use this model when we are faced with the topic of future age-appropriate trips. Firstly, we need to establish future thinking. Then, we can use method cards, such as 'A Day in the Life', to help us to identify problems. Similarly, in the later stages, the appropriate method cards can be selected according to the specific objectives. The model guides us through the process of managing the topic in an organized way and completing the tasks at each stage.

The aging problem requires us to create more inclusive solutions, and designers should think and respond more systematically. The Double Diamond Model itself is a systematic design methodology. Based on the Double Diamond Model, we combined knowledge from various aspects to create a new model. It employs both the Future Cone for thinking inspiration and the Double Diamond Model for design process management, and it integrates IDEO method cards to help designers to put the goals of each link into practice. Regarding the whole design process, the model is comprehensive and systematic.

Undeniably, there are some limitations to this study. Firstly, 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 in this workshop were all Chinese designers. Despite their broad horizons,

the limitations imposed by a single cultural background are unavoidable. In addition, the participants worked in a single industry, and the workshop lacked the participation of people with decision-making experience and capacity, such as politicians and analysts. Thirdly, the framework model is completely qualitative, whereas data are rather important for determining trends in future development. Therefore, this study lacks consideration of the best way to incorporate some mathematics topics, like probabilities. 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, as well as wanting to think outside of the box. Section 4 explains in detail possible development directions, such as helping design tools to 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 the 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 and 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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