



A Study of Smart Desks in the Home by Content Analysis

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1 Introduction

1.1 Background

Currently, the domestic smart lift desk market size grows from 1.538 billion yuan in 2017 to 3.273 billion yuan in 2023 (Zhiyan Consulting ,2024). With the progress of time and technology, intelligent furniture is gradually becoming a new trend in social development, and enhancing the convenience of life has become the core goal of contemporary intelligent furniture. As a necessary product for modern life, smart furniture gradually caters to consumers' demand for personalisation and humanisation. This research is increasingly focusing on the user-centred design concept, which significantly improves the user experience through a high degree of compatibility between smart home products and the user's lifestyle.

Accompanied by the development of Internet technology, the online shopping mode of e-commerce platforms has become the new normal of shopping in China, and more and more users make product purchases through the Internet of Things. After purchasing a smart desk, users usually leave evaluations on the e-commerce platform, which truly reflect the user's demands. With the progress of computer technology, transforming user reviews on e-commerce platforms into valuable information for design has become a new research hotspot. However, some of the current home smart desks are too uniform in shape and the user experience is too complex. This overly homogenised design may not be able to meet the style and individual needs of all families. In addition, overly complex functions may lead to a complicated user experience and increase product costs. Big data contains a wealth of information such as product feedback and user preferences, which have a guiding value for the innovative design of smart desk products. However, how to use artificial intelligence technology to quickly obtain user needs from this information and guide the design of smart desks by modelling and transforming the needs has become a difficult point of research in academia. Therefore, it is especially necessary to study the user demand orientated product design method for home smart desks.

1.2 Purpose of the study

The main objective of this research is to explore and develop new methods and processes for smart desk design that should be based on an in-depth understanding of the diversity of user needs, changes in the social environment, and cultural differences, with the aim of facilitating a symbiotic experience between users and smart desks. This includes understanding and incorporating the user's home style and individual needs, especially in the context of Chinese culture, and how the design can be designed to meet the user's diverse and individual needs while promoting emotional connection and long-term use.

In order to optimise the user experience of smart desks, this research will identify and analyse the sources that influence the complexity of the user experience through qualitative and quantitative research methods, including factors such as personal preferences, work habits and home environments. In addition, this research will explore the impact of changes in the social environment (e.g., shrinking living space, popularity of teleworking) and cultural differences (e.g., aesthetic preferences, work values) on the design needs of smart desks. Based on the design practice of user participation, this research will develop design methods that can promote the symbiosis between users and smart desks, and collect user feedback through user journals, user comments, and the design proposal of Lego. At the same time, this research will conduct functional optimisation studies and implement a series of modular designs, such as foldable expansion panels and built-in storage solutions, to ensure functional diversity without taking up extra space. Finally, the study will conduct multi-environmental testing to ensure that the smart desk is widely applicable in different sizes and types of home spaces.

1.3 Research Problems

The key to designing a smart table that can adapt to multifunctional needs within a limited space lies in adopting a modular design that allows the table to be adjusted and combined according to the needs of different users, thus maximising the use of space

and providing a diverse range of functional options. In order to resolve the conflict between aesthetics and practicality, the design needs to find a balance between the principles of simplicity and utility, and ensure that the table is both aesthetically pleasing and functionally efficient through clever design and material selection. At the same time, a high degree of personalisation is achieved through the introduction of user feedback and meta-design theory, which allows users to participate more actively in the design process, enabling them to customise the function and appearance of the table according to their personal preferences.

1.4 Research Methodology

1.4.1 Rooted theory

Rooted theory is a research methodology that generates theory from data through a systematic approach, rather than starting from existing assumptions. It uses a cyclical process of comparative analysis in which the researcher collects, codes, and analyses data to gradually abstract concepts, form core categories, and ultimately construct a theory with strong explanatory power. The research process emphasises theoretical sampling and theoretical sensitivity and supports theory development through memory recording (Chun Tie, Y., Birks, M. and Francis, K., 2019).

The applicability of rooted theory is particularly evident in the field of user experience design, where research often requires the immediate application of its results rather than the mere development of macro theories. UX design research questions are often complex and rooted in social contexts, which necessitates the use of diverse research methods to gain a comprehensive understanding.

1.4.2 Content Analysis Method Description

Python Data Collection method

The advantages of using Python to collect user review data include automated data crawling for efficiency, flexibility and scalability to support customised data collection,

and open source no-cost features to reduce the financial burden. In addition, Python's powerful data preprocessing and analysis libraries streamline the entire process from collection to analysis, plus an active developer community provides a wealth of support and resources (Mitchell, R., 2018).

1.4.3 Objects of the study

Object: Home smart desk produced by Lego

The Chinese mainland market is dominated by the 'Lege' brand, and the overseas market is dominated by the 'FlexiSpot' brand, which has opened up a sales network both inside and outside China, and both online and offline. As of 2022, 'Flexispot' brand lifting tables ranked first in sales of lifting tables on e-commerce platforms such as Amazon, Home Depot, Walmart, Rakuten, Yahoo, etc.; and 'Lege' brand lifting tables continued to hold the first place in market share on the platforms of Tmall and Jingdong. Continuously maintain the first. (Loctek Ergonomics Technology Co., Ltd. 2022)

1.4.4 Why Taobao

Taobao.com, Jingdong.com, and Amazon were chosen to collect user reviews because these platforms have large and diverse user bases that provide rich, real-time product feedback, allowing the researcher to analyse the user experience of smart desks in depth from a broad market perspective. These e-commerce platforms not only cover a wide range of consumer groups, but also have high activity levels and detailed user reviews, which can provide comprehensive data support for product improvement, helping researchers to grasp consumer trends and assess product market performance. In addition, through cross-platform comparative analyses, it is also possible to explore the differences in users' needs and preferences in different cultural and market contexts.

1.4.5 Content Analysis: Data Analysis and Research

Content analytics can be extremely effective in user experience design research, especially when it comes to analysing and making sense of large amounts of user-generated text data. This approach systematically and objectively evaluates user

comments, feedback, and discussions, revealing users' true needs, preferences, and perceptions of product features. Through quantitative and qualitative in-depth analyses, the content analysis method helps this study capture key user experience details, guiding the functional improvement and innovative design of smart desks to ensure that the final product better meets users' expectations and enhances their work efficiency and comfort.

1.4.6 Category coding and model construction

The research steps of rootedness theory are usually divided into four steps: formulation of the research question, data collection, coding and theory construction. In the ZT approach, coding is the process of comparing concepts, which leads to the formation of more categories and the conceptualisation of data.

2. Literature Review

2.1 History and current status of smart furniture design

The smart home concept was introduced in the 1990s, initially focussing on home automation and remote control for economical and safe operation of appliances through integrated communication systems. (Alam, M.R., Reaz, M.B.I. and Ali, M.A.M., 2012) Moving into the 21st century, projects such as MavHome and GatorTech pushed the intelligence of the smart home to recognise user behaviour and adjust the environment automatically. With the development of the Internet of Things (IoT) and Artificial Intelligence (AI), modern smart furniture not only retains traditional functionality, but also provides a personalised interactive experience through technologies such as voice recognition and image processing. By integrating communication systems, smart furniture incorporates technologies such as combinatorial intelligence, electronic intelligence, mechanical intelligence and IoT intelligence into furniture products to achieve economical, safe and comfortable operation of electrical appliances in the home. Its development has transformed furniture from a static object into an artificially intelligent product with multi-functionality and intelligent linkage, enhancing functionality and adaptability. Currently, smart furniture is developing in two main

directions: combining the functions of electronic devices with traditional furniture, or transforming furniture through multifunctional design. In the future, smart furniture will pay more attention to multifunctionality and humanised design, especially in small homes, to alleviate the problem of lack of space, while enhancing user experience, safety and health. (Zhang, H., Xu, W. and Zhan, X.X., 2020.)

Early smart desk designs achieved functional intelligence through integrated communication systems, such as height adjustment, charging devices and displays, aiming to enhance office efficiency and user experience. With technological advancement, smart desks gradually incorporate humanised and personalised functions, such as smart reminders, health management and voice control, and modular design and multifunctionality have become mainstream to suit different user needs and scenarios. (Qiang, F., Zhen, B. and Xuan, L., 2021) Nowadays, the functional design of smart desks transforms these needs into achievable design solutions through in-depth analyses of users' needs, and ultimately creates smarter and more convenient office furniture.

The design trend of smart desks focuses on modularity and multifunctionality, which can flexibly adjust the height, layout and functional modules of the desktop according to the user's needs in order to adapt to different work scenarios. Meanwhile, health management functions such as sedentary reminder and drinking water reminder have also become design priorities to help users stay healthy at work. (El Murr, R., 2018) Portability and flexibility are also improved, making the desk easier to move and adjust to meet the diverse needs of the modern office environment.

2.2 Theoretical basis of modular design

The concept of modular furniture design pays special attention to its association with the concept of fractals. By incorporating fractal theory, it is shown how repetition, extension and self-similarity can be utilised to develop diverse and variable furniture designs.

Modular furniture design builds furniture through separable and recombinable modules whose colours, materials, shapes and functions can be customised to suit the user's needs and space. The design is flexible and variable to meet individual needs and diverse preferences, and is suitable for mass customised production, while balancing economy and personalisation. (Lee, H.J., 2010) Modular design modularises the functions of the smart home so that these modules can be flexibly adjusted and combined according to the spatial layout of the room. This not only makes full use of the limited space, but also improves the efficiency of space use while maintaining functional integrity. The combination of modules is diversified in such a way that it can be adapted to different spatial constraints as well as adjusted in response to changes in user needs, thus ensuring maximum space utilisation while meeting the user's requirements for functionality. (Zhang, X., 2024) Through modular design, smart homes can be flexibly customised to meet users' individual needs and optimise space utilisation through efficient module combinations.

The modular concept table designed by Francois Dransart aims to organize clutter by providing plenty of storage space for specific items, while hiding cables and wires. The elegant wooden desktop is thoughtfully designed with multiple rectangular slots on the 1side and back edges, providing space for storage boxes to neatly organize everything from cable clutter to notebooks and writing utensils. This design not only enhances the functionality of the desk by keeping the workspace tidy, but also allows for custom layouts. Furthermore, the desk is part of a modular system that enables users to easily rearrange and adjust its components to suit their specific functional needs and personal aesthetic tastes, making it a versatile addition to any workspace.

2.3 The Role of User Experience (UX) in Furniture Design

The importance of user experience in furniture design, especially in enhancing user comfort and productivity. UX is regarded as the core of furniture design, especially in smart furniture design, where emphasis is placed on enhancing the overall user

experience through emotional design.

Instinctive layer design focuses on the shape, material and structure of the furniture to enhance sensory experience and comfort; behavioural layer design emphasises ease of operation to improve efficiency of use by simplifying processes; and reflective layer design establishes a deep emotional connection through personalised service and cultural significance to enhance long-term satisfaction. Smart furniture reduces distractions and enhances work efficiency through functional integration and easy-to-use interfaces such as wireless charging, voice control, and touch panels. (Li, J. and Han, H., 2022)

Key user experience elements in smart table design include ergonomics, interface friendliness and ease of use. Ergonomics ensures that the height, angle and material of the table conforms to the human body's natural posture, enhancing comfort and work efficiency; user-friendliness requires that the design of the digital interface or control panel is simple and intuitive so that users can operate it easily; and ease-of-use is embodied in the simplification of the functional design and operation process to ensure that users can achieve the required operations quickly and meet the individual needs of different users. These elements together determine the overall user experience of the smart desk.

3 Practical Work

3.1 Design Research and Analysis

In this design research, the main goal of the study was to gain an in-depth understanding of users' needs for the functions and appearance of the smart table, especially their pain points and expectations in the usage experience. In order to achieve this goal, the research adopted a rooted theory approach and combined questionnaires and user interviews for data collection and analysis. A questionnaire covering users' basic information, occupational background, current table functionality needs, and appearance preferences was designed in detail and widely distributed through online

channels to ensure coverage of user groups of different age groups and occupational backgrounds. In addition, Python scripts were used to capture user reviews from major e-commerce platforms and social media platforms and identify key issues and needs in the reviews through open coding.

Through the collation and visual analysis of this data, the study identifies that the main functional needs of users for smart tables focus on privacy storage, angle adjustment and increased storage space, with 41.82%, 49.09% and 50% of users focusing on these features, respectively. Meanwhile, most users are dissatisfied with the height and space of the existing table, with more than 76% of respondents saying they are very dissatisfied or dissatisfied. In terms of appearance, users preferred a clean design with a preference for light tones and minimalist lines to make the table look neat and uncluttered.

Combining these findings, the study further exploited the user interview data and review analysis results through axial coding and selective coding to delve deeper into the core needs of users, and adjusted and optimised the design accordingly. The results suggest that the design of smart tables should focus on the diversity and adjustability of functions to meet the actual needs of users, while maintaining a simple and aesthetically pleasing design style to enhance the overall user experience. Through this integrated approach, the study not only ensures the accuracy and practicality of the design, but also improves product satisfaction and market competitiveness through in-depth user involvement

3.2 Generation of design concepts

In the process of generating the design concept for the smart table, this study synthesised user feedback and theoretical guidance to ensure that the design could accurately meet user needs and reflect innovation. Through a detailed questionnaire survey, this study clarified the specific needs of users for the function and appearance of the smart table, especially the high concern for privacy storage, angle adjustment and sufficient storage space. At the same time, users generally expressed dissatisfaction with the height and space of the existing table and preferred a simple, light-coloured

design style. Incorporating this feedback, this study established the core design elements of a smart table, including adjustability, modular storage, and a clean look. In addition, this study referenced theories of ergonomics and user experience design (UXD) to ensure that the table conforms to the body's natural posture when in use, improving comfort, and making the table's functional configurations more flexible through modularisation to adapt to different work scenarios and user needs. In terms of design inspiration, this study draws the qualities of simplicity and stability from the Chinese character '工', and translates them into the modular design concept of the smart table. The horizontal and vertical lines of the Chinese character '工' are abstracted into the basic structure of the table, making the table stable and flexible with modular component combinations, allowing users to freely configure components such as the display stand, keyboard tray, and storage space according to their individual needs. This design not only adapts to diverse work scenarios, but also meets the user's needs for personalised configuration. In the end, by organically combining user feedback with theoretical guidance and incorporating the design inspiration of the character '工', the design concept of the smart table successfully realised the unity of functionality and aesthetics, significantly enhancing the overall value of the product and ensuring high user satisfaction in actual use.

3.3 Details of the design process

The design and fabrication process of a smart table is a systematic process from conceptualisation to the development of a finished product. This research first produced preliminary sketches based on user feedback and design inspiration, which demonstrated the overall structure of the smart table, the layout of the modular components, and the possible functional configurations to ensure that key requirements such as privacy storage, angle adjustment, and other functionalities were adequately considered at the early stages of the design. After finalising the sketches, this research started to produce preliminary physical models, which were made using cardboard or lightweight materials, to help this research assess the stability of the table, the

compatibility of the modules, and the rationality of the overall layout. Meanwhile, in the process of modeling, this research also tested different materials, and chose those that were both aesthetically pleasing and practical in order to satisfy the structural strength and sustainability needs of the product. Next, this study produced functional prototypes, which at this stage had the core functions of a smart table, such as adjustable height, modular storage and privacy protection, and conducted functional tests covering the stability of the table, the precision of the adjustment function, the ease of installation and removal of the modular components, as well as the product's durability and adaptability in different usage scenarios. Subsequently, this study invited users to participate in the trial session of the product, and through collecting feedback from users' experience in the actual working environment, design adjustments and optimisations were made, such as re-designing and functional improvements for the problem of a module not being stable enough or a function not being intuitive enough. During the design process, this study also encountered challenges such as space constraints and functional complexity, which were solved through modular design so that the table could be adjusted according to different spatial needs, and through intuitive user interfaces and simple control mechanisms so that users could easily operate complex functional modules, ultimately ensuring that the smart table could meet the diversified needs of the users while maintaining operational simplicity and aesthetic design. Through this systematic design and production process, the design of the smart table gradually evolves from a preliminary concept to a fully functional finished product, fully reflecting the flexibility of modular design and the user-centred design concept.

3.4 Selection of materials and technology

In the design process of the smart table, material selection is the key link to ensure the functionality, aesthetics and durability of the product. Based on the performance, sustainability, processing ease and aesthetic effect of the materials, wood, plastic and iron materials were selected and tested and analysed in detail. Wood was chosen as the main material for the tabletop due to its natural aesthetics, structural stability and easy

processing characteristics, especially its resistance to deformation and corrosion, which ensures a long life for the table. Plastics, on the other hand, were used for lightweight modular components, such as corner protectors and removable storage boxes, due to their lightweight, low-cost and easy-to-mould properties, while iron, due to its high strength and structural stability, was used for the table's support structures, such as the legs and the frame, to ensure overall stability and load-bearing capacity. Detailed tests were carried out on beech, pine and birch to determine the most suitable wood. The results showed that beech wood, with its hard texture, good elasticity and excellent resistance to bending, is the ideal material for high-quality furniture and was chosen as the main material for the smart table because of its durability and aesthetics, despite being difficult and costly to process; pine wood is suitable for non-load-bearing parts due to its lightness, ease of processing and low cost, but not for structural parts due to its softness and lack of durability; and birch wood is suitable for its flexibility. Birch, with its flexibility, robustness and smooth surface, was chosen for parts requiring fine finishing, but with the risk of warping in environments with high humidity. In the end, beech was chosen as the main material, with pine and birch as secondary materials, a strategy that not only ensured the structural strength and durability of the smart table, but also took into account the aesthetics and sustainability, enhancing the overall user experience.

3.5 Modelling and Rendering

In the design process of the smart table, the modelling and rendering demonstrates the overall effect of the final design and conveys the functional and aesthetic significance of each design element through intuitive visual representation. The final design model not only shows the overall structure and modular layout of the smart table, but also describes in detail the functional use of each component. For example, the adjustable module of the desktop allows users to adjust the height and angle according to their needs, optimising their working posture and enhancing their comfort; the privacy storage module provides users with a secure storage space and meets the need for privacy protection. In addition, the overall design of the table features clean lines and

natural wood textures, which not only meets the user's requirements for aesthetics, but also creates a clean, modern visual experience.

During the modelling process, cardboard and other lightweight materials were used for initial modelling to test the structural stability of the smart table and the interworking of the modular components. However, the cardboard model could not accurately demonstrate some complex details, such as the connection mechanism of the modules and the operation of the hidden components. Therefore, this study used 3D printing technology to produce fine models, through which this study was able to accurately reproduce every detail of the smart table and verify the actual functionality of each module. For example, the 3D printed model enabled this research to test the installation and removal process of the modular components to ensure smooth operation, as well as to assess the compatibility and durability between the individual parts.

Through modelling and rendering, the work not only successfully conveyed the overall design concept of the smart table, but also continuously optimised the design through practical testing. 3D printing technology played an important role in this process, addressing the limitations of the initial cardboard model in terms of displaying the details, enabling this research to better understand and improve the functionality and structure of the smart table. In the end, the design of the smart table found a balance between functionality and aesthetics, and through accurate modelling and meticulous testing, ensured the product's efficiency in actual use and superior user experience.

4 Discussion

4.1 Design Challenges and Solutions

During the design process of the smart table, this research faced challenges such as space constraints and the diversity of user needs, which required the integration of multiple functions within a limited space while meeting the individual needs of different users. To solve these problems, this research adopts a modular design so that the parts of the table can be flexibly combined and the desktop extension components can be folded and stored to maximise the use of space. In addition, this research enhances the adaptability of the product by providing a variety of optional functional

modules that allow users to customise the table according to their individual needs. A key challenge in modular design is to ensure the interchangeability and stability of the components. Through repeated testing and optimisation, this research has improved the way the components are connected, enhancing their durability and stability in use. To address these challenges, this study also introduced hidden storage and folding features to further reduce space occupation while simplifying the operation of complex functions. In the end, this research successfully overcame these challenges through innovative design and continuous optimisation to create a powerful, flexible and adaptable smart table that is aesthetically pleasing and practical, meeting the diverse needs of users.

4.2 User Feedback Analysis

Users expressed a high level of concern about the functionality of the smart table, especially strong demand for modular storage, desktop height adjustability and privacy protection features. However, some users also gave feedback on some problems in use, such as the complexity of operation of certain modules, the lack of convenience in desktop adjustment and the optimisation of storage space that still needs to be improved. In terms of comfort, users generally hope that the desk can be flexibly adjusted in height and angle according to different work scenarios, so as to improve the comfort when using it for a long time. At the same time, some users mentioned that the design of desktop materials and edge treatments have a direct impact on the comfort of long-time use, so they would like to see more ergonomic design improvements.

In terms of aesthetics, users mostly approved of the table's minimalist design, especially the use of light colours and natural wood grains was widely praised. However, some users suggested adding more personalisation options to the design, such as different colour choices or material customisation, to meet more diverse aesthetic needs. Based on these user feedbacks, this study adapted and optimised the smart table. Firstly, in terms of functionality, this study simplified the operation process of the module and optimised the adjustment mechanism of the table height and angle to make it more convenient and intuitive. At the same time, the design of the storage space was

expanded to make it more in line with the user's actual usage needs, and the flexibility of the privacy storage module was increased to ensure that the user's privacy protection was further enhanced. In terms of comfort, this study improves the choice of desktop material by adopting a softer and more durable edge treatment material to enhance user comfort during prolonged use. In addition, by optimising the ergonomic design, the table now better supports the user's natural posture and reduces fatigue. Finally, in terms of aesthetics, this study has increased the personalisation options for the table, with users now able to choose from different colours and materials to better match their personal preferences and interior décor. With these adjustments and optimisations, the design of the smart table is more closely aligned with the actual needs of the user, while also enhancing the overall user experience.

4.3 Utility of Modular Design

Modular design demonstrates significant functionality enhancement and user experience optimisation in smart desks, allowing users to freely select and combine different components, such as storage units, display holders, keyboard trays and privacy dividers, in order to adjust the desktop layout according to their work habits and task requirements for optimal configuration. The easy upgradability and maintenance features of the modular design extend the product's lifespan, allowing the desk to be updated as technology advances and user needs change, keeping it modern and practical. In addition, the modular design enhances the adaptability of the desk to meet user needs in multiple scenarios, such as a home office, a traditional office or a shared office space. User feedback indicates that this design greatly improves productivity and comfort, especially in situations of long hours and teamwork, where users can adjust the desk height and module layout to reduce fatigue or free up more space. In terms of personalised experience, the modular design gives users a high degree of autonomy and control, enabling them to customise the desk to suit their personal preferences and work needs, significantly increasing user satisfaction. The current study group particularly appreciated this adjustability and variety of module combinations, while home users valued its flexibility and storage capabilities in a compact space, allowing them to stay

organised at home as well.

5 Conclusion

This study provides insights into the design process of smart tables and their enhancement in terms of functionality, adaptability and user experience through systematic design and user feedback analysis. During the research process, this study combines modular design and meta-design theory, focusing on how to achieve the personalisation and practicality of the product through flexible configuration and user participation. Through questionnaire surveys and practical tests, the study found that modular design significantly improves the versatility and adaptability of smart tables, enabling them to meet the diverse needs of different users. The application of meta-design theory, on the other hand, emphasises the active participation of users in the design process, which enhances product personalisation and user satisfaction.

In the field of smart table design, the main contribution of this paper is to achieve product versatility and personalisation through modular design. Modular design not only enables the table to be flexibly adjusted in different work scenarios, but also allows users to add, remove and configure components according to their personal needs, thus extending the product's service life and enhancing user experience. In addition, this study has made a breakthrough in sustainable design, minimising the waste of resources through the rational use of materials and the re-optimisation of functions. The introduction of meta-design theory further emphasises the importance of the user in the design process, enabling the product to evolve with the changing needs of the user and maintain its modernity and practicality.

Future research directions could focus on further optimising modular design to enhance its adaptability and ease of use in different scenarios. For example, new materials that are lighter and more durable can be explored to improve the overall performance of the table. In addition, the user experience can be further enhanced by developing more intelligent modules so that the table can automatically adapt to the user's habits. At the same time, increasing user participation in the design process is also an important direction for future research, through a more interactive design platform, so that users

can participate in real-time in the design and improvement of the product, to ensure that the product is always close to the user's needs and in line with market trends. Overall, the design of smart tables still has great potential for development, and this study provides strong theoretical support and practical guidance for future design and improvement.

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