Object-Mediated Innovation: Case Study of Adventures in the National Palace Museum in Taiwan

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Abstract--**In the new economic era, cross-boundary innovation is a critical topic, particularly in the cultural and creative industries. In this study, we introduce knowledge management literature to indicate that there are at least three frontiers of knowledge that cross domains: (a) knowledge that must be transferred to resolve syntactic differences, which requires establishing a common ground; (b) knowledge that must be translated to resolve semantic differences; and (c) knowledge that must be transformed to satisfy the interests of two parties.**

To facilitate the cross-boundary sharing of knowledge, a boundary object was proposed for establishing a communication interface. This study examined the collaboration between the National Palace Museum (NPM) and Digimax that was undertaken to develop a film "Adventures in the NPM." The research objective was to analyze the process of co-creating this film and the mutual exchange and sharing of knowledge.

We examined the data by conducting triangulation through multiple sources. The results showed that the cross-boundary sharing of knowledge can be divided into three types, namely, translation, the process by which animated characters are converted into heritage; transformation from heritage significance into animated stories; and transcendence, the cultural implications derived from the symbolic meaning. We also identified the boundary objects of each process. In conclusion, this study contributes to the literature of cross-domain knowledge management and the practices of creative industries.

I. INTRODUCTION

The new technology age of the 21st century is a time of creation, learning, and sharing of knowledge, making it essential that we find ways of effectively using knowledge. For the most part, industrial growth in the new economy will be driven by the intelligence of professionals. From the management of tangible assets, the key factors yielding organizational success will gradually shift to intangible human intelligence and systems management [31]. Due to dramatic changes in the external environment in recent years, companies have been forced to seek change and innovation. Nevertheless, many companies have found it increasingly difficult to keep up with the times and cope with change, much less to promote innovation. Because of this, innovation through cross-boundary alliances has become a major option for overcoming corporate difficulties.

While cross-boundary can help corporate enterprises to innovate, innovation requires "capital." Knowledge constitutes a very important part of this capital, and knowledge management must be applied to effectively create or apply new knowledge and products [29]. As a consequence, knowledge management is an important part of innovation for modern corporate enterprises. Furthermore, knowledge management includes not only the internal knowledge of a single department or organization within an enterprise, but must invariably include the knowledge of different teams, departments, or even organizations, and requires the integration of professional knowledge from many sources [20] [36].

From the perspective of knowledge management, an organization must continuously accumulate knowledge, must integrate individual and group knowledge in the process of providing products and services, and must rely on its internal system, rules, and sharing to achieve effective use of knowledge [23]. But while many companies have sought to promote internal knowledge sharing and transmission, most of these have emphasized the establishment of procedures, such as the deployment of electronic operating systems intended to automate and standardize forms and processes. The fact that knowledge is difficult to imitate [33] also makes its transmission challenging; as a result, many corporate enterprises that have established thoroughgoing knowledge management systems and procedures still find it difficult to reap the benefits of knowledge sharing and learning.

In order to maintain its competitive advantage, an organization must remain in constant contact with other organizations, and the interplay between these organizations will lead to the establishment of mutual relationships. When an organization becomes aware that it lacks a certain type of knowledge, after clarifying its knowledge gap, it must seek to obtain that type of knowledge through acquisition or transfer. In order to obtain new niches, an organization must emphasize its cooperative relationships with its partners, and can obtain important information and knowledge through the constant process of interaction with those partners. Research on knowledge communities reveals that the transfer of knowledge inevitably occurs through the process of close contact and mutual discussion between two parties, and may be accompanied by the acquisition of product-related activities and operating methods [8].

Cross-boundary innovation requires inter-organizational cooperation. Because of this, scholars have expanded the scope of their research to barriers between organizations, and regard an enterprise's external resources as an important source of knowledge [32]. However, since even knowledge sharing between different departments of the same organization may be very difficult, knowledge transmission with an external organization can be daunting indeed. Furthermore, much knowledge is tacit or implicit, and is difficult to compile, transmit, and replicate [17] [22] [23] [24].

Another aspect preventing the circulation of knowledge is that knowledge may be localized, which we may say implies that knowledge possesses "boundaries" to a certain degree. The specialized terminologies, technical methods, and habitual practices and actions of different fields and levels have many differences, which often poses barriers to the cross-boundary transfer of knowledge, and may even give rise to sectarianism and a "not invented here" attitude [6].

Star & Griesemer proposed the existence and use of "boundary objects" when different communities engage in cross-boundary cooperation and knowledge sharing [34]. Leonard-Barton further pointed out that product models or prototypes can play the role of boundary objects, which serve as bridges for interdisciplinary communication [18]. Carlile further proposed the concept of "object-mediated learning," which referred to the use of three methods—transfer, translation, and transformation—to clarify the meaning embedded in boundary objects and transfer that knowledge across boundaries [7]. According to this framework, but "transfer object" is first used to transmit the substance of knowledge, "translation object" is then used to communicate meaning, and a "transformation object" is finally used to transform meaning and achieve mutually-beneficial communication. "Objects" are used as communication interfaces throughout the process of transfer, translation, and transformation, and ultimately serve to share and transmit knowledge [7].

Bechky noted that, because differences in work context between departments in an organization with different functions tend to cause barriers to communication, boundary objects are not merely beneficial to individual work communities, but can also provide common interfaces between different fields [2]. And since objects have different meaning for different professional fields, intermediaries must understand objects' different meanings, and have the ability to skillfully combine objects with each department's work practice. Furthermore, in the process of cross-boundary cooperation, members of an organization must span information, cultural, and political boundaries.

Cross-boundary cooperation between different industries may force organization members to integrate many types of professional skills, and simultaneously be able to meet the needs of both parties. The implementation of cross-boundary cooperation involving industries with different professional knowledge will be different from the case of different functional departments within a single organization. As a result, this study sought to investigate what boundary objects are and how they can serve as a basis for communication.

This study took "*Adventures in the NPM*," which was jointly produced by the animation company, Digimax and the National Palace Museum (NPM) in Taiwan, as its subject, analyzed knowledge transfer and sharing processes and phenomena during the course of inter-organizational cooperation and innovation, investigated the dynamic processes used by the two parties to engage in frequent knowledge transfer and communication during the case, and clarified boundary objects and how they serve as communication interfaces.

II. LITERATURE REVIEW

A. Cross-boundary innovation

Leonard-Barton suggested that companies can employ knowledge creation activities to cultivate and strengthen their core competencies [19]. The literature widely indicates that organizations that strive to engage in cross-boundary cooperation can often achieve relatively good operating performance. Because a new product is a tangible manifestation of an organization's knowledge, product value is determined by the value of the knowledge embodied in that product. Nevertheless, how to apply knowledge from different fields and integrate individuals' different professional skills for the sake of solving common problems and creating product value in the new product development process remains a thorny problem for innovation managers. Because of this, we must seek a better understanding of the essence of knowledge creation and cross-boundary knowledge transfer.

Nonaka & Takeuchi proposed the concept of "knowledge spiral," which they used to identify four important stages of the knowledge creation process, namely "socialization," "externalization," "combination," and "internalization." [25] Knowledge creation begins from individuals, and the scope of interaction gradually expands and rises in level from the individual to the group, and even to other organizations. Organizational knowledge is the result of this ongoing four-stage process of transformation, which is known as a "knowledge spiral." This framework suggests that, although knowledge is derived from individuals, it must diffuse to the group and organization, and even outside the organization. However, cross-boundary integration problems may be encountered at the stages of combination and externalization.

From an early date, numerous scholars have acknowledged that cross-boundary knowledge sharing is a challenging process [1][9]. Bechky suggests that several preconditions must exist if an organization wishes to transmit knowledge internally in overt form: the knowledge must have a shared meaning within the organization, and the metaphors and context of the knowledge must be consistent throughout the organization [2]. However, when inter-organizational communication occurs, some organization members may find it impossible to understand the knowledge because of their differing usage and interpretation of the knowledge's context.

As the need for cross-boundary cooperation and knowledge transfer increases, scholars have begun to focus on the topic of "knowledge boundaries." Knowledge boundaries emerge naturally when knowledge workers direct their attention to a certain professional field, and continued to grow and evolve as the workers' professional practice continues [6][11]. Because of this, an organization must instill knowledge boundary spanning skills in its knowledge workers [14][32].

Apart from the existence of knowledge boundaries, the

inherent characteristics of knowledge will also affect cross-boundary knowledge sharing. The localization and contextualization of knowledge that results from individuals' different social backgrounds and cognitive limitations imply that knowledge is "sticky" [22], which hampers the transmission of knowledge. Even when there are no communication problems, professional differences tend to obstruct common understanding between organizations and among departments within an organization [14]. Individuals in different professional fields and possessing different experience inevitably develop "local understandings" [16]. As a consequence, Gilbert & Gordey-Hayes assert that the transfer of knowledge can only be achieved through an ongoing dynamic learning process [15].

Contextual factors influencing communication between different departments include culture, language, actual work content, and location. It is common for context to cause communication difficulties within an organization. When a communication problem occurs, community members can use boundary objects with a common basis in the communities involved to provide explanations; the participants can then create a new communication platform enabling the transformation of knowledge, allowing them to generate a new product and gain a better understanding of the problem at hand.

B. Boundary objects and boundary management

Broadly defined, a boundary object can be any type of artifact, such as standard operating procedures [2][6], engineering drawings [3], and standard report formats [4], etc. In the wake of the recent emergence of information technology, many boundary objects exist in the form of information methods, which can support an organization's cross-boundary communication. Many cases of boundary objects are investigated in information systems literature, and ERP and KMS systems, and FAQs, can be considered boundary objects [5][28].

Because knowledge is embedded in cultural understanding [2], looking from a knowledge culture perspective, boundary management must promote communication between individuals, and thereby eliminate professional knowledge differences and conflicts across boundaries. Communication is thus seen as essential to knowledge transfer. But while cross-boundary communication may initially be ineffective, after information sharers quickly discover things they do not understand, and ask questions, their counterparts will usually be willing to share knowledge, which is the beginning of cross-boundary sharing.

Furthermore, we can also examine knowledge boundaries from a political perspective. This perspective asserts that all boundaries surround a certain niche, or that knowledge sharing can take place only after benefits are exchanged across the boundary in question. Knowledge sharing that occurs under the circumstances tends to be brief, urgent, and conditional. A political perspective assumes that the success of cross-boundary cooperation hinges on the fact that individual interests can be transformed into the shared interests of the organization as a whole, and otherwise boundaries will inevitably suppress knowledge sharing. An implication of this perspective is that community members spend time establishing relationships, and they will be able to accommodate their mutual interests, display mutual tolerance, and engage in side-by-side cooperation only after their values have been transformed. This process has been termed "transformation"[6][7].

According to Carlile, individuals can have different "relationship forms" due to objects, and their relationships are shaped by information, cultural, and political perspectives [7]. The first type of relationship format depends on information processing systems to resolve information asymmetry between individuals. The second type takes the form of subjective community norms and professional views, and knowledge sharing can be performed effectively only through translation relying on one's self or a third party. The third type of relationship takes the form of "conflict of interest"; knowledge sharing can take place through negotiation or creative abrasion in this form of relationship [19], and only deliberate distortion of meaning can resolve mutual conflicts of interest.

Apart from examining boundary objects and boundary management from different knowledge perspectives and forms of relationships between individuals, Fong et al. also analyze boundary objects from the perspective of three different work stages (communication, coordination, and cooperation). During the communication stage, different boundary objects exist depending on participants, point in time, location, and technical context. During the coordination stage, the boundary objects depend on different rules and common bases, and during the cooperation stage, the boundary objects reflect inter-organizational trust, mutual concessions, creation of value, and understanding between upper managers.

In summary, the boundary management and boundary object perspectives remind us to first gain an understanding of knowledge workers' practice and the nature of knowledge boundaries when designing knowledge management solutions and effective boundary objects. Different boundary objects must be used to promote knowledge sharing across different knowledge boundaries. For instance, Orlikowski's study of global cooperation among software engineers [26] revealed that an organization's cross-boundary knowledge sharing capabilities are embedded in members' daily practice. The current study seeks to investigate how knowledge management can span different industries, how innovation is generated in a professional case, and how boundary objects can be used to achieve cross-boundary knowledge sharing in the process of innovation. This study selected "*Adventures in the NPM*," which was produced by the National Palace Museum in cooperation with Digimax, as the case study investigated in the following.

III. RESEARCH METHODS

This study employs the qualitative case study method [35].

This research method is based on the supposition that social phenomena are the result of interactions by groups of subjective participants, and it is consequently impossible to obtain completely value-free data. The researchers allowed their preconceptions to guide their research, and interacted with the research subjects, which altered the perspectives of both parties [37]. This study also used interpretive methods to analyze work practice [26] and thereby understand workers' actions and thinking, which enabled a better understanding of how culture and technology jointly create value. The following is an explanation of the reason for selecting this case, the data collection methods, and the analytical approach.

A. Case Description

This study took the film "*Adventures in the NPM*," which was produced by the National Palace Museum (NPM) in cooperation with Digimax, as the research case due to the facts as following. First, both parties' team members achieved growth during the course of cooperation. Personnel at the NPM and Digimax first engaged in contact and dialogue, which initiated the subsequent cooperative project. The introduction of the foregoing video shifted the NPM's positioning from a repository of ancient palace artifacts to a modern platform for the display of artifacts. At the same time, the NPM's past political codes took on new cultural coded meanings. Finally, the video has caused a new generation to become interested in culture (artifacts) and created new star artifacts; many tourists visiting the National Palace Museum specifically mention that they wish to view artifacts they have seen in the video.

B. Data collection

This study employed the interview method as its primary means of data collection. Depending on its format, the interview method may consist of structured interviews, semi-structured interviews, informal interviews, and retrospective interviews [13]. This study used the foregoing types of interview interchangeably, and all interviews content was recorded in the form of field notes. The chief subjects interviewed in this study included the Digimax's president and vice presidents, personnel in various departments, managers at the National Palace Museum, and participating museum personnel. Interviews with the president of Digimax and the former director of the NPM enabled the researchers to understand the overall thinking and concepts of both partners, including their reasons for certain decisions and relevant considerations, and their understanding of policy as a whole. Furthermore, our interviews with personnel in Digimax's different departments provided information concerning practical aspects of the case, such as the problems that were faced, and the ways in which they were resolved, during the development and implementation process.

The goal of the interviews was to gain an understanding of the decision-making thinking of Digimax and the NPM, obtain historical data concerning the company, and examine Digimax's development strategies and aspirations. In conjunction with secondary data, information from the interviews enabled the researchers to understand the process of innovation and cooperation in the case and clarify knowledge sharing and the role of boundary objects via analysis and comparison with accounts in the literature.

C. Data analysis

This study employed the editing analysis method to analyze the content of the interviews. This method involved editing, arrangement, and concept extraction on the part of the researchers, who relied on their subjective interpretations and a process of comparison, imagining, and thinking about the interview text, followed by rearrangement to find meaningful concepts and determine their correlation. This method can also be considered the conceptualization of descriptive data, determination of the frequency with which phenomena appeared, incorporation of individual discoveries in the research topic, and use of annotations concerning phenomena or concepts to record the researchers' subjective interpretations and readings of the interview segment in question. This process enabled the researchers to elucidate the relationships between conceptual categories, aspects, and levels. For instance, difficulties hampering knowledge sharing between the two parties were determined on the basis of events that actually occurred, and the interview content was then used to clarify boundary objects (including their identity and their effect or result) and analyze the effectiveness of the boundary objects.

D. Triangulation

Also known as "Delaunay triangulation" [38], this method enabled a full-scale examination of the case, and ensured that the conclusions had greater persuasiveness. The use of this method was also motivated by the fact that each type of data may have its own inherent bias, and a variety of methods should therefore be used to collect and investigate the data. It was necessary to employ triangulation in the study because the researchers not only employ the interview method, but also collected secondary data such as magazine and newspaper reports. Triangulation enabled the researchers to appropriately screen the data text, and remove any possible bias before using the data for analysis or corroboration. Triangulation of evidence and information from various sources enhanced the quality, reliability, and validity of this study.

IV. RESEARCH FINDINGS

A. Case background

The government of Taiwan drafted the "Law for the Development of the Cultural and Creative Industries" in 2010, and has provided generous support to relevant industries. In particular, the digital content industry, which includes "content software, online services, mobile applications, digital publishing and collection, digital audio/video, digital games, e-learning, and computer animation," has been a focus of promotional efforts and constitutes an important link among

cultural and creative industries. The output value of the digital content industry soared from USD$11.37 billion in 2006 to USD$14.08 billion in 2010. Within the digital content industry, the annual output of Taiwan's computer animation industry has reached USD$149.3 million; although computer animation is not a major part of the digital content industry, or cultural and creative industries as a whole, in recent years many Taiwanese-made computer animation works have received international awards and recognition.

The biggest problems currently faced by Taiwan's animation industry is recovering the cost of products produced in-house; because animated movies are costly to produce, but the domestic movie market is too small, it is difficult to recover costs. In addition, many media platforms such as TV stations have very limited film purchase budgets, and consequently cannot support investment in domestic self-produced animated programs. Because of this, animated film producers do not chiefly target domestic media when marketing their animated works, but instead focus on overseas markets. Nevertheless, because film production requires long-term funding and manpower inputs, and most domestic animation producers are small and medium-sized enterprises, these companies cannot imitate major international firms by making large investments in story and character R&D, much less earn juicy profits by licensing peripheral products based on successful, widely recognized animated characters.

As a consequence, how to expand capabilities and acquire more resources through strategic alliances has become an important management issue for the computer animation industry. Taiwan's 3-D animation industry has recently entered the new areas of joint production or self-production, and some animation companies are gradually shifting from an OEM role to development of their own brands. These companies are relying on their 2-D production capabilities and international OEM experience, as well as operating procedures and development processes gleaned from foreign companies, to accumulate brand development experience. Digimax is one such company.

Founded in 1990, Digimax originally specialized in audiovisual special-effects production services. In 1993, Digimax acquired digital visual special effects technology, and became able to handle all-digital audiovisual production projects. After that time, Digimax also expanded into 3-D computer animation production and established a digital audiovisual production center fully equipped with hardware and software. Prior to entering the 3-D animated film market, Digimax gained considerable experience in the OEM animation market. However, being aware of trends in the industry, the company's management team decided to adjust Digimax's development strategy. The following is a comparison of the company's two development stages:

1. From 1990 to 1999, Digimax established its core competencies and enterprise network in Taiwan. The company spent this period chiefly accumulating production technology and experience, while developing new technologies. Around 1999, Digimax actively learned from relevant firms in Europe, America, and Japan, increasing his experience and network resources. The company also established an R&D department chiefly engaging in high-quality movie-grade 3-D computer animation and interactive media technology R&D, which made Digimax the sole audiovisual production company in Taiwan's to reach this level.
2. From 2000 to 2009, Digimax engaged in cooperation with partners in Asia, giving it international status. The company devoted further effort to production and technology, and raised its original design capabilities to a first-rate international level. Digimax's core services currently consist of 3-D computer animation technology, development of original 3-D computer animated films, and joint production of international movies/TV programs. In addition, active participation in major international trade shows and conferences has enhanced Digimax's international visibility. Apart from ceaseless innovation in animation technology, the company has also differentiated itself from Western animation firms in terms of scripts.

Digimax's 2004 animated short feature "Paradise" won the Skill Award at the Tokyo International Animation Fair, and many of Digimax's animated papers have been shown at ACM Siggraph. President Huang had this to say about Digimax's excellent international visibility:

> "*In the past, America's animation industry developed through the combination of Silicon Valley (high technology) and Hollywood (creativity). Thanks to the development of technology in the last 20 years, Taiwan's digital entertainment industry can stand on the shoulders of Taiwan's outstanding high-tech industries. Thanks to global interest in China, Chinese culture can serve as the cornerstone for our global success. Digimax's operating goal is consequently to create Eastern content with Western technology.*"

This indicates that content is still the most important element when developing original innovation. Having targeted the global market, Digimax plans to focus on Eastern content, and the completion of *Adventures in the NPM* is consequently an important milestone in the company's development. In this regard, a company possessing technical expertise and access to resources from an enterprise network must take active steps to expand its market. After reflecting on its position in the animation industry value chain, Digimax has concluded that, apart from mastery of technology, the ability to create characters that can be used in features with plots is extremely important. Digimax President Huang had this to say about the subject:

> "*World-class movies must meet international standards. For example, you cannot fail to make the walking posture of cartoon characters look natural if others can do that already. And you naturally cannot compete if you are still doing correction, while others can make people's hair look like it is flying in the wind. So,*

animation effects have to in step with modern technology. At least you should stand on the same footing as the leading international technology, even if you are unable to be a leader. What Digimax hopes to achieve is to develop new technology and genres, and make entertaining and educational content. Digimax's core value is to possess intellectual property rights in the three categories of films, technology, and characters."

The fact that *Adventures in the NPM* was able to win the highest honor—1st Place Award—at the 2008 Tokyo International Animation Fair out of 466 works from 21 countries, while earning international recognition of its originality and technical expertise, establishes an important milestone for Taiwan's animation industry. The Tokyo International Animation Fair attracts an average of more than 110,000 visitors each year; the fact that an animation company from Taiwan was able to win a major award gives the country a great international visibility. How did Digimax board the NPM's cultural creativity train and develop *Adventures in the NPM*?

The government of Taiwan has put great effort into the development of cultural and creative industries in recent years. The National Palace Museum is the largest repository of artifacts in Taiwan and has played the role of a bellwether in the development of these industries. At the same time, since the application of technology to artifacts can generate value, the museum has focused its technical application efforts on digital archives. The NPM's digitization plans focus on digital archives, the digital museum, and e-learning, which also support the museum's mission of collection, research, education, and exhibition." In 2002, Digimax used its animation technology to help the NPM to find story elements for major artifacts and produce five animated short features: "Dreaming in the NPM," "Fashion at the NPM," "Freshness at the NPM," "Imagination at the NPM," and "Surprises at the NPM." These five short features elicited a great response from the public, which encouraged the two parties to engage in further cooperation. When the NPM celebrated its 50th anniversary, Digimax produced an animated film for the rededication of the museum; this film sought to interest viewers in the historical stories behind some of the museum's artifacts, and thus fulfill the museum's educational mission. President Huang recalled the museum's expectations:

"The goals of this film included getting everyone to visit the NPM again, creating new star artifacts, and inspire interest in the historical tales behind some of the artifacts."

Digimax lived up to the NPM's expectations by introducing *Adventures in the NPM*. The following case study of *Adventures in the NPM* investigates the cooperation between Digimax and the NPM, examines their cross-boundary innovation, and looks at what boundary objects they used to implement cross-boundary knowledge sharing and transformation.

B. Translate, transform, and transcend: Cross-boundary innovation in Adventures in the NPM

The NPM's chief mission is to preserve artifacts and promote education, while Digimax specializes in creative thinking and animated production. The partnership between Digimax and the NPM constitutes a case of interdisciplinary cooperation. This study discovered that three types of boundary objects were used in the transformation of innovative knowledge during the course of cooperation, and refers to the roles of these objects as translation, transformation, and transcendence. The following is an explanation of how the two parties innovated through the translation, transformation, and transcendence of boundary objects.

Translation: Translation of artifacts' significance into animation stories

In keeping with American principles of animated movie production, Digimax focused on creating appealing animated characters, and used the film as a vehicle for introducing the animated characters. Digimax consequently developed suitable animated characters when first planning the film. After selecting suitable artifacts to serve as the main characters from among the 680,000 artifacts kept at the NPM, Digimax then transformed the significance of the artifacts into animated stories. This study found that the boundary objects were used to perform translation in both of these two processes, which enabled the exchange of knowledge and completion of the necessary tasks, as described below:

1. Significance of artifacts

When selecting artifacts to serve as the main characters, Digimax sent personnel on numerous visits to the NPM, and also purchased many artifact books and publications to serve as reference materials. The company also invited international partners to examine the artifacts from different perspectives. Digimax ultimately selected artifacts felt to be suitable for both domestic and foreign viewers, including a Song Dynasty ceramic child pillow, an Eastern Han jade pi-hsieh evil-averting beast, and a Song Dynasty jade duck, as the film's main characters. In the eyes of the NPM's researchers, the significance of the three artifacts was embodied in their form, material, and relationship with the emperor; this information is summarized in Table 1.

TABLE 1 SIGNIFICANCE OF THE THREE NPM ARTIFACTS

Name	Photo	Form	Material	Significance
Ceramic child pillow		Has the form of an infant lying on its front on a mat and facing to the side. The infant's back serves as a pillow.	White porcelain. The body of the artifact features the molding and decorative techniques seen in Ding Kiln ware, and the work is both powerful and appealing. The charming baby expresses an impression of wealth and honor.	The Qing Dynasty's Qian Long emperor likened this ceramic child pillow to the "alert pillows" used by the great emperors of past dynasties, and hoped it would remind him to be vigilant, diligent in caring for the people, cherish time, and not be negligent and indolent.
Jade pi-hsieh evil-averting beast		The jade pi-hsieh is an evil-averting beast with the form of a lion with wings. It is intended to ward off any evil influences.	Popular during the Han Dynasty, pi-hsieh are typically depicted as beasts with wings; this form may have originally been transmitted from Western Asia.	Apart from satisfying the Qian Long emperor's love of beauty, this jade pi-hsieh was acquired by the Imperial Palace as a symbol of orthodoxy and legitimate authority.
Jade duck		The duck's head, breast, and two feet are brown, and its tail is plump and upraised.	Made from yellow nephrite, this duck's plump and upraised tail gives it a perky, appealing appearance, and it gives viewers a natural and charming impression.	In line with the Neoconfucian precept "to investigate things and extend knowledge to the utmost," the people of the Song Dynasty observed nature and studied natural principles. This jade duck is a fine example of Song craftsmanship.

2. Animated story

The story is the key to successful animation, and a good story requires clever script writing. Digimax originally planned to make the NPM artifacts' "trip south" (when they were rescued from the invading Japanese and Red Chinese) the theme of the animation, because this saga distinguishes the NPM from the world's other major museums. However, since people at the NPM felt that since one of the film's goals would be to attract people to the Taipei NPM, the setting should be the Taipei NPM, and the contents should emphasize introduction to the artifacts. The NPM was undergoing a major renovation project at the time, and it was hoped that this film would highlight the NPM's charming new look following renovation.

The NPM provided the services of artifact experts in its artifact and painting/calligraphy departments. These individuals, along with Digimax's employees, formed a project task force. The NPM's personnel bore responsibility for providing their professional information and views to Digimax, which bore responsibility for creative decisions and animation. Digimax hoped to make the story's main character appealing to viewers, and he had to have a mouth (in order to speak), eyes (in order to express emotions), and limbs enabling him to perform various actions. While these standards were adequate to meet animation production requirements, this was not sufficient. Another important criterion was that a number of articles concerning these three artifacts had been published in NPM's monthly, which indicated that researchers were interested in these artifacts. In addition, in accordance with the script, the characters based on the three artifacts were designed to respectively play the wise person, the leading role, and the clown. Vice President Wu of Digimax, who was in charge of this project, noted:

> "*We did a lot of homework, bought an assortment of Chinese and English information and enlisted the help of some foreign acquaintances in choosing things that Chinese could accept and foreigners could understand. Because it was character-based animation, artifacts would be more appealing, while calligraphy and paintings would be harder to express. It would be easier for artifacts to perform, since they have faces, hands, and legs. These three objects are among the true treasures of the National Palace Museum. They were listed in the National Palace Museum's Research Monthly and were chosen by the researchers. These three play the three characters of the wise person, leading role, and clown, which are the best choices for introducing the National Palace Museum.*"

The animated story in the final version of *Adventures in the NPM* centered on a search for Katydid on the Jade Cabbage. The process of exploration through the museum in the search for Katydid provides opportunities to introduce five of the NPM's other major artifacts, including the female figurine, and emphasis is placed on the artifacts' significance and history. Table 2 provides a summary of the film's plot.

TABLE 2 SUMMARY OF PLOT

Main plot elements	Name of character/artifact	Personality/ behavior	Plot focal points
Main characters appear	Jade duck, ceramic child pillow, jade pi-hsieh	The jade duck is uncultured, the ceramic child pillow is mischievous, and the jade pi-hsieh is dignified	The different personalities of the main characters are pointed out as a reference for the subsequent plot action
Katydid disappears	The ceramic child pillow pulls out Katydid from the Jade Cabbage	Katydid runs off	After the well-known Jade Cabbage attracts viewers' interest, Katydid introduces the artifacts, which provides the main theme of the story
Journey of exploration through the museum	Female figurine, oblation tsun, jade gui tablet with human mask pattern, gilt bronze Shakyamuni Buddha, and Tibetan Dragon Sutra	Each artifact derives its personality from its characteristics	The artifacts' notable details are explained in an interesting manner: The female figurine's hairstyle, the oblation tsun's use as a drinking vessel, the mystery of the jade gui tablet, the Buddha's compassion, and the Tibetan Dragon Sutra's rarity
Storeroom	Another ceramic child pillow, history of the NPM's southward journey (snowstorm at Qinling)	Perils of the southward journey	Explanation of the importance of the artefacts' southward journey to the NPM (how the artifacts arrived at the NPM)
Conclusion	The artifacts returned to their respective places	Return to everyday reality/normalcy	The museum is about to open

3. Use of boundary objects in the translation of artifact knowledge into the animation story

The artifact knowledge obtained from the NPM researchers forms the basis of the animated story, and the creativity and animation skills of Digimax's employees are used fully in the film. However, as the work proceeds, a boundary appears between the knowledge of the two parties. Table 3 displays differences in the two parties' knowledge.

This study discovered that boundary objects served as cross-boundary communication interfaces in the completion of this work, and thus played a translation role. These boundary objects were connected with either the artifacts or the story, and included the artefacts' shapes or materials, the displays within the museum, and the significance of the artifacts, as well as the script, story concept, and draft animation (see Table 4). Vice President Wu stated:

> *"The researchers at the National Palace Museum provided us with in-depth artifact knowledge, which was given to the story team. The production was simple but it wasn't poorly done. After we completed something we sent it back to the researchers, and if the researchers thought it was too different from the original we continued to work on it until it was right. We were the one who worked on creative aspects, and the researchers provided us knowledge, while ensuring that our creative ideas were not too different from the original history."*

TABLE 3 ARTIFACT KNOWLEDGE OF RESEARCHERS AND ANIMATORS

Artifact name	Researchers	Animators
Ceramic child pillow	This Song Dynasty Ding Kiln work is an everyday article It represents a successful child, and expresses a wish for sons and many descendants.	The ceramic child pillow is the main character in the story, and is curious and not wise in the ways of the world
Jade pi-hsieh evil-averting beast	This mythical beast from the Han Dynasty was once part of the Emperor's collection. People once hoped to rely on the beast's magical power to dispel evil.	The wise character in the story. Highlighting techniques are used to emphasize the jade article's warm, translucent material.
Jade duck	Song/Ming dynasty, made from yellow nephrite, it is inferred that the brown parts have been dyed	The story's clown. Clumsy and slow-witted, the duck often causes trouble.

TABLE 4 TRANSLATION BOUNDARY OBJECTS

Type	Boundary object	Function	Explanation
Artifact type	Artifacts in the museum and large photographs of details	Appearance and materials of artifacts vs. appearance and styling of characters	NPM let the Digimax team observe the material and texture of the museum's artifacts, and examine details visible under strong lighting. Large photographs were taken of details, allowing the designs of the animated characters to approximate the actual artifacts at the NPM.
	Recorded images taken inside the NPM (including video and photographs)	The museum's internal furnishings and lines of movement vs. the setting of the animated film	The NPM authorized the Digimax team to record the museum's lines of movement, the style of display cases, large display panels, signs, locations of power outlets, the locations of various articles, and the actual lighting. The Digimax team used the resulting images to decide how to create a more realistic animated setting (most of the animated film was set inside the NPM), and also to facilitate production of 3-D models.
	NPM Monthly	Significance of artifacts vs. personality of characters	The content of this official NPM publication consists largely of articles reporting the results of research on artifacts in the museum. Digimax judged the importance and significance of artifacts based on articles in this publication, and used the significance of the artifacts as a basis for creating the script.
Story type	Storyboards	Text concept of the script vs. visual concept of the animation	The setting of materials and frameworks proceeded in tandem with the production of storyboards and 3-D models. The director transformed the text concept of the script into a visual concept, represented like a comic book. This allowed the NPM researchers and the production team to understand the story content and its direction as a whole, so that a consensus could be reached. These tasks were completed following an arduous process lasting a half-year.
	3-D dynamic script (first draft)	First draft of animation	Using the storyboards as a blueprint, in conjunction with the 3-D models and scenes, splicing was used to determine the time of each scene, camera movement, and the characters' locations and movements. This completed the first draft of the animation. This first draft was created when a consensus emerged concerning the storyboards, which was when the NPM personnel and Digimax team reached a state of agreement.

Transformation: Transforming different work norms

The museum's work norms focus on "things," since the preservation and management of artifacts is the NPM's most important mission. In contrast, Digimax and other animation firms emphasize "people" or "specialized technology." Because of this, the two parties had to confront knowledge boundaries arising from different work norms during the course of their collaboration, and required boundary objects to perform transformation. These boundary objects included works by animation personnel and a digital archives system.

The NPM's researchers focus their attention on artifacts, and feel a deep affection for the museum's artifacts, which they regard as being sacred and inviolable. As a consequence, when manipulating the characters based on artifacts, they had to pay close attention to balancing entertainment with positive images. It is worth mentioning that the NPM director introduced new work norms while *Adventures in the NPM* was being produced, and looked for ways to shift from artifact-centered thinking to people-centered thinking. One concrete example of this shift was the search for world-class personnel to participate in the *Adventures in the NPM* project.

With regard to the screenwriter and director, the NPM hired Canadian screenwriter Desmond Crofton, who specializes in promotional films, to help select the characters and provide creative ideas. Tom Teng, who works in Hollywood, was hired to assist with editing. Because the story was originally centered on the artifacts' southward journey, and emphasis was placed on action, prominent French director and action film specialist Gérard Pirès[1] was chosen as director. Afterwards, responding to the changing story concept, American Hollywood animation director Tom Sito[2] was hired to complete production.

With regard to 3-D production technology, Digimax hired Teddy Yang, who lives in the United States, has worked in Hollywood for over a decade, and served as the animation director for the DreamWorks film "Shark Tale," to serve as the film's special effects director. As for technology R&D, Digimax possesses Taiwan's most professional 3-D animation R&D team, and many members hold master's and PhD degrees in computer graphics from Taiwan's finest universities. The works of these talents played a very important role when communicating how these individuals were chosen, and their works provided the case task force with a means of confirming whether the selected persons could achieve the standards and style expected by the two parties.

Another type of boundary object promoting changes in work norms consisted of the digital archives system that the museum had recently established. This system was part of a key project promoted by the government, and was being used by the NPM to digitize and store images of the museum's artifacts. Participation in this project added the item of "creation of virtual images" to the NPM researchers' original mission of "preserving physical artifacts." Because of the increased workload entailed by this project, the NPM hired close to 100 contract employees with professional qualifications quite different from those of existing personnel. The new personnel brought new working, new values, and new norms with them, and their integration with the NPM's existing personnel established an excellent foundation for the creation of *Adventures in the NPM*. Lin Kuo-ping, who participated in the NPM's digital archives project, had this to say:

> *"The National Palace Museum's digital archives could not be outsourced, and had to be done inside the museum. This was because artifacts were not allowed to leave the museum, and must stay inside the storerooms, which were our studio was located. Individuals and experts were sent in, and equipment was bought and brought in there. The entire process paid meticulous attention to the conservation of the artifacts."*

Transcendence: Transcending the symbolic meaning of artifacts to attain the cultural meaning

While the members of the project team organized by NPM and Digimax diverged greatly in terms of their professional backgrounds, knowledge systems, and work norms, they were ultimately able to successfully complete *Adventures in the NPM*. This study discovered that the third way that boundary objects were used in knowledge sharing involves the transformation of conflicts into creativity, which ultimately resulted in transcendence of the artifacts' symbolic meaning and attainment of their cultural meaning. This study terms this process transcendence. Boundary objects used for this purpose included animation technology, laws and regulations, and conference records.

After large amounts of research and planning work, before submitting a proposal, Digimax performed computer drawing and modeling of the selected artifacts, designed a background for the story, and introduced story processes. When submitting a proposal at the end of 2005, Digimax also

TABLE 5 TRANSFORMATION BOUNDARY OBJECTS

Type	Boundary object	Function and explanation
Image data	Works by professional personnel	Enabled the two parties to achieve a consensus concerning artistic expression standards and style
Information system	Digital archives	The transformation of artifacts into digital images enabled the case task force to get involved in animation production, and also transforms the work norms of the NPM personnel

[1]A well-known French director, has directed such major films as the 1998 movie "Taxi."
[2]A prominent Hollywood animation director; honorary chairman of the Hollywood Animation Association.

submitted R&D and design results connected with the proposal. This ensured that the NPM researchers had confidence in Digimax's world-class animation capabilities, and its ability to faithfully represent the fine quality and cultural substance of the NPM's artifacts. In short, Digimax worked to ensure trust between all project personnel, and created two types of trust: Trust that modern technology could do the job, and trust that the case task force could complete the project. President Huang said:

> *"Back then the researchers didn't know much about technology, and were worried that we might defile the artifacts or might not be able to represent them faithfully. They invested a lot of time in communication and interaction with our staff. I think this project allowed them to be able to accept new technology and significantly increased their trust in new technology's ability to interpret artifacts. The trust I am talking about here is their trust in us and the technology. Their trust in modern technology reached this level!"*

The greatest concern the NPM researchers had about *Adventures in the NPM* was that the real appearance and quality of the artifacts be faithfully represented. To ease the researchers' misgivings, Digimax provided two images at a conference: One image consisted of a high-resolution photograph of an artifact, and the other consisted of an emulated image produced using computer animation technology using the same photographic angle and lighting. The researchers at the meeting were asked to guess which was the real photograph, but were unable to do so. This incident also increased NPM's trust in Digimax's technology.

The boundary object of information technology created trust. Digimax developed various utility programs to express the quality of the different artifacts. For instance, in the case of jade, the film contained the various types of jade used in the Fish-Creature Flower Holder, the Jade Cabbage, the jade duck, and the pi-hsieh, and each had different qualities. Digimax consequently developed different programs to deal with these types of jade. In addition, Digimax also invited the NPM's experts to provide assistance. Because the researchers spent every day together with the artifacts, Digimax felt that they could provide the most accurate appraisal of Digimax's materials. The long and intensive process of collaboration included comparison of real objects and animation, location of subtle differences, repeated adjustment, and further review. The artifact knowledge possessed by the NPM personnel was the key to obtaining value from Digimax's technology.

Digimax's R&D team developed many new technologies specifically for this project. Apart from its aforementioned methods of representing the quality of jade, it also developed "3-D highlighting technology for traditional Chinese paintings," which used 3-D technology to create 3-D models with the same proportions and styling as the original works, and then applied a sub-surface scattering highlighting technique to represent the material. Digimax also used occlusion and HDRI techniques to fully capture the variations in lighting inside the museum, and then employed a program to calculate the lighting and colors in the film on the basis of photographs. These methods were developed to ensure that the film faithfully represented the look and atmosphere of every corner of the NPM.

This instance of collaboration between two very different organizations resulted in great conflicts and many contradictions. The project conferences held during that period were all supervised by the NPM director, who used leadership techniques to transform conflict into positive creative energy, and she also bore responsibility for decisions. This was a key element ensuring that the heterogeneous cooperation between the two parties was successful. The former director expressed:

> *"There were a lot of clashes between us, and the sparks really flew. Nevertheless, the outcomes were astonishing, surpassing our expectations, when we channeled our energies in a positive direction. Of course, if you are not willing to collaborate, and wish to stay within your own field of expertise, you can be your own authority, and you can always stay within your domain. But when it comes time to integrate heterogeneous areas, this inevitably creates many challenges."*

The former director led the project team with the thinking of an artist, and the resulting work was *Adventures in the NPM*. Each conference constituted part of the creative process. Thanks to appropriate participation, involvement, and stimulation, each conference generated even more sparks of creative energy, which helped the project to proceed successfully. This study suggests that this type of dynamic team process was the only way to liberate the artifacts from knowledge, and transform them into creative works with social functions (see boundaries in Table 6).

TABLE 6 TRANSCENDING BOUNDARY OBJECTS

Type	Boundary object	Function and explanation
Animated character type	Sketches	Digimax designed the characters on the basis of their importance to the NPM and their representativeness, as well as to make them appealing. In order to meet the NPM's high standards of quality and historical authenticity, the Digimax team created more than 1,000 sketches over a period of more than four months during the creative design process.
	Clay models	A professional sculptor on the Digimax team created clay models based on the finalized characters portrayed in the design sketches. The characters were painted after being represented using reinforced resin, and used in final confirmation of the characters' appearance.
	3-D models	Models were made of characters, settings, and props. In order to meet the needs of the script, realistic and caricature 3-D models were made of all major characters. The Digimax team used 3-D technology to make 3-D model reproductions with the same shapes and proportions as the originals. After NPM personnel saw 3-D models of the animated film's settings, they felt they were too real and asked Digimax to beautify some of the floor defects that appeared in the settings.

V. DISCUSSION AND RECOMMENDATIONS

A. Theoretical implications

Cross-boundary innovation inevitably encounters various challenges. Using the perspective of knowledge management and boundary objects, this study discovered three types of object-mediated innovation, namely translation, transformation, and transcendence. Among these, translation occurring when the significance of an object is used as a basis for communication has been widely discussed in the literature [8]. In addition, the transformation of work norms can ensure that the exchange of knowledge will not be constrained by existing work norms. Furthermore, the transcendence of symbolic meaning in order to attain cultural meaning is similar to the concept of creative abrasion (Leonard-Barton, 1995), but has been seldom discussed in past literature. This study suggests that investigation of the nature of knowledge boundaries may be a key element in resolving difficulties hindering cross-boundary innovation.

This study has also discovered that, apart from boundary objects existing in the form of working documents, image documents produced using high-tech equipment can also serve as important boundary objects. It was further found that "emulation" can be of very important function of boundary objects. For instance, the ability to faithfully emulate the appearance and material of various artifacts established trust and confidence among members of the project task force, and thereby eliminated unnecessary knowledge boundaries. Furthermore, with regard to the possible personalities, behavior, and movements of the characters based on the artifacts, the working documents concerning the animated characters facilitated the exhibition of knowledge between the two parties, and played an important role in easing misgivings.

B. Practical implications

The key to development of cultural and creative industries is to use creativity to add value to culture, which will inevitably lead to the problems facing cross-boundary communication in the process of innovation. This study analyzed a process in which ancient artifacts were transformed into modern animation, which shed light on how to embody culture, and many boundaries were developed, which facilitated the transformation and dissemination of cultural meaning.

This study found some insights concerning the NPM. While the NPM is considered a driver of cultural and creative industries, many gifts modeled on artifacts have low levels of added value, and are unlikely to enjoy thriving sales. The great significance this project had for the NPM was due to the fact that it transformed the abstruse language of ancient artifacts into the language of animation, which can be understood by young and old alike. This project thus certainly points the way to an important future cultural creativity strategy for the NPM.

VI. CONCLUSIONS

This study took *Adventures in the NPM*, which was jointly produced by Digimax and the National Palace Museum (NPM), as its subject, and investigated how to achieve cross-boundary innovation. The study discovered three cross-boundary innovation processes, namely translation, transformation, and transcendence. Knowledge must be translated to resolve semantic differences in communication, and work norms must be transformed to resolve restrictions on knowledge. Transcendence involves the use of boundary objects to establish trust, tolerate conflict, and achieve a creative state. Knowledge is the basis of innovation, and cross-boundary knowledge is a source of innovation. As for how to transcend knowledge boundaries, this study discovered that one solution is to investigate the nature of boundaries and locate possible boundary objects.

REFERENCES

[1] Adler, P. S.; "Interdepartmental Interdependence and Coordination：The Case of the Design/Manufacturing Interface," *Organization Science*, vol.6, No.2, pp.147-167, 1995.

[2] Bechky, B. A.; "Sharing meaning across occupational communities: The transformation of knowledge on a production floor," *Organization Science*, Vol.14, pp. 312-330, 2003.

[3] Bechky, B. A.; *Crossing Occupational Boundaries: Communication and Learning on a Production Floor*, unpublished Ph.D. dissertation, Stanford University, CA, 1999.

[4] Bowker, G., Timmermans, S., and Star, S. L.; "Infrastructure and Organizational Transformations: Classifying Nurses' Work," in Orlikowski, W. J., Walsham, G., Jones, M. R., & DeGross, J. I. (eds.), *Information Technology and Changes in Organizational Work*, 344-369. London: Chapman and Hall, 1996.

[5] Briers, M., and Chua, W. F.; " The Role of Actor-Networks and Boundary Objects in Management Accounting Change: A Field Study of an Implementation of Activity-Based Costing," *Accounting, Organizations and Society*, Vol.26, No.3, pp. 237-269, 2001.

[6] Carlile, P. R.; "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development," *Organization Science*, Vol.13, No.4, pp.442-455, 2002.

[7] Carlile, P. R.; "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries," *Organization Science*, Vol.15, No. 5, pp. 555-568, 2004.

[8] Ciborra, C. U., and Andreu, R. "Knowledge across Boundaries: Managing Knowledge in Distributed Organizations," In Choo, C. W. & Bontis, N. (Eds.) *The Strategic Management of Intellectual Capital and Organizational Knowledge,* 575-586. Oxford: Oxford University, 2002.

[9] Clark, K. B., and Fujimoto, T.; *Product Development Performance*, Harvard Business School Press, Boston, MA, 1991.

[10] Cohen, W. M., and Levinthal, D. A.; "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly*, Vol.35, No.1, pp.128-152, 1990.

[11] Dougherty, D.; Interpretive barriers to successful product innovation in large firms. *Organization Science*, Vol.3, pp.179-202, 1992.

[12] Dyer, J. H. and Singh, H.; "The Relational View: Cooperative Strategy and Sources of Inter-organizational Competitive Advantage," *Academy of Management Review*, Vol.23, No.4, pp. 660-679, 1998.

[13] Fetterman, D. M.; *Foundations of empowerment evaluation*. Thousand Oaks, CA: Sage, 2000.

[14] Fiol, C. M.; "Consensus, diversity and learning in organizations," *Organization Science*, Vol.5, pp.403-420, 1994.

[15] Gilbert , N., and Gordey-Hayes, N.; "Understanding The Process of Knowledge transfer to Achieve Successful Technological Innovation," *Technovation*, Vol.16, No.6, pp.301-312, 1996.

[16] Jelinek, M., C., and Schoonhoven, G. B.; *The Innovation Marathon Lessons From High Technology Firms*. Blackwell Publishers, Oxford, UK, 1990.

[17] Kogut, B., and Zander, U.; "Knowledge of the Firm, Combinative capabilities, and the replication of technology," *Organization Science*, Vol.3, No.3, pp.383-397, 1992.

[18] Leonard-Barton, D.; "Inanimate integrators: a block of wood speaks," *Design Management Journal*, Vol.2, No.3, pp.61-67, 1991.

[19] Leonard-Barton, D.; *Well springs of knowledge*, Harvard business school press, Boston, 1995.

[20] Levina, N., and Orlikowski, W. J.; "Understanding shifting power relations within and across organizations: A critical genre analysis," *Academy of Management Journal*, Vol.52, No.4, pp. 672-703, 2009.

[21] Nelson, R. R.; "Why do firms differ and how does it matter," *Strategic Management Journal*, Vol.12, pp.61-74, 1991.

[22] Nelson, R. R., and Winter, S. G.; *An Evolutionary Theory of Economic Change*, Belknap Press, Cambridge: MA, 1982.

[23] Nonaka, I.; "The knowledge-creating company," *Harvard Business Review*, November-December, pp.96-104, 1991.

[24] Nonaka, I., A.; "Dynamic Theory of Organizational Knowledge Creation," *Organization Science*, Vol.5, No.1, pp.14-37, 1994.

[25] Nonaka, I., and Takeuchi, H.; *The Knowledge Creating Company*, Oxford University Press, New York, 1995.

[26] Orlikowski, W. J.; "Using technology and Constituting structures: a practice lens for studying technology in organizations," *Organization Science*, Vol.4, No.4, pp.404-428, 2000.

[27] Orlikowski, W. J.; "Knowing in Practice: Enacting a Collective Capability in Distributed Organizing," *Organization Science*, Vol.13, No.3, 249-273, 2002.

[28] Pawlowski, S. D., and Robey, D.; "Bridging User Organizations: Knowledge Brokering and the Work of Information Technology Professional," *MIS Quarterly*, Vol.28, No.4, pp.645-672, 2004.

[29] Pitt, M., and MacVaugh, J.; "Knowledge management for new product development," *Journal of Knowledge Management*, Vol.12, No.4, pp.101–116, 2008.

[30] Powell, W. W.; "Neither Market nor Hierarchy: Network Forms of Organization," *Research in Organizational Behavior*, Vol.12, pp. 295-336, 1990.

[31] Quinn, J. B., Anderson, P. and Finkelstein, S.; "Managing professional intellect: Making the most of the best," *Harvard Business Review*, Vol.74, No.2, pp.71-80, 1996.

[32] Sanchez, R.; "Managing articulated knowledge in competence-based competition," in Sanchez, R., Heene, A. & Thomas, H. (eds.), *Strategic Learning and Knowledge Management*. Chichester: John Wiley, 1997.

[33] Simonin, B. L.; "Ambiguity and The Process Of Knowledge Transfer In Strategic Alliances," *Strategic Management Journal*, Vol.20, No.7, pp. 595-623, 1999.

[34] Star, S. L., and Griesemer, J. R.; "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology," *Social Studies of Science*, Vol.19, pp. 387-420, 1989.

[35] Sutton, R. I., and Hargadon, A.; "Brainstorming groups in context: effectiveness in product design firm," *Administrative Science Quarterly*, Vol.41, No.4, pp.685-718, 1996.

[36] Tortoriello, M., and Krackhardt, D.; "Activating cross-boundary knowledge: the role of simmelian ties in the generation of innovations," *Academy of Management Journal*, Vol. 53, No.1, pp.167-181, 2010.

[37] Walsham, G.; "Interpretive case studies in IS research: nature and method," *European Journal of Information Systems*, Vol.4, pp.74-81, 1995.

[38] Yin, R. K.; *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage, 2009.