Information and Experience Visualization: An Analysis Approach and Decision-Making Tool for the Usability Research

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Abstract. With the transformation and development of the age of network, information and digital, information has evolved into the basic exchange in our lives. Information visualization serves as a communication and dialogue interface between people and objects, between human and environments, and between individuals themselves. It emphasizes the context of information application scenarios and the need to effectively convey information oriented to users' needs and purposes, providing users with sound and efficient meaningful behavior guidance as well as experience characterized by cultural metaphors and aesthetic significance. In the usability research of products and services, visualization is a means of external representation of thinking as well as an expression method of cognitive tools or conceptual structures. Based on dematerialized service systems, user behavior and experience, information and experience visualization present quantitative or qualitative usability-related research in an intuitive and figurative manner. In this way, it enables us to objectively understand the operational status of products or services, analyze the effectiveness and adaptability of links between process tasks, functional architectures, system feedback of user behaviors and experience. In addition, it offers guidance and new insights and plays an analytical and decision-making role in solving complex problems. Meanwhile, visualization represents an ideal tool to help the team to promote comprehensive cognition, build consensus to ensure smooth communication in the design research process.

Keywords: Visualization · Usability · Service design · Analysis and decision-making

1 Introduction

Whether in the past, the present or the future, in the natural world or the artificial world, whether from micro or macro, and from material or non-material perspective, all existence, each of which has with its own mysterious code, constitute a large and intricate system of human social life. By means of abstract or figurative representations and evolving technologies and media, information, including texts, symbols, messages, sounds, graphics, images, codes, numbers, diagrams, signals, signs, are constantly involved in the process of production and consumption, transmission and reception, and encoding and decoding. Gleick states in A Brief History of Information:

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"Evolution itself embodies an ongoing exchange of information between organism and environment" [1]. By acquiring and identifying different information in nature and society, human beings are able to distinguish different things and thus understand and transform the world.

With the continuous transformation and development of network, information and digital technologies, "DNA of information" (Nicholas Negroponte, Being Digital) is replacing atoms as the basic exchange in human life at a lightning speed, and massive data clusters and TMI (too much information) have become an important component of social life. In our daily life and or in increasing public and commercial services, the mass production, collection, storage of data and the organization, transferring, sharing and application of information have profoundly changed the way we think, behave, communicate, live and work and have become the source of new inventions, new services and new models.

On the one hand, as the computing power and graphics processing technology of computers spring up, the new field of visualization has emerged as a result of people's unremitting efforts to explore multi-dimensional visualization of the complex relationships between big data and information using computer graphics technology. In fact, information visualization applications, such as annual reports, maps, brochures, popular science, medical illustration, geographic surveys, news reports, public space guides, interactive virtual navigation, website interfaces, Apps etc. have long been available in all aspects of our daily lives. From two-dimension, three-dimension, four-dimension to multi-dimension, from vision to five senses, and from static, dynamic to interactive visualizations, these lead to more diversified forms of visual telling and presentation.

On the other hand, TMI has posed a serious threat to the decision makers of public management and business operations. As information systems generate more and more data, it is a crucial yet arduous task to provide users with useful information to solve problems. After all, information recipients must gain access to a large amount of abstract data before making a decision. Commercial services such as retailing, shopping, communications, and finance have a deluge of raw transaction data, which prove to the precondition for further abstracted market behaviors. Instant information visualization applications facilitate financial analysis and sales decision-making and guide user behavior so as to gain new significance and even direct rewards. In the field of public services, data or information visualization presents huge development potential in such areas as abnormal network detection, real-time urban traffic information, disease monitoring and prediction, monitoring and forecasting of severe weather and geological disasters, public event reporting, etc. Information visualization programs and analytical reports are effective means to assist public decision-making and create social value.

2 Related Concepts

2.1 About DIKW

Data Information Knowledge and Wisdom Hierarchy (DIKW) refers to a classic model widely accepted in such fields as information science, information theory, and knowledge management. Interestingly, DIKW hierarchy was first mentioned in T. S. Eliot's poetry published in 1934, "The Rock" [2]: "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?" But another interesting thing is that the hierarchy was mentioned by Frank Zappa in album Joe's Garage in 1979 [3]: "Information is not knowledge, Knowledge is not wisdom, Wisdom is not truth, ……" Later, the concept is interpreted differently in Milan Zeleny's (1987) article "Management Support Systems" [4], Michael Cooley (1987)'s article, "Architecture or Bee?" [5], and Russell Ackoff's (1989) article "From Data to Wisdom" [6]. In 1999, Zwaga et al. focused on the shifts from data to information and from information to knowledge [7]. In 1999, Shedroff pointed out that understanding is a continuum that leads from data, through information to knowledge, and ultimately to wisdom [8].

Data itself cannot "inform or transmit data". Instead, it is an objective fact that is non-subjective and raw, but can be discovered, collected, and recorded. Data is the raw material of information that can be generated continuously, and exists in a quantitative or non-quantitative form. It is only through filtering, sorting, collecting and processing that data becomes usable and effective information.

With a plethora of raw data in our daily life, it is impossible for us to understand them one by one. Only when data is organized into information that needs to be informed, and when there is a comprehensive and corresponding relationship between the output and receiving of information about certain object, content, purpose, media and form, can specific and targeted information be transmitted to inform others of what to do. As processed and meaningful data, information has the internal attributes of informing and telling facts, helps users to think and make better decisions and guides their following actions in the context of specific application scenarios.

Knowledge is an elusive concept which is difficult to measure and define. The transformation from information to knowledge is another sublimated and integrated process filled with cognition and communication. The connection and summary between various information and between concepts constitute knowledge, which is designed to help explore and grasp the intuitive information and the nature. Instead of a simple accumulation of data and information, knowledge is information that can be used to guide practice; it is the sum of the understanding and experience gained in the practice of transforming the world; it is a dynamic combination of structured experience, values, and related information and professional insights.

Knowledge eventually evolves into wisdom. Shedroff explained that Wisdom is a kind of "meta-knowledge" of processes and relationships adjusted through experiences [8]. Wisdom refers to the ability to utilize knowledge, experience, understanding, common sense, and insight to guide thinking and actions, thus obtaining a quick, flexible, and correct understanding and judgment. It emphasizes abstraction from the perspective of philosophy, thus, in a sense, it is a more intelligent process. Or the process of making decisions is intelligent, involving meditation, evaluation, interpretation and reflection.

2.2 Brief Analysis of Visualization Types

The report of *Visualization in Scientific Computing* [9] published by the National Science Foundation (NSF) in 1987 emphasized the necessity of applying graphics and image technology into scientific computing, a new computer-based visualization technology. The report has exerted a far–reaching impact on the field of visualization. Visualization is an essential auxiliary tool in the process of scientific research from observing natural phenomena to simulating natural phenomena and to analyzing related results. Based on the principles and methods of computer graphics, scientific visualization is referred to as loop and iterative visualization exploration and analysis (data filtering, mapping, drawing and feedback) about scientific data obtained by measurement and large-scale multi-dimensional data generated by experimental calculation. The purpose of scientific visualization is to graphically illustrate scientific data and objective phenomena to enable scientists to gain insights into them and thus grasp the essence of nature.

Data visualization mainly focuses on data services and warehouses in finance, retail, communications and other business fields. Through visual quantization techniques, it allows researchers to understand the information and rules embedded in data, thus providing material basis for decision-making. Data mining, as a crucial link, involves classification, clustering, predication and association analysis. Classification is a process of categorizing the data with unknown class labels in the database with the help of classification models (classifier). Clustering is a process of organizing samples without classes into different groups and describing the data clusters. Prediction denotes the establishment of models based upon historical data, and the application of data to forecast the future development trend and possible outcomes. Data association refers to important and discoverable knowledge in the database. The purpose of the related analysis is to find out the hidden associations in the database. Data visualization focuses on the close relationship between graphics and statistical modelling, as well as the statistical properties of results. The former enables readers or viewers to understand data structures, while the latter plays an important role in the process [10].

In a general sense, the goal of information design is to allow audience to communicate in a smooth and convenient manner, because clear and intuitive way of visual communication can transcend the barriers among regions, languages and cultures. Information visualization is closely related to information design and usability. In terms of information design, it is defined as "the art and science of preparing information so that it can be used by human beings with efficiency and effectiveness" [11]. Nathan Shedroff pointed out that information design is related to the organization and presentation of data, and that how data is transformed into valuable and meaningful information, which elaborated the attributes of and relationships between information and data. According to International Institute for Information Design (IIID), information design is the defining, planning, and shaping of the contents of a message and the environments it is presented in with the intention of achieving particular objectives in relation to the needs of users." Visualization is defined as "the use of computer-supported, interactive, visual representations of data to amplify cognition" [12]. It focuses on visualization and navigation of abstract data structures using graphics and interactive animation. However, information visualization values the context and user needs in application scenarios, with efficiency and effectiveness of information transmission its ultimate goal. It covers such knowledge fields as graphic design, visual design, cognitive psychology, communication theory and cultural studies and other aspects of knowledge. Therefore, information visualization is more concerned with aesthetic metaphors and pleasures of visual languages and forms.

Eppler and Burkard argue that knowledge visualization designates all (interactive) graphic means that can be used to develop or convey insights, experiences, methods, or skills [13, 14]. In addition to transmitting facts, knowledge visualization conveys insights, experiences, attitudes, values, expectations, perspectives, opinions, and predictions, and thus helps others correctly reconstruct, memorize, and apply related knowledge [13]. These interpretations reflect extended objects, means, goals of the visualization field, whose main purpose is to support users in creating and sharing knowledge with others. Generally speaking, the field of knowledge visualization examines the use of visual representations to improve the creation and transfer of knowledge between at least two people. Knowledge visualization thus designers all graphic means that can be used to construct and convey complex insights [13].

Regardless of different types of visualization, DATA represents raw and unprocessed objective facts and first-hand materials. In comparison, scientific visualization focuses more on the data in physical world and natural science fields, such as the real-time tracking or display of computing results of astronomy, meteorology, medical images, astrophysics, biochemistry, geological survey. The data gained through data visualization is mainly applied in business operations and services such as finance, retail, communications, travel, etc. Although these abstract data do not correspond to the meaning of physical space, they are displayed in perceptible space fields to help people understand, manage, utilize these data and related laws. As the nature of "information" is to inform facts, information visualization values the application scenarios in real life, effective transmission of information about user objects and target needs, and description or storytelling about events related to specific themes or opinions. It can enable users to analyze, judge, and understand phenomena, characteristics, relationships, causes, and trends. Since knowledge denotes cognitively processed information that is integrated into human knowledge structures, knowledge visualization emphasizes the application of visual representation to promote the reorganization, description, dissemination and co-construction of group knowledge.

With the technological advancement of network, big data, information technologies and artificial intelligence, the visualization application has been expanding in breadth and depth in social life, producing greater intertwined coexistence. It is difficult and unnecessary to make a clear distinction between differently described terms, but the objectives and functions of the visual presentation varies in different research, application or user communication scenarios. In spite of different types of visualization, visual exploration is carried out functionally and formally, because there is no absolutely natural mapping between abstract data or information and graphic images. At the same time, the multi-dimensional application of auditory, tactile and other non-visual media has led to more diversified multi-sensory and interactive presentation and communication models in the practice. Therefore, how to maximize the audience's understanding and usability matching remains the biggest challenge facing visualization technologies and design.

3 Information Visualization as a Method and Tool for Usability Research

In the general interaction design and service design centered on user experience, the behavior, activity, process, system and experience have taken place of objects as the dematerialized research and design object. When using specific products or interactive service system, there are various factors concerning the usability evaluation criteria, such as whether the products and services have smooth procedures, reasonable behavior, stable system, and satisfactory experience or not.

The International Organization for Standardization (ISO) 9241-11 defines usability as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.” Steve Krug states in his book *Don’t Make Me Think* that usability really just means making sure that something works well: that a person of average (or even below average) ability and experience can use the thing—whether it’s a website, a fighter jet, or a revolving door—for its intended purpose without getting hopelessly frustrated.

Tullis and Albert argue that usability metrics can help reveal patterns that are hard or even impossible to see, and also help you gain new insights and lead toward a better understanding of user behavior [15]. From the perspective of user behavior and experience, usability is an important quality indicator to evaluate and develop user-friendly interactive products or service systems. When using the products and interactive service system in daily life, whether the product is effective, easy to learn and memory, efficient, error-free, satisfactory for the user, whether the product meets the user’s needs and expectations, whether it can offer users favorable experience, whether users can use the product to perform their tasks, and how about subjective feelings (i.e. Flow or not? Any problems? Better than other products? Want to use it again? etc.). There are many specific and quantifiable data involved in usability indicators, and also many qualitative data, such as uncertain elements or events difficult to quantify that are related to user perception, emotion, and experience.

For product use or service study, information visualization is a significant method or tool to present usability indicators, to analyze, illustrate, explain and judge usability-related objective facts, and to tell facts logically. In the process of visual design, it is important to identify and mine raw data related to product and service availability, including all objective facts, quantifiable and non-quantifiable. It is more important to truly understand that the data alone do not make sense. Meaning will gradually become clear only when combined with the context through analysis and processing as well as purposeful and logical induction, integration and narration. The process of information visualization mainly includes: (1) collection, mining and correlation exploration of the original data or objective facts; (2) filtering, classification and association of data, and the construction of information organizations and architectures with views and paths; (3) visual coding of related classified information, selection of graphics, images, symbols, colors and their logic; (4) the formal exploration of visualization perception. Its forms should not only correspond to the original objective data and material, but also conform to the cognitive habits and experience of information receivers. In the first two procedures, special attention should be paid to the correlation between quantitative data and non-quantitative facts such as participants' activities, environment, behaviors, actions and emotions, as well as the logical relationship between basic data and the information to be conveyed, so as to intuitively present the usability problems in the practice; The last two procedures are not completely independent of the first two. When adjusting the visualization sketch based on the sorting of data and information, the correspondence among data or information, visualization elements coding and visualization forms has been gradually established. The selection of all abstract or representational elements, such as points, lines, planes, volumes, graphics, images, symbols, texts, colors, and their matching with size, height, thickness, texture, orientation, direction, and lightness, is directly related to quantitative or qualitative data. And the final form of visual presentation bears closer relation to the attributes of the data itself, the logic and narration of the information architecture and its description. For the sake of the final visual presentation of information logic, the visualization process represents an important link and tool of visual thinking centered on the research of product and service availability.

In days when Nokia and Samsung phones dominated, it was somewhat difficult to say which brand was better in terms of usability. The operational comparison of the two brands (Fig. 1), in which the main functions of Nokia (black) and Samsung (blue) phones are stacked, and the process and steps of using mobile phones to complete tasks are visualized through information architecture for usability analysis.

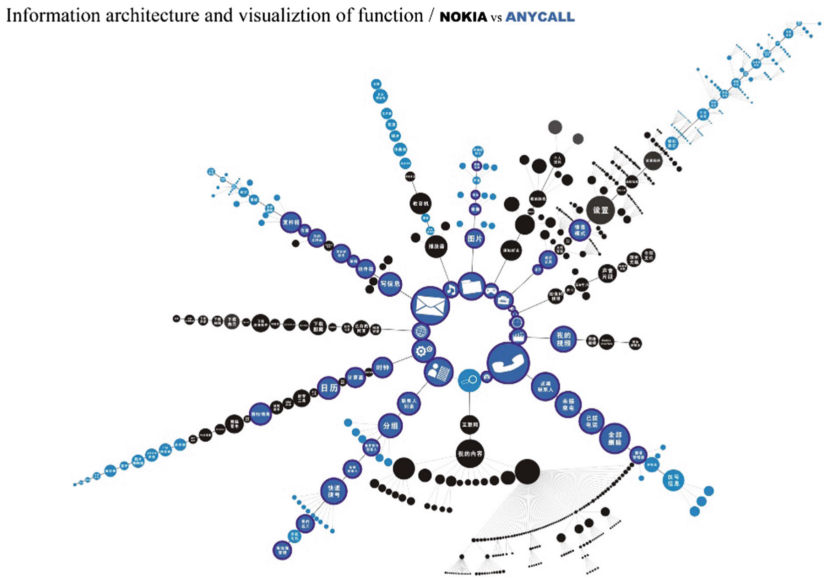

Fig. 1. NOKIA vs ANYALL: information architecture and visualization of function (Color figure online)

The center of the illustration shows the functions, with the size of the circle corresponding to the frequency of usage and steps required to complete a tasking using each function. As shown in the figure, it takes 5 steps to make a phone call with the Nokia mobile phone, and 8 steps with the Samsung mobile phone; it takes 8 steps to edit and send specified text message with the Nokia mobile phone, and 14 steps with its counterpart. Similarly, we can intuitively see from the figure the overall comparison and difference in terms of tasks to steps. This is also the reason why users claimed that Nokia's enjoyed greater usability in previous user experience evaluation.

The Liming daycare center for the disabled in Zhangqi town, Cixi city, Zhejiang province, is a small non-profit organization run by a private community. With government grant as its main funding sources, the center still relies on elderly care service fees to make ends meet. The center hopes to report to the official Civil Affairs Bureau and obtain more financial support. The design service is need to help sort out and visualize the various interests and operation status of the center, understand the needs of different stakeholders, analyze and propose specific projects and contents for service design, help gain more government support and thus build a public service brand platform and service chain. In the previous design survey, we have developed multi-dimensional understanding of the needs of stakeholders, including central managers, care workers, disabled people, volunteers and government. Through various information visualization diagrams, the visual management analysis, judgment and description are carried out in a more intuitive and concise manner in light of the interests of stakeholders, the process of day care, the status of behavior and activities. In this way, the government management department can have a better understanding about challenges facing the center. There are 19 disabled people in the center, including 16 with mental handicap, 3 with polio and physical disability. In terms of day activities, social care enterprises, namely, Bull Power Strip Factory and Xinhai Lighter Factory, provide and assemble working parts, which are paid services. The center offers limited space which has a combination of functions, such as work, eating, rest, activities, and relatively fixed seats for the nursing staff and three physically handicapped people. In the spatial layout map and personnel activity heatmap (Fig. 2), it can be found that the activity area has low utilization rate, with nobody using the treadmill; the space around the work table is the most popular place where a variety of activities have been conducted; two working tables will be temporarily changed into dining tables at noon every day, and the area is in disorder due to the movement of parts on the table; except for 2 couches, there are no other facilities for more people to take a break in the afternoon. The visualization diagram reflects the inconsistency between space, equipment and people's behavior, and provides decision-making basis for later space function division and design, facility design and transformation, and product ordering based on the special needs of disabled people.

4 Information and Experience Visualization in Service Design

Service design involves a variety of interwoven factors that are human or non-human and tangible or intangible. As the subject of service interaction, people has various interactive relations with information, products, equipment, systems and environment in the service process. Usability analysis runs through the whole design process

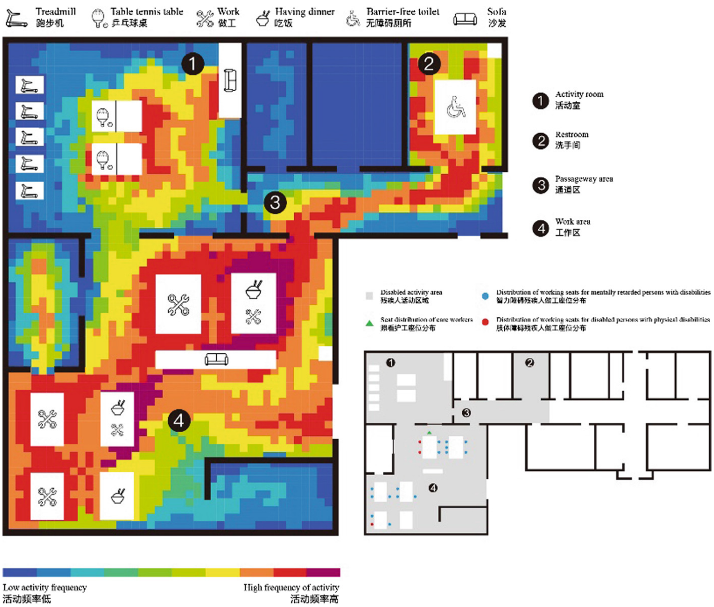

Fig. 2. Spatial distribution and behavioral heatmap of Liming daycare center for the disabled

characterized by gradual and repeated exploration. As one of the user-oriented design methods, usability research aims to design products and services that are useful and easy and pleasant to use, directly influencing and guiding users' behavior and experience in using the products and participating in the service. Conversely, if the user experience is used as the content and goal of designs, it also offers the basis and standard for the usability analysis and testing in the product and service design process. For the visualization of dematerialized service systems and processes, user behaviors and experiences, tools such as service blueprints, service system diagrams, and experience maps are all visually developed for quantitative and qualitative research and analysis. It involves sorting the relationship between processes, tasks, people, behaviors, purposes, and contact points in different contexts of the service process, decomposing tasks and steps in each phase, refining and quantifying actions, time consumption, work intensity, operational results, and emotional changes so as to reveal the relationship between the above aspects and service efficiency, service quality, and user experience, as well as usability-related issues.

4.1 Case 1: Campus Service Design

The purpose is to help the family members of faculty to solve the problem of how to accompany their preschool children to play in the school. The design goal is to carry out more meaningful service design and transformation without damaging and interfering the teaching environment. The pre-design team conducted follow-up observations, interviews and records of typical user households, and observed and recorded their relatively fixed paths and places in school, participants, activity content and methods, and duration. In the user behavior and experience map (Fig. 3), it can be seen that the design team divides the activity into four scenes based on geographical location. c.17-min journey for walking and playing along route 1, c.20-min staying for playing on the site1, c.6-min journey for walking and playing along route 2, and c.35-min c.20-min staying for playing on the site2. That means parents accompany their children to play for c.78 min (excluding return trip). The time on the left represents importance of the behavior with the color and text size. On the right side, pictures and texts are displayed to clearly and briefly reminds the participants of the main behaviors and activities, among which the red image is a sign or warning of problems in relevant places. The team members visualize the presentation ideas and mark the questions to achieve a global view and weighted consensus on the service activities.

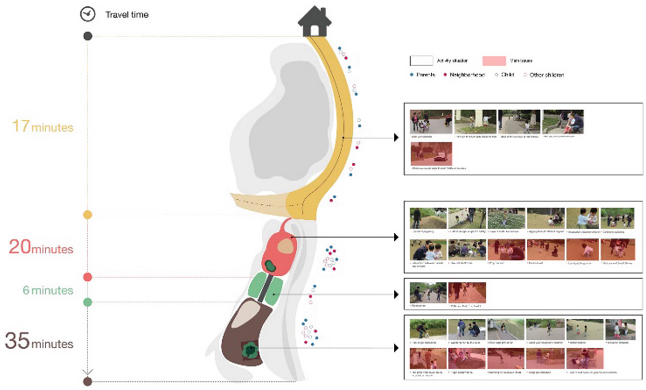

Fig. 3. User behavior and experience map of campus service (Color figure online)

In the concept sketch and interaction model (Fig. 4), the brainstorming conceptual sketch on the left, a means of visual discussion, enables the team to quickly sort ideas and conduct conceptual analysis. It serves as an effective visual dialogue and reasoning, and quickly presents the exploration of uncertainties on the service context. The interaction model on the right, which is based on the original data, the information architecture and visualization, adopts a more rational, abstract and simplified visual organization approach. In this way, it shows the relationship between participants, the exchanges and flows of materials and information, and complex and intertwined relationships in the service system, such as activities and environment interactions, and also directly guides the design logic of the final service design at the process and contact point.

The service activities involve too much content and details. In the design process, especially in the participatory design process, the information or experience visualization at different stages with different goals is not only a useful tool to help the team to analyze the phenomenon, sort ideas and discover problems. At the same time, it is an intuitive way to promote communication between teams, service providers and participants. In the pre-design phased analysis process, it is necessary to conduct valuable

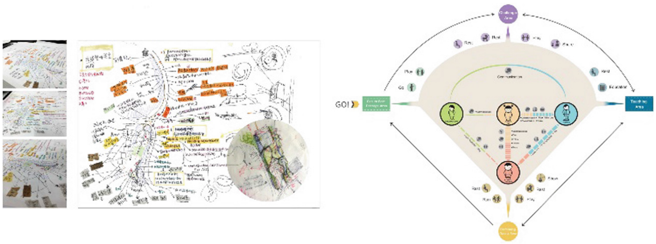

Fig. 4. Concept sketch & interaction model of campus service

information extraction and organization based on the repeated analysis, understanding of participants' behaviors and activities and to construct clear information logic (architecture) during data screening and collation. In this way, we can integrate the scattered understanding of team members into stories that can be told, and into different types of basic data as objective facts. The information logic and simplification mean of visualization description are relevant to the most effective way to present the objectivity of the service site and how to improve the smoothness of design communication.

4.2 Case 2: Medical Service Design

Medical service involves extremely complex systems and relationships. In the design research process, it is necessary to consider various questions, such as how to truly understand the attributes of service, namely IHIP (Intangibility, Heterogeneity, Inseparability, separability, Perishability) in a specific medical service, how to recognize the normality and suddenness of medical service, the difficulty in evaluating service output, and the particularity of doctor-patient relationship, how to understand the complex interwoven and interactive relationship in the medical service system, and how to establish the appropriate design weight and principles and how to guide the detailed design of contact points.

A county-level comprehensive hospital is located in a remote area in western China, with very limited conditions and resources, such as funds, equipment, personnel, all of which are far worse than those of other first-class hospitals in first-tier cities in China. According to the three-year adverse event records in the hospital, the seemingly normal daily care work of infusion has contributed to a majority of such events. Although many medical staff are involved in different stages of the whole process and there are strict, standardized and repeated checks and verification, the process still has a relatively high error rate. Therefore, the infusion-related safety problem put forward by the hospital has become the entry point for the medical care service design. The research subject is the infusion care service of the adult general unit (department of respiration). The department has a total of 10 medical staff, including 8 general administrators, dispensing nurses and responsible nurses, who are the main executives who actually enter the infusion care process. The department has a total of ten medical staff, eight of whom, including the general nurse, dispensing nurse and responsible nurse, are main individuals involved in the infusion care services. During the high incidence period of respiratory diseases in winter, average 50–70 patients are under care per day. If the desired daily dosage for each patient averages 4–6 bottles, nurses need to infuse at least 200–400 bottles per day. At the same time, limited by the overall medical conditions at the county level in western China, there are many prominent problems such as insufficient medical staff, lack of high-tech means and obsolete medical equipment. Through methods and tools such as on-site follow-up observation, nurse interviews, scenario simulation, mind maps, behavioral decomposition maps, and experience maps, quantitative and qualitative research and analysis are carried out to discuss the design weight of the contact point and the specific design solution under the service contact situation. All this is made possible by sorting the relationship between people, processes, and tasks in the service process in different situations.

For infusion care systems, visual exploration with different logic is part of the visual discussion and analysis based on on-site tracking observations and interviews, reflecting different dimensions and perspectives to help understand the systemic relationship of infusion care. The final infusion care system context diagram (Fig. 5) shows overall systemic relationship of infusion care, starting from the doctor's advice to nurse's entering the ward. It covers the main stakeholders (doctors, nurses, patients, care workers), places (pharmacy, warehouse, nursing station, treatment room, ward), nursing methods, work content in order to show and help understand the current status of the infusion care system.

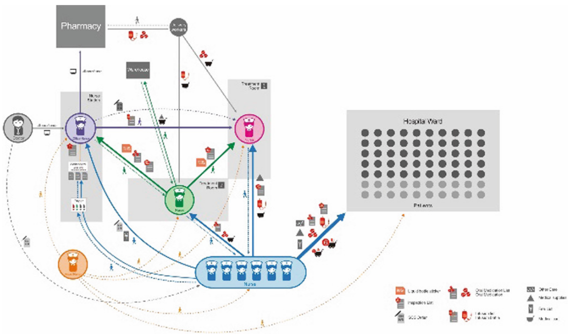

Fig. 5. The relationship of roles and tasks of current infusion care system

The daily infusion process visualization diagram in temporal logic (Fig. 6), presents different nurses, times, tasks, work intensity, and associated emotion changes with the passage of time, as well as gradually refined relationship between time, roles, tasks, and main contact point. The whole process runs from the infusion preparation in the treatment room in the afternoon to the infusion in the ward in the next morning.

According to the role simulation in different stages, the contextual relationships between daily care tasks, operational behaviors, workloads and service touch points, the team simulates the thinking patterns and behavioral habits of nurses after training, decomposes and quantifies the time consumption and operation results of tasks, steps,

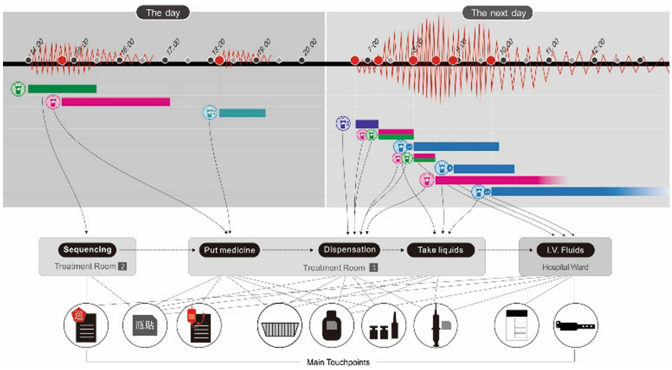

Fig. 6. The procedure and main touchpoints of daily infusion process

and actions in each stage, and presents experience and emotions in the whole nursing process (Fig. 7).

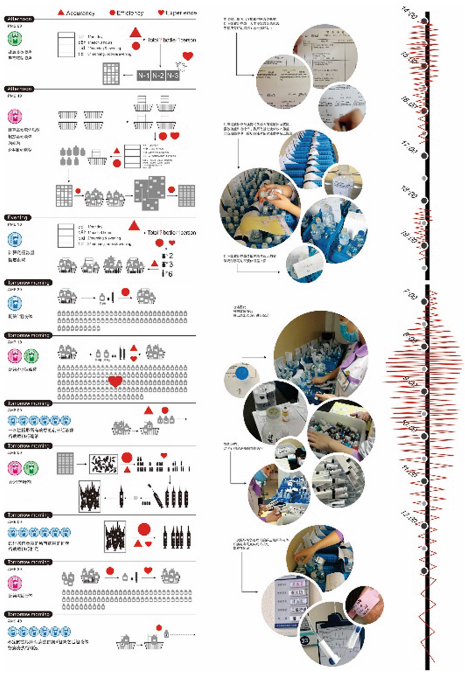

Fig. 7. Contextual details and experience analysis in different steps of infusion care service

With the gradual refinement of the overall relationship and each link of the infusion care service, the visualization abstraction of process, touch points, problems and relationship (Fig. 8) shift the focus on design thinking. Combined with the visualization analysis of different dimensions and the understanding of nursing service in the early stage, visualization abstraction defines the objectives, principles and the design weight of contact points.

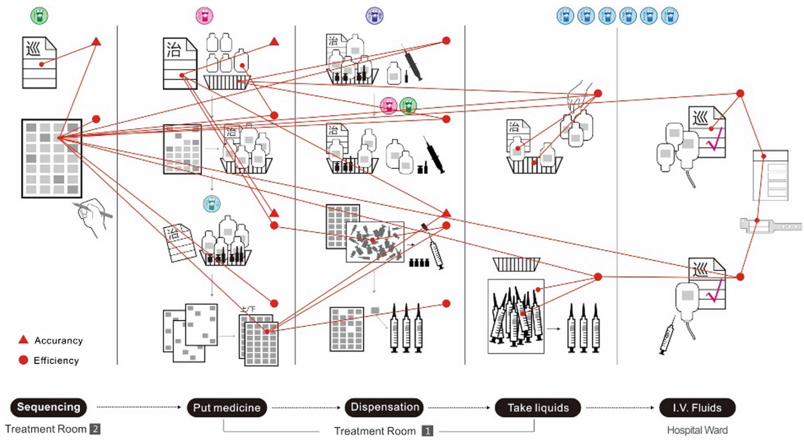

Fig. 8. Analysis of touchpoints and relationship in infusion care process

A case in point is the improvement of medicine baskets design as part of touch point design. The improvement design takes the purpose and behavior of the liquid-taking link (Fig. 9-A) as the design weight (the responsible nurse takes the first three groups of liquid into the ward at one time) and is aligned with the information description and operational behavior (the first three groups of liquid are placed according to the order of that of infusion) in the put-medical link (Fig. 9-B). Therefore, additional partition in the structural design of the medicine basket can be deduced and added (Fig. 9). It is also a example of actively designing and enhancing nurse's behavior and norms in building the interactive relationship between the information contact point and the product contact point.

During the analysis and advancement of infusion care service design research, the design team constantly adjusts and mines different types of data in the practice. With quantitative and qualitative analysis interwoven, data is collated and reorganized ceaselessly. By means of information visualization tools, the design team specifies and visualizes abstract intangible services in practical research, develops an objective understanding about the interactive relationships and weight basis of process, time, places, people, tasks, behaviors, and touch points from different logical dimensions. Based on the understanding of complex motivations, needs and emotions of different stakeholders, final design solution has been put forward in light of design objectives, principles, and weight.

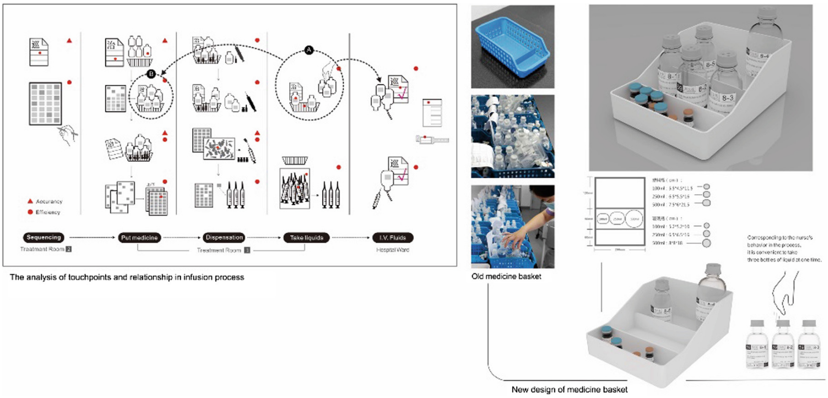

Fig. 9. Context analysis and decision making with the visualization

5 Conclusion

Information visualization is a unique way of presenting information. By mining, analyzing and exploring the laws or connections of various data or information, information visualization transforms these laws and connections into appropriate visual or other perceptible forms. Information visualization serves as a communication and dialogue interface between people and objects, between human and environment, and between individuals themselves. It makes full use of people's natural ability to recognize, understand and remember information. With the help of intuitive visual graphic languages and forms, perceptible materials, sound media, and a variety of interactive means and media, it enables users to observe, analyze, scan, and understand abstract information. Accurate information visualization design can provide users with useful, smooth and efficient guidance on behavior; vivid and creative visual presentation can also show differences in the complicated information-based world, generating physiologically and psychologically aesthetic pleasure. At the same time, visualization is a means of external representation about thinking, a cognitive tool or expression method for abstract concepts and structures. In product and service usability research, it visually describes and interprets objects that is abstract, intangible and non-material, and reflects the usability activities of products or services in a non-textual manner. In this way, it enables us to analyze the effectiveness and adaptability of links between process tasks, functional architectures, system feedback of user behaviors and experiences. Furthermore, it offers users guidance and new insights and plays an analytical and decision-making role in solving complex problems. In addition to providing visual experience, it adds new meaning to define and design new services.

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