# A Convergence Framework for Developing Contents in Museum Exhibition

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# A Convergence Framework for Developing Contents in Museum Exhibition

（博物館における展示コンテンツの開発のための融合フレームワークに関する研究）

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# I Introduction

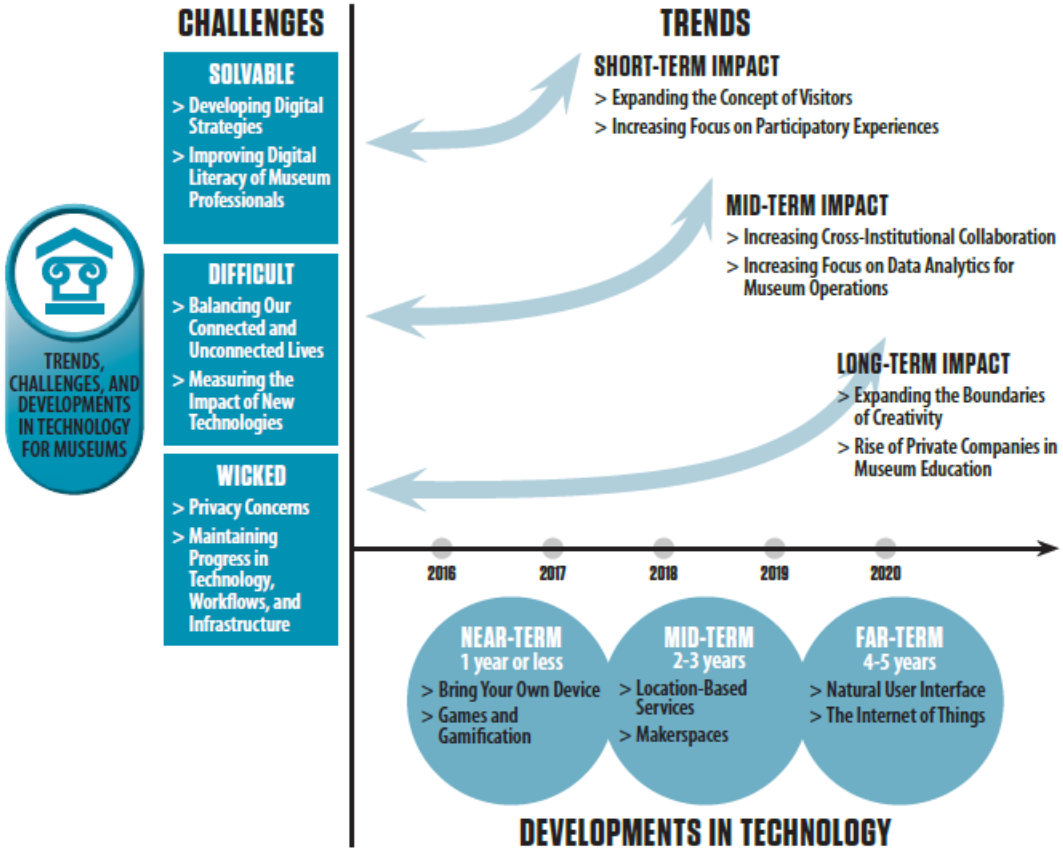
## 1. Background of the study

### 1.1 Convergent industrial structure and the evolving museum environment

The fourth industrial revolution—Industry 4.0—can be seen through the prism of tech innovation, manufacturing innovation, and platform-based service innovation. Industry 4.0 is powered by information and communications technology (ICT) to allow once-disconnected fields of knowledge to co-evolve via multidisciplinary convergence and brings about a variety of socio-economic and structural transformations. With an emphasis on platforms, soft power strategy gains more importance as a dominant force affecting our ecosystem and leads to a broader expansion of human-centered services based on platforms. Today, UX interface (user experience interface) that boosts convenience by leveraging user experience, recognition technology that reads all five senses, etc. are emerging fast as the new news in the market. These new technologies maximize the usability of IT by presenting a more convenient and pleasant user experience. As industries are being reshaped by services needed for human, the ever-more-blurry line between conventional industries with similar services turns into a convergent environment and generates unexpected synergetic effects through newly-emerging industries.

Against such a backdrop, museums are going through a new paradigm of change. The museum edition of *2016 Horizon Report* published by the New Media Consortium offers a step-by-step explanation of key trends that trigger the adoption of new museum technologies. The Report identifies "Expanding the Concept of Visitors" and "Increasing Focus on Participatory Experiences" as having a short-term impact that will accelerate the adoption of educational and interpretive technology in museums over the next one to two years. "Increasing Cross-Institution Collaboration" and "Increasing Focus on Data Analytics for Museum Operations" are mid-term impact trends, expected to drive technology use over the next three to five years; meanwhile, "Expanding the Boundaries of Creativity" and

"Rise of Private Companies in Museum Education" have been identified as trends with long-term impact, anticipated to shape cultural heritage institutions for the next five years or more.[1]




[Figure 1] Key Trends Accelerating Technology Adoption in Museums[2]

The most-talked-about theme of the 21st century exhibition is "convergence". A wild wind of change is blowing to transform the exhibition content of museums in Korea and abroad. A case in point is a brand-new type of

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[1] The New Media Consortium. (2015*). It's here! The nmc horizon report>2015 museum edition.* Retrieved from https://www.nmc.org/news/its-here-the-nmc-horizon-report-2015-museum-edition

[2] Johnson, L., Adams Becker, S., Estrada, V., and Freeman, A. (2015). *NMC Horizon Report: 2015 Museum Edition*. Austin, Texas: The New Media Consortium.

exhibition techniques such as *exhibition content with the convergence of art and science* and *IT convergence*. Museums strive to break away from the old style and drive technological convergence to provide contents fitting for the 21st century. With the application of internet and mobile technologies, VR, etc., museums are driving dynamic innovations for their operations in general. On a nation-wide scale, numerous museums are committed to adopt convergence technologies in order to refine the quality of their exhibition.

In particular, the fourth space, exhibition storytelling, reality converged with VR game, media space, and the likes are rocking our notion of space on its head; museums are evolving in a way that their audience become engaged in the intended flow of exhibition as if they go through a complete story (story-telling) or create their own story by directly participating in the exhibition (story-making). To do so, museums are developing a variety of multimedia contents and utilize digital technologies so as to be equipped with the most optimal exhibition technique befitting the call of the 21st century. Therefore, in the near future, museums need to develop various exhibition contents that suit the taste of IT-savvy audience.

### 1.2 Focus on audience-centered experiential consumption

In the 21st century, museum has become an iconic institution of art and culture as it has rapidly expanded in number and grown in popularity. Traditionally, museums used to be all about collection and research. However, modern museums are met with increasing demands for its public role as a viable medium or provider of culture that satisfies people's craving for more delicate cultural experiences. Modern museums are expected to offer intellectual joy in a cozy atmosphere while serving as a cultural space where audience can not only find enough room for play, fun, and excitement, but also breathe and communicate with the past.

It is particularly notable that there has been a major shift of focus from supplier to consumer. In the past, the highest value for museums was to deliver a message of artistic or historical importance to audience. In contrast, modern museums tend to make *artistic experience and knowledge* more easily

understandable and approachable. In other words, museums have come forward to better communicate with audience, sharing fun facts rather than preaching noble knowledge about art, culture and history.

Such attention to "communicative function" is considered as a key driver for changing museums; it means that museums should be able to offer more than simple souvenirs and move outwards to communicate with audience and design their contents from the perspective of consumers. The essence of a consumer-centered exhibition is to fully grasp what the audience wants and maximize their personal experience. And one of the most favored tools for this is convergence technology. Museums have started to rely on various digital technologies to provide audience with convenient information or add an interesting space for communication and experience to their exhibitions or educational programs. Appealing to cultural sensibilities through technology is seen as a game changer in the exhibition industry which has already reached its maturity phase. In this context, an increasing number of exhibitions and educational programs are designed with unique sophistication to please the aesthetic sensibilities of audience and maximize their convenience and satisfaction.

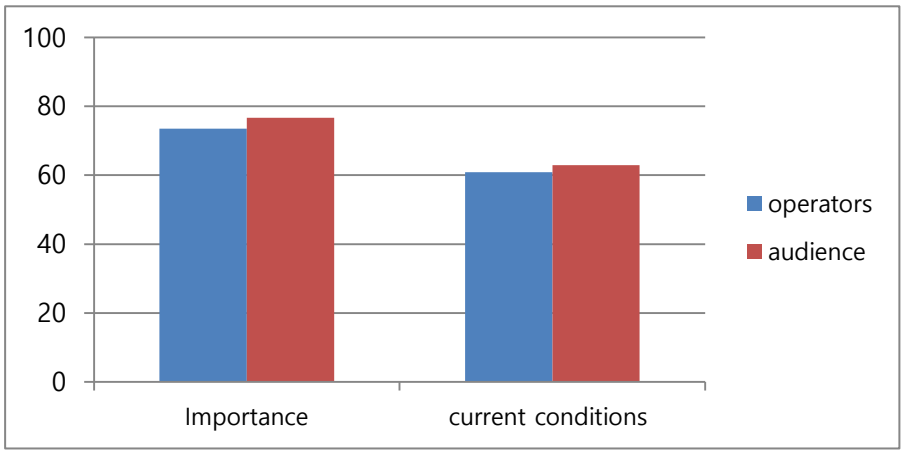
To suit the delicate taste of audience, museums have begun to apply UX technology to their exhibitions and educational programs. Emotional UX technology is a type of convergence technology that maximizes such values as user's subjective experience of product or service, emotion, definition, convenience, efficiency, etc. In other words, emotional UX technology is the entirety of technologies developed from user's perspective, not supplier's, and is a user interaction technology that enhances the recognition of/response to user's product and service.

Such new changes in the function and role of museum and exhibition techniques have been actively studied by scholars and researchers with a rising interest in seeking a better means of expression to deliver the exhibition message based on the transfer of information and in boosting communication with audience.

### 1.3 Necessity of high-quality exhibition content

Digital technologies have been variously applied to museums lately. In terms of feasibility, however, the adoption of new technology is always confronted with doubts due to the intermittent use of digital technology and the vast amount of budgets needed for just a single project. To make matters worse, it is not just museums that cherish the value of audience experience. Many other types of cultural institutions have also entered the fray of *adopting new technologies* and churned out too many similar contents, thus diluting the differentiation strategy of museum. Exhibition techniques have been too slow to keep pace with the fast-changing social environment of latest technologies and failed to attract prospective audience over time, hence leading to the operational concerns of museums. And now, questions are being raised about the original purpose of museum per se—which is greatly undermining the reason for the historical importance of museums.

According to *The 2016 Pilot Survey for the Analysis of Revisit Rate and Social Class of National and Public Museum/Gallery Audience*, operators and audience both believe that it is highly important to provide exhibition contents in which audience can directly participate, but describe that their satisfaction for the current conditions is quite low.




[Figure 2] The survey for participatory contents[3]

Cutting-edge exhibition technologies may have the power to allure audience more effectively. Digital media used in an exhibition makes up for the simplicity of analogue exhibition. However, it is not desirable to merely wow the audience with a fancy technology without putting it into the right perspective. No matter how approachable the content becomes due to the advancement of technology and media, it won't be consumed properly if it lacks the right understanding of the subject, background, etc.

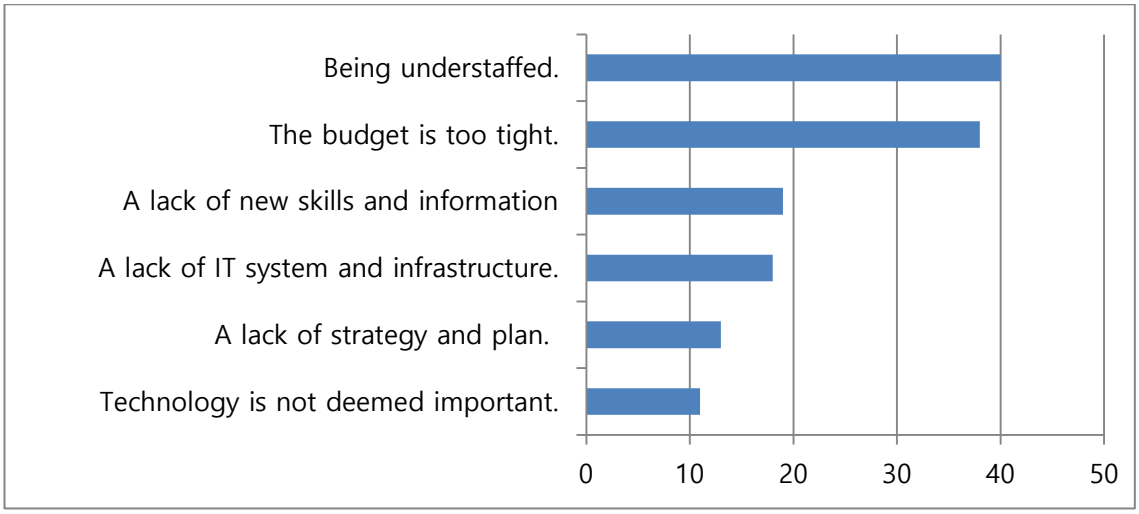
Museum should be selective in using technologies in order to display its content in the most effective way. The technology in question may not be the latest or the most advanced. What matters here is that the content materialized by the technology should be most effectively understood by audience. At museums, a new technology comes and goes quickly due to the advent of another new technology. But the message and information delivered by technology won't disappear as easily. Therefore, museums should find the most suitable technology for the message and information they intend to deliver rather than recklessly chasing technological advancements. This is how museums can set itself apart from other institutions as a custodian of high-quality contents which provide contemporary people with the

[3] Korean Culture & Tourism Institute. (2016). *The Pilot Survey for the Analysis of Revisit Rate and Social Class of National and Public Museum/Gallery Audience*. Retrieved from http://kcti.re.kr/03_1.dmw?method=view&reportId=0%20&reportSeq=1185

utmost cultural and artistic experience based on the proud heritage of civilization. In an era when it is easier than ever to share individual information and messages, it is museums that harbor a rich potential to transform the inherent message of art and culture into an optimal content in the best possible environment.

### 1.4 Necessity of building strategies for an efficient adoption of technology

According to *The 2016 Survey on the Current Status of Smart Convergence Environment of National/Public Museums and Galleries*, the limitations that hamper the application of digital technologies and the establishment of smart environment at museums and galleries in Korea were as follow.




[Figure 3] The rankings for the limitations hindering the application of digital technology[4]

As indicated by the aforementioned survey result, understaffing and tight budgets are weighing down on the adoption of new technologies at museums. Another problem is attributable to a lack of strategy and infrastructure. A solution

[4] Korean Culture & Tourism Institute. (2016). *A study on the functional improvement of National/Public Museums and Galleries on Smart Convergence Environment*. Retrieved from http://kcti.re.kr/03_1.dmw?method=view&reportId=0%20&reportSeq=1118

for this is to build a strategy for cooperation system. In a technologically-convergent environment, museums can offer a new and powerful ICT experience to audience by leveraging its collections as original sources. This requires more human resources than curators who are merely familiar with the conventional museum environment. There is little room in the legal requirements for curator to make it possible to appoint as museum curators those who have adeptly adjusted to the digital environment or have been engaged in an industry related to digital technologies. For this reason, most of the museums provide their collections as original sources to external developers for digital content production. As a result, as mentioned above, digital contents with a showy technology and a dull message are mass-produced.

As a sharing platform of cultural content, a museum should establish a collaboration model to work with professional curators, designers, and technicians specialized in content development and management. These individual specialists should not only possess convergence skills and expertise, but also have a common understanding of why convergence is needed based on pertinent research. The purpose of convergence study is to generate new ideas and knowledge from an integrated perspective by sharing multidisciplinary knowledge and to solve a problem through the collaboration of professionals from various fields. To adapt to a new digital environment, museums should fully harness its capacity and strengths to build a convergence strategy framework (e.g. a specific guideline based on multidisciplinary expertise). With outcomes generated through such a framework, museums will be able to reinforce its functions as a more attractive space of art and culture.

## 2. Purpose of the study

Application of new digital tools and technologies to museum exhibition is bound to change relevant development methodologies and the content and essence of exhibition design. Developing content from museum's cultural resources is a complex process of turning original sources into an intermediate content and demonstrating it through an exhibition. However, the logical grounds for such content development have been separately discussed by experts in diverse fields including technology, design, humanities, and etc. and there has been a lack of integrated research. Therefore, this research aims to suggest a convergence framework that combines the strengths of methodologies based on the theoretical foundation of various fields. Also, beyond simply proposing the convergence framework as a viable solution, this research aims to ensure that the essential value of audience-centered cultural service is properly expressed in the course of cultural and technological convergence as a result of the framework. Furthermore, this research will confirm the validity of convergence framework by applying it to an actual case before suggesting them as a strategic alternative for collaboration process. The fundamental purpose of this research is to create a positively-reinforcing cycle for sustainable exhibition content development. The following is the specific action plan to achieve the purpose:

Firstly, predict the changes of museum exhibition design based on the digital convergence environment and analyze their characteristics so as to better understand the prerequisites for a convergence framework and relevant processes. Secondly, analyze the design convergence methodologies discussed in the field of humanities and business management and draw out significant implications for museum exhibition content development accordingly. Thirdly, suggest a convergence framework customized for tech-applied exhibition and validate the effectiveness of the framework by applying it to an actual project.

## 3. Methodology of the study

### 3.1 Scope of study

The main subject of this paper is *digital contented museum* which is meant to converge various original cultural contents of history, art, design, etc. with interactive media technologies such as AR, VR, GSI, game engine, sensing, display, etc. in a creative manner to exhibit the subsequent outcome in an offline space. Although sometimes defined as virtual museums, digital museums display separate contents to a website on the Internet and generate an electronic space by digitizing the partial functions of museum such as exhibition, research, PR, etc. on the website. In this research, the meaning of digitized relic content is confined to an exhibition displayed in a museum space with an aim for the two-way communication with audience.

At this point, clarification is needed on the notion of content. Byun (2015) maintains that the meaning and concept of content evolve in the digital era. Byun states that "the original meaning of content—a contained information—has expanded through the digital paradigm of a new era to create a semantic field of media-based contents. In a similar vein, information or data generated by a variety of software, program, or other technologies can be construed as part of the expanded definition of content." [5] This paper defines content as *information materialized by media technology system*. And *content development* is defined as a process in which the information curated for the purpose of museum exhibition is materialized through the right medium of visualization and formatting.

Lastly, the word convergence, mentioned in this research, should be defined. Recent scientific advancements have classified technology into engineering, design, manufacture and so on, thus segregating design and technology even further. This research recognizes the limits with this specialization and subdivision and focuses on the creative results that are derived from experiencing many different fields or

[5] Byun, Min-joo. (2010). *Contents Design.* CommunicationBooks Inc.

discussion between the educational systems. In other words, convergence can be defined as a strategy and process in which the pre-existing technology, service, and industry are integrated to create a much larger value, and could be applied in museum exhibitions. The convergence framework for developing the contents of museum exhibition is the specific methodology and tools based on the understanding of various fields such as curators, designers, and technicians.

### 3.2 Organization of study

Based on prior literature and research, the chapter 2 touches upon the changes of museum exhibition in digital environment with respect to the elements of exhibition, the characteristics of exhibition content, the process of communication, etc. and considers a list of items needed for the establishment of a development framework for museum exhibition content.

Secondly, the chapter 3 analyzes prior research models on convergence framework development through theoretical explorations and offers implications for the convergence framework intended by this research. In the field of humanities and design, *design methodology based on value recognition* and *social science-design convergence research model* are analyzed while in the field of business management and design, *lean advanced design process model* and *digital engagement framework* are analyzed.

Fourthly, the chapter 4 presents a development framework for museum exhibition content based on the analysis results on prior research and research models, suggesting a basic structure and process of framework and relevant methods and contents per phase.

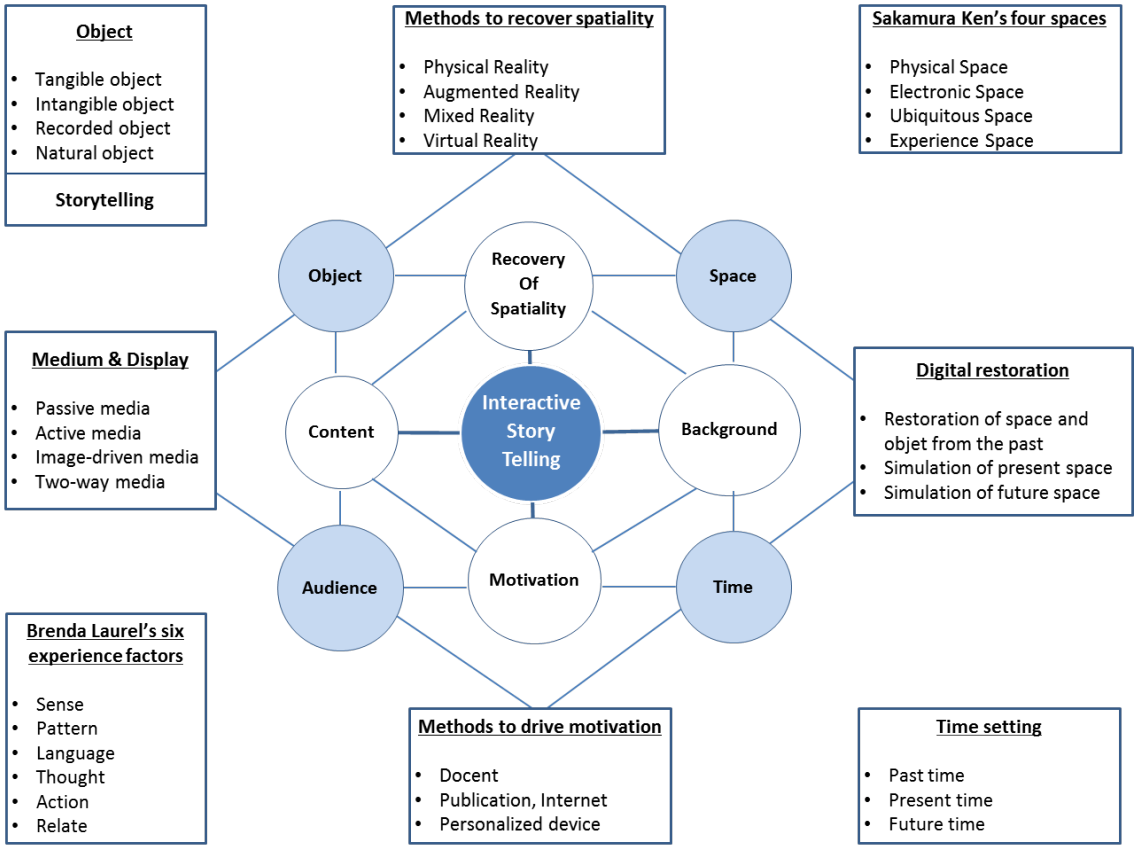
Fifthly, the chapter 5 verifies the effectiveness of the suggested content development framework by applying it to an actual project. This chapter explains the entire development process on how contents were planned, produced, and displayed at the Naju National Museum according to the framework and validates the feasibility of the framework by rating the level of audience satisfaction.

# II Theoretical consideration

## 1. Introduction and application of digital environment at museums

### 1.1 The elements of exhibition changed by the adoption of digital technologies

Adopting a digital technology to museum exhibition can be interpreted as an effort to explore a new form of exhibition and design or exhibition design based on a firm understanding of technology. According to the dictionary on exhibition studies published by *the Japan Association of Exhibition Studies*, exhibition planning is comprised of four basic elements: *object*, *space*, *person*, and *time*. And such elements can be combined into three categories of object and person, the relations between time & space and person. The notion of these four basic exhibition elements and combined elements are expanded by the adoption of digital technologies. Park (2014) describes an expanded concept of the four basic elements by graphing Sakamura Ken's notion of digital museum, Brenda Laurel's six experience factors, Janet Murray's four characteristics of digital environment, etc. into the following figure:




[Figure 4] The expanded concept of the four basic exhibition elements[6]

Exhibition objects are no longer confined to tangible items. A variety of both tangible and intangible objects are expanded by digital contents. Space consists of physical space, electronic space, and ubiquitous space that combines both physical and electronic space, and expands into experiential space where the experience of audience is maximized. The time setting for exhibition expands from present to past and future. The experience of audience expands in a way that they selectively accept six experience elements of human-computer activities. The expansion of exhibition elements also affects the relationship between individual elements. As for object and space, spatiality is recovered by digital technologies that realistically display spatial presence. In terms of space and time, temporal and

[6] Park, Jae-Young. (2014). Study on Storytelling of Digital Museum's Exhibition Content. *Humanities Contens*, 33, 149-183.

spatial backgrounds are brought back to life by restoring the space and objet from the past and simulating present or future space. As for audience and time, the motivation for accessing the time setting of exhibition is boosted by such means as personal guide, publication, internet homepage, or smartphone. Object and audience exchange contents via the display of medium including passive, active, image-driven, and two-way media. Such expansion of exhibition elements and their correlations is mainly driven by interactive storytelling.

### 1.2 Characteristics of digital technology-based exhibition content

Due to the complex application of various digital technologies to physical relics behind showcase, there have been changes to the characteristics of exhibition content which is the theme and the core information intended by the exhibition. Digital technology-based exhibition contents are characterized by three major traits: *experientiality*, *presence*, and *affordance*.

Firstly, *experientiality* is a trait that enables audience to understand the theme of exhibition through their active behaviors; in other words, it refers to the interactive nature of digital media applied to museum exhibition. Experiential exhibition content encourages audience to better perceive the exhibition through their independent interaction with objects, creating a learning environment where audience naturally engage with the content through a fun play instead of a one-way transfer of knowledge. Experiential exhibition content helps audience firmly grasp the meaning of exhibition and the educational purpose of exhibited objects and have an active learning attitude. Such experience not only encourages audience to obtain the information of object through all five senses, but also provides motivation for their voluntary participation by sparking their utmost curiosity and interest. Jang (2009) summarizes the experiential elements of Bernd Schmitt's strategic experiential module (SEM)—sense, feel, think, act, and relate—in the context of exhibition as follows:

[Table 1] Exhibition experience based on the strategic experiential module[7]

| Experiential Marketing | Experiential Element | Developments of Experience | Change of Participatory Perception |
|---|---|---|---|
| **Sense** | Aesthetic experience | Basic level of experiential exhibition: The five senses of users are stimulated along with sensory arousal, sensory appeal, and perceptional interest. | Attention ↓ Interest ↓ Desire ↓ Memory ↓ Achievement |
| **Feel** | mood<br>emotion | Stimulations are perceived through five senses with emotion and sensibility triggered by the feel, image, etc. of object | |
| **Think** | Divergent thinking<br>Convergent thinking | Users understand the meaning and symbolization of object by directly using it and analyzing and processing its information. | |
| **Act** | Participation | Visitors participate in the exhibition by moving around to understand and process the given information. | |
| **Relate** | Experience the stimulation of self-improvement desire | Based on the behaviors promoted by the given event and participation, visitors perceive and expand the relevant meaning and develop potential intellectual capacity. | |

[7] Jang Hong-beom. (2010). *A Study on Directing Space for Experience by Experienced Element: Pine and Gilmore's Experience Economy Perspective*, Unpublished master's thesis, Kookmin University, Korea.

Secondly, the dictionary definition of presence is *existence* and it is often used interchangeably with a sense of realness or hereness. This paper discusses the characteristics of exhibition content in the following [Table 2] based on the multi-dimensional traits defined by Lombard and Ditton (1997):

[Table 2] Multi-dimensional traits of existence[8]

| **Type of Presence** | **Content** |
|---|---|
| Social Richness | Subjective or objective intimacy felt through media |
| Realism | Vividly sensing a virtual world through a life-like depiction or a rich sensory stimulation based on social and perceptional feelings |
| Transportation | The feeling that users have actually come to a virtual world (*You are there*), a virtual world is coming to users (*It is here*), and users are sharing a virtual world with other users (*We are together*). |
| Immersion | Users become immersed in a virtual world through their perceptional system and sensory stimulations. |
| Social Actor within Medium | Unable to sense the characteristics or the artificial nature of actuality within media and the virtual object mediated via interaction |
| Medium as Social Actor | Unable to sense the artificial nature of social interaction process with media itself in the course of interaction |

[8] Matthew Lombard, Theresa Ditton. (1997) At the Heart of It All: The Concept of Presence. *Journal of computer-mediated communication*, 3(2). Retrieved from https://academic.oup.com/jcmc/article/3/2/JCMC321/4080403

Digital technology-based exhibition content effectively delivers information by enhancing the sense of reality through real-like sensory stimulations. As more and more immersive media technologies are applied to museum exhibition, audiences perceive the sensory stimulations in an artificially-designed exhibition space as real ones. Such presence—a state of perception experienced by audience in the process of communication with exhibited objects—is emerging as a notable concept in the field of exhibition design since it has been highlighted as an important aspect of exhibition content.

Third, affordance can also be called 'behavior guidance' as it guides a certain behavior. The term was first coined in Gibson's book in 1979. Gibson focused affordance in direct perception and defined it as "what it offers the animal, what it provides or furnishes, either for good or ill."[9] Donald Norman applied this concept of affordance to design and classified affordance to two categories, real and perceived affordance, according to how they help the user's behavior. Harson defined affordance as 'providing something to help the user's intended behavior,' and classified it into four categories: sensory, physical, cognitive, and functional.

The digital exhibition content strengthens the design characteristics that can provide the compatibility in the relationship between human and the exhibition environment. This research plans to discuss the qualities of contents based on Harson (2003)'s concept and classification of affordance, which was based on the usability in HCI (Human-Computer Interaction) environments.[10] The digital exhibition content strengthens the design characteristics that can provide the compatibility in the relationship between human and the exhibition environment. This research plans to discuss the qualities of contents based on Harson's concept

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[9] Gibson, J. (1979). *The ecological approach to visual perception.* Lawrence Erlbaum Associates, Inc.

[10] Hartson, H. R. (2003). Cognitive, physical, sensory and functional affordances in interaction design. *Behavior & Information Technology*. 22(5), 315-338

and classification of affordance, which was based on the usability in HCI (Human-Computer Interaction) environments. Choi (2015) specified the design properties of Harson's affordance applicable in digital exhibition environments as below.

[Table 3] Type and Element of Affordance[11]

| Type | Description | Element per Affordance Type | Example |
|---|---|---|---|
| **Sensory Affordance** | Design that assists with a user to feel something | • Noticeability and possibility for sensing<br>• Color and contrast<br>• Timeliness<br>• Attraction / distraction of user attention<br>• Visibility / Possibility to find<br>• Discernibility / Clarity<br>• Means of expression, etc. | Easily-readable font of label |
| **Physical Affordance** | Design that assists with a user's physical behavior | • Operability<br>• Physical fatigue and stress<br>• Appropriate access and size of moving object<br>• Interactive device<br>• Shape and location of object<br>• Environment, efficiency, etc. for the operation of object | A button which is big enough for a user to click accurately |
| **Cognitive Affordance** | Design that assists with a user who wants to know something | • Clarity/Accuracy of meaning, and predictability<br>• Discernibility/Relevance to content<br>• Easy to enter data<br>• Easy to start<br>• User centeredness of expression and design, etc. | A button label that helps a user better predict what happens if the button is clicked |
| **Functional Affordance** | Design that assists with a user to solve a task | • Usefulness of system function | A top menu that shows a function to sort out a series of number |

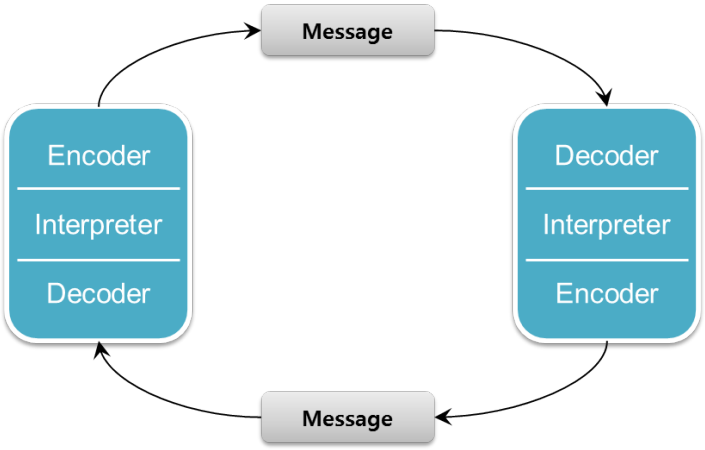
[11] Choi Soo-min. (2015). *A Study on the Augmented Reality-based Experience Exhibition Design Scenario.* Unpublished master's thesis, Seoul National University of Science and Technology, Korea.

### 1.3 Change of exhibition communication

#### 1.3.1 Model of exhibition communication

An exhibition intends to deliver certain information to viewers through a medium. And an exhibition communication can be regarded as the answer to how viewers can understand history more easily. Through development of the digital media, the perspective of observing the exhibition has changed from being a one-way delivery, but to a channel that converses and communicates with the viewers, which actively promotes an interactive communication.

Schramm (1954), who proposed the interactive design, saw this as a circulation between the sender and the receiver as an encrypted message being deciphered and getting feedback. This model is a structure in which the sender and the receiver transmit message in equal grounds, where the receiver receives the message encrypted by the sender, deciphers it, encrypts it again and sends it back, making this an interactive discussion. Like this, communication preserves an equilibrium, shares feelings, promotes and delivers information, and enables conversation and persuasion.



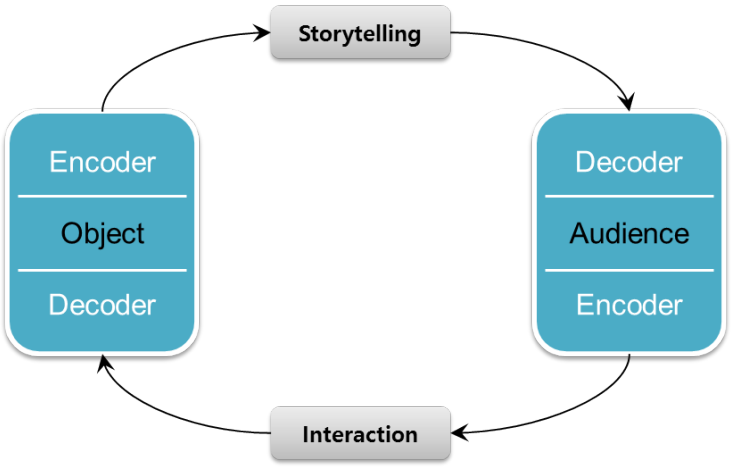

[Figure 5] Schramm's Model of Communication[12]

[12] Schram, W. (Ed.). (1954). *The process and effects of mass communication.* Champaign, IL: University of Illinois Press.

From this model, the specific properties of the message delivery needs to be observed from a side angle of the change according to the digital environment.

Firstly, the viewers become the core of the exhibition, creating their own stories. These exhibitions are being developed based on *storytelling* methods that develop the contents focusing on historical and environmental factors. In other words, Digital Contented Museums aim to encrypt messages according to the stories influenced by the spatial and temporal consequences in history, and actively express and converse through various expression media.

Secondly, as viewers actively participate, they also get to select certain information and create new messages, as well as easily absorbing the encrypted messages. This exchange of action between human and device is called an *interaction*, and the design of the interface of these specific reaction is called an interactive design. Digital Contented Museum promotes a diverse experience through this interaction and an active communication that envelops the physical and mental interactions.



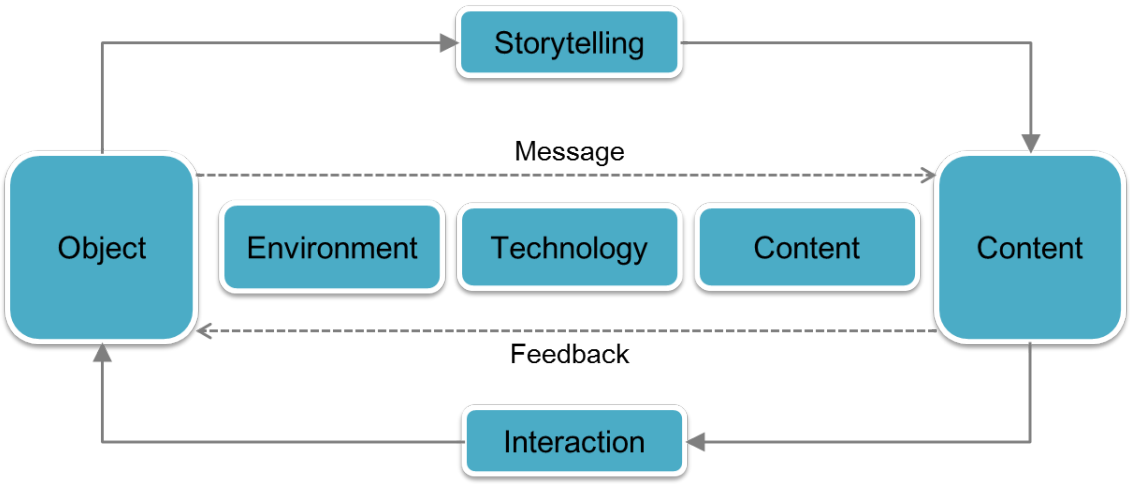

[Figure 6] Communication model of the digital technology-based exhibition

### 1.3.1 Components of exhibition communication

Exhibition under a digital environment became more focused on viewers' experience in the exhibition rather than the objects of exhibits displayed. According to this, the exhibition space is emphasizing its needs more on efficient communication between the viewer and the space to enrichen the psychological and emotional experience. We plan to derive the components of exhibition communication from this need and the changes in digital exhibition elements discussed earlier in 1.1.

First is the *environment*, which is an extension of the exhibition space. This is the environment in which enables viewers to accept and manage the elements and relationships that make a message, and is a concept derived from material experience and temporal relations expanded from the physical element that makes up the space. This is because the digital exhibition provides a novel environment that surpasses the physical and temporal limitations of previous exhibitions with components such as the restoration of past spaces and a simulation of space in imagination or in the future. To advance exhibition communication, the environment that relates viewers with the exhibit, the exhibit with the space, and the viewers with the space should be observed.

Next is the *technology* which is the medium of digital exhibitions and the *contents* which are the digital forms of the messages. The exhibit containing messages are applied to the exhibition environment combined with the digital technology as a new form of signal. In other words, the exhibition messages are being transmitted as contents combining various direction and experience through the media technology. The contents combined with technology directs the viewers to absorb the messages and create a new message through their own interpretation as active participants. As such, exhibitions that use digital technology expands the field of the medium and provides a new potential of exhibition communication through the real time, indeterminacy, and intermedia characteristics of digital media. If these components are applied to the digital exhibition communication model, it can be schematized to the following:




[Figure 7] Communication process of the digital technology-based exhibition

## 2. Research of convergence framework

Technological progress provides an environment that transcends our conventional thoughts on human desires and actualizes previously-unimaginable experiences. Such environment promotes interactions as a new driver of human desire and turns into a paradigm of generation and dissipation of human-centered values. It is notable that technological advancement is enabling and catalyzing multi-disciplinary convergence of technology, design, etc. It is expected to tap into convergent ways of thinking to organically blend and evolve the knowledge, theories, and access of separate fields and create a new outcome. Convergent thinking can be construed as an ability to explore humanistic values, discover a technology to actualize promising ideas that can uplift the value of human life, and connect the technology with existing institutions to generate new market values. This chapter aims to analyze the research model on digital convergence framework discussed in the field of humanities and business management and draw out implications relevant to this research.

### 2.1 Humanities-design convergence framework

In the field of design, as the system of human needs are observed and such needs are embodied into specific design ideas, an emerging challenge is that the object of ideation becomes fragmented into separate individuals. A new change is bound to be pressured to exercise a far greater capacity for the fundamental value and understanding of individual humans that are based on humanities. Such capacity serves as a rich feeding ground for new intuitions by making it possible to go beyond the quantified knowledge base of conventional academic system and lays a foundation for in-depth analysis and problem solving in the course of design thinking. Thus far, research on the fundamental value of human has developed into an academic system with a focus on humanities. Humanities-design convergence framework is a series of methodologies and processes which, in pursuit of realization of human values, identify problems and issues emanating from varied

human needs and desires and seek tech-based solutions. This research studies *design methodology based on value recognition* and *social science-design convergence research model* to further develop a new framework for tech-adopted exhibition.

### 2.1.1 Design methodology based on value recognition

1) Notion

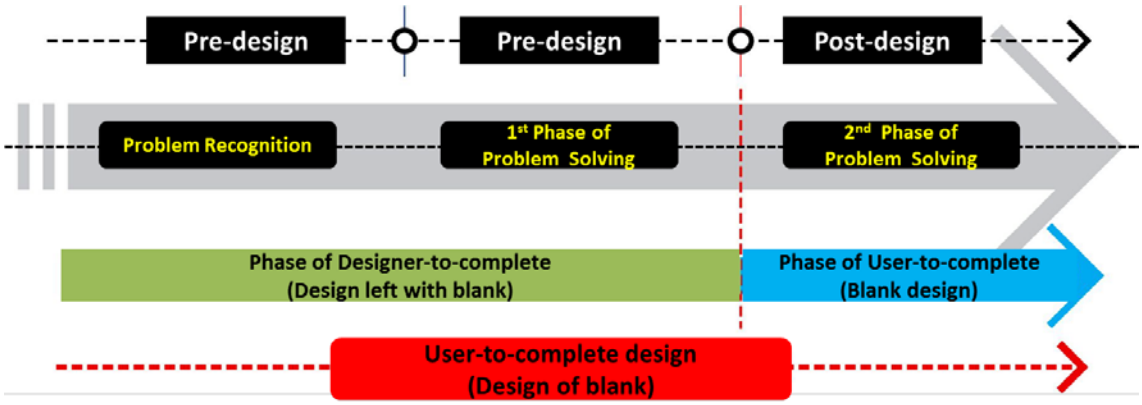
Lee (2011) claims that the perception on design needs to be shifted and expanded as the demand for user experience has recently surfaced while prior research interpreted a user as a passive recipient of content. According to her definition, *design* refers to a complete form of a designer's work, a process to create the form, and a byproduct of the process while the meaning of *designing* encompasses the behavior and relevant process of a non-designer who adds to the complete form. In other words, the notion of design as *a complete form created by a designer* needs to be expanded with the meaning of *designing* which *brings more room for change in the original design*.

2) Process

She theorizes *user-to-complete design* as an ongoing process changed or evolved by a user. User-to-complete design is comprised of design stage and designing stage. While design process can be seen as a problem-solving process based on the use of design, user-to-complete design consists of pre-design phase (recognition of a problem), design phase (search and suggestion for possible solutions), and post-design phase (a complete solution). The pre-design phase and design phase belong to design stage while the post-design phase is designing stage.

User-to-complete design should be a part to be completed by a user; it should be a design that harbors some blank space to fill left by its designer. The

blank space left by a designer is to be filled by a user. She coins an expression *design of blank* to integrate *design left with blank (1st phase of problem solving)* and *blank design (2nd phase of problem solving)*.




[Figure 8] The structure chart of User-to-complete design[13]

As a methodology for design of blank, she suggests multi-disciplinary approaches and interpretations for pre-design phase and storytelling techniques for design phase, and John Dewey's Experience Theory for post-design phase.

① Multi-disciplinary approach to problem

Finding a solution based on the possibility of user-to-complete design necessitates a design-centered multi-disciplinary approach which makes it possible not just to address visible, pronounced problems but also to discover and meet the innate needs of consumer (user). A multi-disciplinary approach is to deal with a problem by narrowing down *from a physical* phase*, to behavioral* phase*, and to psychological* phase with a sequential analysis on what kind of problems are listed during the problem-recognition & approaching process of pre-design phase, how

[13] Lee Ju-hyang. (2011). *A Study on the User-Consummatory Design Model Based on the Value-Perception Type in Design*. Unpublished doctoral dissertation, Kyonggi University, Korea.

these problems are presented through human behaviors, what psychological conditions are behind such behaviors, etc.

② Problem solving via storytelling technique

As for design, storytelling connects the dots among behavioral problems, turns the connected dots into a well-integrated virtual scenario, and visualize it though an aesthetic and formative work process. Since its subject is unrestricted to physical materials and encompasses psychology and behaviors, design connects the dots of its subject so as to create a *story* and shape the story in the form of *telling*; the story becomes complete in the form of "storytelling" through user experience. In the phase of seeking a solution, unlike the sequence of problem-approaching method, the flow of work is to spot an inherent psychological problem, plan a behavioral system that can rectify and weaken the problem, and install and produce a supportive environment and behavioral device. As the outcome is shaped and structured in the form of product or system, a close coordination is needed between pertinent fields of academic disciplines.

③ John Dewey's Experience Theory

John Dewey (1980) states that our experience is *a sum of doing and deeds.*[14] This is a view on the aspects of active and passive experience. Dewey contends that experiences should be interconnected in human's internal temporal dimension rather than a spatial dimension in order to meet the conditions for the generation and growth of experience.

A designer comprehends the life of a user in terms of *experience* and approaches it from a perspective that offers a newly-refined experience. And what a user pursues is not just a product, but also the utility that they can directly experience and relate to since the value of product itself changes rapidly. In other

[14] John Dewey. (1980). *Art as Experience*. A PeggiBooks.

words, a user pursues his/her creativity applied to a product, the message and identity embedded in a product, etc.

[Table 4] Characteristics of user-to-complete design process[15]

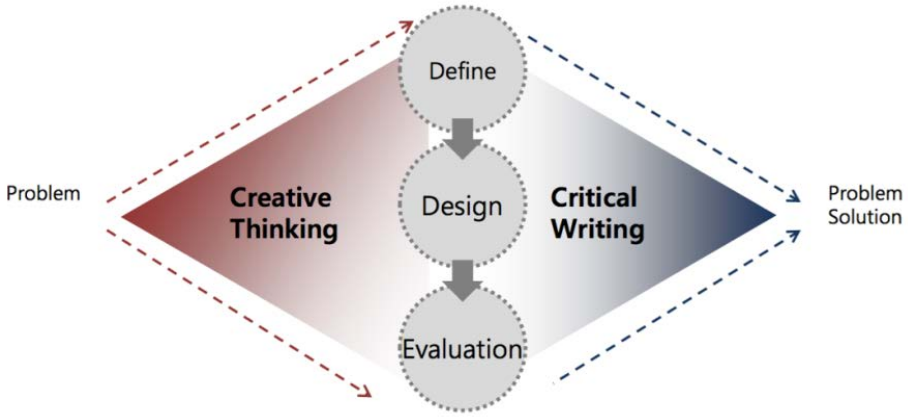
| | **Pre-design Phase** | **Design Phase** | **Post-design Phase** |
|---|---|---|---|
| | Problem Recognition & Approach | 1st Phase of Problem Solving | 2nd Phase of Problem Solving |
| **Main Agent Per phase** | PLANNER | DESIGNER | USER |
| | Quantifying, collecting, and analytical | Intuitive, aesthetic, relating, and integrated | Emotional, intuitive, individualizing, and distinctiveness |
| **Sequence of Problem & Method Approach** | Physical approach → Behavioral approach → Psychological approach | Psychological Solution → Behavioral Solution → Physical Solution | Physical response → Behavioral response → Psychological response |
| | Visible → Invisible | Invisible → Visible | Visible → Invisible |
| **Role & Status of Design** | Individual being | Integrated being | Personalized being |
| **Producer Designer** | Story → | Telling → | Storytelling |
| **Consumer User** | Targeted user | Self-driven user | Essential user |

[15] Lee Ju-hyang. (2011). *A Study on the User-Consummatory Design Model Based on the Value-Perception Type in Design*. Unpublished doctoral dissertation, Kyonggi University, Korea.

### 2.1.2 Social science-design convergence research model

1) Notion

Jung and Lee (2011) propose an integrated research process that combines the strengths of design methodology and social science methodology with an aim to enhance the completeness of problem-solving. The upside of design methodology is that it sparks ideas to suggest a problem-solving prototype and effectively materialize the prototype whereas the strength of social science methodology is to analyze the environment, pinpoint a research subject, and verify how valid and persuasive a suggested solution prototype is. Likewise, these two methodologies approach the same problem with different aims. Design methodology is specialized in planning while social science methodology offers a high-quality analysis. Therefore, it is desirable to utilize both methodologies in an integrated manner in order to ensure a successful planning and analysis process.




[Figure 9] Convergent thinking model[16]

[16] User Intergrated Research. (2015). Retrieved from https://www.slideshare.net/jylee_sidlab/imrweek01-45653309

2) Process

As a problem-solving convergence research model, they puts forth the five phases of PARIS—*Phenomenon, Analysis, Ideation, Review,* and *Supply*—and describes an applicable design methodology and a social science methodology for each phase.

Firstly, *phenomenon* is a phase to identify a problem from a social phenomenon and deep dive into the details of the problem. As the phenomenon phase aims to glean and amass ideas for the first time, it is important to collect as much information as possible and investigate user needs and social problems so that the problem in question can be properly defined in the next phase. This phase involves a literature study, an intensive interview, FGI, observation, participant observation, probe research, eye tracking, etc.

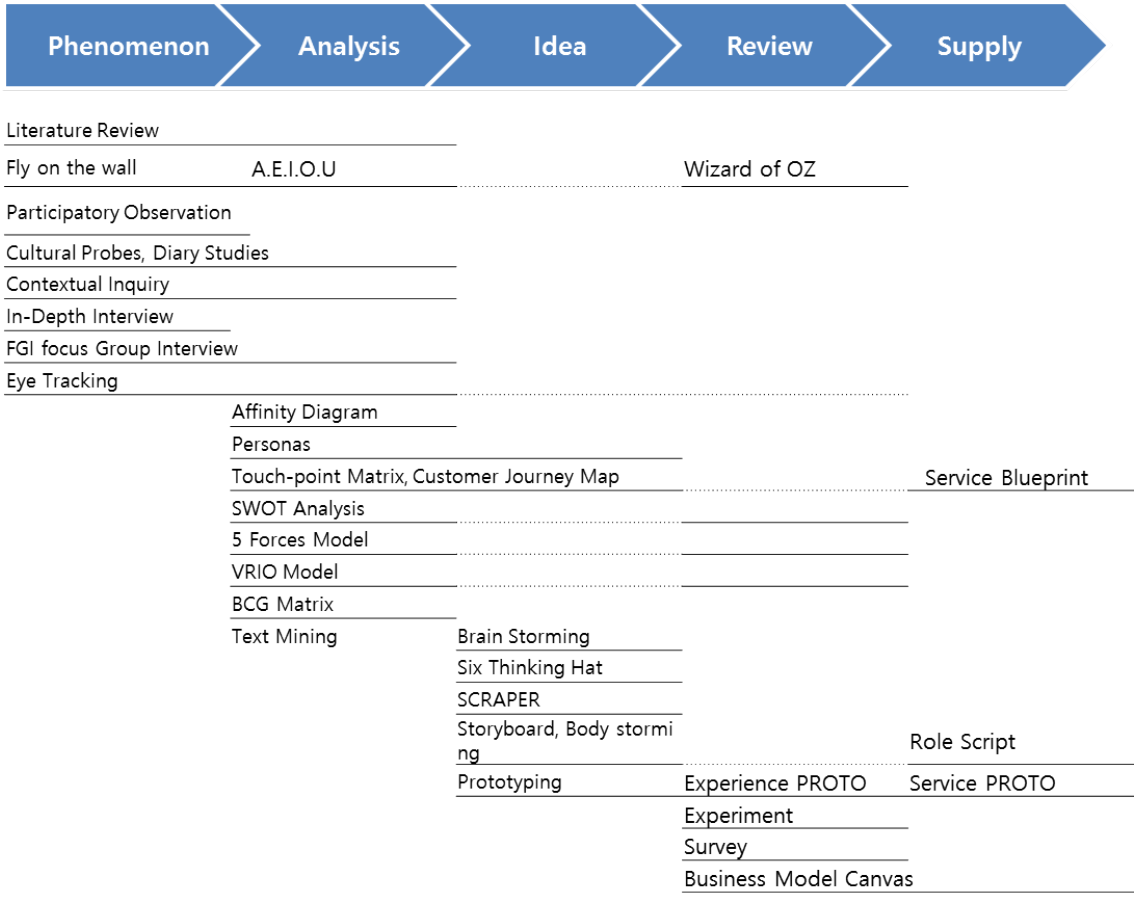
Secondly, *analysis* is a phase to define and reaffirm the problem related to research subject based on the information collected in the previous phase. As the analysis phase aims to trim down a flood of collected ideas based on meaningful insights, it is necessary to observe the correlation between variables and conduct a structural analysis on the surrounding environment of research. In particular, the core concept or correlations of the research problem should be defined with a focus on users and stakeholders. This phase involves affinity diagram, persona, touch point matrix, etc.

Thirdly, *ideation* is a phase to produce a service idea as a solution to the problem identified in the previous phase and actualize prototyping accordingly. The ideation phase stirs up robust discussions among participants and encourages researchers to come up with creative ideas. In the field of design, various methodologies have been developed for ideation and prototyping. This phase involves brainstorming, SCAMPER, context mapping, a storyboard, etc.

Fourthly, *review* is a phase to assess service planning, prototype, and research design. The review phase aims to validate the feasibility of planning via a well-thought-out assessment. For a scientific validation and evaluation of an idea or a plan, social science methodology proves to be a relatively more thorough

assessment tool. This phase involves a survey, an experiment, a business model canvass, the Wizard of Oz, prototyping, etc.

Fifthly, *supply* is to showcase and deliver a proven solution to a user. The supply phase aims to produce an outcome of research by visualizing the concept and solution scenario of the research problem and delivering them in the form of product. This phase involves role script, service prototype, service blueprint, etc.




[Figure 10] Phase-by-phase methodology of PAIRS[17]

[17] Jeong Hoe-kyung, Lee Jeong-yeon. (2015) *PAIRS framework, convergence research for solution.* CommunicationBooks Inc.

## 2.2 Business management-design convergence framework

On the back of criticisms that conventional academic studies and industrial classification system are limited in their capacity to spearhead a present or future value-creation paradigm shift or solve new problems, many have shed light on the necessity of design-centered business strategy as the next game changer. This is because taking an integrated approach to business management can prove extremely effective given that the field of design generates a viable solution by leveraging multi-disciplinary knowledge. In particular, if experts with varied personalities and traits have to team up with each other to attain a common goal, cohesion in the context of business management is far more important than ever. In a shifting environment where new individual human desires should be converged with required knowledge and technologies, a business management-design convergence framework can serve as a strategic means of creative business model for problem solving. This research aims to reflect on *lean advanced design process model* and *digital engagement framework* and apply the insights to and make changes to the development of a new framework.

### 2.2.1 Lean advanced design process model

1) Notion

Oh (2015) has developed *lean advanced design process model* to set a broad direction for convergent applications based on the common denominator between *lean start-up methodology* and *advanced design process* (both of which are start-up business management methodologies) and change and revise specific elements so as to complement the two methodologies. As a newly-minted term frequently talked about with regard to cultural recreation, *advanced design* refers to

*an action taken to define the right design concept prior to an actual behavior of design so as to generate a work of design desired by next-generation users*.[18]

As for advanced design process, it is highly likely to generate a fresh and innovative concept since the process mostly gleans insights from a user-centered perspective. However, as the concept produced by advanced design process mostly emanates from the observations and insights of users targeted by designer, there is *a burden of risk* that market needs are not proven yet. He selects *lean start-up methodology* as an alternative method to address such burden of risk. The essence of lean start-up methodology is to turn an idea into a product, measure how customer responds to the project, and learn whether to maintain the original development plan or make a shift in direction. In other words, if a lean start-up methodology, which enables a more detailed and accurate testing of customer needs, is applied to an advanced design development process for further development, it is possible to *remove the burden of business risk* which prior advanced designs have not been free from.

2) Description

Lean advanced design process sets a general direction in accordance with the following basic structure of lean start up and improves and advances its specific elements.

① Lean advanced design canvass (LADC)

*Lean canvass* is a cornerstone and channel that connects each and every process of lean start-up methodology. Lean canvass helps users consider as many elements as possible as a quick glance and, in case of a project, serves as a basic

[18] Craig M. Vogel, Jonathan Cagan, and Peter Boatwright. (2005). *The Design of Things to Come: How Ordinary People Create Extraordinary Products*. New Jersey, USA: Pearson Education, Inc.

tool for swift feedback such as communication among team members and for project management such as recording project histories, etc. Oh identifies the elements of advanced design processes commonly used in the market and summarizes them into a total of nine elements in the following *lean advanced design canvass (LADC)*. The five out of the nine LADC elements overlap with the ones used in business models while the other four are gleaned from pure advanced design processes. LADC is a viable complementary model to minimize the burden of business risks that advanced design processes are bound to entail. The specific elements of LADC are explained as follows:

<table>
<tr><td rowspan="2">Problem<br>Define a problem to solve or a thing to improve.</td><td>Solution<br>Once a problem is well defined, suggest a solution to the problem.</td><td rowspan="2">Necessary Technology<br>In case of a new product, describe the technical specifications and standards for the actualization of product planning.</td><td rowspan="2">Mass Production<br>It is a prerequisite for actual product roll-out. Describe detailed information on mass production phase</td><td>Customer Group<br>Clearly define the customer group targeted by product planning.</td></tr>
<tr><td>Value Proposition<br>Explain a product's selling point and why it deserves buyer's attention.</td><td>Profit Source<br>Contemplate the price range to offer to the targeted customer group.</td></tr>
<tr><td colspan="3">Design<br>Exterior design which best expresses the product concept to consumers by embracing every product aspect ranging from the definition of problem to core technologies</td><td colspan="2">Mock-up/Sample<br>Build an actual mock-up/sample. Briefly record the functions and particular characteristics displayed by the mock-up/sample.</td></tr>
</table>

[Figure 11] Lean advanced design canvass (LADC)[19]

[19] Oh Jin-ook. (2015). A proposal study on Advanced design process applied Lean startup methodology. *Design convergence study* , 14(2), 121-136.

② Minimum viable design (MVD)

*Minimum viable design (MVD)* is a concept made for advanced design development just as *minimum viable product (MVP)* is used for user-centered product development. Usually, MVD involves *a Designing-Measuring-Learning feedback cycle* that initiates a learning process. MVD includes the minimum scope that can be used by a user.

③ Designing-measuring-learning feedback cycle

The Designing-Measuring-Learning feedback cycle model of lean start-up aims to help start-ups to revise and enhance a business model via a direct product testing on users, thus serving a different purpose from advanced design development which drives product development only. He suggests a Designing-Measuring-Learning feedback cycle model by building on the essential value of lean start-up methodology—the complementary cycle of *Testing-Revising*—and fitting it into an advanced design development process through revisions and improvements.

With a Designing-Measuring-Learning feedback cycle being the same as a single iteration. If the cycle is combined with MVD, a test process becomes completed. Then, the project starts its $0^{th}$ iteration. Before the start of each iteration, the project team selects a scenario they want to work on, fleshes out the scenario in a short period of time, and moves on to development and testing. The aim is to produce a valuable outcome before each iteration ends.

### 2.2.2 The digital engagement framework (DEF)

1) Notion

As the digitization of media technology brings about a paradigm shift in conventional communication, media is going through a complex evolution based on myriads of platforms while personalized forms of media and customize services are mushrooming across the board. PR activities under the analogue paradigm used to rely on the interventional function of media. Under the digital paradigm, however, new values will be further created due to an increasing number of methods to directly relate with the public and diversely-convergent fields.

In this context, Jim and Jasper (2014) suggests *digital engagement framework (DEF)* as a way to establish and vitalize optimal agencies befitting digital communication. DEF is a worksheet which describes what those working at art & culture agencies can achieve through the use of digital media and how they can attain it. This clarifies the connection between various internal characteristics of an agency and makes it possible for an agency to deliver a persuasive story based on its unique aspects. Jim and Jasper state that this becomes the agency's PR strategy. DEF is based on years of designing and implementing innovative communication, marketing, audience development and new media strategies around the world. DEF helps institution staffs identify the value creation opportunities of digital engagement for their organization and develop the strategies, processes and technologies to structurally engage audience to maximize co-created value.

2) Description

DEF consists for three phases of processes: *organizational basis*, *engagement strategies*, and *technologies and processes*. The elements per each phase are displayed as a total of ten main building blocks in the worksheet. Each building block contains a key question for project planning. [Figure 12]

① Organizational basis

*Organization basis* is a phase to clearly define a new value which can be created by promoting audience participation via the use of digital media. This phase is comprised of five elements: asset, audience, objective, vision, and trend. This phase not only helps working-level staffs clarify their agency's tangible and intangible resources and the characteristics of their targeted audience, but also presents an ideation process on the expected outcome in the aftermath of an adoption of digital media.

② Engagement strategies

*Engagement strategies* is a phase to seek a strategy for an agency's communication with audience. This phase consists of *reach* (to deliver the agency's resources to audience) and *engagement* (to help audience to interact with the agency's assets). For example, *the reach* of a museum would be a strategy to deliver exhibition information or PR materials to audience via digital media whereas the engagement would be a strategy to promote the interest of audience about the exhibition and encourage them to participate in the museum experience.

③ Technologies and processes

*Technologies and processes* belong to a phase to design specific action plans on the strategies from the previous phases. This phase is comprised of three elements: *metrics, channel, and guideline.* The phase specifically suggests how to arrange the most suitable media, technologies, and contents for strategies, write a guideline to organize necessary tasks, and evaluate performance. The constituent elements of this phase are not fixed, but flexible depending on the nature of project. It is crucial to define the critical elements for the accomplishment of project objective and set up specific an action plan per element.


[Figure 12] The digital engagement framework[20]

[20] Jasper Visser, Jim Richardson. (2014). *Digital engagement in culture, heritage and the arts* (2nd ed.) Retrieved from http://digitalengagementframework.com/digenfra3/wp-content/uploads/2016/02/Digital_engagement_in_culture_heritage_and_the_arts.pdf

## 2.3 Implications from case analysis

This chapter deals with the notion of research model based on the theoretical exploration regarding the research cases of a design convergence framework being discussed in the field of humanities and business management and reflects on processes via various ways of thinking. Here are some implications from this research.

Firstly, user experience-centered design is gaining more importance than ever in convergence paradigm. User experience is an activity to efficiently plan and design everything related to a targeted subject. Consideration factors for user experience-centered design include user, user behavior, interaction, surrounding environment, targeted system, and user perception & response. The scope of user experience-centered design is enormously broad as it requires a robust multi-disciplinary research. Therefore, user experience-centered design can be seen as a strategic design process applicable to every field of design. Design scenario is suggested as the strategic means of user experience-centered design. Design scenario is an outcome of design which visualizes the subject of design and user interaction into a story based on predictable backgrounds and events in the form of a storyboard, an interface map, etc.

Secondly, an analytical approach also matters. Design methodology is mainly driven to identify user needs, offer a broad range of problem-solving ideas, and design a solution prototype. The focus of design gravitates more towards planning than analysis as it prioritizes solving a realistic problem rather than an addressing academic problem. As for design, methodologies are not strictly standardized and utilize myriads of methods depending on circumstances and the subject of research. However, as the scale of design problem expands and multi-disciplinary problem-solving methods mushroom in number, an analytical process of deep-diving into the surrounding environment and pinpointing a problem is becoming ever more important in design planning. Such analysis requires a structural way of thinking. Structural thinking refers to a way of thinking that approaches a phenomenon with a "why" question and contemplates what action to

take to locate the root cause of problem. This necessitates a well-balanced design process which combines design's problem-solving oriented, intuitive thinking and analysis-oriented, structural thinking.

Thirdly, integrated thinking and effective methods are needed for non-visible problem solving. Due to the shift of focus in the market environment from supplier to user, design problems and relevant solutions are going through drastic changes. Preparations should be made to address non-visible problems like user requests, the perceptional process on value-related matters, etc. There has been a series of design process research with regard to seeking viable solutions to design problems which are constantly reshaped by complex, multi-dimensional changes. There will be a need for a design process which goes beyond physical and visible designs and takes into account the relationship with user, environment, etc. The diagram which expresses the underlying logic of process will function as an effective means in the phase of execution.

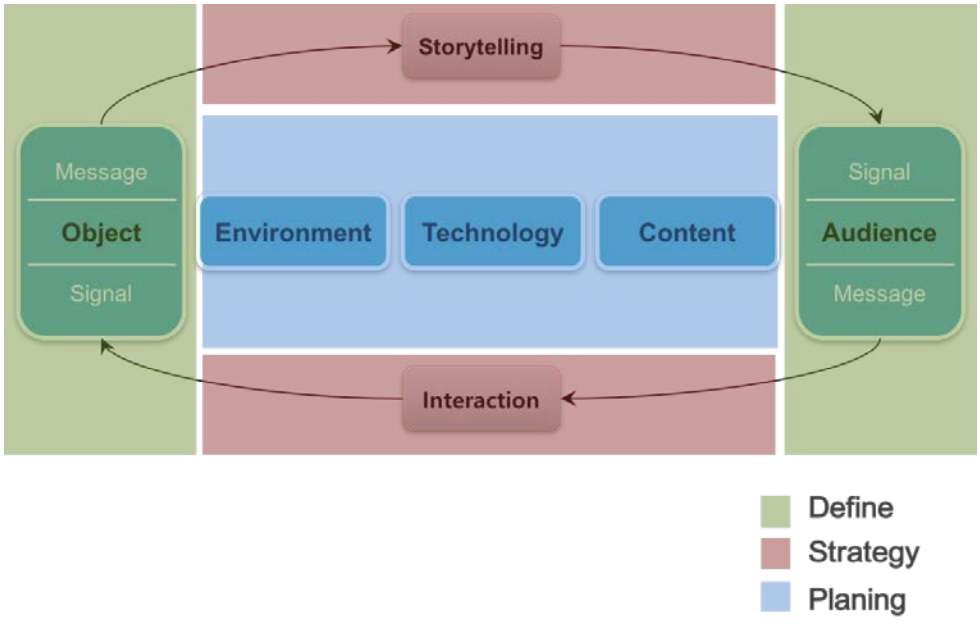
# III Application & Implementation

## 1 Proposal of framework for museum exhibition content development

### 1.1 Basic structure

The framework proposed in this paper aims to build on the process and structure of *digital engagement framework (DEF)* put forth by Jim and Jasper and revise DEF to suit a more narrowed purpose of museum exhibition content development. For the sake of convenience, museum content framework is herein referred to as *MCF*.

Firstly, MCF is based on the digital technology-based exhibition communication model derived from section 1.3 and is constructed so that it displays the process and each element. When the exhibition communication is applied to the development process, it can be said that the exhibit and viewers are the objects of analysis to define the problem, and the story-telling and interaction are the strategic elements for user experience designs. The environment, technology, and contents would then be the plan in the manufacture level. A graph to see this structure more easily would be represented as such.

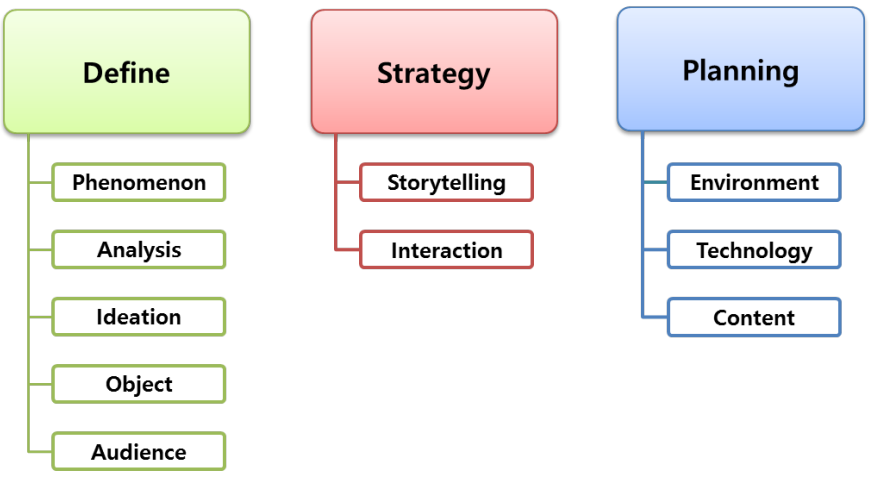



[Figure 13] A schematized structure of the communication model

Furthermore, the MCF's deep analysis process based on the conclusion derived from the two case studies is a fundamental basis for the planning, and it also effectively visualizes the relationship and organization of each elements so that it can be used as a tool for the cooperation project. In the case of DEF, the organizational basis is composed of five elements: assets, audience, objectives, vision, and trends. DEF is a framework that focuses on the positive outcome the arts & culture organizations can earn by using digital media and the market value that provides the method to earn it. On the other hand, MCF is a framework that aims to realize the humanistic values, by analyzing present issues and obtain a creative solution. Therefore, the basis is composed of five elements referring to the research model PAIRS: object, audience, phenomenon, analysis, and ideation.

### 1.2 Process

MCF is comprises of 3 levels of process: definition, strategy, and planning. The elements of each process is shown as below according to the schema of communication discussed before.




[Figure 14] The elements of MCF process

Firstly, *define* is a phase to conduct a multi-faceted analysis on the problem in question, discover the demands of audience, determine the direction of exhibition content development accordingly, and produce a concept idea. Proceeding with three activities of phenomenon, analysis, and ideation, the analysis phase can clarify the desirable value and purpose of project only when the analysis and definition of exhibition object and audience in each of the three activities are taken into account simultaneously. In this context, audience are the subject for the analysis on user experience and needs and. Based on such analysis, the outcome of ideation is summarized in the form of a proposal via a sketch or a graphic drawing.

Secondly, *strategy* is a phase to formulate a specific plan for the materialization of the concept made in the previous phase. This necessitates a comprehensive activity such as writing a scenario which is a brief synopsis of a series of events suggested and planned in reality or imagination. In the context of exhibition, a scenario can be defined as planning to turn the probable situations in exhibition space into predicted or desired situations. A visual scenario gives a sense of realness to a story and makes it easier to understand a complex idea. The strategy phase offers two activities—*storytelling* and *interaction*—that encourage audience to complete the scenario as self-driven users. *Storytelling* is to write a narrative of entire information which audience are supposed to experience in an exhibition and is often visualized via a storyboard while *interaction* is to design rules and a system of behaviors regarding the events occurring in line with audience movement route and is often expressed via a flow chart.

Thirdly, *planning* is a phase to set up an execution plan for the object and space which actual audience are supposed to experience and the technology to materialize such object and space. As a process to execute the strategy made in the previous phase, the planning phase consists of three essential elements in terms of exhibition content development: *environment, technology* and *content*. This phase offers a guideline on what object and environment to select for the sake of audience experience, how to materialize them via technology in pursuit of the right strategy, and what needs to be done in an actual production phase per element.

This phase tends to use a mock-up or simulation modeling of system for visualization.

The characteristics of each level can be organized in a table as below.

[Table 5] The characteristics of process per phase

| | Define | Strategy | Planning |
|---|---|---|---|
| **Purpose** | Value creation | User experience | Execution Plan |
| **Elements** | Phenomenon, analysis, ideation, object, and audience | Storytelling and interaction | Space, technology, and content |
| **Position of audience** | Targeted user (For the user) | Self-driven user (By the user) | Essential user (Of the user) |
| **Communication Material** | Proposal | Planning repot | Blueprint |
| **Design Expression** | Sketch and drawing | Story board and flow chart | Simulation modeling |

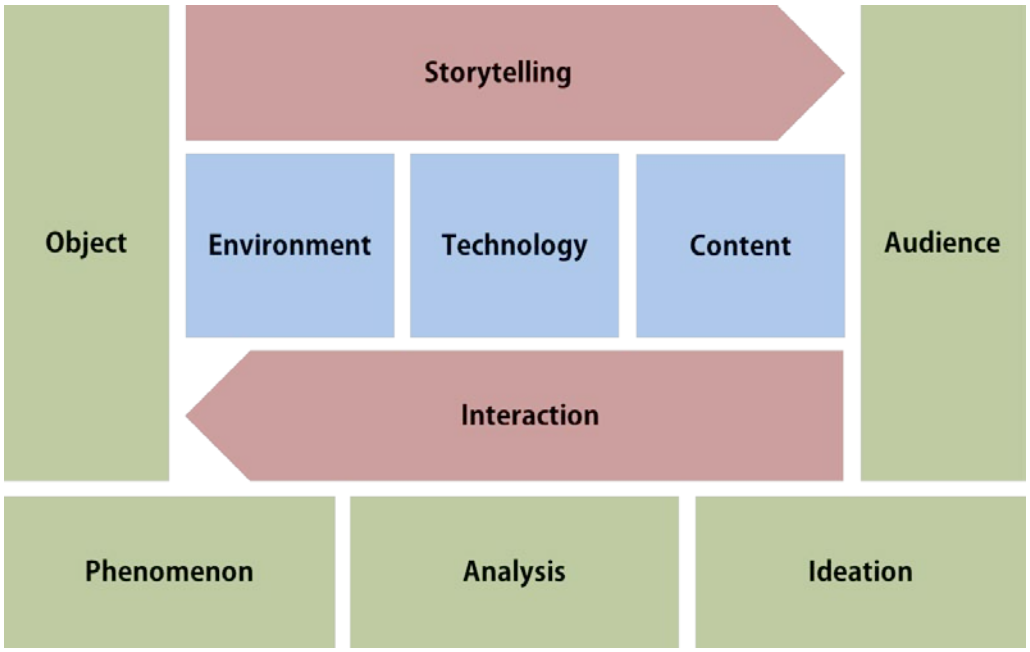
### 1.3 Design canvass

MCF provides a design canvass which is a cornerstone and channel connecting each and every process mentioned above. This design canvass is customized for museum exhibition content development based on the building-block structure of DEF and is utilized as a communication tool to enable every project participant to check the status of project at a quick glance and ensure a swift feedback exchange and project management.

The three levels of process in MCF is organized as below so the circulatory communication process of the digital environment based on the pre-discussed schema of the communication model could be displayed on canvas. The graph of the strategy level shows the direction of exhibition communication, and the define level was set up on the bottom since it is the basis of the project as a whole.


[Figure 15] The canvas setup of the three process levels

The 3 levels of MCF process are composed of seven communication elements and three problem definition elements. The arrangement of the 10 elements is as the [Figure 16], and the specifics of each elements are as follows.




[Figure 16] Design canvas of MCF

1) Phenomenon

This phase is focused on discovering problems in the current situation, identifying the inside story of the problems and recognizing the necessity of digital technology-adopted exhibitions. Archer (1964) said there are no solutions without problems and no problems exist without restriction, while restrictions are certainly subject to necessity.[21] Therefore, designs start when certain needs emerge. It is a phase for primary thoughts for planning, and thorough observation and data collection are required to properly define problems.

Necessities can directly come to the fore from the museum's purpose or communication policies. As necessities can also be recognized through various channels, including outsiders and audience, information should be openly collected by judging values and the effectiveness of collected information based on the directions.

2) Analysis

Analysis of problems is a very important phase. Many personnel in charge of exhibitions often make the error of providing answers without fully understanding the problem. It is necessary to review similar problem-solving methods or previous cases by gathering various information and collected materials, analyzing data and applying them to exhibitions.

In addition, the organization's numerous criteria and various restrictions, including conditions, budget and exhibition environment, should also be clarified. Based on such criteria, importances should be prioritized and assigned with certain values. Restrictions should be listed to judge these values. As the complexity and parameters of problems become clearer through the process of analysis, the scope and details of tasks, including new planning's effectiveness and schedules, can be established.

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[21] Michael Belcher. (2006). *Exhibiton in museum*, Yekyong Publishing Co.

3) Ideation

Whereas *analysis* elicits solutions by disassembling phenomenon into subdivisions and going through the processes of seeking answers for each problem, *ideation*, based on intuition, repeats modification until ideal combinations are produced after proposing specific forms. The expansion of divergent thinking is once again required in this process, which induces creative ideas through a variety of activities, including exhibition team members' vigorous discussion and joint workshops.

The meticulously reviewed ideas are documented in an exhibition proposal through visual languages. This proposal is made into a plan through the feasibility verification by collecting opinions from relevant people and experts inside and out of the museums. In digital technology-adopted exhibitions that generally require high production costs, the time required for the conception and preparation of exhibition planning should be considered important.

4) Object

*Exhibits* in exhibition planning are the general term for *objects* that are deemed appropriate for the goals and functions of the exhibition and selected accordingly. Exhibits include not only material objects that have a shape, like physical objects and models, but also digitalized nonmaterial objects such as images and information. Exhibits should be carefully selected according to their purpose, and this selection is a crucial part in the communication between the exhibits and the audience. Although objects contain a lot of information ranging from background to environment, not all of this information is relevant to the exhibition theme. It is therefore imperative to first comprehend the exhibition purposes and goals before determining which information to convey to the audience with regard to each object under the given circumstances.

Beyond the provision of simple truth and information, a process of interpretation is required. F. Tilden (1957) defined the word *interpretation* as *an*

*educational behavior that clarifies meaning and relations by explaining through media and enables hands-on experiences by using genuine relics rather than by merely providing factual information*.[22] Interpretation can be used to deliver ideas and concepts designed to stimulate the audience, and the audiences who understand the interpreted information can have a more interesting, stimulating experience.

5) Audience

The audience as the subject receiving messages, can be subdivided in accordance with many criteria. Overall factors including exhibition content, exhibition method and movement routes through the exhibition space are most influential to the audience. Successful exhibition designs should be made for people. The following is a list of considerations of audience in terms of digital exhibition designs.

① Age group: Each age group has different physical and psychological characteristics, which affects design approaches. Particularly, exhibitions aimed at children or a senior audience will show striking differentiation in methods, content and facilities of direction.

② Knowledge level: Communication methods vary greatly for those audiences who have a lot of prior knowledge and information about the exhibits, and those who do not.

③ Human engineering: Differentiating human engineering should be considered in accordance with age groups. Adjusting the size of various facilities, such as moving heights to meet the eye level of the audience, and having different-sized chairs, are representative examples of this.

④ Estimated number of audience: Designers plan the composition of exhibition spaces, movement routes and the width of passageways by predicting the expected

[22] Michael Belcher. (2006). *Exhibiton in museum*, Yekyong Publishing Co.

maximum capacity of exhibition halls and the average length of time the audience is expected to stay there. When recommending a group tour of over 10 or 20 people, an appropriate exhibition space should be created accordingly.

⑤ Audience's social background and language: Exhibitions should utilize a language that their target audience is familiar with. Cultural characteristics and customs should also be considered in exhibition designs.

6) Storytelling

A message to convey in an exhibition or a message that embodies the purpose of an exhibition is called *exhibition theme*. As a core concept for the organization of exhibition content, exhibition theme plays a central role in governing the A to Z of an entire exhibition from the aforementioned methods of experiential display, to the display of exhibition environment, to operational services. In the end, all that matters is what theme to choose and how to communicate with audience via efficiently-curated contents. For this, a storytelling-driven exhibition planning is needed for a more efficient communication with audience. At the heart of exhibition, it is storytelling that allows a richer and more exciting expression of intended information by interweaving the experiential elements of audience. Thus, storytelling writes a narrative of the entire information which audience are going to experience in exhibition space. The elements of exhibition storytelling are as follows:

① Message: The core objective to deliver to the audience is the message. When it contains exact messages, storytelling can deliver messages very well instead of merely conveying interesting stories. In spaces, messages are conveyed through symbolism. Such symbolism plays a key role in making stories.

② Tension: When problems occur, immersion should be induced through the process of improvement, maintenance and abolition. Then, it will be possible to express elements of tension in the space. For example, uncertain production through figurative forms will likely express dramatic tensions.

③ Character: Storytelling requires main characters and extras to create a story. Stories unfold based on the feelings and experiences of characters or beings with unique names, personalities and behaviors. Audiences can easily become familiar with characters reproduced in the form of media, maintaining smooth communication.

④ Plot: Plot meaning the flow of storytelling, namely time and space, is a broad frame consisting of storytelling. Storytelling in the space can be made through the movement routes.

Storytelling is mainly made in the form of a storyboard. A storyboard becomes the basic element of content production, expressed with paintings and writings by visualizing the content conception of proposed topics. Digital technology evolves the linear storytelling of a beginning, middle and end into flexible non-linear story routes. However, even though it is a non-linear story, the audience can have the goal of unfolding stories based on the premise of an archetypal story. In other words, creating the value of stories to elicit the audience's emotional experiences from exhibits is the most crucial factor in storytelling regardless of the medium.

7) Interaction

As for exhibition content development, while storytelling serves as the skeletal structure of exhibition, *interaction* fleshes out the structure by offering a method to connect the dots of a story. Interaction prescribes rules in regard to space layouts, spatial movement routes, and the order of events to occur depending on audience movement routes. Interaction also predicts the possible choices, behaviors, etc. of audience and plan out suitable responses in advance. Since the entire story may differ depending on the choice of audience, it is crucial to connect their choice with the following change of events. The interaction phase is deeply related with digital environment; this work called *algorithm setting* is to structurally organize the aforementioned tasks in the logical computing environment, thereby materializing a content which swiftly responds to the behavior

of audience. Such way of designing an interface for user behavior and response is called *interactive design*. The following is a list of exhibition interface processes made by referring to the considerations of Woo (2002)'s study of interactive designs. [23]

① The first interaction that users can come into contact with is with hardware (exhibition installations). It begins as sensory organs react to stimuli, including visual, tactile and auditory stimuli.

② Then, interaction with software (content) is made – media and technology that contain interactive designs. The design can be displayed on a screen and it can also be induced in other logical operation methods.

③ As users (audience) implement the prepared programs, they encounter interactive interfaces. Users can engage in visual tasks, listen to sounds and control other multimedia elements by reacting to interactive designs.

④ Interaction with interactive designs occurs in reaction-related relations with the environment where such behavior occurs, namely exhibition spaces (including images and virtual exhibitions).

⑤ There is also interaction with multiple users, which is considered the same as using interactive designs as a medium. In this interaction, simultaneous interactions like online chatting, and non-simultaneous interactions, like message boards, are possible. The fact that many users (audience) can experience reaction results together in special spaces shows that this is an interaction that has advanced one level higher than interactions with machines only.

[23] Woo Sang-gi. (2002). Interface and Communication for Museum's Exhibition Space. *Collection of theses*, 10(2002), 249-264.

8) Environment

*Exhibition environment* refers to a behavior to display information for user interpretation via specific means of expression in a certain space and the space where such behavior takes place. This space is called *exhibition space*. Exhibition space serves as a place which delivers information to the public at a specific time and venue by using a certain media for the transfer of information. Therefore, exhibition space encompasses the correlations with object, the behavior of human as an acceptor, and the environment as the intrinsic property of architecture, thus possessing a meaning as an environment where elements from various fields play out in a complex manner. Therefore, the most important point of consideration should be how to physically design audience's direct experience with static objects while walking through the exhibition space. And basic elements for consideration include the layout and deployment of exhibition space, the formation of audience movement route, audience experience, and other display methods.

As the nature of space in digital exhibition is shifting away from conservation and passive perception towards participation and experience, the immersive display driven by five human senses is becoming ever more important. The followings describe the sensory elements and their characteristics that should be analyzed in exhibition space design.

① Visual factors: People perceive situations and acquire information through vision, which causes more direct responses than other senses. Objects of visual effects in exhibition spaces include not only objects but also the spaces themselves including walls, floors and ceilings. Visual action factors that also enhance various experiences in exhibition spaces include colors, forms, images, materials and lighting.

② Tactile factors: Since information acquired through tactile factors is directly associated with people's behavior, feelings about information are specific and an ardent desire for active participation to obtain information is induced. Tactile factors in exhibition spaces can enable interaction between the exhibits and the audience,

maintaining direct relationships with the exhibits, producing special feelings and memories.

③ Auditory factors: Auditory factors in exhibition spaces can be effective in perceiving information and situations when interconnecting with other senses, as a background rather than as a subject. In addition, people's emotions are controlled through various sounds and a certain atmosphere can be created, focusing on objects and spaces.

④ Olfactory and gustatory factors: Olfactory factors are deeply connected with gustatory factors, relaying memories of smell and taste to recognize spaces and reproducing spaces with these memories. Olfactory and gustatory factors in exhibition spaces are limited to space directions inducing comfort, but when using these factors in combination with other sensory factors, information on exhibits can be more effectively conveyed.

9) Technology

Technology in digital exhibition is used as a channel to meet the demand of audience more actively. First and foremost, it is important to determine the type and medium of technology befitting the purpose of exhibition. Lately, the most promising technology in museum exhibition in terms of usability is *immersive technology*. The essence of immersive technology is to deliver an impactful engagement of user and a sense of realness as in watching an actual object. [Table 6] demonstrates the type and characteristics of immersive technology.

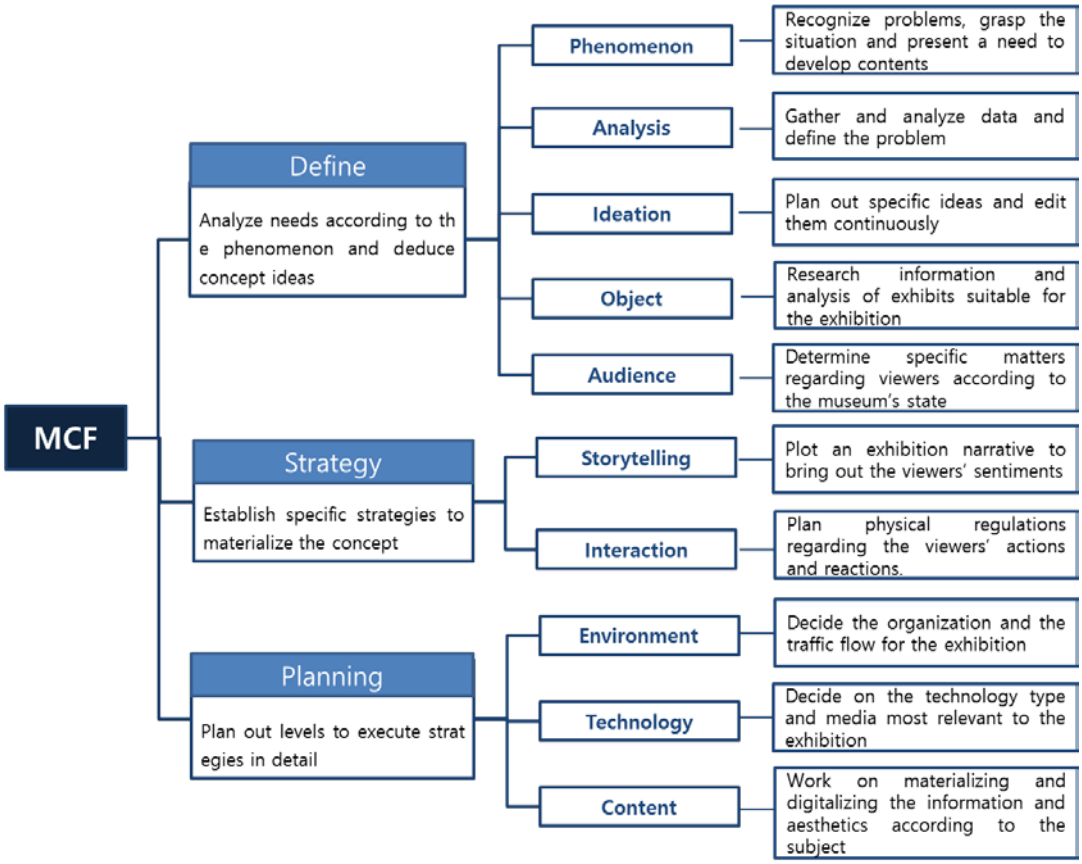
[Table 6] Type and characteristics of immersive technology

| Type | Characteristics |
|---|---|
| **Virtual Reality** | · To be projected onto a monitor or a head-mounted-display computer screen (HMD) via CG effects<br>· It offers a powerful engagement and virtual perception.<br>· The downside is the heavy weight of HMD. It is difficult to wear it a long period of time. |
| **Augmented Reality** | · A technology that superimposes a virtual image on a user's view of the real world, thus augmenting the information of an object or image<br>· It enables a real-time interaction.<br>· It is often used with a location-based technology. |
| **Hologram** | · A three-dimensional image formed by the interference of two light beams from a laser<br>· It gives a sense of multi-dimensional reality as in watching an actual object. |

Once the medium is determined, the next step is to plan for an integrated system of both hardware and software so that the medium can be materialized in the actual museum site in accordance with the purpose of exhibition. For example, if the aim of an exhibition is determined to be oriented towards audience participation via AR display, a thorough plan is needed for technologies to optimally project multi-dimensional images onto display and vision/sensor-driven technologies to accommodate numerous inputs. To place such system in an actual exhibition site as an intended object, it is imperative to plan out the operation by audience, the expected movement routes of audience, and exhibition environment from a hardware perspective.

10) Content

Exhibition content selects materials within the scope of the exhibition theme, reproducing the materials' tangible and intangible information and emotions. In order to use the selected components as exhibition materials, it is necessary to convert them into forms suitable for production. In this process of conversion, the medium and forms to be used, exhibition type and scope of expression of certain works should be fully considered, because these components are used for the production of actual materials for exhibition content, which determine the qualitative level of the exhibition content. Most components are digitalized through this phase. Among them, because of the characteristics of the medium's form, the exhibition image takes up a significant position in digital exhibitions. Image medium with the senses of visual and hearing is easy for the audience to understand and it is possible to intensively deliver compressed, comprehensive content in a short period of time by using image editing or image effects. Fundamental visual media comprising of images are texts, images, graphics, animation and videos. With each media expressed within the images according to space and time frames, backgrounds by images and graphics are created and information based on texts are delivered, creating a dynamic motion and flow of animation and videos.




[Figure 17] Organizational structure of MCF

## 2 Development case with the application of MCF: "The Mahan Gilt-bronze Shoes Hologram Experiential Exhibition" of the Naju National Museum

This study created the museum's exhibition contents by applying MCF in order to present the actual development process of the MCF framework. Also in order to verify its specific effects, an exhibition with audience evaluation was held in the museum. As a result, the efficiency was verified.

### 2.1 Project overview

This project was set in motion as an MOU was signed with the Naju National Museum regarding content development & display and a decision was made to hold a week-long special exhibition in mid-March of 2016 after six months of development. Since its official opening in 2013, the Naju National Museum has been located in Bannam-myeon, Naju, Korea. The Bannam-myeon area is clustered with massive tumuli of earthenware coffins that represent the tumulus culture near the Yeongsan River valley. Although its exhibition halls are relatively smaller than those of other national museums, the Naju National Museum makes constant efforts to adopt new technologies to provide audience with exciting archaeological experiences in a more intriguing setting. For a swift progress of this project, the museum selected its curator with a project team of writer, developer, and designer who actively supported various activities and communication. As an expert in marketing and content development, the author of this paper was appointed to be in charge of planning and set up a team to orchestrate the production process. The curator and writer were in Naju whereas the developer and designer resided in Seoul. Therefore, there were more individual meetings than plenary sessions. For an effective team communication, however, the planner documented a periodic progress reports on the developments of MCF execution process and regularly shared these documents among the team. The name of the project, Mahani Project, was inspired by the character name from the project content. For the sake of convenience, the project is herein referred to as Mahani Project.

## 2.2 Writing and application of design canvass

A design canvass was created to enable a quick-glance view on each process of the Mahani Project. The followings are the key points of consideration for this design canvass:

Firstly, the first design canvass was quickly made at all once. The design canvass was written as if to jot down fresh ideas right off the brain rather than organizing a perfect plan and blanks were used when it was hard to produce ideas right away. As it was supposed to be updated and advanced over time, the canvass had to be written with a focus on core elements first and then be expanded and revised afterwards.

Secondly, the canvass should be simplified. In this project, the design canvass boiled down to one sentence so that the gist could be immediately understood at a single glance. Design canvass is a tool to communicate with team members of a collaboration project in a consistent manner. As the canvass becomes the basic information for the action plan of later phases, it is crucial to simply express the essence of process so that the basic direction can be consistently reflected into more specified phases. [Figure 18]

The canvas documents the initial subjects and strategies of the exhibition and sets the scope of work clearly, which makes it a crucial data that helps communication among teams when changes are made later. It is also used as a documenting tool for sharing information regarding changes and for cross-checking. For example, all the teammates may not be able to come together to one area and discuss when there is a change in plan that needs to be discussed quickly. The canvas would be used here to share major announcements and exchange information regarding the additional work.

Furthermore, perspectives have changed with the use of the canvas from one that sees each professional field as a part of the project to one that unites all the teammates towards a single goal. In other words, mutual understanding and trust, which are the most important aspects of convergence projects, were used to create a strong and solid cooperative system.


[Figure 18] Design canvass of Mahani project

### 2.3 Phase-by-phase elements of process

The Mahani Project followed the typical process of MCF: define, strategy, and planning. Also, in the strategy and planning phase, the process was reversed back to the previous phase if a testing-related problem occurred; in this case, documents or visual information were revised or added to form an intuitive understanding of the change in the middle of progress and ensure a smooth communication among team members.

#### 2.3.1 Define Phase

1) Phenomenon

A series of literature study, interview, observation, etc. were carried out in order to analyze the current status and characteristics of exhibition and the needs of audience at the Naju National Museum (hereafter referred to as *the Naju Museum)*. The literature study involved a source of information including books published by the museum, and the reports, dissertations, and documentaries on the current status of museum exhibition. An interview was conducted in the sequence of curator, docent, and audience. The analysis results are summarized from three points of view as follows.

① Current status

The Naju Museum aims to publicize the distinct native culture of the Yeongsan River valley by collecting, conserving, and displaying the prehistoric and historic remains lying dormant around the valley. The predominant view states that the tumuli in this area were made by a leader group of the Mahan people who used to reside in the south-western region of Korea for centuries from B.C. to A.D. The main relics of the Naju Museum include the gilt-bronze crown in the 9$^{th}$

tumulus in Sinchon-ri and the golden plate ornaments, gilt-bronze shoes, silver crown ornaments, etc. excavated from Bokam-ri.

In general, the museum exhibition of archeological relics has emphasized their functions, usages, or other aspects in terms of usability as a tool in the context of the Korean history and the demands of the time. As a result, a great number of museums have been erected with featured exhibitions in the areas of well-known capitals of ancient societies and kingdoms such as the Three Kingdoms, thus inevitably distracting public attention away from less-known native cultures such as that of Mahan. According to this research's interview on audience, before coming to the Naju Museum, many of them had been unaware that there used to be an independent culture of Mahan and a number of ancient tumuli were scattered across the Museum and its vicinity. This is the reason why museums should take an expanded role as an educational institution and a cultural service provider in order to raise the public awareness of the unique and independent culture of Mahan.

② The characteristics of exhibition

The basic exhibition direction and purpose of the Naju Museum are to inform its audience about the history of the Jeonnam Province with a focus on the Yeongsan River Valley and publicize the developments and characteristics of the tumulus culture around the area which is best represented by tumuli of earthenware coffins. Unlike other museums, the Naju Museum curates its objects based on archaeological information and set up separate exhibition halls to explain to audience the function of archaeology and museum. For the first time in Korea, the Naju Museum has introduced an open-type storage and offered an unprecedented form of content unseen from conventional museums.

Although its exhibition halls are relatively smaller than those of other national museums, the Naju National Museum goes beyond merely demonstrating relics kept in showcases and actively leverages new digital technologies in order to make audience touched by the immersive experience with relics via intriguing

technologies. The following [Table 7] describes the exhibitions of the Naju Museum and the type of digital contents used for respective exhibition.

[Table 7] The exhibitions of the Naju Museum and the type of digital medium used[24]

| Category | | Detail | Type |
|---|---|---|---|
| **1st Exhibition** | Zone 1 (The Dawn of History) | · Introduction<br>· The vegetation and environment of the Yeongsan River Valley | · Projector<br>· Digital frame |
| | Zone 2 (Mahan, the Center of Three Hans) | · The prehistoric life and culture around the Yeongsan River Valley | · Digital frame |
| | Zone 3 (Tumulus Culture in the Yeongsan River Valley) | · The culture of the Yeongsan River Valley from B.C. 1st to 6th century<br>· The tumulus culture of the Yeongsan River Valley) | · HD Projector |
| | Zone 4 (River Channel, Sea Channel) | · The trade between Korea, China, and Japan during the unified Silla period centered around Cheonghaejin | · LED Monitor<br>· Digital frame<br>· Projector |
| **2nd Exhibition** | Zone 1 | · Understanding the study of archeology through experience<br>· Exploring the excavation process of historical remains | · Augmented Reality<br>· Jog-and-shuttle based 3D game<br>· Touch screen<br>· LED Monitor |
| | Zone 2 | · Understanding the management and conservation of relics through experience | · LED Monitor<br>· Transparent monitor<br>· Touch screen |
| **Others (Exhibition Information Service)** | | · Providing the specific information of exhibition objects via text and voice | · NFC technology |

[24] Lee Myung-jin. (2016). *A Study of Using Digital Contents for Exhibition of Museum of Baekje Cultural Heritage in Iksan.* Unpublished master's thesis, Wongkwang University, Korea

The 1st Exhibition is located on the 1st ground floor with a total of four zones and equipped with relics in showcases as well as informative videos to ensure a better understanding of showcased relics. The videos are shown by LED monitors, projectors, digital frames, etc. At the last section of the exhibition, a monitor is installed to enable an augmented reality experience. The 2nd Exhibition on the 2nd underground floor is an exhibition hall where audience can experience the nature and role of archaeology. Audiences are allowed to operate a job and shuttle to look inside a tumulus via an endoscope.

The results of observation revealed that the experiential contents of the Naju Museum was faced with the unskilled operation of audience, frequent errors, and a lack of updates, thus proving insufficient in boosting the learning effect of audience. Furthermore, video content lacked a strong interaction with audience due to its one-way delivery of information; in fact, many of the audience did not watch it thorough to the end, but just took a glance at it for a while before moving on—meaning that the overall contents were no different from relics kept in showcases and graphic panels since these contents failed to strip up and retain the attention of audience. In general, it was difficult for non-expert audience to find excitement in watching ancient relics. Therefore, a more fresh and interesting exhibition content was needed. Also, the entire story of the Naju Museum exhibitions was too simple to make audience want to come back. To do so, the Museum had to come up with a more differentiated exhibition content.

2) Analysis

The *analysis* phase analyzes the data previously identified in the phenomenon phase and defines problems and solutions by using a SWOT analysis—a methodology to deep dive into the *strengths*, *weaknesses*, *opportunities*, and *threats* of an organization, analyze its current status, and produce countermeasures

① Strengths

- In addition to the collection and conservation of relics, the Naju Museum aimed to expand its experiential exhibition space by utilizing cutting-edge technologies so as to become a audience-centered "open cultural space".
- As the Naju Museum was located in vicinity of a cluster of massive tumuli, audience could see relics and remains all at the same time.
- Mahan shaped a well-developed culture by cultivating fertile plans and utilizing water ways. As it belongs to the ancient history of Korea prior to the era of the Three Kingdoms and is relatively less known to the public, the Mahan culture had a huge potential to spark the imagination of audience.
- The signature relics of the Naju Museum were gilt-bronze crowns and shoes which were thought to be buried with the supreme leaders of the Mahan people. The relics were of major historical and academic importance as they indicated the after-life belief and the sophisticated craftsmanship of the Mahan people.

② Weaknesses

- Distance: By car, it took more than an hour from places such as Gwangju and Mokpo to reach the Naju Museum which was located in a rural plain.
- Technology: Although its use of digital technology was more advanced than other museums, the Naju Museum offered a low level of immersive experience and failed to make people revisit the place.
- Archaeology: Given the nature of archaeological properties, most of the relics were not free from damage and erosion of time. It was not easy for non-expert audience to appreciate the value of relics based on their pure imaginations of the ancient time.
- Budget: Since its inception, the Naju Museum mostly focused on its management and maintenance. The museum found it hard to allocate a separate budget for a new exhibition and, if any, the budget was too restricted.

③ Opportunities

- Due to the addition of Seoul-Naju KTX line, the access from other cities to the museum was greatly enhanced, driving up the expectations for the further attraction of tourists.
- As more and more people sought out a more sophisticated cultural experience and leisure and the policy of five working days per week expanded, a increasing number of audience were viewing a museum not simply as an education institution, but as a complex cultural space where they could enjoy a variety of artistic and cultural activities.
- There were movements to revitalize the local economy of Naju by tapping into the growing interest in the Mahan culture in the Yeongsan

River valley and turning the local area into a festival celebrating a rich cultural heritage.

④ Threats

- Already benchmarked by other museums and exhibitions as a best practice case of digital technology utilization, the Naju Museum needed to further differentiate its exhibition contents.
- Due to the reinforcement of operation rating of national/public art-and-culture institutions, there was a fierce competition between museums to attract audience.

Based on such analysis results, the direction of solution development went as follow. First of all, most of the exhibition objects in the Naju Museum were excavated relics which were displayed at the museum after having been dug out from a tumulus. Originally, these relics were buried items in a tumulus that were meant to respect the deceased and usher them into the afterlife. However, as such relics were cut off from their original context and kept in museum showcases, it was difficult for audience to fully appreciate their true value just by watching them. The museum had to reshape the plot of its exhibition in a way that galvanizes the historical imagination of audience and helps them relate to the plot by narrating a story of key figures and events at a certain point of ancient time.

In this vein, intensive discussions had to be made to find the right subject for such story-based exhibition contents. As for the signature relic of the Naju Museum, the gilt-bronze shoe from the 3rd tumulus in Bokam-ri, a fascinating story could be gleaned from the cultural representation and aesthetic impression of the fish ornaments attached to the bottom of the shoe. In addition, fish was perfectly fit for a main character of exhibition story as it was considered a friendly animal to all and often appeared in the ornaments of ancient relics at both home and abroad inspired by numerous myths, legends, and folktales.

Even though the Naju Museum established a NFC-driven exhibition guide system for smartphone, it was no better than an information guide and merely offered an one-off experience, thereby necessitating a more innovative exhibition content that encouraged people to visit the museum again. A more brilliant consent idea was needed for the use of smartphone in a way that makes audience want to come again by bolstering the fun factor of the NFC-driven app and allowing the app to remain useful and fun to play even after the exhibition is over.

3) Ideation

Project team members brainstormed ideas for exhibition content development which eventually boiled down to two methods: ① *a story-based exhibition technique* with a focus on character building of the fish on the gilt-bronze shoe and ② *expandability* that makes exhibition content drive up the revisit rate and reinforce the PR effect of the museum after exhibition experience.

This ideation process involved *SCAMPER* methodology—which is used to spark fresh ideas by exploring and asking inquiries about a certain agenda item. For this, without setting any particular items or a list of questions, numerous questions were thrown to the pictures of gilt-bronze shoes and various images of exhibition cases. Such "what if" questions were fleshed out and revised based on more specific inputs before coming down to an ideal combination of thoughts. The following is the finalized hypothesis:

① Exhibition technique

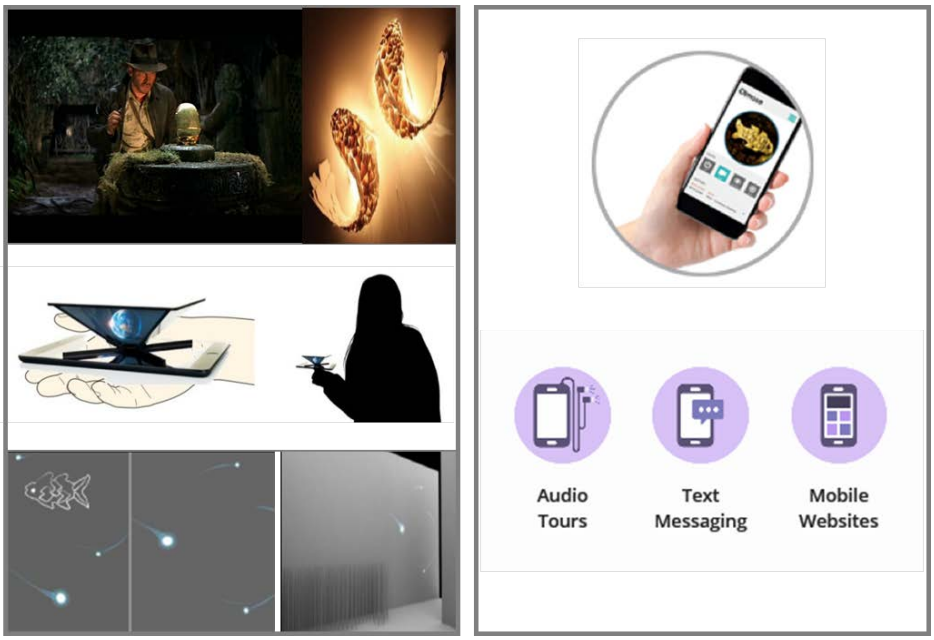
- What if the gilt-bronze shoe is restored in its original form and its bottom ornament fish vividly moves around before the eyes of audience?
- What if the fish appears on the screen of audience's hand-held medium and serves as an exhibition guide?

- What if the fish on the palm guides audience through the exhibition and the fish's journey in the Mahan era is expressed in visuals following the audience movement route?

② Expandability

- What if the fish on the palm is materialized as a smartphone app and the app is used as a means to interact with exhibition content?
- What if the smartphone app expands into a gaming content using the fish character and motivates audience to keep receiving museum information or revisit the museum by offering them some desirable promotional items?

These what-if questions were then visualized to allow an intuitive description of meaning. As for the visualization process, if time was running short for detailed graphic work, similar images were lifted off from the web for the sake of convince and brief-and-clear descriptions were added.




[Figure 19] Visualization by ideation

4) Exhibition object

The project team collected information about the gilt-bronze shoes selected above and described how exhibition contents were to be informed and construed. Above all, the team identified audience needs based on the current status of gilt-bronze shoe exhibition and launched literature study to sum up the interpretations on relics such as the information of original forms, the symbolic representation of fish-shaped ornaments, etc.

① The current status of Mahan gilt-bronze shoe exhibition

The gilt-bronze shoes found in the 3rd tumulus in Bokam-ri were already seriously damaged and eroded at the time of excavation and thus were restored and conserved in an independent display showcase—the primary purpose of which was the protection of relics. As their metallic part of was very fragile, the shoes were conserved along with the clinging soil covered with their metallic part, which might make it difficult for audience to figure out the original shape and emblem of the relic. In addition, although a mirror was installed on the showcase floor to show a reflected view of the fish ornaments beneath the shoes, not many audience realized the mirror as there was no noticeable guide on how to appreciate the relic. The exhibition method needed to be changed in a way that the relic could be viewed from various angles and audience could relate to the historical value of the relic by watching a restored version of its original form.

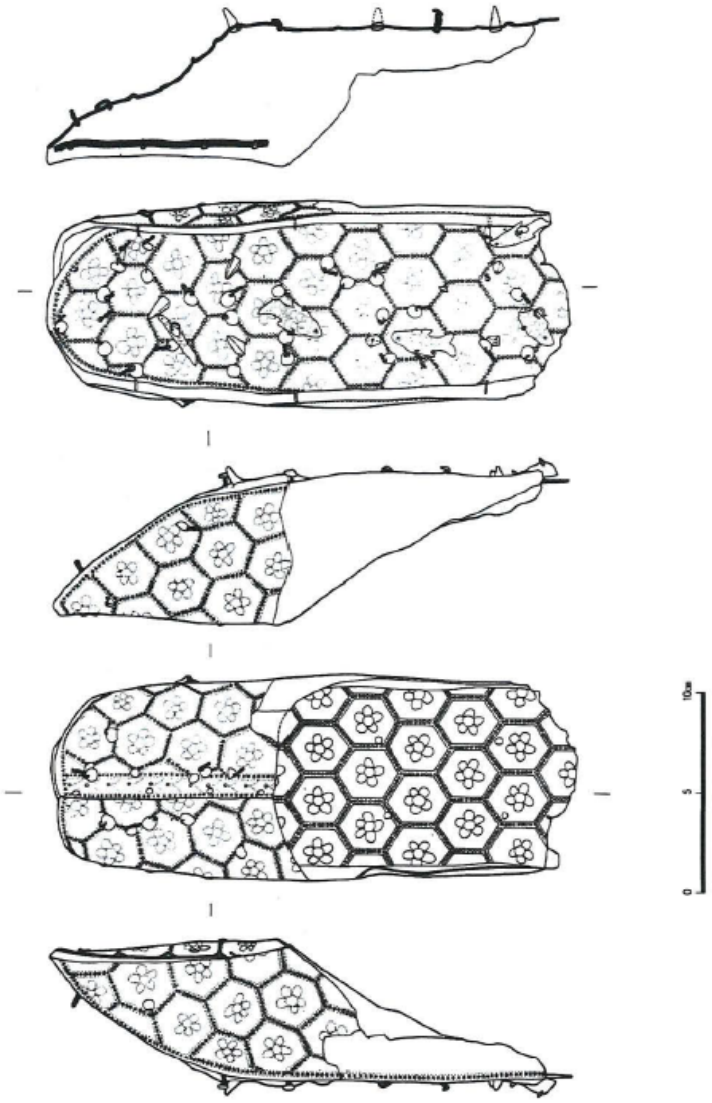
[Figure 20] Mahan gilt-bronze shoe exhibition in the Naju Museum

② Relic information of Mahan gilt-bronze shoe

When the gilt-bronze shoes first came out as a pair during excavation, the left shoe did not have its toecap and sides while the rear part of the right shoe was missing. The surface of the shoes was beaten into a hexagonal pattern carved with four or five pieces of floral patterns. A round-shaped spangle was attached to each node of the hexagonal pattern while the sole and sides of the shoes were decorated with fish ornaments. The fins of fish-shaped ornaments were connected with gilt-bronze threads to the shoe on one side and to the round-shaped spangle on the other side. Although these fins were thought to be nine in total, there were only five of them left on the sole.

When it comes to fins, the shape of fish appeared different with a difference of ±3.2cm. It seemed that the scale and eyes of the fish were carved into spot patterns via a dotted-line carving technique—which gave off a more lively and

tender tone compared with counterparts excavated in Japan. As for the left shoe which was more damaged, fish-shaped ornaments were attached to its side.



[Figure 21] Mahan gilt-bronze shoe[25]

[25] Yu Jae-en, Wi Koang-chul, You In-sook and Shin Ui-kyoung. (1998). Conservation of gilted footware excavated from Bokam-ri, Naju Province. *Research of Conservation Science research*, 1998, 25-37.

③ Interpretation of Mahan gilt-bronze shoe

From a mythical point of view, the fish on the shoe symbolizes a special envoy sent by the Gods of the Land and Sky—which is directly related with the fishery culture described in the myth of Gojumong, the founding father of the Goguryeo Kingdom. *The Heritage of the Three States* describes that the King Seoktalhae supported his old mother by fishing. From a religious perspective, fish can be interpreted as an army as they flock together in a group; the wiggling fish carved in the pillow of the King Muryeong refers to a faithful guardian for the king.

In the oriental culture, fish means sacredness, abundance, and regeneration—as in the two fish drawn in the national flag of Inner Mongolia in which numerous nomads reside. Fish share with birds the same symbolic meaning of fecundity. The iconic meaning of fish includes sanctity, armor, longevity, prosperity, wealth, etc.

5) Audience

First of all, based on the current status of the Naju Museum, the age of audience targeted for exhibition content was determined before deciding on further specifics regarding the physical conditions of exhibition method, etc.

① Age

It was unrealistic for the Naju Museum to satisfy every audience in terms of age and social class. Given that the usual target audience of a comprehensive museum like the Naju Museum was children, the main audience of the Naju Museum had to be defined as those between 4$^{th}$ and 6$^{th}$ graders. Although there were not a small number of adult audience, such targeting of audience was still appropriate since most of the adult audience were parents bringing their children to the museum.

② Level of knowledge

The underlying assumption was that the target audience had little or no prior knowledge about the Mahan culture as well as gilt-bronze shoes. The exhibition content had to be designed in a way that not only delivers historical facts but also generally depicts the Mahan society so that even children can easily understand the unique culture, lifestyle, and values of the Mahan people.

③ Ergonomics

The exhibition contents had to be displayed at the right height for the target audience who were as tall as 140 to 150cm when standing. Although this might be slightly higher than the average height of $4^{th}$ to $6^{th}$ graders, it was deemed as the right height for the holographic display of the exhibition because to look up was better than to look down to watch it.

④ The expected number of audience

Given the size and scale of the exhibition space, no more than eight people had to be accommodated; only one person could directly experience the entire exhibition story via a location-based smartphone app while the other audience could have an indirect experience by sitting or walking together to watch another one experiencing the story of exhibition.

⑤ Social background and language

The flow and manner of exhibition experience could be informed by assistant staffs at all times. There were no written or voice-recorded guide in exhibition contents so that the message of the exhibition was strictly conveyed through visuals while the audience proactively engaged with and interpreted the intended message on their part.

### 2.3.2 Strategy Phase

The *strategy phase* is to write a specific scenario with an aim to materialize the ideas and directions previously drawn out from the analysis phase. This phase involves two activities: *storytelling* and *interaction*.

1) Storytelling

*Storytelling* is a process to shape an exhibition narrative that can promote the emotional experience of audience. The storytelling process starts from plot making with a structure of *introduction, body, and conclusion*. In this context, the approach taken by this research was to raise questions over the Mahan gilt-bronze shoes—which was the essential motif of the relic in this project—and to make assumptions based on the historical facts mentioned above. Also, this project ensured that the exhibition contents could intrigue and excite the children audience of the museum.

[Table 8] The plot making of Mahani project

| | | |
|---|---|---|
| 1 | Question | Why were these shoes buried with the deceased? And why were these shoes decorated with fish ornaments? |
| | Assumption | The Mahan people must have believed in an afterlife and that the deceased can safely cross over to the other world if wearing this pair of shoes as they will be escorted and protected by a fish guardian. |
| 2 | Question | Why did the Mahan people believe that fish protected them? |
| | Assumption | The fish in the river was the staple of the time and symbolized a fertile land—the arable plain around the river. Given that fish never close their eyes literally day and night, the Mahan people must have believed that fish are their guardian who protect them. |
| 3 | Question | What are the meaningful lessons we can learn from these gilt-bronze shoes and the lifestyle of the Mahan people? |
| | Assumption | Based on the record of conducting ancestral rites to the God of the Sky after a harvest, the Mahan people must have seen the life and death of humans as part of the organic relationship with nature and greatly cherished the value of life. |

This storytelling process narrowed down to a plot which was centered around a fish as the main character of a story. As for character building, the fish was named as "Mahani" to resemble the feel of the *Mahan* era and also to be pleasantly received by children as a cute name.

[Table 9] The plot of Mahani Project

| Part | Theme | Synopsis |
|---|---|---|
| **Introduction** | Discovering a Fish | We encounters a fish engraved beneath a pair of dusted shoes which have been buried underground for 1600 years. The fish jumps at you to tell a story of its grand journey. |
| **Body** | The Journey of the Fish | Once upon a long, long time ago, a fish was born through a crack between the land and sky. The fish flew over the sky near, swam across the ocean, and navigated through the wood to absorb the spirits of the sun, water, and greenness and then glowed with a five-colored rainbow.<br>Travelling around the world, the fish bumped into the land of Mahan and served day and night as a guardian who offered an abundant life by turning the land into a fertile plain and ensured that the Mahan people continued to live happily and stayed away from dangers. |
| **Conclusion** | The Creation of Mahani | I want to thank this five-colored guardian fish and call it Mahani.<br>Where would Mahani be travelling right now? |

Based on this plot, and the concept and idea specified in the ideation phase, the project team selected an exhibition theme—the core message to be delivered through the exhibition.

| | |
|---|---|
| **Main theme** | Time-and-Space Travel with<br>the Guardian Fish "Mahani" to the Mahan Era |
| **Message** | Exploring valuable meanings from the fish ornaments of gilt-bronze shoes, to the ancient times, and to modern times and offering an immersive experience to spark new imaginations about the history and culture of Mahan |

Based on the selected exhibition concept and theme, the project team created a storyboard to flesh out the plot in the form of scenario on a step-by-step basis. As it laid a foundation for content production, the storyboard had to be made in consideration of contents.

[Table 10] The storyboard of Mahani Project

| Part | Theme | Synopsis |
|---|---|---|
| **Introduction** | Discovering a Fish | We encounters a fish engraved beneath a pair of dusted shoes which have been buried underground for 1600 years. The fish jumps at you to tell a story of its grand journey. |
| **Theme** | **Content** | **Scenario** |
| Aesthetic Beauty of Gilt-bronze Shoes | Restoration video of gilt-bronze shoes | The dusted condition of gilt-bronze shoes |
| | | Gradually restored back into their shiny original form |
| | | Spinning to show the sole upwards and zooming in on the fish ornaments on the sole |
| | | One of the ornaments wiggles and jumps out.<br>(To express how it turns into a lively fish) |
| | | The fish ornament spins fast as if swimming around the water and suddenly stops at the center of the view before disappearing. |
| | Gilt-bronze fish | A gilt-bronze fish appears on the palm of the audience. |

| Part | Theme | Synopsis |
|---|---|---|
| **Body** | The Journey of the Fish | Once upon a long, long time ago, a fish was born through a crack between the land and sky. The fish flew over the sky near, swam across the ocean, and navigated through the wood to absorb the spirits of the sun, water, and greenness and then glowed with a five-colored rainbow.<br>Travelling around the world, the fish bumped into the land of Mahan and served day and night as a guardian who offered an abundant life by turning the land into a fertile plain and ensured that the Mahan people continued to live happily and stayed away from dangers. |
| **Theme** | **Content** | **Scenario** |
| The Nature of the Ancient Times and The lifestyle of Mahan People | ·Wall Display 1<br>·Blue fish | (Spirit of Water) The beginning of the Mahan civilization which developed along the Yeongsan River / Scene switching as it starts to rain |
| | ·Wall Display 2<br>·Green fish | (Spirit of Forest) Scene switching as rain makes trees and grasses thicker and green fields more fertile |
| | ·Wall Display 3<br>·Yellow fish | (Spirit of Land) Scene switching as the Mahan people harvest crops in brown fields and store their crops in their huts |
| | ·Wall Display 4<br>·Red fish | (Spirit of Fire) An earthenware being baked with fire / The earthenware in the kiln grows bigger till it turns into a massive coffin (tumulus) |

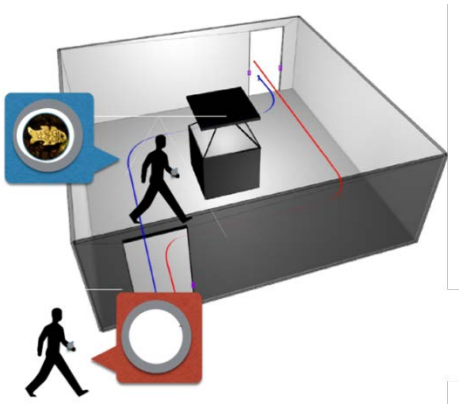
| Part | Theme | Synopsis |
|---|---|---|
| **Conclusion** | The Creation of Mahani | I want to thank this five-colored guardian fish and call it Mahani.<br>Where would Mahani be travelling right now? |
| **Theme** | **Content** | **Scenario** |
| The value of nature | Five-colored fish | A video implying that the fish soars through the sky and heads back to the ocean |

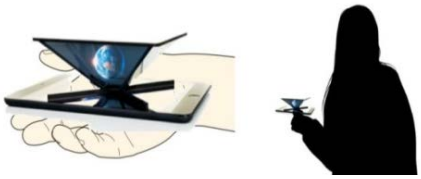
In the ideation phase, there was a suggestion to create a gamified exhibition using a fish character. In pursuit of the suggestion, the fish character was developed along with the elements which can be acquired as in items in a game. The natural spirits described in the plot are materialized into four themes—water, forest, land, and fire—and projected as wall videos. Also, it was decided that the gilt-bronze fish on smartphone screen would take on a symbolic color when one of the four spirit-themed videos was watched. And a final item for mission completion was selected which would make the fish glow in five colors. Such gamification not only creates the enjoyable suspense which drives the audience's immersive engagement into the exhibition, but also motivates children to actively participate in the exhibition experience and broadens the room for further expandability such as adding more item elements to increase the revisit rate.

2) Interaction

The previous phase is to formulate a strategy on developing audience experience regarding how to deliver the storytelling to the audience in a physical environment in what order and via what kind of interaction. The following table explains an interactive scenario in consideration of the link between medium and navigation which guides movement directions based on audience movement routes, the actions of audience and corresponding responses, etc.

[Table 11] The interactive scenario of Mahani Project

| Part | Image | Description |
|---|---|---|
| **Intro.** |  | (1) Audience receives a smartphone at the entrance and moves to the four-screen holographic display at the center.<br>(2) In response to the signal of the audience's smartphone, a restoration video of gilt-bronze shoes is turned on.<br>(3) With the video finished, a signal is activated to turn on the navigation video of the smartphone and Wall Display 1.<br>(4) The smartphone plays a video of gilt-bronze fish.<br>(5) With the gilt-bronze fish appearing on the smartphone, a navigation video is played on Wall Display 1 and grabs the attention of the audience. |
| **Body** |  | (6) Holding their smartphone, the audience move closer to Wall Display 1 which plays the navigation video.<br>(7) With the audience approaching Wall Display 1, a location signal is received to play Video 1 (Spirit of Water).<br>(8) With Video 1 finished, the fish on the smartphone turns blue as in the theme of water spirit.<br>(9) As the audience move to Wall Display 2, 3, and 4, a corresponding vocational signal is received play Video 2 (Spirit of Forest), Video 3 (Spirit of Land), and Video 4 (Spirit of Fire) in a consecutive order.<br>(10) With Video 2, 3, and 4 finished, the fish on the smartphone changes into the corresponding theme color. |

| | | |
|---|---|---|
| **Con.** |  | (11) Audience move in the order of Wall Display 2, 3, and 4 and watch respective videos and witness the corresponding change of the fish on their smartphone before exiting the exhibition.<br>(12) Once audience have moved through all of four wall displays and returned to the entrance point, the fish on their smartphone glows in five colors. |

Next, since this project activated three displays—four-screen hologram, smartphone application, and wall display projector—in a pre-determined order depending on audience location, an interactive flowchart was made in the form of cue sheet in order to build an interface.

| Audience | Four-screen holographic display | Smartphone | Wall display |
|---|---|---|---|
| Entrance | | | |
| A front of Holographic display | A restoration video of gilt-bronze shoes is turned on | | |
| | | Appearance of Gilt-bronze fish | |
| | | | Wall 1, Start of a navigation video |
| A front of Wall 1 | | | Start of a video 1 |
| | | | |
| | | The fish turns blue | |
| A front of Wall 2 | | | Start of a video 2 |
| | | | |
| | | The fish turns green | |
| A front of Wall 3 | | | Start of a video 3 |
| | | | |
| | | The fish turns yellow | |
| A front of Wall 4 | | | Start of a video 4 |
| | | | |
| | | The fish turns red | |
| | | | |
| | | | |
| Exit | | The fish grows in five colors | |
| | | The fish with five colors disappears | |

Cells with colors : Ongoing
Blank cells : Dark mode

[Figure 22] The cue sheet of Mahani Project

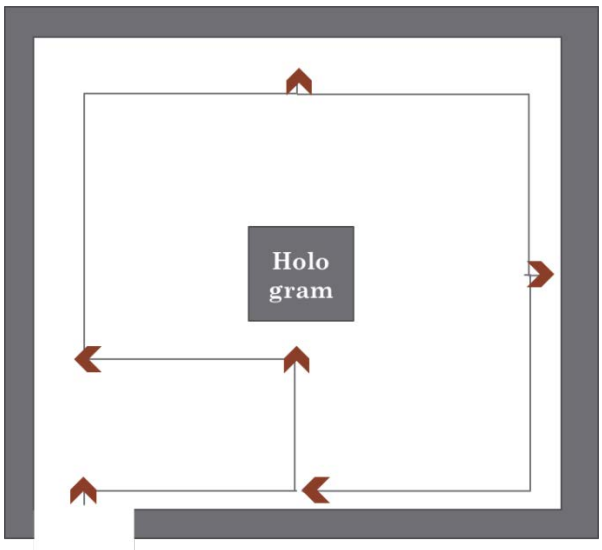
### 2.3.3 Planning Phase

The *planning* phase went through a designing process for production regarding the items for environment, technology, and content based on the strategy which had been established in the previous phase.

1) Environment

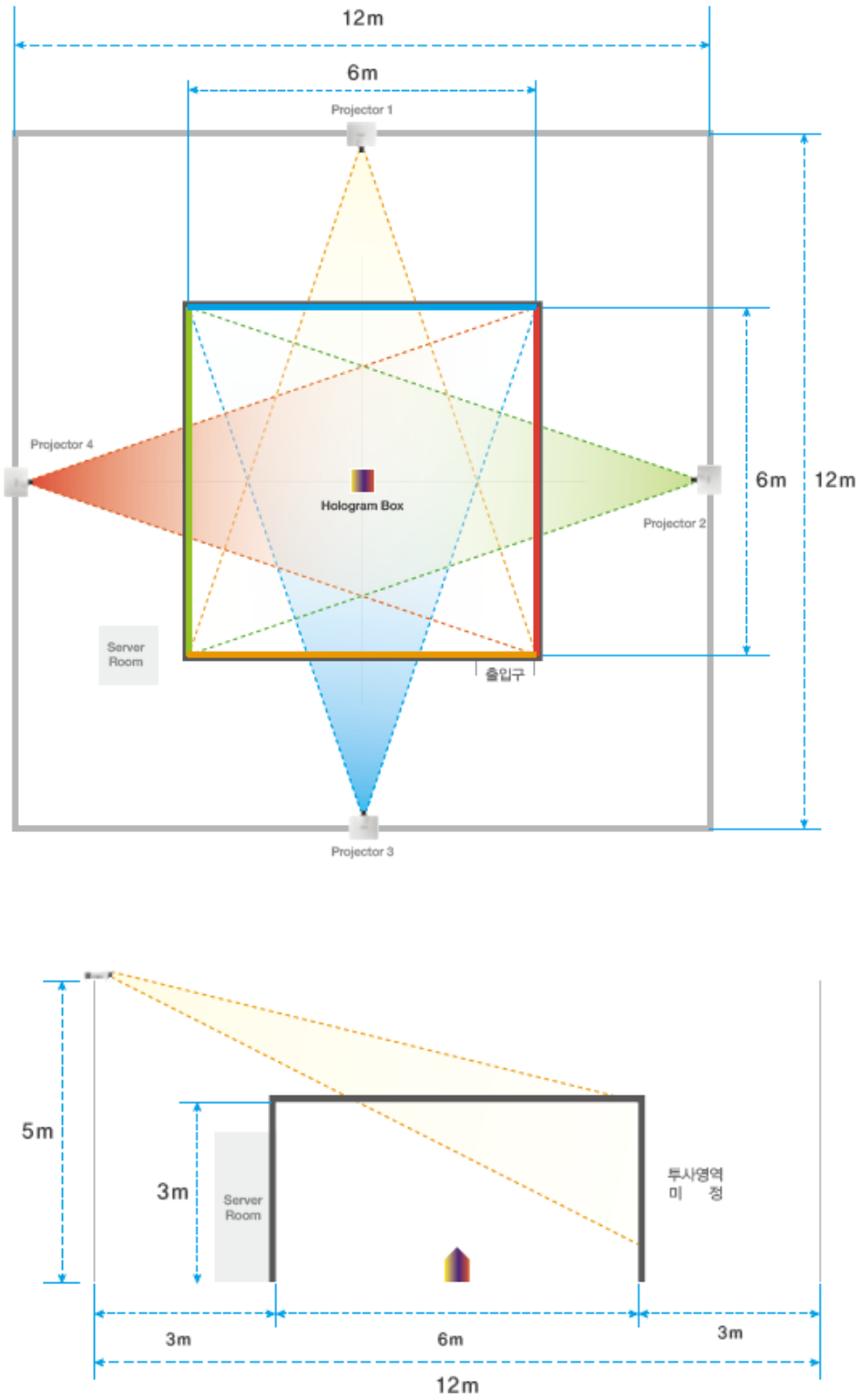
As the strategy required four times of display switching based on audience location, an exhibition space with four walls was needed. A total of four projectors were needed for the display at each wall. The size of wall had to be determined in consideration of allocated space, the surrounding environment, audience movement routes, and the projection distance of projector. This was because the maximum range of projection was fixed once the projector is installed at the ceiling.

At the center of the tetrahedron-shaped exhibition space, a tetrahedron holographic display was installed. Given the entire audience movement route of museum exhibition, the entrance and exit were made the same; audience start from the entrance, watch the gilt-bronze shoes at the center, and move in a circle from the left wall clock-wise before returning to and exiting through the entrance point.




[Figure 23] Indication of audience movement route

The following is the floor plan of the exhibition space.




[Figure 24] Floor plan of exhibition space

2) Technology

The most essential technology of this project included *hologram* for multi-dimensional display and *short-range wireless communications* for the transfer of audience location information.

① Hologram

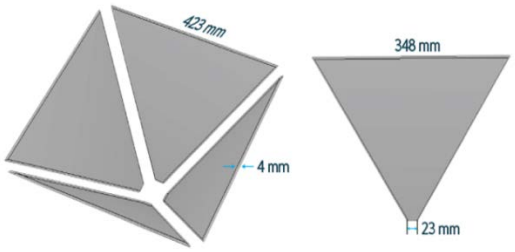
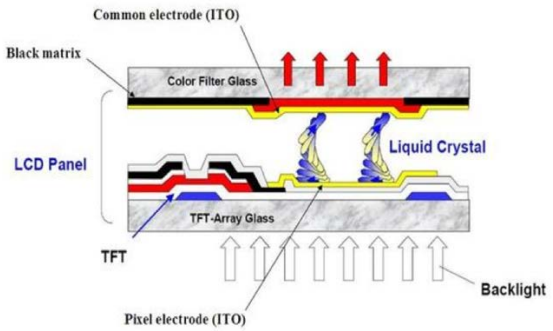
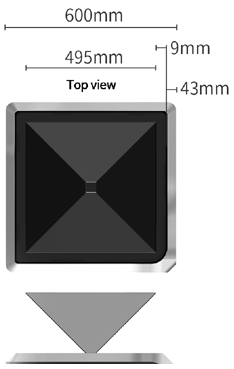
An inverted-pyramid-shaped, tetrahedron holographic system was built to play the restoration video of gilt-bronze shoes. Hologram has a great potential as an exhibition medium as it can projects an image in an empty space in a vivid color and simultaneously generates an independent world. Also, using a hologram to exhibit a relic offers an upside that it can creates the same atmosphere as in an actual cultural property demonstrated in a showcase under a special lighting condition. The biggest problem of cultural property exhibition is to meet the needs for exhibition space and conservational conditions. Hologram is easy to conserve as it is a sort of specially-coated glass panel and does not require a huge exhibition space since it is simple to install for image projection. Hologram can have a strong perceptional impact on audience by allowing them to watch cultural relics closer than they can at conventional museums because the projected image of hologram can be located differently by manipulating the image reproduction process on the glass panel.

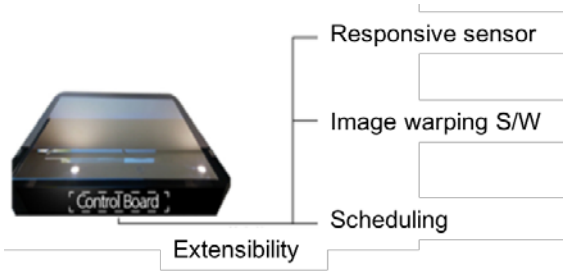
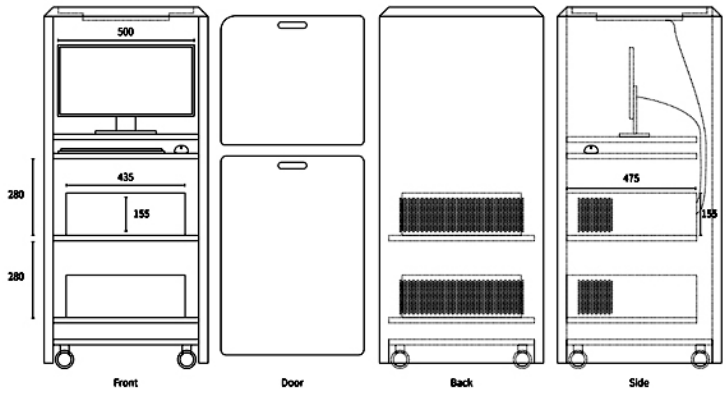
Harnessing such benefits of hologram, this project could reinforce the presence of gilt-bronze shoes by materializing a multi-dimensional display of how the shoes were restored from the current state to their original form. In this way, patterns and ornaments could be viewed from various angles and it became possible to display how the fish ornament moves from the shoe sole and swims around in the air.

An inverted-pyramid-shaped, tetrahedron holographic module was manufactured by connecting four special glass panels while a case was designed to accommodate a monitor and server which controlled the play of holographic videos

and the interaction with other videos or signals. The interior of the case was designed to accommodate hardware functions while its exterior design was formed in harmony with its surrounding exhibition. The height of the case was adjusted to suit the perspective of the targeted children audience. Likewise, this project ensures stability and usability by building a integrated system for the control of display, hardware, and software. The following is the components of this integrated hologram system and its specifications per component.

[Table 12] Hologram system and design

| Component | Image | Specifications |
|---|---|---|
| **Inverted-pyramid-shaped Half Mirror** |  | • Semi-transparent special glass (Non-glare)<br>• +70% display luminance is materialized.<br>• Plasma - conjunction technique is used. |
| **Hologram Module** |  <br>  | A basic hologram module used to project multi-dimensional images into a light-particle-amplification-type semi-gilded glass as in tetrahedron sides |

| | | |
|---|---|---|
| **Control Board** |  | A server for the control of display and interaction |
| **Case Interior** |  | |
| **Case Exterior** |  | |

In order to project the image of fish on the palm of audience, a portable hologram device was manufactured by making it possible to display a holographic video on the screen of smartphone. Given the nature of on-the-go environment, an effective method was needed to internally attach a smartphone with a reflective glass. Without breaching the basic principle of holographic display, an exterior of acryl and half mirror was made to be easily attached to/detached from the smartphone which ran an exhibition-only application.

[Figure 25] A portable hologram device attached to a smartphone

② Indoor location recognition based on short-range wireless communications

Bluetooth 4.0 Low Energy beacon (BLE beacon) was utilized to locate audience and exchange a certain signal. BLE beacon refers to a technological platform or a relevant device which enables indoor location tracking or short-range location tracking based on Bluetooth smart technology. The following is the operational process for BLE beacon-based location recognition:

- Install BLE beacon at the major spots within the exhibition space in consideration of movement routes.
- Register the verifiable ID of beacon to the server.
- Beacon regularly transfers the information of verifiable ID and signal strength to audience via a smartphone app.
- If audience activates their smartphone, enter the exhibition space, and approach an installed beacon, the app sends the signal transferred from the beacon to the server.
- By using a verifiable ID, the server recognizes which beacon has transferred the signal.
- The server sends to the app a display content which matches the signal information and plays it through smartphone display.

Based on an on-site test, a total of six beacons were installed at the spots where there were least signal interferences between beacons. The TX power of beacons was set to -16dBm while the interval was fixed at 318.75ms. The running OS for the app was Android and the smartphone used was Galaxy S6.

Beacon technology is related to the expandability of exhibition in regard to aforementioned revisit rate promotion. This is because a beacon not only enables a real-time communication but also makes it possible to build a business model by assessing data collected by it.

3) Content

For this exhibition, a total of three contents were developed: *restoration video of gilt-bronze shoes* to be played by tetrahedron holographic display, *themed wall display* of four natural spirits, and *fish display* via smartphone hologram.

Multi-dimensional images and videos were displayed by using 3D CG software such as Maya or Max and utilizing a built-in or plug-in type virtual CG camera. Since the gilt-bronze shoe restoration video and the fish video is played as a three-dimensional image within a tetrahedron hologram, the final output was edited as a 4 sided screen.

① Three-dimensional Gilt-bronze Shoe Restoration Video

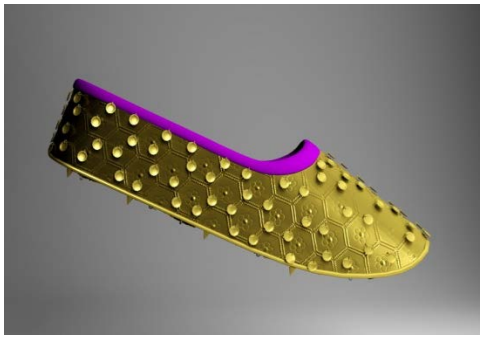
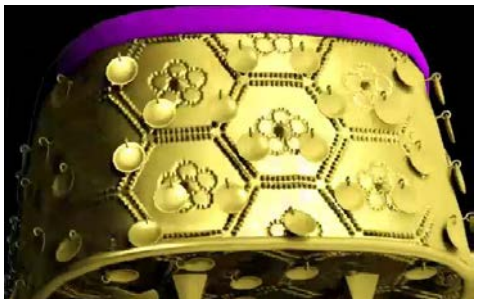
The work was progressed by implementing the storyboard's introduction contents of the [Table 13] as the 3D gilt-bronze shoe restoration video, and an animation of the fish on the sole coming to life.

[Table 13] Introduction Part of Storyboard

| Part | Theme | Synopsis |
|---|---|---|
| **Introduction** | Discovering a Fish | We encounters a fish engraved beneath a pair of dusted shoes which have been buried underground for 1600 years. The fish jumps at you to tell a story of its grand journey. |
| **Theme** | **Content** | **Scenario** |
| Aesthetic Beauty of Gilt-bronze Shoes | Restoration video of gilt-bronze shoes | The dusted condition of gilt-bronze shoes |
| | | Gradually restored back into their shiny original form |
| | | Spinning to show the sole upwards and zooming in on the fish ornaments on the sole |
| | | One of the ornaments wiggles and jumps out.<br>(To express how it turns into a lively fish) |
| | | The fish ornament spins fast as if swimming around the water and suddenly stops at the center of the view before disappearing. |
| | Gilt-bronze fish | A gilt-bronze fish appears on the palm of the audience. |

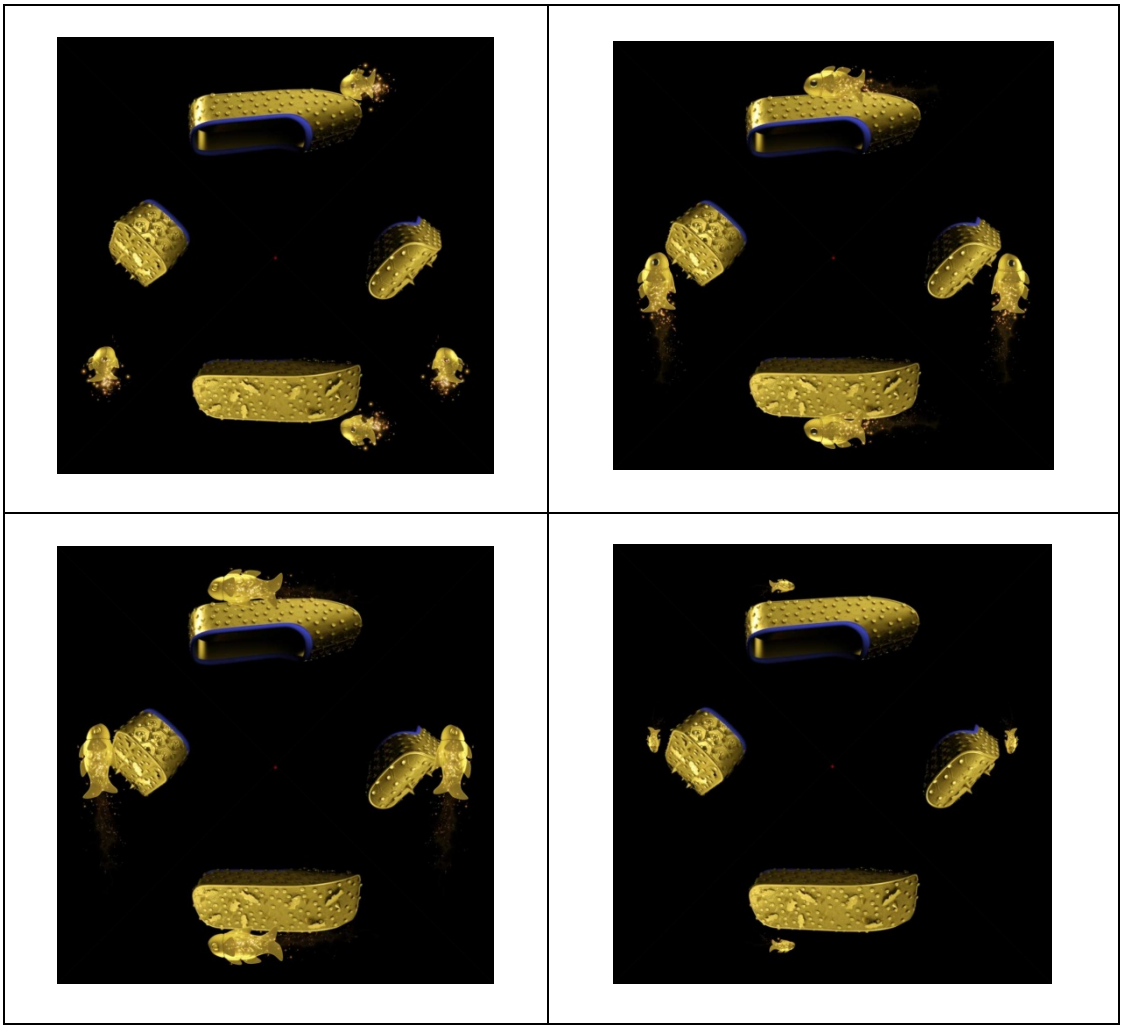
The heel of the gilt-bronze shoe was lost due to decay and was unrecognizable so the restoration process was focused on restoring the damaged areas. The original form was modeled by using the data from the three-dimensional scanning of a mock-up, and the information from a scientific and archaeological analysis. Next, for the creation of texture the images of the gilt-bronze shoe and archaeological documents were used to analyze the components of the gilt-bronze shoe and the pattern, and then by deducting the similar texture and color, the appropriate texture was compiled. [Table 14]

[Table 14] Gilt-Bronze Shoe Restoration Reference Information

| Division | Archaeological Analysis | Restoration Image |
|---|---|---|
| **Shape** | • Existing Length 27.0cm, Width 9.5(Sole width 8.0cm), Height 7 cm<br>• The front of the shoe is circular, and looking from the side fore sole is upwards |  |
| **Texture** | • Every side is plated, but the inner side is not. Traces of soiled fiber in the edge where the instep touches the shoe. | |
| **Pattern** | • Tortoiseshell shaped patterns overall, and flower patterns with 4 or 5 petals are placed within the tortoise shell-shaped patterns.<br>• The tortoise shell-shaped pattern is stamped outwards as a dotted hexagon, and the dotted hexagon is followed with another outwards stamped pattern.<br>• The flower pattern is shaped inwards.<br>• A circular decoration is attached to a entwined decorative chain. |  |

| | | |
|---|---|---|
| **Sole** | • On the sole of the shoe spikes of 1cm is attached in three rows of two, and on the very front only one spike is attached making nine in total.<br>• The number of fished shaped accessories seem to be 9 as seen from the arrangement of the spikes<br>• The length of the fish is approximately 3.2cm<br>• The scales and eyes of the fish is stamped outwards as a dotted pattern<br>• The overall form is smooth, and the tail is broken into two circular shapes<br>• Both fins are attached to the soles by making a hole connecting a ring on one side, and on the other a decoration is attached. |  |

In order to increase the immersion for the animation of the fish decoration on the sole coming to life, the cubic effect of the fish was increased by using the original design, and the movement of the fish was expressed with liveliness. The three-dimensional spacial sense and the deepness of the fish's movements were maximized by taking video reproducing tests. [Figure 26, 27]



[Figure 26] Gilt-bronze Shoe Fish Decoration Animation

[Figure 27] Animation Materialization Test

② Flat display on wall

The mahani project uses 4 projectors and creates an image on a 4 sided wall surface. The software After Effects, which is optimized for creating expansion multi-channel display image contents was used. By building the frame of the display for video contents virtually and using that frame as a base for creating video contents the margin of error is decreased when the contents are actually materialized. Also, by using the 3D elements of the video a cubic effect was shown on the flat display, and the sense of distance and space was expressed with the shadows effects from the light.

A total of 4 videos with themes of water, fire, earth, and forest are created with the contents of the development part of the storyboard in the [Table 15]. The specific information was directed so that the historical imagination can be simulated through expressing fantastic atmosphere than the descriptive elements focusing on the theme of "Journey of the Fish".

[Table 15] Development Part of Storyboard

| Part | Theme | Synopsis |
|---|---|---|
| **Body** | The Journey of the Fish | Once upon a long, long time ago, a fish was born through a crack between the land and sky. The fish flew over the sky near, swam across the ocean, and navigated through the wood to absorb the spirits of the sun, water, and greenness and then glowed with a five-colored rainbow.<br>Travelling around the world, the fish bumped into the land of Mahan and served day and night as a guardian who offered an abundant life by turning the land into a fertile plain and ensured that the Mahan people continued to live happily and stayed away from dangers. |
| **Theme** | **Content** | **Scenario** |
| The Nature of the Ancient Times and The lifestyle of Mahan People | ·Wall Display 1<br>·Blue fish | (Spirit of Water) The beginning of the Mahan civilization which developed along the Yeongsan River / Scene switching as it starts to rain |
| | ·Wall Display 2<br>·Green fish | (Spirit of Forest) Scene switching as rain makes trees and grasses thicker and green fields more fertile |
| | ·Wall Display 3<br>·Yellow fish | (Spirit of Land) Scene switching as the Mahan people harvest crops in brown fields and store their crops in their huts |
| | ·Wall Display 4<br>·Red fish | (Spirit of Fire) An earthenware being baked with fire / The earthenware in the kiln grows bigger till it turns into a massive coffin (tumulus) |

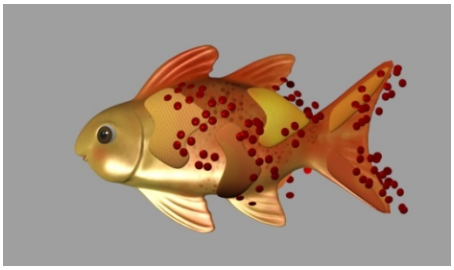
[Figure 28] The video source of 'Spirit of Water'

[Figure 29] A projected view of 'Spirit of Water'

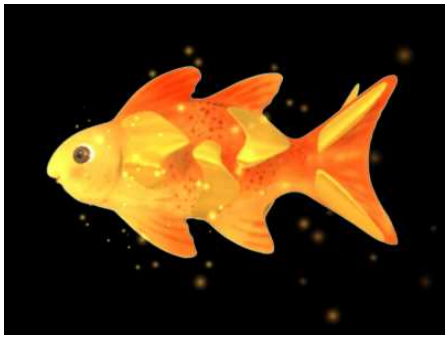
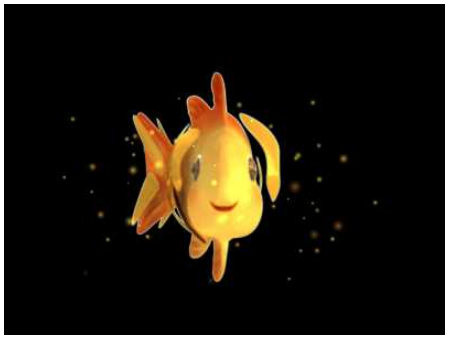
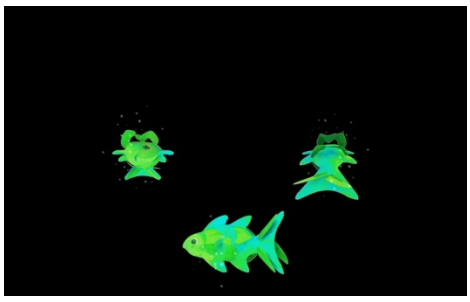
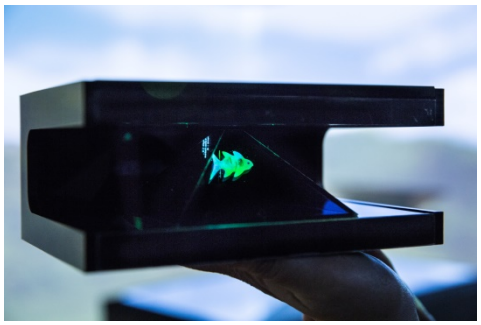
③ Multi-dimensional display of fish

After creating the basic design with the character's personality and characteristics a more specific job is done on the front, sides, and back by using additional sketches for three-dimensional creations. After the modeling operation is done a task for giving the texture to the character has commenced. In the case of Mahani since it's going to be materialized through a small three-dimensional hologram projector after actual play test the most appropriate light and texture are set. On a flat display screen, the texture might seem a bit bright and stiff but it was deemed appropriate because on a textured device it projects a lively and fantastical atmosphere. [Figure 30]

Finally, the animation was created by inserting movement frames according to the structural characteristics. The operation progressed by focusing on the natural movements of the fins and color differentiation of the gilt-bronze fish on each theme. [Figure 31]

| Gilt-Bronze Shoe Fish Decoration Original | Textile Craft Work <Mahani> | Character ‘Mahani’ |
|---|---|---|
|  |  |  |

[Figure 30] Characterization of Mahani design

| Mahani’s Side Design | Mahani’s Front Design |
|---|---|
|  |  |
| **Green Mahani Video Source** | **Green Mahani Projection Form** |
|  |  |

[Figure 31] Animation of Mahani

## 2.4 Exhibition

The Mahani Project was a special exhibition held in March 2016 at the National Naju Museum after six months of development. The following is the exhibition overview and promotional poster.

- Exhibition Title: The Mahan Gilt-bronze Shoes Hologram Experiential Exhibition
- Subtitle: Time-and-Space Travel with the Guardian Fish "Mahani" to the Mahan Era
- Period: March 15th (Tues.) ~ 20th (Sun.) 2016
- Venue: The National Naju Museum


[Figure 32] A poster of Mahani project exhibition

Although the size of audience was not huge due to the short exhibition period, the exhibition per se succeeded to grab the attention of media for its unprecedented exhibition technique and was publicized through TV programs and news dailies.


[Figure 33] Media coverage of 'Mahani Project' exhibition

[Table 16] Article's list of 'Mahani Project' exhibition

| Division | Media | Title of article |
|---|---|---|
| **Broadcast** | Gwangju MBC <News Today> | Historical Imagination projected by IT technology |
| | Gwangju KBS News | Relics restored through 3D hologram … Original Recovered |
| **Articles** | Dong-A Daily News | Mahan gilt-bronze shoe hologram exhibition is opened |
| | Electronic Newspaper | Mahan Gilt-Bronze Shoe 3D Hologram Exhibition GIST Restoration |

The followings are the curated contents in the exhibition and audience who experienced the contents.

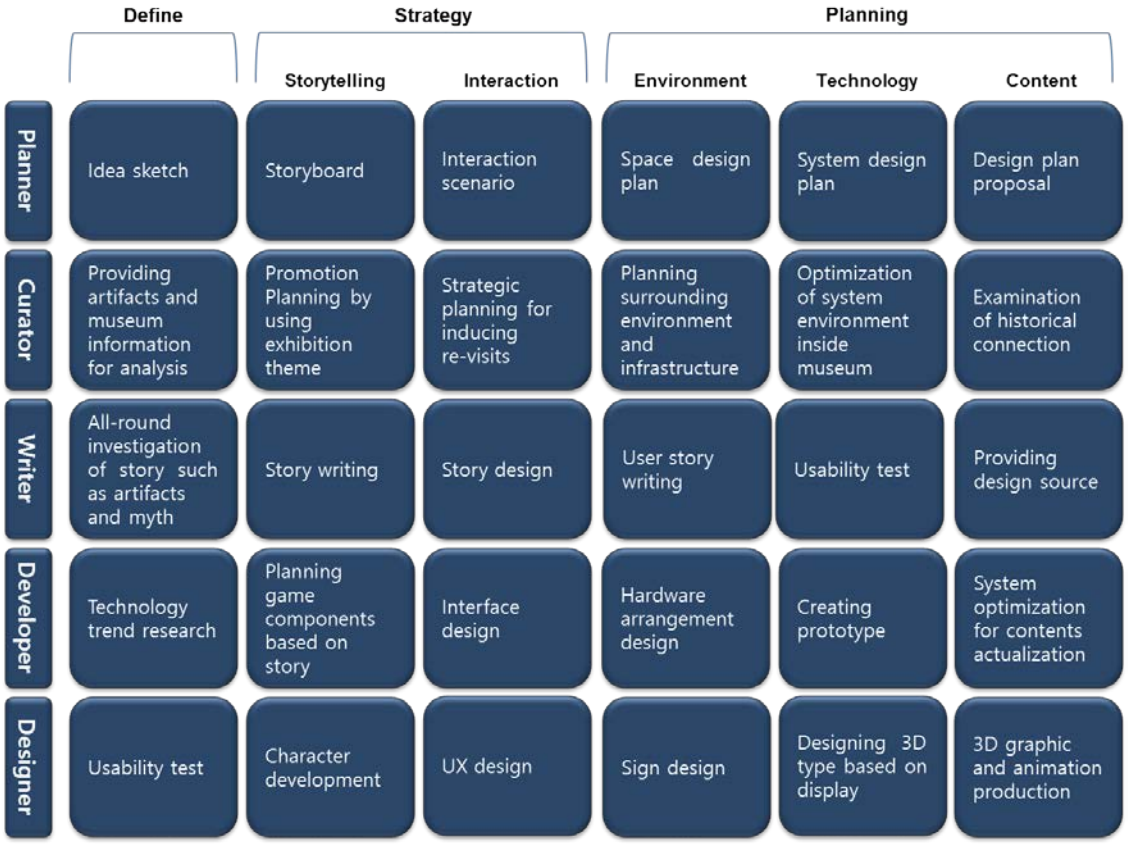
[Figure 34] Photos of Mahani project exhibition

## 2.5 Assessment of framework

The Mahani Project was in progress for 6 months with a five-man team of a curator, writer, developer, designer, and a planner (author). The planner, the author of this paper, was responsible for managing each teammate's responsibilities and coordinating the cooperation.

Previous digital exhibitions had their production directed mostly by professional agencies since they competed for the planning in the initial stages of the project, which would lead them to participate in establishing the exhibition plans. Recently, however, exhibition designs and technology became mandatory for curators as well, while research and analysis for strategies became mandatory for developers and designers. MCF follows this trend by providing a cooperation tool that shares the same prospect with teammates and gives effective communication and feedback. Therefore, the planning was done according to the MCF process to divide each's work and exchange feedback, instead of segregating each field and working privately.

Following is the tasks of each member according to the MCF process.




[Figure 35] Tasks of Mahani project

There are no tasks that were focused on one person, and it can be seen that everyone participated to a certain degree to achieve results continuously. We can also see that the planner combined the work of each person and documented it to many forms. The results from this helped the team understand each other and were used as a guide whenever there was need of deciding details or outsourcing partially.

After the project was over, the team gathered to give feedback about the MCF process. One of the major feedback was that they all achieved a better understanding of other fields. Exhibition contents until now divided fields into development, design, planning, etc. and was outsourced or was handed over to outside professionals. However, by participating in the project process and giving feedback to each other, they all were able to understand more of the work method and communication method of other fields.

Also, all team members understand the overall process through MCF, so information exchange that is done in each stage became the motivation that leads to participation in the next phase. For example, an engineer carried out a test recognizing mobile location signal according to movement by making test space in environment phase of planning level and shared its result. Accordingly, the designer recognized that design source of navigation that will instruct the direction of movement to audience is necessary, and added graphic image source in content phase.

Another major feedback was the efficiency of communication and decisions. MCF is written so that core contents of each phased element can be understood at a glance through design canvas. Team members were able to suggest solutions in each area in the process of materializing ideas based on phenomenon analysis, and suggest integrated project proposal through the process of writing with design canvas, dividing and reestablishing the structure. Project proposal that is written through this kind of cooperation became the motivation to effectively communicate when cooperation among team members is necessary.

Also, an exhibition that uses technology has many matters to take into account, and has many variables that could change the plans. In case of the MCF, each part was connected and processed to one united goal and they were continuously recognized by each member through the canvas. Therefore, when there was a change that needed to be decided, the necessary content and the interested party would be decided easily. This efficiency was able to sustain the project's standard direction even though small details would be changed. Furthermore, it was good that checking the rate of project progress and tracing history of business activities among team members is available through the process of updating design canvas.

### 2.6 Assessment of exhibition

With an aim to verify the assessment on the MCF-applied exhibition content of this research, a survey was conducted on the audience of *the Mahan Gilt-bronze Shoes Hologram Experiential Exhibition*. Group discussion and survey were carried out to assess whether the purpose of storytelling and interaction—the strategic elements of MCF—was achieved or not.

#### 2.6.1 Group discussion

1) Purpose of the research and Method

The purpose of this research is to understand the effect of the storytelling strategy of the exhibition. Also, the discussion method was determined by referencing Lee (2017)'s research of developing a museum education program using the artifact connection storytelling method.[26] The study was progressed by analyzing the results of the research participants' discussion and submitted drawing and report of the exhibition topic after viewing the exhibition. The participants were all visitors of the exhibition and were consisted of 10 elementary school students, and the discussion was held with two teams of five for two hours.

[26] Lee Eun-joo. (2017). *A Study on the Development of an Educational Program for a Private Museum by Applying a Story-telling Technique Associated with the Relics*. Unpublished master's thesis, Chungang University, Korea.

[Figure 36] Photos of Group discussion

2) Investigation Result

Using whether the exhibition topic was delivered well to the selected audience through participating and viewing the exhibition as the main standard of the result analysis, the exhibition theme and specific evaluation elements are as following:

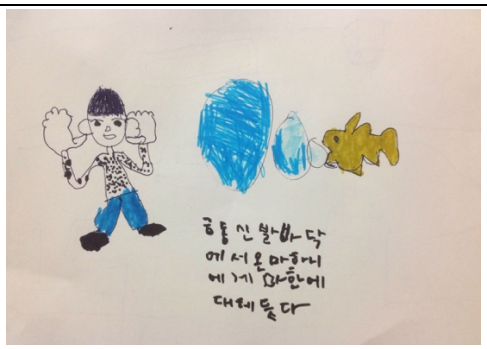
| | |
|---|---|
| **Main theme** | Time-and-Space Travel with<br>the Guardian Fish "Mahani" to the Mahan Era |
| **Message** | Exploring valuable meanings from the fish ornaments of gilt-bronze shoes, to the ancient times, and to modern times and offering an immersive experience to spark new imaginations about the history and culture of Mahan |

[Table 17] Evaluation Criteria

| part | Evaluation Criteria |
|---|---|
| **Understanding** | • Did the participant understand the exhibition's story created through its connection with historical knowledge?<br>• Could the participant find new value through the exhibition's story? |
| **Expansion** | • Was dynamic reinterpretation and reconstitution possible by displaying imagination?<br>• Could the participant create a creative piece of his/her own with their interpretation? |
| **Interest** | • Did it spark the interest and attention about the relics and history?<br>• Was pleasure felt by the new exhibition experiences? |

The following is a summary of the participants' submitted drawings and phrases on the drawings.

[Table 18] Participants' submitted drawings

| | |
|---|---|
|  |  |
| P1. Hearing about Mahan from Mahani who came from the soles of the gilt-bronze shoe | P2. Sharing the water, forests, land, and fire. |
|  |  |
| P3. Let's observe Mahani's past. | P4. A place comfortable like the forest. |
|  |  |
| P5. Mahani, who is a link with the Mahan times and the present. | P6. The culture of our times will be left in the future |

| | |
|---|---|
|  |  |
| P7. Mahan's history is not well-known, but it is important history. If there was no Mahan then Korea's growth would have happened a bit late. | P8. The word 'hope' which the fish in the shoe shows us |
|  |  |
| P9. Living as a nice person does not matter, whether you're living right is important. | P10. Delicate as the waves and strong like the waves |

Participant P1, P2, and P3s' drawings show that they understood the exhibition's topic and context of Mahan's history through the gilt-bronze shoe's decoration; Mahani. Especially P2 drew the exhibition's main themes in one drawing, which indicates that the participant is well aware of the whole story of Mahan. In P3's case the fish is drawn like land, and by following the lines it tells Mahan's culture of seaborne trade, gigantic tombstones and etc. with Mahani as the basis.

P4's drawing has Mahani on a cellphone's hologram device, and includes the phrase 'A place comfortable like the forest' this indicates how Mahani represents nature and the regional characteristics.

P5, P6, and P7 describe the historical value that can be found in relics, and this coincides with the exhibition's purpose. Especially, P6 drew the fishes on the

soles of the gilt-bronze shoes spreading out downwards and decorated one of them with various colors. Also included the phrase 'The culture of our times will be left in the future'. This indicates the thought of just like how the gilt-bronze shoe's historical value kept on maintaining until the present, the current culture is creating history. This is an expression of the participant's own interpretation by expanding from the exhibition's meaning.

P8, P9, and P10 found Mahani's message not in the historical value but in individual terms, and they express it creatively. Especially, P10 uses a figure of speech to show how the fish creating wakes of water and the shoes walking right next to them is similar to the shape of waves. This is also similar to how humans, historical beings, live out their lives.

The following are references from the reports the participants submitted.

*When I first heard of Mahan yesterday, I could understand some because of the difficulty of the vocabulary, but I could understand why the fish was decorated on the shoes, and also learn about Mahan from the exhibit.*

*Learning about Mahan's history, which doesn't have a lot of documentation, through the fish Mahani gave me a very new experience of imagining Mahani's thoughts.'*

*Mahani is a guardian fish that gives people energy, and when I drew the picture I wanted to express Mahani as a kind being that gives people energy.*

*By pretending to be Mahani and telling fun stories I had so much fun that I thought to myself 'Did I imagine I'll have so much fun?'.*

*By thinking about new stories of Mahani, and viewing the hologram and the maker in the quiet museum was a good experience.*

*The process of learning history through hearing other teammates' opinions on Mahani's story was a fun time.*

By looking at the reports it could be seen that the storytelling tactic was very positive because there were lots of opinions how learning history through the story was a joyful experience. The participants tell how the learning experience of Mahan's history was a new and fun experience because the exhibition's way of storytelling connected with historical background. Also, a participant expressed how the quiet and difficult exhibition turned into a joyful area by telling the stories of relics with various mediums. It can be seen through the impressions on the experience of guessing Mahani's thoughts and symbols with imagination that by using the exhibition's character as a medium to communicate what the present life it provided an opportunity to think about the universal human value. Furthermore, in the report that says the process of talking to other people of about the exhibition was joyful implies that the new exhibition method relying on storytelling can provide the joy of sharing imagination.

### 2.5.2 Survey

1) Survey Purpose and Method

A survey was conducted in order to find out the exhibition's overall satisfaction rate and whether the MCF framework's main strategic factor of interaction was well implemented in the exhibition. The survey was conducted in the field to the visitors during the duration of the exhibition, and with the exception of the demographic questions, the rest was all questions that could be answered with the Likert 5 point scale. Also, descriptive questions were included for freely expressing one's opinion. Two investigators conducted the survey and explained the questions that the participants could not understand.

The questions with the Likert 5point scale was determined with the basis of the concept definition from Choi's study in 2015, and the theory of experience and affordance which are the digital technology exhibition contents' characteristics as discussed from chapter 1.2.[27]

[27] Choi Soo-min. (2015). *A Study on the Augmented Reality-based Experience Exhibition Design Scenario.* Unpublished master's thesis, Seoul National University of Science and Technology, Korea.

[Table 19] The component of Survey

| Higher Factor | Lower Factor | Concept Definition | Number of Questions |
|---|---|---|---|
| **Satisfaction** | Entertainment | An experience factor that gives satisfaction and a joyful mood through games | 2 |
| | Education | An experience factor that improves knowledge and ability and tweaks intellectual curiosity | 2 |
| | Level of Recommendation | An after exhibit intention resulted by satisfactory exhibits leading to good intention explanation to other people and recommendation | 1 |
| **Interactivity Side** | Feedback Affordance | A design factor that helps the visitor to have a smooth tour | 3 |
| | Physical Affordance | A design factor that aids the visitor when doing physical activities | 3 |
| | Cognitive Affordance | design that helps the visitor to understand the exhibit easier | 3 |
| | Sensory Affordance | A visual, acoustic, tactual design that helps the visitors to grasp the interaction exhibit method | 3 |

[Table 20] Survey Evaluation Questions

| Higher Factor | Lower Factor | | Concept Definition |
|---|---|---|---|
| **Satisfaction** | Entertainment | 1 | The exhibit was Fascinating |
| | | 2 | It was a new stimulation for me |
| | Education | 3 | The meaning of the exhibition was clear |
| | | 4 | More fascination with the gilt-bronze shoes was formed from experience |
| | Level of Recommendation | 5 | I would recommend it to a friend |
| **Interactivity Side** | Feedback Affordance | 6 | The video on the wall changes depending on my motions |
| | | 7 | The cellphone hologram changes depending on my motions |
| | | 8 | My motions ara a part of the exhibit |
| | Physical Affordance | 9 | I can control it freely |
| | | 10 | I can operate the exhibit exactly according to my intentions |
| | | 11 | There were no malfunctions in the exhibit |
| | Cognitive Affordance | 12 | The guide of the exhibit was easy to grasp |
| | | 13 | The exhibit guide on the wall helped with comprehension |
| | | 14 | Visitors of any age can participate in the exhibit |
| | Sensory Affordance | 15 | The order of the exhibit can be quickly learned |
| | | 16 | The method of operation could be intuitively learned |
| | | 17 | The method of progress could be easily remembered |
| **descriptive questions** | Fascination aspect | 18 | What was the most fascination aspect of this exhibition? |
| | Lacking point | 19 | What was the most lacking in this exhibition? |
| | Need to improve | 20 | What is needed to be worked on in this exhibition? |

2) Survey Results

The total participants in the survey were 80 people, and excluding the seven insincere participants, 73 valid responses were obtained. The resulting analysis of the 17 questions of the 5 points Likert scale and the 3 descriptive questions is as such.

① The means of every factor and the standard deviation

The means of the 17 questions and the standard deviation is portrayed in the [table 19]. Points on the exhibit satisfaction rated 4.4, on interactivity, it rated 4.29, so as a whole it rated 4.33. Looking at the lower factors, the entertainment factor and the recommendation factor both scored the highest rating which was 4.42, and the physical affordance and the sensory affordance scored the lowest which was 4.20. By looking at the ratings of each question the number 1 question which asks 'fascination' scored the highest of 4.49, and number 16 which asks the intuitiveness scored the lowest of 4.01. Question number 3 which asks whether the participant could understand the meaning of the exhibition scored 4.35 which was the lowest in the satisfactory factor and this indicates that there were visitors who found the understanding of the exhibition and experience method to be difficult. However, as the cognitive affordance scored the highest of 4.44 within the interactivity factor, and question 13 of the cognitive factor which asked whether the exhibition guide helped the understanding of the exhibition scored the highest, it indicates that the cognitive design supplemented the understanding of the visitors.

[Table 21] The means and Standard Deviation of each Question

| Higher Factor | Lower Factor | | Means | standard deviation | Means | | | standard deviation |
|---|---|---|---|---|---|---|---|---|
| **Satisfaction** | Entertainment | 1 | 4.49 | 0.76 | 4.42 | 4.40 | 4.33 | 0.69 |
| | | 2 | 4.36 | 0.72 | | | | |
| | Education | 3 | 4.35 | 0.82 | 4.37 | | | |
| | | 4 | 4.39 | 0.74 | | | | |
| | Level of Recommendation | 5 | 4.42 | 0.83 | 4.42 | | | |
| **Interactivity Side** | Feedback Affordance | 6 | 4.40 | 0.82 | 4.32 | 4.29 | | |
| | | 7 | 4.33 | 0.90 | | | | |
| | | 8 | 4.24 | 0.81 | | | | |
| | Physical Affordance | 9 | 4.19 | 0.87 | 4.20 | | | |
| | | 10 | 4.14 | 0.86 | | | | |
| | | 11 | 4.29 | 0.96 | | | | |
| | Cognitive Affordance | 12 | 4.40 | 0.78 | 4.44 | | | |
| | | 13 | 4.47 | 0.73 | | | | |
| | | 14 | 4.43 | 0.80 | | | | |
| | Sensory Affordance | 15 | 4.31 | 0.78 | 4.20 | | | |
| | | 16 | 4.01 | 1.03 | | | | |
| | | 17 | 4.31 | 0.80 | | | | |

② Descriptive Question Opinions

The following is the answers for the descriptive questions by the visitors.

[Table 22] Deviation of each Question

| **• A Fascinating Factor in the Exhibition** |
|---|
| - The usage of novel methods, making unremarkable parts memorable<br>- The movement and change of relics in the hologram<br>- The 3 dimensional fish in the cell phone, and the changing into five cardinal colors in the final section<br>- How the fish came out from the hologram<br>- How the video changed according to Mahani's colors and how the story changed according to the color<br>- An exhibition targeting children that weren't seen before<br>- How storytelling was attempted by applying imagination to historical facts |
| **• The Most Lacking Factor in the Exhibition** |
| - The short exhibition period<br>- How the shadow covers up the wall side video when an audience is in front of it<br>- How multiple experiences can't be conducted at the same time<br>- It can be understood through explanation but independent experience is difficult<br>- The video is rather long for children so it may seem boring<br>- How it is only a one time exhibit |
| **• Things to Improve in the Exhibition** |
| - Active involvement inducement and advertisement<br>- A clearer wall-side video<br>- Making Mahani in the cellphone visible to multiple people, and not individual<br>- Dynamic and various background music and video<br>- The expansion and extension of the exhibition |

③ Complete Analysis

By putting together the analysis result from the top and bottom component means and descriptive answers it is as such. The satisfactory factors from the descriptive answers of 'Fascinating components' were mainly how the video changed due to specific reactions or signals, and the interesting factors from the exhibit's interactions. This connects to how the exhibit received a high entertainment factor point. However, this didn't stop here and also lead to the high points in how it relayed information of the relics memorably. This coincides with the main strategic point of the MCF's creating the visitor's experience through storytelling.

In the 'Desirable Factors' and 'Things to Improve' section the main topic was the need for a way to enable experience without an exhibition guide, in other words, the demand from the visitors of a dominant interaction. The visitors prefer an experience in which they can operate freely, and for this to happen a natural way to influence the visitors' actions is needed instead of an exhibition guide. This connects to how the interaction evaluation and affordance factors had low points. A discussion for how to design an easily accessible and free exhibit is needed as the contents and experiences become more and more various.

Also by looking at the opinions stating that the exhibit was too short, or how they felt that a one-time exhibit wasn't enough can deduct the demand for the expansion of the exhibit. As a way to ensure the revisit of the visitors, an application that has the gaming features of making a fish character and collecting items from the exhibit's stories was created. In this exhibit, the application wasn't publicly released, so the exhibit could only be viewed from certain smartphones, but later on, the extension and expansion of the exhibit will have to be planned for the release of the application.

## Ⅳ Conclusions and Future Work

The museum is using various digital environments and smart converging technology in order to respond to the changing demands of the visitors. The exhibition environment and content creating methods are also changing, but the empirical study about the multidisciplinary methodology is currently lacking. This research started from this problem and tried to suggest a convergence framework meant for digital exhibits in a museum by analyzing the methodology models in different fields and putting together the positive sides.

Also, beyond simply proposing the convergence framework as a viable solution, this research aims to ensure that the essential value of audience-centered cultural service is properly expressed in the course of cultural and technological convergence as a result of the framework. Furthermore, this research will confirm the validity of convergence framework by applying it to an actual case before suggesting them as a strategic alternative for collaboration process.

In the process of finding these solutions, proposed research problems and results are as follows.

Research problem 1. How are changing trends of museum exhibition in digital environment reflected onto framework?

As digital media advanced, perspective on museum exhibition began to switch from unilateral transfer of information to conversation and communication channel with visitors. Characteristics of storytelling and interaction in large have been identified by analyzing exhibition technique for visitor multilateral interaction based on communication theory. Storytelling is where visitors become the principal agent in the exhibition area and make their own story as narrative structure. Interaction enables visitors to become active participants not only absorbing symbolized messages with interpretation to media but also choosing information and creating new messages. These two characteristics are the strategic elements composing the framework.

Then, execution elements needed to realize previously stated strategies have been deducted based on communication process. First is the environment, which is an extension of the exhibition space. To advance exhibition communication, the environment that relates viewers with the exhibit, the exhibit with the space, and the viewers with the space should be observed. Next is the technology which is the medium of digital exhibitions and the contents which are the digital forms of the messages. The exhibition messages are being transmitted as contents combining various direction and experience through the media technology.

Research problem 2. What is the implication with reference to development of new framework in preceding research related to design fusion methods?

Firstly, user experience-centered design is gaining more importance than ever in convergence paradigm. User experience is an activity to efficiently plan and design everything related to a targeted subject. Design scenario is suggested as the strategic means of user experience-centered design. Design scenario is an outcome of design which visualizes the subject of design and user interaction into a story based on predictable backgrounds and events in the form of a storyboard, an interface map, etc.

Secondly, an analytical approach also matters. Design methodology is mainly driven to identify user needs, offer a broad range of problem-solving ideas, and design a solution prototype. However, as the scale of design problem expands and multi-disciplinary problem-solving methods mushroom in number, an analytical process of deep-diving into the surrounding environment and pinpointing a problem is becoming ever more important in design planning. This necessitates a well-balanced design process which combines design's problem-solving oriented, intuitive thinking and analysis-oriented, structural thinking.

Thirdly, integrated thinking and effective methods are needed for non-visible problem solving. Due to the shift of focus in the market environment from supplier to user, design problems and relevant solutions are going through drastic changes. Preparations should be made to address non-visible problems like user

requests, the perceptional process on value-related matters, etc. There will be a need for a design process which goes beyond physical and visible designs and takes into account the relationship with user, environment, etc. The diagram which expresses the underlying logic of process will function as an effective means in the phase of execution.

Research problem 3. What is the structure and process of integrated framework (MCF) specific to museum exhibition made?

The MCF's deep analysis process based on the conclusion derived from the two case studies is a fundamental basis for the planning, and it also effectively visualizes the relationship and organization of each elements so that it can be used as a tool for the cooperation project.

MCF has 3 process of define, strategize, and design. define is a phase to conduct a multi-faceted analysis on the problem in question, discover the demands of audience, determine the direction of exhibition content development accordingly, and produce a concept idea. strategy is a phase to formulate a specific plan for the materialization of the concept made in the previous phase. The strategy phase offers two activities—storytelling and interaction—that encourage audience to complete the scenario as self-driven users. planning is a phase to set up an execution plan for the object and space which actual audience are supposed to experience and the technology to materialize such object and space. As a process to execute the strategy made in the previous phase, the planning phase consists of three essential elements in terms of exhibition content development: environment, technology and content.

Lastly, MCF proposes design canvas which constitutes as foundation and acts as medium connecting each of the stages in the process. This canvas is utilized as communication tool for exchanging inter feedbacks between team members of the project and its management thereof.

Research problem 4. What is the evaluation and efficiency in result of MCF application to the project?

Curator, author, developer, designer, and planner made a team to proceed with the project by applying MCF and developed museum exhibition contents. In internal evaluation of MCF, understanding of other fields and communication efficiency were mentioned. MCF has supported overall participation of team members and exchange of feedback which has resulted in gaining more knowledge and understanding in other fields. Also, in MCF, each part is connected organically and continuously acknowledged between team members through design canvas. These advantages became driving force for efficient communication during change of plans.

Next is the visitor evaluation of the exhibition contents. The evaluation was done by survey and focus group investigation to determine the goal achievement rate of the strategic components of the MCF, which are storytelling and interaction. It could be seen that the visitors' interest was tweaked by when the exhibit progressed by connecting various mediums with historical story. Also, according to the survey results, the video changing according to specific reactions and signals was a positive aspect in the entertainment factor, and the need for a way to have independent experience, in other words, the need for a dominant interaction was realized.

This research tried to increase the completion as an empirical research by suggesting methodologies that are able to be implemented on the field and use the actual suggested framework to make contents. However, the verification process by the actual workers who will use the framework wasn't carried out. A follow-up study that targets the museum workers has to be made to verify the effects of the actual progress process and feedback to supplement the framework.

Museums don't have to adapt to the new digital environment, and all visitors aren't expected to interact in the new method of the museum's activities. There will be people who do not pull the lever on a display that had been

implemented with new technology, and there will be people who worry that the natural value might be damaged. However, there will also be an increase of visitors who wish to interact in the museum activity as an entertaining learning space in the current life. Using this research as the basis, follow-up researches for the museum to be a representative culture enjoyment facility within the various visitors' lives and research for new methods of interacting with visitors are anticipated.

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