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Original Paper

Research on the Application of Information Visualization Design Based on the Three-level Theory of Emotions

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Abstract

As society progresses, environmental challenges have emerged as a central concern in modern discourse. The degradation of ecosystems has led to the endangerment and extinction of numerous plant species. Moreover, the overwhelming influx of information available to individuals often hampers their understanding of the significance of these endangered species. Conventional written narratives are frequently inadequate in fulfilling the audience's informational needs. As a nascent medium for scientific communication, information visualization presents an innovative and effective approach for individuals to swiftly acquire and interpret data. This paper concentrates on the endangered aquatic flora within the South China Botanical Garden, grounded in a three-tiered emotional theory framework. Strategies are developed across instinctual, behavioral, and reflective dimensions. The outlined strategic goals aim to elevate design aesthetic literacy, broaden cognitive processing capability, and enhance the efficiency of information dissemination. By employing endangered aquatic plants as a focal point for design initiatives in the South China Botanical Garden and integrating it with the theoretical framework, the objective is to present information regarding these vulnerable species in a more direct, inventive, and concise manner. This methodology aspires to raise public awareness surrounding the conservation of endangered plant life.

Keywords

endangered aquatic plants, information visualization, scientific communication, emotional theory

1. Introduction

As society and technology evolve, environmental challenges are progressively surfacing. Biodiversity is fundamental to human existence and advancement, acting as the lifeblood and foundation of Earth's

ecological network. A report titled "Focusing on Biodiversity," released by the American non-profit organization NatureServe on February 6, 2023, reveals that globally, 34% of plant species and 40% of animal species are facing extinction threats. This assessment is based on half a century of data compiled by the organization, highlighting that the extinction rate of plant species may exceed the rate of their discovery, classification, and research. The "Opinions on Further Strengthening Biodiversity Conservation", published by the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council in 2021, stresses the importance of enhancing the conservation framework for biodiversity through translocation efforts and increasing public engagement and education, along with promoting relevant laws, regulations, and scientific information about biodiversity conservation in China. Within this framework, botanical gardens hold significant importance, dedicating their efforts to scientific research, plant introduction, domestication, and educational outreach, thereby playing a vital role in the spread of botanical knowledge.

2. Overview of Information Visualization

Information visualization represents a pivotal advancement in the realms of computer-aided design, graphics, and related fields. The concept was initially articulated by Mackinlay and Robertson Card in 1989, and in collaboration with Stuart K. Card and others, it was characterized as a graphical approach for representing abstract data. The methodologies and styles of graphical presentations utilized in information visualization are varied and encompass a multitude of domains, including finance, statistics, and business, promoting interdisciplinary collaboration. As the economy and society continue to evolve rapidly, individuals are confronted with an overwhelming influx of information in their daily lives, necessitating enhanced quality in the dissemination and reception of data. Information visualization fortifies the communication of information by employing a dynamic amalgamation of graphics, text, and color, facilitating an enriched user experience and adeptly catering to the needs of information consumers.

3. The Theory of Emotion's Three Levels and Its Design Model

3.1 Overview of the Theory of Emotion's Three Levels

Donald A. Norman's "Theory of Emotion's Three Levels" comprises three distinct yet intricately linked levels: the visceral level, the behavioral level, and the reflective level. The visceral level concerns the innate, automatic, and instinctual traits of human emotions, which largely operate outside of individual volition. Conversely, the behavioral level addresses the manageable facets of human conduct, specifically the goal-driven strategies crafted by individuals in response to particular environments or situations, allowing them to attain desired results in the most efficient manner or with minimal effort.

3.2 A Model for Information Visualization Design Grounded in the Three-tiered Theory of Emotions

The instinctual layer, behavioral layer, and reflective layer operate independently within the multifaceted emotional system, each influencing and correlating with the others to forge a holistic emotional experience. In the design phase, it is crucial to amalgamate these three layers, leveraging their insights to formulate a design framework. The process commences at the instinctual layer, where one discerns objective entities and classifies feedback grounded in visual instincts. Subsequently, attention shifts to the behavioral layer, whereby logical analysis of information guides strategic advancements aimed at achieving the desired outputs of the behavioral framework efficiently. Ultimately, the reflective layer is invoked, employing insights from the memory system for introspection and evaluative integration of the design methodology (as illustrated in Figure 1).

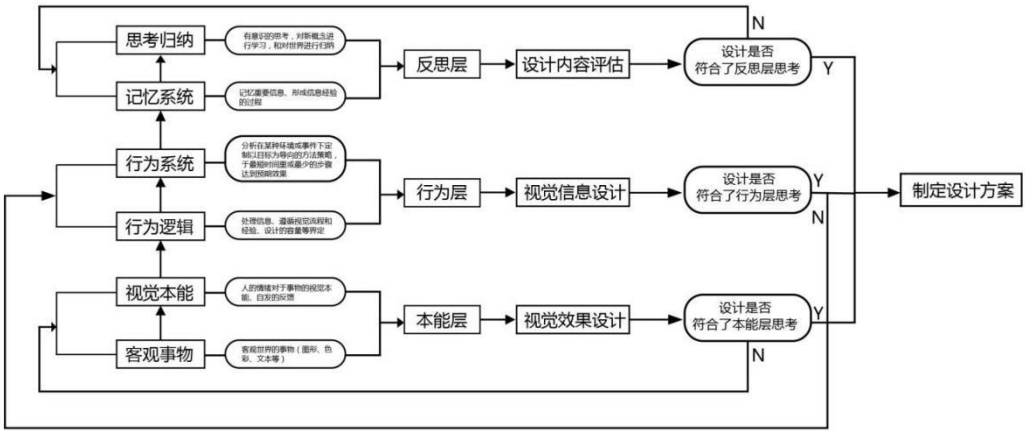

Figure 1. Framework for Information Visualization Design Grounded in the Tripartite Emotion Theory

3.3 The Ramifications of the Three Levels of Emotion Theory for the Information Visualization Design Concerning Endangered Flora at the South China Botanical Garden Warrant Reevaluation

I reexamine the scientific communication design related to endangered plants within the park through the prism of the three emotional levels, with particular emphasis on the challenges surrounding the dissemination of information about endangered aquatic species. By leveraging instinctual cognition, I aim to elevate aesthetic design outcomes, thereby compelling the audience to engage with and retain information through visual allure, which consequently ignites their intrinsic curiosity regarding scientific discourse. From a behavioral standpoint, I can enhance the information's cognitive effectiveness by systematically structuring it in layers, enabling the visual material to permeate the audience's awareness in alignment with the hierarchies determined by the designer, thus optimizing the reception of information. Ultimately, by utilizing reflective thought and integration, I can adjust through multiple assessments to improve the efficacy of information exchange.

4. Strategies for Designing Information Visualizations for Endangered Aquatic Flora at the South China Botanical Garden Utilizing the Three-Tiered Emotion Theory

4.1 Improving Design Aesthetic Comprehension by Leveraging Instinctual Strata

The fundamental structure of the instinct level within the three-tier theory of emotions emphasizes the intrinsic nature of visual stimuli—elements that can be directly perceived through sight, touch, or emotional response, complemented by the rationale that resonates with the audience. In the midst of myriad information flows, our cognitive processes instinctively eliminate monotonous expressions. Information visualization incorporates visual components such as graphics, colors, and textual elements, transforming written content into engaging visual representations. This does not necessitate an adherence to minimalist aesthetics; instead, it accentuates the vital connections between visual components, ensuring each element conveys a functional semantic meaning, thereby facilitating audience interpretation without obstruction.

Color utilization holds paramount importance in information visualization. Human sensitivity to color necessitates the formulation of a cohesive color palette that resonates with audience psychology, ultimately minimizing cognitive strain. For example, red typically signifies alerts, blue evokes associations with water, and green reflects ecological themes. When crafting visually dynamic information graphics, it is essential for designers to maintain harmonious color synergy, avoiding jarring color shifts in animations to mitigate visual fatigue.

In terms of typography, text arrangement must incorporate hierarchical scaling, where various text types, data points, and additional explanatory content are organized by levels. This typographic strategy guarantees that both the overarching visual composition and the informational substance remain distinguishable, effectively highlighting critical elements and steering the viewer's focus.

4.2 Optimize the Encoding of Cognitive Information through the Analysis of Behavioral Strata

Behavioral design, commonly known as usability, emphasizes the functionality and practicality inherent in design. It investigates the ways users partake in communication tasks, assessing both the effectiveness and efficiency with which they accomplish their goals, while also considering the degree of unnecessary steps involved in the execution of these tasks.

4.2.1 The efficacy of data collection methodologies

In light of the recent restructuring and filtration of data concerning endangered aquatic flora, my objective is to augment the cognitive framework pertaining to these species within the South China Botanical Garden. Through a comprehensive analysis of ecological classifications, I have delineated the aquatic plants into distinct categories: wetland plants, emergent plants, floating-leaved plants, and submerged plants. Additionally, I plan to systematically collect, organize, filter, stratify, and reconstruct this information for enhanced clarity and accessibility.

4.2.2 Hierarchical organization of information

In accordance with the emotional stratification theory, humans initially engage in an unconscious hierarchical processing of information within their cognitive frameworks. Consequently, it is imperative to establish a visual hierarchy for the content that pertains to endangered aquatic plant species in the South China Botanical Garden, categorizing relevant information into three distinct tiers. Since the audience typically comprehends information predominantly at the genus level with limited insight into specific species traits, this critical subject for plant science communication is classified as primary information at level one. Level two information extends this foundational knowledge by encompassing common traits shared across species, including similar endangerment causes, significant ecological roles, geographical distributions, and growth requirements. Finally, level three information focuses primarily on the life habits of these species, providing intricate details such as species nomenclature, specific growth needs, and distribution patterns. While this level three information might not immediately captivate the audience's attention, it nonetheless contributes to the broader understanding of plant knowledge, thus justifying its classification within this tier.

4.2.3 Improving the efficacy of information transfer via reflective strata

The reflective component predominantly draws from the instinctual and behavioral levels, emphasizing the reasoning that underpins design, thus epitomizing the pinnacle of emotional design. Engaging in reflective thought allows for the analysis of environmental stimuli, which in turn impacts the behavioral level, ultimately improving the efficacy of information exchange as viewed through the lens of reflection.

Many individuals erroneously assume that incorporating numerous diverse data points into a single chart bolsters credibility. However, a design that is cluttered with excessive information or devoid of a clear storyline can perplex the audience, prompting them to abandon the effort to comprehend the content. Research shows that most viewers allocate only 5-10 seconds to a visual, underscoring the necessity for effective infographics that convey critical information swiftly. Consequently, infographics regarding endangered plant species should streamline intricate scientific concepts and employ more accessible graphic language to relay vital information to readers within five seconds.

5. Designing Conservation Strategies for Endangered Aquatic Flora in the South China Botanical Garden Utilizing the Three-Tiered Emotion Theory

5.1 The Present Level of Public Consciousness Concerning Threatened Aquatic Flora within the South China Botanical Garden

The evaluation of the conservation status of wetland flora in Guangdong reveals that there are presently 30 species of endangered aquatic plants requiring urgent preservation efforts, with 12 species currently safeguarded at the South China Botanical Garden. Within this botanical institution, the data pertaining

to endangered aquatic flora is predominantly textual, resulting in inefficiencies in the conveyance and reception of information. Moreover, there exists a notable uniformity in the visual graphical representation, with the exhibits largely composed of photographs, which can be perceived as somewhat tedious. This ultimately detracts from viewer engagement, consequently hindering the efficacy of information transfer in scientific education.

Prior to executing information visualization design, it is essential for designers to define their target audience and the intent behind the design, ensuring that the final information presented aligns with audience requirements. Research findings (refer to Figure 2), alongside the systematic organization and analysis of survey data, demonstrate that the current status of popular science within the park correlates directly with public awareness levels. Numerous shortcomings in the realm of popular science contribute to a diminished public interest in endangered aquatic plant species and result in ambiguous conceptual comprehension. This scenario underscores the critical need for implementing information visualization strategies in relation to endangered aquatic plants.

华南植物园观光人群调研（437人）					
年龄段	0-6岁	7-18岁	19-30岁	30-50岁	50岁以上
人数	12人	31人	276人	77人	41人
比例	2.70%	7%%	63%	18%	9.70%

Figure 2. The Findings of the Audience Age Survey conducted at the South China Botanical Garden from February 10 to February 14, 2023

A survey revealed that the 19 to 30 age group represents the highest visitation rate at the South China Botanical Garden, primarily consisting of young adults. This demographic is distinguished by their stable yet ambitious mindset, showing a preference for novelty and fashion-driven trends, while favoring convenient and digital modes of social interaction. Additionally, an examination of the present informational content concerning endangered aquatic plants at the South China Botanical Garden is set to identify existing challenges. This will be accomplished through effective communication and collaboration with internal stakeholders to establish a comprehensive information framework. The survey findings indicated that the youth exhibit a stronger inclination towards a presentation style that fuses dynamic and static elements in a three-dimensional format.

5.2 Comprehensive Visual Presentation of Data on Threatened Aquatic Plant Species Sourced from the South China Botanical Garden

5.2.1 Visual transformation of information regarding endangered aquatic plants at the South China Botanical Garden

The content of information visualization in science communication needs to maintain a strong resemblance to the original plant images. Only by accurately representing their complex structural

characteristics can we ensure the truthfulness and precision of the science communication content. Therefore, the morphological features and overall appearance of the species in this design serve as the primary tier of information content, with a realistic style being the optimal form of expression. Building on this accurate representation and incorporating contemporary popular styles rooted in instinct, I can enhance visual appeal.

In today's fast-paced society, the communicative function of images surpasses that of text. People tend to process simple image information more quickly than written content. To improve the audience's reception of information, I have summarized and transformed the tertiary information content into straightforward and understandable graphics, accompanied by simple text to bolster information conveyance and retention. This design approach effectively addresses the issue of excessive and monotonous text, making it applicable across all botanical science communication efforts.

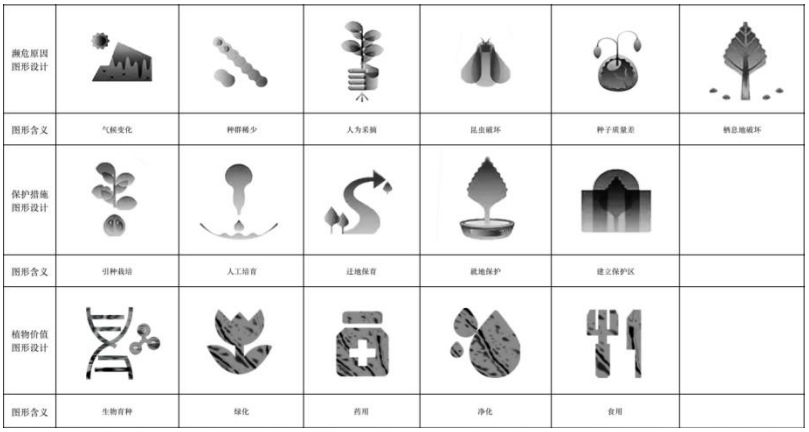

Figure 3. Visual Transformation of Tertiary Information Content

Although static infographics can convey a substantial amount of information, they are relatively less engaging and fail to achieve an effective promotional impact at an instinctual level. Therefore, it is essential to capture the audience's instinctive attention through innovative presentation methods. Building on the foundation of static graphics, I have considered the concept of instinctual engagement to design dynamic representations of complete plant morphology, thereby better communicating their growth conditions. Through evaluative testing, it has been determined that dynamic visuals maintaining a duration of 5 to 10 seconds provide the optimal visual experience. Additionally, during the assessment, the majority of the audience expressed a strong ability to quickly comprehend the conveyed information, while also demonstrating a high degree of acceptance regarding the stylistic effectiveness of the overall design.

5.2.2 Design of a Visual Framework for Endangered Aquatic Plant Information at the South China Botanical Garden

Using a hierarchical structure as the foundational framework for the chart, I organized the information based on the aforementioned details. From a science popularization perspective, I positioned the primary appearance information as the focal point of the chart, while arranging the remaining information hierarchically from left to right to build a coherent framework. This arrangement allows for flexibility in the information, creating a progressive relationship that facilitates comfortable reading and enhances memorability for the audience. The framework is succinct, versatile, and can serve as a model and extension case for other endangered plant species.

5.2.3 Design and Development of Dynamic Information Graphics and Derivative Products for Endangered Aquatic Plants at the South China Botanical Garden

The organization and integration of information and graphical elements regarding endangered aquatic species at the South China Botanical Garden will employ a more contemporary design language to achieve the chart design. In terms of information hierarchy, the primary focus will be on the most visually relevant aspects that resonate with the audience, serving as the main visual cue to create the most immediate point of memory. Furthermore, the arrangement will follow conventional human visual habits, progressing from left to right and top to bottom, descending in information hierarchy. Finally, font sizes will be adjusted based on the levels of information importance. The culmination of these design elements will construct 12 dynamic visualization charts for endangered aquatic plants at the South China Botanical Garden (as illustrated in Figures 3-4).

Figures 3-4. Design of Dynamic Information Charts for Endangered Aquatic Plant Species

6. Conclusion

With the development of digital media and the internet industry, disciplines such as art and technology are intertwining. Through the arrangement of visual elements in various charts—composition, narrative

techniques, and so forth—a story can be conveyed to the audience. An analysis of the aforementioned research reveals that the primary focus of plant science popularization visualization design is the efficient transmission of effective information. Therefore, it is essential to thoroughly understand the audience's needs and preferences, as well as to skillfully graph information under the popularization theme, to attract viewers and facilitate rapid communication of information. Furthermore, there is currently a relative scarcity of research on information visualization design pertaining to endangered species in the country, indicating significant research potential and value in this field. The study and application of information visualization for endangered aquatic plants at the South China Botanical Garden can not only broaden the scope of science popularization but also provide a new mode of communication and presentation for various endangered species. In an era where information inundates human life, I hope that the design approach I propose in this article will contribute to information visualization serving humanity and provide modest support for the popularization of knowledge regarding endangered plants.

References

Gong, Y. (2016). Study on the Communication of Dynamic Graphic Information in Art and Design. *Packaging Engineering*, *37*(18), 211-214.

Kang, J., & Li, X. (2015). Research and Application of Dynamic Visual Information Graphics Design in Sports Data. *Design*, (19), 27-30.

Li, M. F., & Li, X. (2021). An Exploration of Information Graphics Design for Aromatic Plants in "Chu Ci". *Packaging and Design*, (02), 104-105.

Li, S. D. (2021). *Introduction to Information Visualization*. Tsinghua University Press.

Liu, Z. X. (2016). Research on Information Visualization Design Methods Based on Needs. *Packaging Engineering*, *37*(16), 1-5.

Nathan, Y. (2014). *Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics*. Renmin University of China Press.

Wang, R. J. (2021). *Red List of Higher Plants in Guangdong*. Henan Science and Technology Press.