

A Preliminary Model of Creativity in Digital Development of Architecture

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Abstract: Research into the various forms and processes of creativity has been a topic of great interest in the design field for many years. Part of the view is personality, and part of the answer is behavioural. Creativity is also explained through the identity of social values and the whole creative process. This paper proposes to use the interacting creativity model of Csikszentmihalyi as the basic structure, to establish the major criteria of testing creativity in the digital era. This paper demonstrates two facts: first, it confirms that creativity in architecture is truly valuable in the digital age; second, it proves that in the digital era, individuals, cultures and societies are all under the impact of digital technologies, a fact which transforms the model of interacting creativity proposed by Csikszentmihalyi in 1988 into a new model of digital interacting creativity.

1 INTRODUCTION

In general, creativity is a novel, unexpected, and useful ability. Most studies have confirmed that creative activity includes motivation, persistence, originality, and variation. Cognitive research has found that problem finding and problem solving are also involved in creativity. According to Mitchell (2003), media are absolutely related to creativity. He indicated that digital computers provide us with the means to express human creative capability to its fullest extent. Eisenman (2000) highlighted the new possibilities for creative thinking that have been opened up by the computer, which can keep the thinking process going, through the connection of memory to develop creative projects. However, the development of individual intelligence is insufficient to explain the whole picture; creativity must be tested by society and culture. Creativity involves not only internal mental activities but also mental activity generated by a group of people (Gardner 1993). Creativity is confirmed by the general culture context. Csikszentmihalyi (1988) stated that a system of view of creativity consists of the cyclic influences existing among three basic elements (person, domain, and field) of society. Huang and Liu (2001) tested the unpredictability of computers as the crucial stimuli of creativity. Their theory showed that computers maintain the interconnection between concepts from different design periods, which in turn suggests the potential creativity of digital architecture.

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However, most studies on creativity in designs focus on the individual's contribution or that of the computational operation and media. In doing so, one avoids questioning whether digital architecture is inherently creative within a larger social context. Therefore, the major question that this study will attempt to answer is as follows: What role does creativity play in the cultural identification of society? More specifically, we want to investigate whether individuals who use computers to change design can be considered creative designers. When reviewing the forward documents, digital technology seems to have an impact on the entire human society. It not only changes a single domain but also changes the whole knowledge system as well as the design domain. Liu (2001) combined Simon's search model of personal creativity with Csikszentmihalyi's dynamic model of creativity and then reconstructed a double creativity model. Therefore, this study should also attempt to answer the following question: When the digital elements invade the knowledge system, does the framework of Csikszentmihalyi's model of creativity need to be modified? The methodology will be divided into three stages. First, case studies will be conducted to check whether digital architecture contains creativity or not; following the results of the analysis, we will then attempt to build a preliminary model of creativity in the digital development of architecture. To ensure the maximum reliability of this model, it will also be applied to other cases.

2 FRANK GEHRY: A CASE STUDY

This investigation selects the dynamic triangle model of creativity proposed by Csikszentmihalyi (1988) as its main analysis framework (Figure 1): The PERSON refers to personal experiences, the FIELD signifies the social organization of the domain, and the DOMAIN means the information-processing system or the symbol system. One has to seek information relevant to each of the elements and analyze the phenomena and models related to the individual and the interactive operations of all three axes, with which the criteria for examining the creativity of digital architecture could then be established.

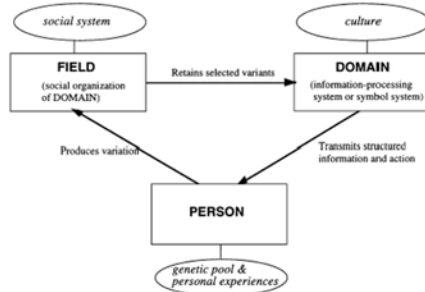


Figure 1 The dynamic model of creativity. (from M. Csikszentmihalyi, 1988)

As Csikszentmihalyi (1996) expounded, "creativity," as commonly used, is too broad in meaning to describe those (1) who express unusual thoughts, (2) who experience the world in novel and original ways, and (3) who have changed our culture in some important respect. Because the third type of creativity is by definition easily identified,

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a case study will be conducted to test whether or not Frank O. Gehry, the famous architect, possesses this type of creativity.

2.1 PERSON

The personal environment effect and domain knowledge: Frank Gehry is of Canadian Jewish descent. According to Jewish custom, his family ate fish every Friday when he was growing up. Thus, the image of the fish was embedded deep in Gehry's mind early in childhood. When he ran out of ideas, Gehry once said that he would draw pictures of fish swimming in the water to stimulate his thinking. This habit seems to provide support for Csikszentmihalyi's (1996) comment that creators' childhood experiences exert an essential influence on their works. Gehry studied urban planning at the Harvard Graduate School of Design after graduating from the Department of Architecture at the University of Southern California in 1954. During his youth, Gehry spent time studying the techniques of architecture expressionism and drawing perspectives immediately after leaving school. During this period, Gehry worked for some famous American architects and thus became qualified as a professional designer. He admired modernism and drew perspectives exclusively for John Portman. The experience that Gehry gained during his youth served as his professional training, in accordance with Akin's (1990) statement that a creator needs professional knowledge to become qualified. In the late 1960s, Gehry tried to study free sketches out of the designing of furniture. He used a knife to cut cheap-glued papers into different shapes, such as tables, chairs, cupboards, doors, or floors. After the 1970s, Gehry's work began to attract attention, starting with the design of his own house. To stimulate his creativity, Gehry gathered different materials, such as iron boards, iron nets, wooden boards, and plywood. In summary, creative individuals can absorb knowledge around them and promote the formation of personal creativity through personal experience and environmental influence. In accordance with the creativity triangle proposed by Csikszentmihalyi, it could, therefore, be proved that the individual is affected by special domain knowledge.

New stimulus of material and digital media: During the early 1980s, Gehry progressively pursued free-form expression. At that time, he also joined a competition of light. Gehry used the fragments of new material known as Colorcore to make his famous fish lamps (1983–86) and figured out how to use specific materials to create a three-dimensional twisted curve. Before designing the Walt Disney Concert Hall (1989–2003), Gehry had already extended his prominent fish lamp to architecture. In 1992, Gehry first utilized the CATIA software, developed by Dassault Systemes, to assist the fish-shaped design (Figure 2). Owing to the new stimulation provided by digital media, Gehry is able to propel his personal creativity into new, unexplored directions, and he achieves the highest value from the field. After studying Gehry's projects, Lindsey (2002) observed that repeated manipulation of a prototype could help avoid dropping into the only form. Gehry repeatedly applies different design models to a single case and compares the various models for their differences and flaws. Digital media are essential in this process. In his study, Ranaulo (2002) put forth that Gehry represents a new type of designer who uses digital media in

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architectural design. For Gehry, the computer becomes a thinking material in design, and architecture becomes an art. Using computers to generate designs, Gehry then studies these models and makes revisions, based on his own observations and repeated discussions with his partners. New digital media help Gehry to realize his architectural vision and reduce mechanical, material, and budgetary inaccuracies. Restated, Gehry requires the use of a computer throughout every step of the design process, including free-form designing, material, and construction. Based on Gehry's approach to designing, this investigation thus identifies another element in the design process—digital media. This new type of media, regarded as a new stimulus, influences individual creativity in Csikszentmihalyi's creativity triangle.

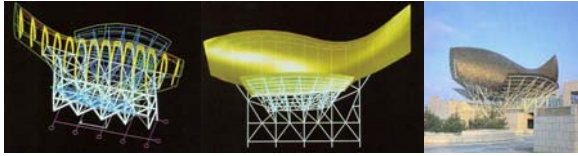


Figure 2 Fish sculpture at Villa Olympic, Barcelona, 1992 (from Ragheb, 2001)

2.2 FIELD

This part of the study focuses on Gehry's honours, exhibitions, publications, and changes occurring in the field. The creativity system proposed by Csikszentmihalyi demonstrates that the field of fine art has more powerful effects than other domains because of its dispersed structure. This field will thus repeatedly evaluate artists. As a result, artists will be recognized as having social creativity. In 1974, Frank Gehry received his first professional honour, indicating that the field of architecture was starting to recognize Gehry as a creative architect. Gradually, Gehry earned a name for himself, as evidenced by the number of honors he received between 1974 and 2001 (Figure 3). After 1984, he held some exhibitions around the world. Within the field of architecture, his unique design style has attracted acclaim, and in 1989, Gehry was awarded the Pritzker Architecture Prize. Mitchell (2001) has said the following of Gehry's projects: "He has created a powerful new architectural language of computer-constructed curved surface..." Schindler (2002) mentioned in "digital Gehry" that Frank Gehry is the most important architect after the opening of the *New York Times*' web search engine in 1996. Gehry's retrospective show held at New York's Guggenheim Museum in 2001 (including 36 compositions in 5 countries, 24 cities) was the important milestone in Gehry's career. Philip Johnson openly stated that "Gehry's design is the most important compositions in the present age" in *Time* magazine (Sept. 2000). The comments and approvals from experts represented the key to Gehry's success. Thus, Gehry's creativity extended from the individual level to the field of architecture. This phenomenon is in accordance with a part of Csikszentmihalyi's creativity triangle.

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However, digital media also affected the field of architecture to some extent at that time. While examining reports and news items in famous magazines, I discovered articles dealing with the architectural domain and then collected data to compare the vicissitude recently (Figure 4). Dialogue magazine, “Computer and Architecture” (in Nov. 1997), and “Digital Architecture” (in Jan. and Feb. 2001) all have had specially subject devoted to discussing digital architecture since 1997. The design projects described in these reports were gradually turned to free, curved architecture style. Since 2002, “Architecture record” has had one or two monthly professional reports describing changes in digital architecture. More and more reports related to digital media in architecture appeared during this period. The influence of digital media on some composition awards was also apparent. The Association for Computer Aided Design in Architecture (ACADIA) held two international conferences regarding the issues of computer-aided design in 1998 and 2001. The Far Eastern International Digital Architecture Design Awards have been held since 2000. The goal of this competition is to develop new creative designs using digital media. In accordance with the creativity triangle proposed by Csikszentmihalyi, I believe that the field of architecture is affected by digital media, thus confirming Gehry’s creations. Because of changes in the field of architecture and the influence of digital media, Gehry’s use of CAD in his compositions has increased their creativity value.

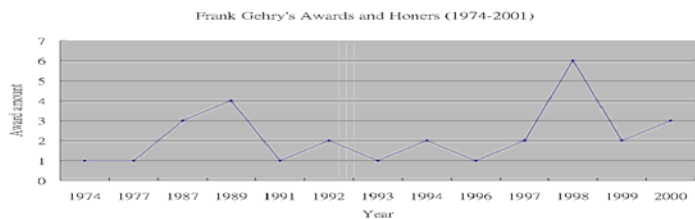


Figure 3 Frank Gehry's awards and honors (1974–2001)

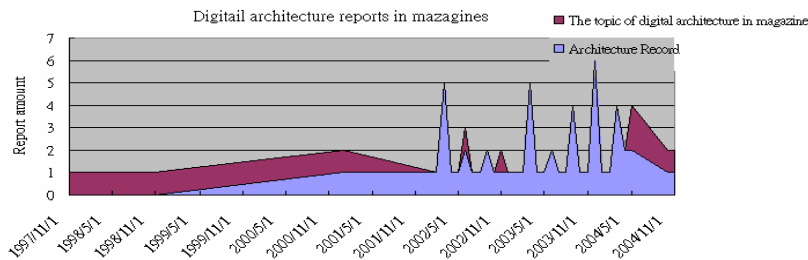


Figure 4 Digital architecture reports in famous magazines

2.3 DOMAIN

In 1979, Gehry began teaching design at Yale University. According to Csikszentmihalyi (1996), architects or artists reach the pinnacle of their careers in their old age in contrast to people working in other domains, such as math and

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computer programming. From 1979 to 1999, Gehry taught in four architecture programs at well-known universities, taking both short-term and long-term teaching positions. His teaching career suggests the following about Gehry: 1. by being invited to teach at university, Gehry has been recognized by the field of architecture. 2. Gehry has transmitted his expertise and ideas to the architectural domain. However, Gehry loved to create architecture most of all. When a project of his was finally completed, many publications would broadcast his achievement to the rest of the world. Gehry's buildings resemble a distinctive trademark in different countries. Continuous free curves, which characterize Gehry's designs, have altered our vertical and horizontal modern landscape. Gehry's designs have not only influenced architecture but also changed the human sensation of space. In 1999, Gehry was awarded the AIA Gold Medal. In terms of Csikszentmihalyi's creativity triangle, this case study has shown that Gehry's creativity, as a consequence of his use of digital media, has extended from the field to the domain.

As a result of changing the shape and thought process of architecture, digital media have thus become incorporated into the long-established domain knowledge of architecture. Many renowned universities (University of Sydney, Delft University of Technology, Carnegie Mellon University, Harvard University, MIT, etc.) have changed their programs and tried to introduce digital media or computer-aided design courses. From the research perspective, several famous journals, including *Design Studies*, *Automation in Construction*, and *Environment and Planning B: Planning and Design*, have frequently published papers about using CAD in architecture and held workshops to promote communication in this area. The computer has had a tremendous impact on design and, as a result, changed the original structure of the architectural domain. It has not only affected the validity of Gehry's case in terms of his creativity but also brought about this position. Therefore, digital media indirectly affect the architectural domain and provide new creative individuals (such as Greg Lynn, Makoto Watanabe, UN Studio/Ben van Berkel, and Asymptote/Rashid+Couture) with new nutrients of the architectural domain. The domain knowledge of this new generation of creators has been affected by digital media, as demonstrated through Gehry's architecture. The use of digital media in design has gradually changed the traditional scenography, the model design method of the Renaissance. Because of the role digital media has played in stimulating the creativity of digitized architecture, the confirmation of the domain occurred when it reached society, the last phase. This confirmation means that new creators have accepted the changed domain, which, in turn, has aroused new creativity. Csikszentmihalyi's creativity triangle has thus been verified in this case.

2.4 ANALYSIS

Gehry is similar to all creative individuals; his creativity can be traced back to his childhood. My previous study mentioned some important individual characteristics, which, in Gehry's case, are in agreement with Csikszentmihalyi's opinions. These individual characteristics include the following: (1) possession of multiple intelligences, (2) childhood experience as a source of creativity, (3) extensive expert

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knowledge, (4) an ability to face problems that are not widely recognized in a given field of study at a young age, (5) adoption of an unconventional approach by trying previously untested methods, and (6) creation of novel and unprecedented designs (Hsieh 2004). These individual properties are the sources of Gehry's creativity and also represent the process through which Gehry adopted the domain knowledge to become a creator (Figure 5-1). When the individual creation is mature, the field–Social Organization of Domain, defined by Csikszentmihalyi, will help individual creativity be accepted by the public. These factors, which concluded from the person to the field of Gehry, include the following: (1) news reports in the professional media (e.g., TV, magazines, and books), (2) recognition from competitions, (3) individual exhibitions, and (4) participation in exhibition organizations. By combining new media-CATIA to create the sculpture of Fish in Barcelona, Frank Gehry produced something creative and unprecedented. Individual creativity in a particular field is always associated with a breakthrough, which usually entails problem solving and a new solution. Cognition science treats this as a problem-finding and problem-solving process. In Gehry's case, two such breakthroughs are evident. The first breakthrough occurred when Gehry used fragments of new material to create his fish lamp; the second breakthrough occurred when he used CATIA computer software to complete his large-scale, free-form fish sculpture in Barcelona. This sculpture played a key role in solidifying Gehry's social acceptance, thus allowing Gehry to move from individual creativity to field creativity (Figure 5-2). When the gatekeeper accepts and encourages the creator, Csikszentmihalyi posited that domain knowledge, such as symbol systems, would change. Some parts of the variations, such as administering knowledge, exist in the symbolic system itself; other parts affect other individuals in the domain. In this case study, changes in the architectural domain caused by Gehry include the following: (1) the emergence of free-form architecture; (2) the promotion of academic and research organization; (3) the moulding of new designers, as a consequence of his teaching at academic institutions; (4) the birth of a new generation of architects who create new architectural forms, design processes, and constructions; and (5) the inclusion of numerous digital media courses taught in universities. When the creativity triangle of Csikszentmihalyi is applied to this case study, it indicates that Gehry's influence has moved from the field to the domain of architecture (Figure 5-3).

According to this case study, digital architecture has survived the tests of human society and culture. Meanwhile, the introduction of digital media has also prompted the appearance of "the other element," which refers to digital media itself. Utilizing digital media enabled Gehry to pass the test from person to field to domain. Digital media directly affected the development of Gehry's artistic abilities. Furthermore, the domain of architecture was significantly changed by the stimulus of digital media in terms of form, process, and material after modernism. Based on the above findings, this author proposes that creativity in the digital age is no longer an interactive structure consisting of three elements and that media should act as a trigger in the centre of the model, thereby driving the flow of the model (Figure 5-4).

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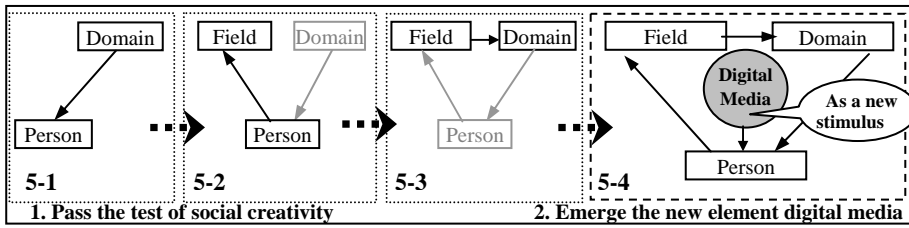


Figure 5 The process of inference in creativity about Gehry

3 VERIFICATION OF MAKOTO WATANABE

Considering the limitations of using only one case study, this thesis also applies the model (Figure 5-4) to other cases in order to maximize the model's reliability. As a result, Makoto Watanabe, who uses a computer program when designing, was selected as the focus of another case study. His design and process are significantly different from those of Gehry, as determined through the justice of verification.

3.1 A Test of Creativity from Person, Field and Domain

Person: Makoto Sei Watanabe was born in 1952. He graduated from Yokohama National University in 1974 and also received a master's degree from the same school. Watanabe established Makoto Sei Watanabe/Architects' Office at 36 years of age in 1984. In describing his architectural vision, Watanabe has commented, "I always see everything in two layers"(Developing Digital Architecture : Digital Creativity, 2002, 38). The special thoughts he had during his childhood helped make him a pioneer and a creator in design. While at university, Makoto tried to apply computers to the design process. He wrote programs and developed the concept of machine learning via artificial intelligence (AI). Makoto saw machine learning or artificial intelligence as a form of cooperation between humans and machines. Similar to other creators, Makoto designed architecture, showrooms, furniture, interactive art, and cars. According to Gardner (1993), the thesis of multiple intelligences suggests that creators possess diverse talents; this theory applies to Makoto as well as to Gehry. *The Morrow Showroom* (produced in 1988), the *Naked Car* for Toyota, and a piece of interactive art entitled *Fiber Wave* are all famous projects of Makoto. The *Fiber Wave*, which simulated waves of wind, won the Art Future Award in 2000. Excellent professional training and curiosity have made Makoto an important figure in the world of art.

Field: Makoto was awarded first prize at the International Design Competition for Aoyama Technical College in 1988. Subsequently, in 1993, he won the International Design Competition for New York Public Toilet U.S.A. This news was published in *The Upper East Side Resident*, the *Daily News*, and *The New Yorker* magazine. From 1988 to the present, Makoto has received 35 international prizes. Makoto was invited to the Seventh Architecture Biennale exhibition in Venice, and his project *Fiber Wave*

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earned the reviewers' appreciation. The planner of these exhibitions, Massimiliano Fuksas, stated that Makoto is the greatest architect devoted to using AI in the development of digital architecture in Asia. Articles on Makoto have appeared in numerous global publications, such as the following: *The Architecture Review*, *World Architecture*, *L'Architecture*, *Casa Vogue*, *Deutsche Bauzeitung*, *md*, *The New Yorker*, *LD+A (Lighting Design + Application)*, and *Inter*. In total, approximately 100 articles have been published on Makoto in international journals. Vitta (1998) said that Makoto's work represents a new form that is beyond what is considered architecture. Therefore, Makoto has passed the test of the field component of Csikszentmihalyi's creativity triangle.

Domain: Makoto started his teaching career at Yokohama National University in 1988. From 1994 to 1995, Makoto taught at Kyoto Seika University, and after 1997, he taught at Tokyo Denki University. During his 16 years of teaching, Makoto gradually evolved from being an architectural creator to a teacher of architecture. After 1995, Makoto published several papers in *Annual Meeting-Summaries*. Makoto also published numerous books, such as *Evolutionary Design*, *Induction Design*, *Liquid Crystal*, and *Makoto Sei Watanabe—Conceiving the City*. These books became textbooks for students interested in evolution or generation design. When digital information invaded architecture, the architectural domain promptly accepted digital media as a part of the domain knowledge because the architectural domain possesses properties that are easily influenced. As a consequence, computer-aided design is a growing field. Ranaulo (2002) stated that Makoto's project, the new capital building in Japan, resembles an organism, with a surface that can change as required. Ranaulo also thinks that this building could be considered a part of the moving architecture that Ron Herron promoted in 1964. This design process, with its operating computational procedure, not only extends the moving architecture but also becomes a part of the architectural domain knowledge.

The emergence of digital media: Digital media are important in Makoto's work. Liu (2002) noted in "Digital Creativity" that "Makoto is fascinated by the field of computers because it opens a door to the new world." Makoto thinks that traditional design processes are linear and cannot be revised. However, through the use of computers, design processes can be modified via organic evolution and generation. Aoyama Technical College, which was built in 1990, was Makoto's first real project. This building, which epitomizes the city of Tokyo, was conceived using a computer to define the relationships and boundaries of the buildings in the city and to generate its form. As a means of reflecting the need for humanity to take better care of its environment, Makoto purposely designed the building's form so that it would appear extremely disordered. In 2000, Makoto's created the subway station IIDABASHI, the first example of Computer-Program-Generated-Architecture, called PGA, in the world. In this case, Makoto used a computer program to generate the design, set parameters, and evaluate the results. In Makoto's words: "My study is induction design or induction city" (Developing Digital Architecture 2002, 38). From Makoto's perspective, a city can move, grow, and assume different characteristics. These properties should all be expressed in architecture, and using computers is the key to making architecture move. Like Gehry, Makoto devoted himself to promoting innovation in materials and design processes. Through his projects and speeches,

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Makoto has demonstrated that computers, as a type of digital media, have become a necessary element, even a collaborator, when he designs. For Makoto, digital media not only are tools but also form a core component of design thinking. Computer programs have solved some problems that humans could not easily figure out. Humans then decided the next stage of the design process. This method of collaborating via computers enabled Makoto to realize his induction design in much the same way that computers helped Gehry to construct free-form architecture. Although Gehry and Makoto used different methods, they both used computers as a new stimulus to enhance creativity.

4 CONCLUSION

Based on previous analyses, this study finds that the development of architectural digitalization has passed the tests of society and culture. Furthermore, Csikszentmihalyi's model should also include digital media as another element. Therefore, this paper proposes that creativity in the digital age is no longer an interactive structure consisting of three elements; the role of digital media should be included as a trigger of the model (Figure 5). The more this crucial element expands, the greater its influence on the other three elements will be felt. Using digital media can affect the person (the architect), culture (experts who engage in that domain), and the entire environment (news, people, and followers). This study confirms the following: 1.) Creativity in architecture is truly valuable in the digital age. 2.) Individuals, cultures, and societies all experience the impact of digital technologies. Based on the findings of this study, Csikszentmihalyi's model of interacting creativity that was proposed in 1988 should be transformed into the model of digital interacting creativity, a new model consisting of four elements (individual, culture, society, and digital media). However, digital architecture is still constantly evolving. Its future might lead to significant new developments of which we are currently unaware. This factor of the unknown highlights one of the limitations of this study. In addition, this research is just a single case analysis; it is a special case in a special domain. Frank Gehry's social creativity has been clarified through painstaking inference, and another important factor/stimulus (i.e., digital media) has emerged from Csikszentmihalyi's three elements. Additional case studies conducted in the future will help verify research in this area. In order to establish the status of motivation in creativity, future research should attempt to integrate an analysis of different domain cases.

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