Doctoral Dissertation Abstract

An Interaction-Based Design Approach for Architecture as A Complex Adaptive System

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Research Content

Creativity is a vital issue in design studies, a great number of literatures approach to design creativity from the perspectives of cognitive and social. Additionally, many creative methods and tools for design thinking are considered and built. These methods and tools for enhancing design creativity are related with two kinds of aspects, one is the process of design and the other is the outcome of design. However, their methods for creative architecture design were mainly belong to reductionist thinking, the complex nature of architecture in the 21st century is ignored.

Research Purpose

In this dissertation, we first review the simplicity and complexity of architecture. On this background, we acknowledge architecture as a complex adaptive system (CAS) and present a new design thinking approach ‘Concept Topology Optimization’ (CTO) for creative architecture design. Then we conducted three case studies by utilizing ‘Concept Topology Optimization’ to explore new methods in architecture location design, architecture space design and architecture construction safety design.

As case studies, three proactive methods are presented. The first case discusses a Soil & Water Assessment Tool (SWAT) model-based expo architectural location design, the second case explores a new method for architecture space design based on Substance-field and the third case focus on design of building construction safety prediction model based on optimized BP neural network algorithm. The results of these case studies indicate that ‘Concept Topology Optimization’ is an effective design thinking approach in architecture design as a complex adaptive system.

After that, we further discuss the changes of knowledge creation by combining ‘Concept Topology Optimization’, ‘creativity’ concerns the process of creating and applying new ‘knowledge’, intrinsically, ‘creativity’ is at the very heart of ‘knowledge creation’. However, our ‘creativity’ is ‘blocked’ in a variety of ways, including deep-seated beliefs about the acquired knowledge. Hence, we argue to accept unpredictability, respect (and utilize) autonomy and creativity, and respond flexibly to emerging knowledge and opportunities.

Research Accomplishment

Papers published in journals (Indexed in SCI & Scopus)

   This journal paper is the main content of Chapter 5 in my doctoral thesis.

   This journal paper is the main content of Chapter 6 in my doctoral thesis.
This journal paper utilizes the design approach presented in my doctoral thesis.

This journal paper utilizes the design approach presented in my doctoral thesis.

**International Conference Proceedings**

This conference paper is the main content of Chapter 4 in my doctoral thesis.

This conference paper utilizes the design approach presented in my doctoral thesis.

This conference paper is the constituent content of Chapter 6 in my doctoral thesis.

This conference paper utilizes the design method presented in Chapter 4 of my doctoral thesis.

**Domestic Conference Proceedings**

This conference paper introduces Chapter 1-3 in my doctoral thesis.
Abstract of Dissertation

A Topological Variation-Oriented Approach for Enhancing Creativity in Education of Product Design

Doctor of Science (Knowledge Science)

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1. Research Content

1.1 Background

The success of a product is dependent on creating unique and superior product characteristics, as perceived by customers. Product design is a key driver of competitive advantage and new product success. Considered broadly, product design encompasses a range of engineering-related attributes including ergonomics, production efficiency, as well as recyclability, distribution ease, and aesthetics. However, recent work has noted the particular relevance of product form on product performance. Product form referred to as product aesthetics or visual product appearance can help products stand out in cluttered markets by capturing consumers’ attention and creating positive emotional reactions. Further, product form can generate desirable inferences regarding product attributes and thus have a positive effect on perceptions of product quality.

The discussions on product innovation and design thinking about existing methods are not uniform in scope or perspective. The method attempts to solve the problem to develop innovations based on consumer demands and comments in the fields of products, services, or other relevant tangible or intangible matters. Design Thinking bridges the gap between a designer’s analytic approaches to solving problems. Its focus is consumer orientation and concrete problems of daily life and the improvement of particular shortcomings in products, services, or processes by innovative thinking.

In this context of intelligent age, intelligent control has been applied in many kinds of products, and the form of products has changed dramatically. Energy, materials, and control are the core technologies of products at present. With their continuous innovation, the original logical structure of many products has been deconstructed and new logical relationships have been created. The bondage of manufacturing products is getting smaller and smaller, and the gap between creativity and manufacturing is
gradually disappearing. Nowadays, with the bursting of new science and technology and the unprecedented degree of product innovation, new innovative thinking emerges in endlessly. By observing the innovation process of existing products, this study summarizes a set of product innovation thinking and methods from its form transformation.

1.2 Objective and scope of the Ph.D. project

The overall aim of this dissertation work can be summarized as: the method of idea generation based on the topological variation-oriented approach for enhancing creativity (TVC) is an effective tool for product design education. The topological properties variations in this study come from topological perception theory, that is, a human vision first perceives topological properties, and graphs with topological differences are first perceived. The study divides two main experiments, the first experiment is to test that people can give priority to products with topological properties variations in shape. With this problem, we began to study human visual cognition and found that the visual cognitive activities advocated by topological visual cognition started from a wide range, and then to local features, which provided a favorable theoretical basis for finding the causes of the starting point problem. Typical morphological topological variations are selected from existing products. Through the first experiment, it is proved that the topological properties variations in product form can attract the attention of people. In the process of showing the existing product innovation ideas with a visualized sheet which operating topological properties variations. And when the visualized sheet is applied to the products without topological properties variations in their shapes, they also happened to the variations on their visualized sheets. Therefore, a hypothesis is proposed: the visualized sheet can significantly improve the design capabilities of students in product design. In the second experiment, not only test the hypothesis but also verified the sheet as a method of product design has certain advantages in some aspects compared with other design methods and can be applied to product design education.

The objective of this study is to build a method based on the topological properties variations of visual perception. This is the start of affective, cognitive processing. Therefore, TPV is a universal method of product innovation for designers and has universality for users. For designers, this model is easier to master and apply to design. On the other hand, it is not limited by the personal experience of users, cultural background, and other factors, and can intuitively perceive product innovation.

1.3 Experiment Result of the Research
In the first group of experiments, the creativity of participants improved significantly from the overall situation. In the second group of experiments, TVC has some significant advantages over other design methods. From the beginning of this experiment, that is, when TVC was taught to students, students initially showed a more acceptable attitude, which mainly benefited from two points. Firstly, by taking several creative products that already exist in our lives as examples, this study analyses the reasons for their successful creativity sums up the commonalities of these successes and then makes assumptions about these commonalities. In fact, these product cases have been deeply rooted in the hearts of students, and students often think about the reasons why they make success. when they find that these reasons seem to have similarities to their own reasons for this success, they have a strong curiosity about the seemingly unrelated ideas are based on the topological variant. Once the creative model of the topological variant is mastered well, students think that more high-quality ideas will be created. Because of the topological variation made on the visual sheet, the product presented a qualitative change, a new function or a new experience.

2. Research Purpose

academic level of your research, originality, novelty, and possibilities

In the product improvement design, the design of new product form relies more on experience, that is, the design of the new form and existing products are compared, through the experience of designers to judge the degree of innovation of form. For a novel product, people always unconsciously notice it. Notice that this activity is very short-lived, but it is significant because it is likely to become an important factor in consumers' decision to buy what kind of goods. Starting from the goal of human attention to product form innovation, the author tries to infer the root cause of this phenomenon. TVC has a relatively effective prescription. The innovative ideas generated by three kinds of topological variations can enable students to generate creative ideas quickly, and the ability to generate creative ideas has been greatly improved even for those students with weak design ability.

The originality of this study is to link human cognitive activities, thinking patterns and mathematics. Human cognitive activities and thinking patterns have certain mathematical properties and can be studied from a mathematical point of view. TVC is based on topological invariances and variations. It is suggested that human cognitive activities and thinking patterns are related to changes in topology. This shows that we have found the basis of topology in our experience, and TVC has a greater degree of universality.
TVC is not only a method of product design, but also a way to reveal the process of the creative idea generation, and it has contributed to the knowledge science. Creativity is the process of product innovation design and seems to be very casual. Designers are often referred to as inspiration. Many designers pay special attention to the generation of inspiration. Design is a creative activity, which emphasizes system characteristics and commerciality. New products should be planned and strategically put into the market for consumers to choose and buy. The creative methods provided by TVC are not significant in guidance and enlightenment but have strong execution. As long as three kinds of topological variations are selectively operated on TVC, it is possible to obtain new ideas. In the previous experiments, it can be seen that the quality of personal design has been greatly improved by ordinary students who have passed the operational design ability of TVC without notifying the purpose of the experiment. Therefore, the contribution of TVC is mainly to provide a relatively high level of innovative thinking that can be sustained.

In the perspective of topological variations, the creative ideas generated by TVC come from three topological perceptual properties: connectivity, caves, internal/external. It visualizes the process of creativity generation and makes the process of creativity generation very clear. There is a correlation between people’s innovative thinking and topological variations. This discovery will continue to be validated in future research until it becomes recognized and correct knowledge.

3. Research Accomplishment

International Journal Papers
5. FEI Fei, Yukari Nagai, Impact of Visual Topological Features on Priority Attention for Product Shapes, JAIST World Conference, 2018 (JWC), poster presentation, February 27, 2018, JAIST.
Part 1: Research Content

Research Background

Archives are unpublished original documents relating to past important historical, cultural, and administrative evidence that have particular message to future generation. As a primary source of documents archives bear functional, social, emotional and epistemic value for education and research. Besides, archives also preserve cultural heritage and historical evidence of nations, regions, organizations, communities, and individuals which are regarded as original source of information for historical research. For ensuring safety and security of such valuable documents, almost all the countries of the world established national as well as regional archives centers. In Bangladesh, the National Archives of Bangladesh (NAB) was emerged in 1973 to preserve and manage archival resources available in Bangladesh. In Japan, the National Archives of Japan (NAJ) was established in 1971 to safeguard public records and archives as well as providing access to them for public use. In addition to NAJ, there are 38 prefecture archive, 9 city archive, 30 municipal archive and 13 university archive centers throughout in Japan. Traditionally, archive centers are supposed to collect, preserve and provide users services to archives. For proper management, archive centers utilize different level of technologies including human expertise.

But it is observed that archival resources cannot contribute to the education and research as expected. This is because archive centers usually do not have integrated framework for value co-creation in archives. Besides, 1) archive centers have little scope of collaboration with other centers for sharing service knowledge; 2) most of the centers do not evaluate users’ feedback and demand on archives for initiating new service or improving existing services; and 3) archives centers are usually do not have advisory committee to suggest/coordinate archive related services. Accordingly, archives centers cannot afford to play anticipated role in delivering archival knowledge to users. As a result, though archival content bears significant value of its own, they cannot create much users’ impact in specific context of knowledge creation. In general, archival science and archive related studies discuss about the preservation and management issues of archival content but could not address how to create more users’ impact during service encounter. Archive centers need to adopt services based on users’ demand.

In Service-Dominant logic (S-D Logic) value can be co-created when service providers and service recipients actively involve and apply their skill and knowledge in the co-creation activity for the benefit of each other. VCC allow service receiver to co-construct the service experience to suit service context. In other words, VCC aims to foster the discovery of users’ interest and value, which can be turn into innovation and competitive advantage. Value co-creation interact with two or more actors where service providers and receiver integrate resources to co-create value in service process. Service system is a dynamic role played by actors and other resources during value co-creation process. In service ecosystem, actors and their respective resources are linked together through value propositions in a network of
relationships. Service ecosystem approach helps to elaborate the relationship between the development of value propositions and the co-creation of values. Actors within a service ecosystems are attracted to share their knowledge and skills, responding to value propositions that offer potentially beneficial outcomes.

For effective archive management system, and to meet ever changing demands on archives as well as to deal with the information seeking and using behavior of archive users, archive centers need to redesign service frequently. In this case, archives center alone cannot handle all issues relation to archive management and users’ satisfaction. Archive centers need to create mutual relationship with other center for knowledge sharing and exchanging competency. Besides, the value co-creation concept help archive center to build sustainable services. Archives center need to involve stakeholders for managing archival content and involve users for design services appropriate for users. Hence, archive service need to redesign services from Value Co-creation (VCC) and service ecosystem point of view.

**Research objectives and research questions**

To come up the above issues the main objective of the research is to develop an integrated archive management framework for increasing archival value. The specific objectives include to: 1) review different management strategies used in archive services; 2) identify the factors of value co-creation in existing archive management framework; and 3) develop an integrated archive management framework incorporating value co-creation strategy.

To attain the above objectives, this study identifies the key mechanism of co-creating values in archives through answering one Major Research Question (MRQ): How to develop an integrated archive management framework for promoting archival value? and three Subsidiary Research Questions (SRQs) as - SRQ1: What are the strategy of existing archive management and services?; SRQ2: What are the factors involve in value co-creation in archives? and SRQ3: How to integrate resources from different actors in archival value co-creation?

**Research methodology**

The research follows descriptive research methodology. First of all, the research reviewed literature on major issues of archive management practice throughout the world. During literature review special focus were given to archive digitization, digital preservation, web-based services in archives, user involvement in archive services, service ecosystem, value co-creation in archives, etc. Secondly, the research conducted case study on national level archive management practice in Bangladesh and Japan for determining value co-creation and resource integration activities in archive services. Thirdly, the research collected primary data from local archive centers of Japan using structural questionnaire for validating conceptual framework on value co-creation activities in archive services. In most cases, questions were adapted from previous empirical studies on stakeholder involvement in archives, organizational effectiveness, users’ involvement in archives, value co-creation in archives etc. and modified to reflect the local situation on the basis of the findings and discussion of the studies. In order to get center specific data, a total of 92 questionnaires had been distributed to the person in-charge/planning manager/manager/director of the center, and 68 (75.56%) responses were collected for analysis. Among the respondents 44.12% are prefecture archive centers, 32.35% are municipal archive centers and 11.76% are city and academic archive centers each. Resource integration and value co-creation activities of local archive centers in Japan have been measured with 21 structural questions and 02 open-end question divided into four sub-categories. A total of 128 items were analyzed using 9 Likert type questions (5 point Likert), 11 check box question and two open-end questions. The collected data were analyzed by frequency count and percentage methods. Besides, descriptive analysis methods were followed using SPSS (version 17.0). In addition, SmartPLS 3.2.8 were used for analyzing Structural Equation Modeling (SEM).
Part 2: Research Finding

Result shows that archive management practice witnesses many changes during several decades. Initially, archival resources were confined to specific place for preservation. People could hardly access and use archival contents for research and development purposes. In addition, improper handling and physical degradation was main threat for archival resources. To come up such physical threat and to ensure usability, durability and intellectual integrity, archive enters throughout the world moved to digitization process. Later on with the development of Web 2.0, archive management system throughout the world incorporated interactive communication tool archives 2.0 in archives services. In addition, adoption of different social media tools helps archive centers to deliver archive service to individual door-step. Social media tools also enable archives centers and users to co-create values through discussion and feedback, following, commenting, sharing and so on. But most of the local archives centers in Japan do not have web-based services. Besides, majority (53%) of local archive centers in Japan do not have advisory committee for administration and initiating new services based on users’ demand; 74% centers do not maintain any collaboration with other centers; along with limited use of users’ feedback in designing new services or developing quality of existing services.

The study explored that archive services is associated with three actors: archive center staff, stakeholders, and archive users. In general, stakeholders and archive users includes different category of people like researchers, academic experts, historians, IT experts, politicians, government officials, local representatives, etc. Each of the actors have different level of skills and knowledge (operant resources). Integration of resources from those expert professionals could jointly increase archival value. But for exchanging ideas, there needs a co-creation platform. Though the platform may be physical or web-based, web-based space is more appropriate to communicate and deliver services to distance users. In this case several components reflect the success of archival value co-creation. Archival value co-creation components include stakeholders’ involvement, motivation of staff of archive centers, co-creation platform, participation of users in knowledge sharing, and organizational creativity and effectiveness. Each of components of archival value co-creation have different essence which act upon another component for value co-creation. Considering the two tire relationship, the research formulated six hypothesis relating the archival value co-creation. The hypotheses were tested with the primary data collected from local archive centers in Japan and found that out of six hypotheses, five were supported.

This research identified that there are several separated but vital entities linked together for uplifting archival value. In other words, archive service ecosystem require direct or indirect relationship among different actors. From the literature review and finding from data analysis, the study identified eight essences that works behind archive service ecosystem as - Essence 1: Stakeholders improve quality of archive services through considering the future direction of archive center; Essence 2: Staffs have attention to potential changes regarding users’ expectation as well as have positive attitudes toward the changes; Essence 3: Social media platform promotes easy access to archival content for users; Essence 4: Social media platform improves recognition of archive center; Essence 5: Social media reduces communication gap between archive center and users; Essence 6: Users provide feedbacks on services which help archive administrator to develop new service ideas; Essence 7: Staffs’ positive attitude in adopting new services is the basis of functioning archive management ecosystem; and Essence 8: Organization cultivates creative climate by appreciating new ideas and services as well as providing technological supports. Considering the essence, the study proposed an archival value proposition framework including implementation guidelines. While testing the model it is found that prefecture archive centers are best suited the model.
Originality

The existing literature on archival studies emphasized on different issues of archive preservation and management. But as far the researcher aware, no study has been conducted on archive management from service ecosystem point of view. Therefore, the present research can serve as a pioneer of archive management in service ecosystem and value co-creation point of view.

Implications

This research address different issues of interaction between users and archives center to know each other service system and develop mutual understanding for designing better services. Stakeholders involvement in archive management addressed in this research provides new opportunity for archive centers in sharing risk and getting direction from other concerned except archive management staff. The research also addressed technological issues for connecting archives centers and users for value co-creation. By implementation of the proposed value co-creation model provided in this research, both archive centers and users can create better understanding and emotional connection for archival education, entertainment, and participation. In addition, the proposed value co-creation framework can be helpful tool for archive administrator who are struggling to build up archival values to re-design their archive services.

By implementing the proposed framework users can have easy and wider access to archival content which will increase archival value-in-use. Archive center will be able to generate new service idea from users, and implementation guideline from stakeholders. As a result, archive center can improve their management process as well as build trust to both users and stakeholders. Effective preservation and management is the main concern of stakeholder. Through value co-creation dialogue with archive center, stakeholders can be benefitted by effective management of archival content.

Part 3: Research Accomplishment

Following publications have been accomplished based on the above studies:

Journal article (Peer reviewed)


Conference proceeding paper (Peer reviewed)


Poster

Keywords: Archive management, digital archives, value co-creation in archives, Archives service ecosystem, Stakeholder involvement in archives.