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Case studies of applying electronic flexible material and technology to create the new media arts

Pei-Hsuan Su [1]

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Abstract The new media-arts revolution which combines art and design with innovative technology has made the shift of social and cultural texts into computer-mediated forms of production, distribution and communication. The invention of digital devices and contents has also revolutionized the quality of sound, image, and data, the way in which they are contemplated and served as the forms of art in relation to the convergence of multiple professions. Within this study, the social context and scenery are visualized and transcoded into design objects. The researcher delves further into the use of new electronic media-FleXpeaker™, which was invented by the Industrial Technology Research Institute, Taiwan. The researcher put specific images printed on both sides of the surface of FleXpeaker™, as well as with sound effects far-distance monitored by a Bluetooth receiver to call out one's imagination of the events, the time and the underlying environment encoded in the new media. Therefore, the devices viewed as design objects do help users to converge diverse elements in relation to artistic expression and cultural representation. As the result, this particular case of media convergence leads to a new hyper-real experience for the viewers and audience.

Keywords Visual communications · New media arts · Innovative technology

1 Introduction

Digital media had a revolutionary impact on the contemporary sound-images art producing, social structure and senses of human. Because of its five characteristics "numerical representation, modularity, automation, variability, transcoding" [9], digital images become the dominant form of images in the modern era. The invention of digital media arts revolutionizes the quality of sound and images, the way in which sound and images are contemplated, and the mode of media arts that produce activities and esthetics concepts. The reproductability of

✉ Pei-Hsuan Su
sherriesutaipei@gmail.com

[1] Department of Visual Communication Design, National Taiwan University of Arts, 59 Daquan Road Section 1, Banqiao District, New Taipei City 22058 Taiwan, People's Republic of China

contemporary new media arts leads to create more hyperreal scenes of modern society where sound and images are produced, copied and stimulated in a way that mimetic text cannot be told apart from the original one. In other words, the "original" ceases to exist especially in the area of the new media arts.

The research focuses on design innovation by conducting case studies, which relates to the issue of how to apply electronic flexible material and technology to create new media arts and digital images. The researcher intends to use different techniques and materials to create digital design objectives in associated with innovative technology for exhibiting. There are two case studies conducted as follows: one is to exam how the electronic new medias applied in the Sun Yun-Suan Memorial Museum, Taipei, as the pilot study; the other one is a kind of experimental study for the researcher to apply FleXpeaker™ in curating the "Cross the sound and vision: the exhibition of cultural creative design and innovative technology" held at National Taiwan University of Arts. The researcher has observed that the curators interpreted and decoded the main signifier of exhibiting creations for probing into the cross-over and integrated innovation in design with visual communication media. There are also digital sound creations in progress. The exhibition creations are based on archiving, digital editing, photomontage and mixed.

In addition, there are principles of new media-arts production which enhance the aesthetics revolution as follows:

1. Through fast-and-amount outputting and re-presentation easily of computerization, the digital images took on the crossing type hybrid to create new ideas of viewing modes.
2. Sound and image like a node is not only the independent existence but with the potential of being intertextuality.
3. We conceive of all possible paths to generate hypertext which is a particular case of media, converging diverse media types — text of words, images and sounds simultaneously.
4. The cross-platform reproduction leads to hyper-real scenes for their viewers and audience easily to experience whole new senses through employing deconstruction (i.e. decoding), collage, appropriation of the original social, historical or documentary data.

2 Materials and method

2.1 Discovery of the material

The researcher suggests that flexible and accessible tools for communication, collaboration, and art production will need to be designed and implemented. Particularly, there are numerous technologies and products related to flexible electronics. In fact, flexible electronics is general term for using organic material, printing manufacturing process, Electronic Circuit, Optoelectronic Components, or the technology of setting on Flexible Substrate with low cost and the characteristics of being flexible [15]. For instance, there is a specific material applied newly electronic technology in the area of new media arts called FleXpeaker™, which it developed by Flexible Electronics Pilot Lab of Industrial Technology Research Institute, Taiwan (ITRI), to receive the Wall Street Journal's 2009 Technology Innovation Award [6]. This technology utilizes two pieces of paper and one metal film layer as the material. When the user converts sound into electronic signals and then transferred to paper via speaker audio cable, the paper sheets coated with metal horns in the film will do energize and vary according to electrical signals. Through alternate inputting positive and negative voltages between the two pieces of

paper, it generates attraction or repulsion forces led to the paper vibrate. In this process, the two sheets of paper in the air will be pushed, thereby causing sound waves to produce a sound (Fig. 1) [14].

The characteristics of the FleXpeaker™ as a flexible electronic material are listed, which especially makes the product environmentally friendly, as follows (Table 1):

Though audio is a pretty integral part of a full media experience, this new technology has brought the acoustic speaker industry into a brand-new era, and helped create revolutionary consumer products such as memory cards with voice capabilities and ultra-thin MP3 players. It could even be incorporated into other products that are integrated into green buildings, electric vehicles, entertainment and medical devices. The technology of flexible speaker will help create new lifestyles to the pursuit of personalized, humanized applications (ITRI, 2012/ 2016) [7, 8].

However, we may wonder whether the better the audio quality is, the more cumbersome the rig out of which it plays. The common sense is that unwieldy over-the-ear headphones tend to deliver a much better audio experience than in-ear buds, and larger speakers or subwoofers tend to provide a louder volume. Because of this, we are left trying to find a place for speakers to fit everything, and an above-par sound system tends to take up space. To solve the problems and redirect the way of thinking speakers in our life, Fuji film showed off a flexible film that can be used as the vibrating plate (the diaphragm) inside a speaker at a trade show in Tokyo, 2013 [10]. Interestingly, Fujifilm showed off its new diaphragm, dubbed “Beat,” via a retractable speaker (the picture of the girl in the middle), and a speaker that resembles a Japanese fan. They have proved those materials can bend, flex, and roll up (Figs. 2–3).

For most of the Taiwanese people, the speaker made of paper has become very attractive to consumers of a product, not just a dream shown off at Dream Pavilion in 2010 Taipei International Flora Exposition. At the end of the Expo, it has been closed and then refurbished open to public visitors for continuing operations till December 31, 2012. In fact, the Dream Pavilion is a combination of technology and new media arts, in which the crews from the Industrial Technology Research Institute (ITRI) developed five kinds of latest technology as interactive instruments, included the FleXpeaker™ like flower blooming in the exhibition hall (Fig. 4). Besides, the researcher arranged a field trip to visit ITRI in Hsinchu, 2014; she has

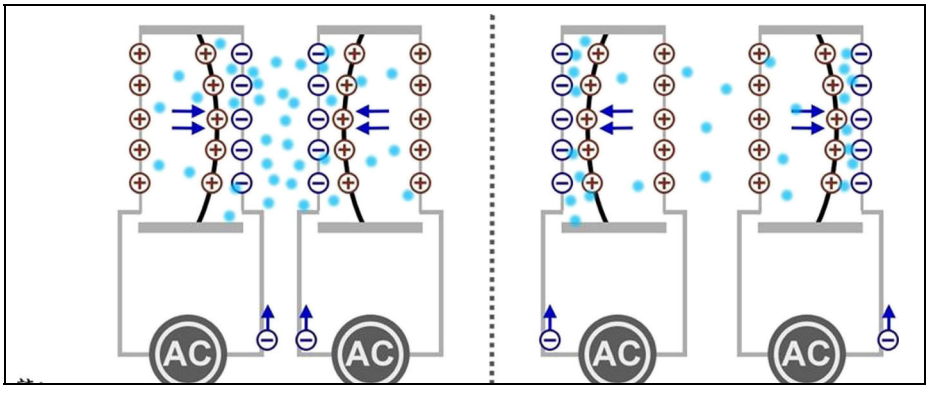


Fig. 1 The principle of sound broadcasting of the flexible speaker

Table 1 The characteristics of the FleXpeaker™

Material	Sound	Image
Paper and metal layers adhered; thickness less than 0.1 cm; 10% as much power of conventional speakers. (ITRI, 2012) [5]	A range of 20 to 200 kHz covered; good for high-frequency sounds; fidelity equals or exceeds that of the conventional speaker. (ITRI, 2012) [5]	Standard printing for large-size thin paper on double surfaces, and mass production allowed.

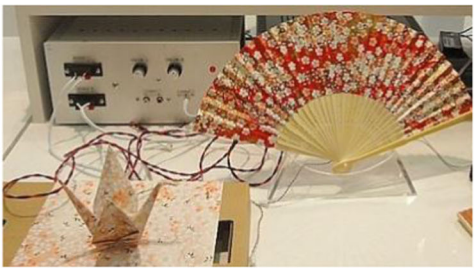
also discovered the alternative applications of FleXpeaker™ that one piece of it has been hanging on the wall in the Lecture Hall of ITRI (Fig. 5).

2.2 "World-as-experienced situated" method in exhibiting

Fundamentally different from creating complete settled–up artworks, the new media artists need to consider a defining activity for empowering participation. They aim at creating certain interactive art pieces associated digital devices as the exhibits, for their viewers and audiences who may get deeper involved and achieve to the "world-as-experienced situated action" later engaged in the exhibition. Here we anticipate the participatory nature strengthened in making new media arts and transit to more autonomous action for one's further discovery. This "world-as-experienced situated" method is based upon the meta-design approach.

Developed by Gerhard Fischer and Elisa Giaccardi since 2004 in the Center for Life Long Learning & Design (L3D), University of Colorado, U.S.A., meta-design has become a socio-technical framework for making new media artworks or demonstrating them in exhibitions that enable their visitors to become the participators of their own situations over time. Developing a meta-design framework is necessary for those artists in the area of new media arts facing to the challenges in a way collaboration and co-creation. In other words, the organization of the meta-design system integrates multiple targets of the art system, its relevant technical equipment, and its rooted situational contexts.

Referred to the concept of "underdesign," Fischer [2] has discussed the design process in developing not solutions, but environments that allow the artists to create the solutions themselves on site. Fundamentally different from creating complete art pieces, underdesign is a defining activity underlying the meta-design approach that aimed at creating spaces for other participators, and then the end-participators will achieve to the "world-as-experienced situated action" to envision contextual use of the media and emphasize co-creation to enable end-participators to act as the new media art designers [3].



Figs. 2 & 3 Fujifilm shows off the retractable speaker, 2013 [10]; retrieved from http://www.extremetech.com/electronics/147441-move-over-flexible-screens-fujifilm-shows-off-the-flexible-speaker

Fig. 4 The Flower of Dream made of paper as a kind of flexible speaker which is installed in the Dream Pavilion, in 2010 Taipei International Flora Exposition. Retrieved from http://www.expopark.taipei/hphoto.aspx?uid=109&pid=27 [11]

3 Applications and discussion

There are two case studies conducted as follows: one is to exam how the electronic new medias applied in the Sun Yun-Suan Memorial Museum, Taipei; the other one is a kind of experimental study of applying FleXpeaker™ in the "Cross the sound and vision: the exhibition of cultural creative design and innovative technology" held at National Taiwan University of Arts.

Fig. 5 FleXpeaker™ has been hanging on the wall in the Lecture Hall of ITRI

3.1 Case study 1: The electronic new media applied in the sun Yun-Suan memorial museum, Taipei

To introduce the significant social-economic-industrial contribution of the ex-Premier of R.O.C., *Sun, Yun-Suan* (November 11, 1913 – February 15, 2006), there are diverse documentary objects displayed in the Sun Yun-Suan Memorial Museum, which are included his personal or historical remains, literary manuscripts, lyrical text and illustration arranged on billboards, paper-carving cardboards, and the duplications etc. (see Table 2).

However, Sun Yun-Suan was a great engineer in addition to a politician who was credited for overseeing the transformation of Taiwan from being a mainly agricultural economy to an export powerhouse [13]. The curation team worked for the museum has added innovative materials and modes for creating this exhibition in memory of him. The new media arts play a critical role over there in converging sound, image and data. According to the semiotic communication theory [4], the curating procedures first include the decoding step, such as dividing the texts into groups of relevant visual symbols as signifiers applied in the exhibition. In addition, the later encoding steps include controlling of visual effects, lighting, color, sound and the speed of motion to imply the connotation of the texts; and arranging those sign of literary scripts and visual symbols, as the signifiers, to facilitate the expressive connotation, as the signified.

As the results, the biographical data of Sun Yun-Suan are visualized and transcoded into specific images and films, and graphics on digital platform s associated with electronic supplements as the new media to introduce the significances of those embedded cultural context, as well as with sound effects to stimulate viewers' imagination of the events, the time and the underlying environment between the past time and the present (see Table 3).

Moreover, his biographical social-contextual data are visualized and transcoded into specific images and life photography printed upon both sides of the surface of paper-thin FleXpeaker™ (Figs. 6 & 7) as well as with sound effects to stimulate visitors' imagination of the events, the time and the underlying environment. Therefore, Sun Yun-Suan Memorial Museum came out the integration of new-media arts-design-expertise in creating new exhibition experiences with technology.

3.2 Case study 2: FleXpeaker™ applied in "Cross the sound and vision: The exhibition of cultural creative design and innovative technology"

The researcher curates a special exhibition entitled as "Cross the sound and vision: the exhibition of cultural creative design and innovative technology" (i.e. CsvExhibition) at International Exhibition Hall in National Taiwan University of Arts (NTUA) on October 17–23, 2016. Within the exhibition, there are diverse usages of the electronic flexible speaker demonstrated by all participating teams of the artists. How to apply FleXpeaker™ as acoustic vehicles becomes a target so that it set up to be hanged, wall-mounted, framed, and displayed on the exhibition (see Table 4).

The researcher coordinated and arranged a group forum for graduate students in the visual communication department of NTUA. During the discussing process, there were 26 members divided into 4 main curating groups, which later developed 9 new-media art projects. Based on the group discussions, all students have taken part in experiencing the curator's role plays in response to revealing the specific visitors' needs of the exhibition. In other words, the researcher as well as the curator helped them to experience a co-creative design-time suitable

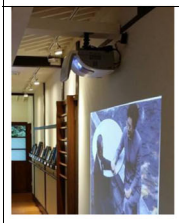
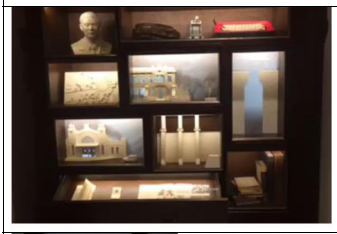
Table 2 Documentary objects displayed in the Sun Yun-Suan Memorial Museum

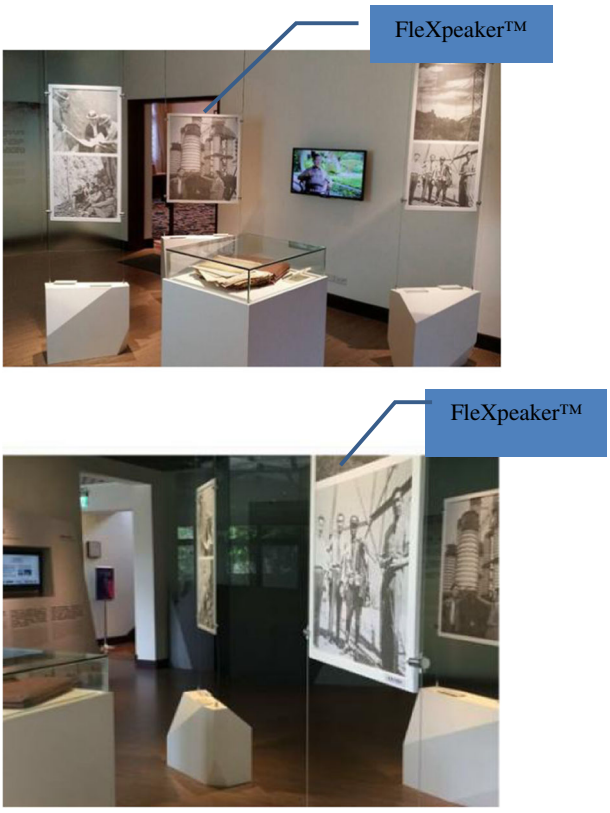
Example of the exhibits	Form & media	Meanings
	personal remains and manuscripts	Notes taken by Mr. Sun during his internship at Tennessee Valley Authority (TVA) in the U.S. in 1943-1945
	historical texts and photographs arranged on glass billboards	Brief introduction of the history of Taiwan during 1945-1950's in the exhibition room entitled as "setting out amidst chaos."
	illustration arranged on paper-carving cardboards	This bird-eye-viewed historical scene addresses to Mr. Sun had experienced the Japanese invasion in 1931 of the northeastern China, known as "Manchuria Incident" in the WWII.
	The scaling-down duplication of "the East-West Power Transmission Monument"	Mr. Sun was able to get 80% of the power network in Taiwan (destroyed during the World War II) restored in five months by managing a staff of several hundreds. His great achievement contributed to Taiwan Modernization and inscribe in the monument, erected in 1951.

for problem-solving and strategic development for evolving their art projects under the concerns of the exhibition visitors. Six-months later, the graduate students' media art and design practices act as the new-media arts converging sound, vision and data to reveal their cultural identity, to exhibit perceptions of their local life style in the exhibition.

On the other hand, for making a new-media art exhibiting certain foreign culture in the name of "Flow with Hindu Rhythm," the researcher acts as one of the CsvExhibition artists, who has tried to interpret and decode the main signifiers of Hindu culture (see Table 5) for

Table 3 Innovative design objects displayed in the Sun Yun-Suan Memorial Museum

Example of the exhibits	Form & media	Meanings
	digital photo frame	The photo of Mr. and Mrs. Sun dancing has been digitalized as a moving image horizontally swinging in the photo frame.
	Image sensor type instruments, optical encoders, and angle sensors installed in the exhibition room as an interactive equipment	The visitor can wave a hand high to make inside sensors act to change sceneries projected on the three surrounding walls, so that they can sense the outside environmental season changes as well as the light shift from the daytime to the nighttime.
 	Power transmission tower mockup model with a hand generator as an interactive installation	Power transmission towers quietly safeguard Taiwan's electricity. As the towers were sometimes frozen over during harsh winters, they also often present challenges to the repair crews, like visitor's experience to roll the handle hardly and then enlighten the electricity.
 	Short-focus projectors, including the device of the "Ultra-short Throw Projector" developed by Delta Electronics, Inc., Taiwan.	There are several short-focus projectors help to flexibly provide information and images, such as the family photo slideshow (left) and Mr. Sun's notebook becoming digitalized (right).
	Mixer of paper-cutting artworks and motion pictures	There are multi-media visual art pieces framed in an antique bookshelf and fastened on the wall to visualize Mr. Sun's early learning life by storytelling.
 	Digital technology with touch panels	The digital platforms of Mr. Sun's Diary (left) and silicon wafer's know-how (right) displayed



Figs. 6 & 7 Ex-Premier Sun, Yun-suan's life photography printed upon both sides of the surface of paper-thin FleXpeaker™

probing into the cross-over and integrated innovation in image design. Next, she has created a bamboo-frame for displaying flexible speaker. Based on digital editing, photomontage and mixed, the new media creation has come out as a sound creation by using flexible speaker with image-printed, in which she also adds motion pictures projected on the background (Fig. 8).

This new-media art is made for remarking her impression of the Indian culture. The researcher firstly has appropriated several sceneries of local life and activities about Hindu

Table 4 Examples of the application of FleXpeaker™ in the CsvExhibition (Courtesy of the artists)

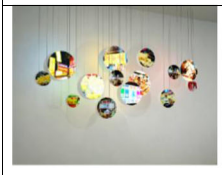
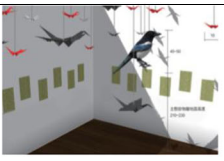
Sparking Night Market	Chanting x Printing Lyrics	Return to the Neverland	Main Stage of the CsvExhibition
			
FleXpeaker™ hidden inside the lights	FleXpeaker™ hidden inside the stand	FleXpeaker™ hanged and hidden inside the main bird-like object	FleXpeaker™ stood, bended and framed on the front curve

Table 5 Collections of documentary images of contemporary India life (Photography by the researcher, Pei-Hsuan Su)

 Village people with ox-drawn carriage in Sravasti, India.	 Village people with horse-drawn carriage in Sravasti, India.
 Riverside of the Ganga in Haridwar, India.	 Lotus flowers bloosoms in India.

people in India, such as: photography shooting village people with ox or horse-drawn carriage, and the riverside of the holly city—Haridwar. Those photographs represent a large mass of the Indian People who live under the middle or the bottom of the Hindu caste system. Their daily lives are full of labors, and they gather together to visit any holly sites, for example the Haridwar, along the Ganga River to purify their souls for salvation. Next, she edits two photographs bearing labor activity of the Indian folks both on the right and left sides; she also puts the riverside secenary of the Haridwar on the upper side in addition to the natural view of blossoming lotus on the bottom. Finally, she cropped one particular lotus icon derived from the pattern decorated on the Dhamekh Stupa in Sarnath and pastes it as a symbol on the center of the background image to represent the spirit of purification in the Hindu culture (Fig. 9). Lotus means "the flower of life" in the Hinduism. In other words, lotus served as a metaphor signifies that one purifies oneself in the life circle.

Furthermore, for creating image projected on the floor as a wash, the researcher adapts a simple photograph she took in secluded riverside along the Ganga in Rishikesh, 2007. The image serves as a vehicle to recall her bird-eye view of the sparking sunlight reflected on the river while she standed on a suspension bridage across the Ganga. She only add one Sanskrit word— ॐ (i.e."OM") on the middle surronded by glamourous halo, which echoes to the radience of sunlight reflection (Fig. 10). This Sanskrit word will be read as a metaphor that

Fig. 8 [Flow with Hindu Rhythm](2016) on the exhibition site

Fig. 9 [Hindu Rhythm], digital editing/photomontage, Pei-Hsuan Su, 2016

Fig. 10 [OM floating with sparkling sunlight reflection on the Ganga River], digital editing, Pei-Hsuan Su, 2016

signifies an audio symbol in relation to the sound "OM." Referred to the universal vibration, "OM" is the basic sound of the Universe as most Indian people believe. By reading the symbolic "OM" with reminding Hindu God's blessings, the viewers may carry the enlightened soul into the heart of the Universe, while encountering and discovering this work of arts.

Moreover, the researcher edits a short period of Hindustan melody mixed with her vocal reading Tagore's [My Song], followed by the sound 'OM' for the flexible speaker's broadcasting. By pointing to a blue-tooth audio receiver imbedded on the frame, the viewer/audience may empower the device of FleXpeaker™ this new media. As the result, the device and image artworks do help ones to realize the significance of diverse elements of sounds, images and data in relation to its cultural representation.

4 Aesthetic notions in contemporary media arts

Electronic and digital devices had a revolutionary impact on the development of image producing and media-arts curation in contemporary. Whether they are created from scratch on computers or converted from analog media sources, the exhibiting media are composed of codes and symbols in conducting digital representation. And, there are principles of media-arts production which enhance the aesthetics revolution as follows:

4.1 Through fast-and-amount outputting and re-presentation easily of computerization, the digital images took on the crossing type hybrid to create new ideas of viewing modes.
4.2 Sound and image like a node is not only the independent existence but with the potential of being intertextuality.

4.3 We conceive of all possible paths to generate "hyper" text which is a particular case of media, converging diverse media types — text of words, images and sounds simultaneously.

4.4 The cross-platform reproduction leads to hyper-real scenes for their viewers and audience easily to experience whole new senses through employing deconstruction (i.e. decoding), collage, appropriation of the original social, historical or documentary data.

To sum up, by embracing "hybrid-hyper" texts, and then the "hyper-real" state quo of the exhibition have derived from semiotic transcoding. Therefore, there are full of revolutionary methods of communication in the contemporary new media arts. As Tsao [12] mentioned in the website of National Taiwan Fine Arts Museum, on the special topic: *The History of Taiwan Digital Arts Development*, the structures of "hybrid" could show out different levels: from the very beginning, image media could divide into digital photography, digital recording and computer graphics; next, through the digital retouching, the creations could edit with misplacement, collage and combination. As the result, the creations showed the regions, sources, types and visual "hybrid."

In addition, as new generations are growing up in a media-rich environment dominated by electronic devices, there is consistent with a general trend in modern society towards presenting more and more information in the converging form of time-based audio-visual moving image sequences, rather than as printed texts. In other words, it is not surprising that people favor cinematic language over the language of print. Cinematic ways of seeing the world, of structuring time, of narrating a story, of linking one experience to the next, are being extended to become the basic ways in which digital users access and interact with all cultural data. Thus, the "hyper" text became crucial in the new media arts. Through the tension of multi-media and peculiar installation in certain a space, the contemporary media arts assembled experiences and forms and created interaction between exhibits and visitors for the museum and exhibition center.

According to the theory of Baudrillard's "simulations" [1], we had the different aspects and thoughts on art creating and curating. Through the digital devices and the cross platform of images and sounds, the artists produce images and sounds that lead to "hyper-real" scenes for their viewers and audiences through the deconstruction, collage, appropriation of the original historical or documentary data. Besides, the artists may collaborate with curators to transform the row data later into the synthesis of exhibit objects. In semiotic terms, the digital interface acts over there as certain codes that carry not texts, music and visual senses but simulations. As D. N. Rodowick has mentioned, the trends of contemporary new media are fashioned upon a cinematic metaphor, and helping people see how digital technologies are serving. The innovation of media has perpetuated the cinematic as the mature audiovisual culture, lasting till the twentieth-first century. Hence, the exhibition visitors today are enchanted with the hyper-real scenes and experiencing whole new senses.

5 Conclusions

There are at least 3 curating groups from the Sun Yun-Suan Memorial Museum, NTUA_the CsvExhibition, and ITRI_the Pavilion of Dream, which have developed more than 12 new-media art projects recently in relation to the use of FleXpeaker™ in contemporary Taiwan. Even though there are lacks of numerical quantitative-analysis results regarding the two case

studies, the research has proved the state quo of conducting the qualitative case studies and the curators' attempts to generate "exhibition-as-experienced situated" in the new media-art field. We realize that the exhibitions' visitors may take part in the experiences converging sound, images and documentary data by getting access to a series of innovative technologies and new media devices. The reproduction of sounds and images leads to certain hyper-real scenes at the exhibition spaces where sounds and images are produced, copied and stimulated in a way that mimetic cannot be told apart from the original data. Just as "simulations," the new media art creations here are attributed to the achievement of establishing such inter-textual experiences which change the traditional distinguished use of the visual communication media and interface into interactive ways and forms in this post-modern era. The visitors in both cases can be introduced to several kinds of expression of the digital images design or synesthesia design underlying the concern of "exhibition-as-experienced situated." And, they can be led to deepening their knowledge of social-cultural context, which also bring in the merit of improving their recognition as well as imagination.

On the other hand, these new media-art creations are based on the system architectures of archiving, digital editing, visual-audio montage and those mixed that have been used in the two case studies. Within this paper, the proposed system has been exanimated and results in the characteristics and principles of new media which have revolutionized visual communication meanings, aesthetics concepts, and design creation modes in curating exhibitions. In both of the case studies of the Sun Yun-Suan Memorial Museum and the CsvExhibition held in NTUA, the researcher has observed that the curators interpreted and decoded the main signifiers of exhibiting creations for probing into the cross-over and integrated innovation in design. Therefore, in the progress of digitalization underlying new global scale of the cultural-creative design, the contemporary images processing, curating thinking, exhibition creations, and aesthetic concepts all changed dramatically. There are also digital sound creations in progress. Through the data access, the texts worked across in different media interface with ease. The curators who employ the digital devices and the cross platform of images and sounds, the structural difference of digital media, and the rise of innovative digital interface, create new state.

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Pei-Hsuan Su is an Associate Professor at the Department of Visual Communication Design in National Taiwan University of Arts (NTUA), New Taipei City, Taiwan. Currently, she served as the Chair of the Department at NTUA. She received her M.F.A. in the interdisciplinary study of visual arts from National Cheng-Kung University, Taiwan, in 1996. And, she received her doctoral degree from the School of Visual Arts, the Pennsylvania State University, U.S.A., in 2003. Prior to joining as the university faculty in Taiwan, she was an exhibition curator who has worked for National History Museum, Taipei. From 2011 to 2015, she served as the Head & Coordinator for the Section of "Cross-disciplinary Research and Teacher's life-long Learning," and the Section of "Zen and Cultural Creative Research," where she led a multi-disciplinary and multimedia team for Taiwan Teaching Resource Center in National Taiwan University. Her research interests are in the area of multimedia, interdisciplinary study of visual arts, exhibition design, and semantic design. She is the member of Asia Society of Basic Design and Art (ASBDA). Recently, she was indexed by 2015 Marquis *Who's Who in the World*, 32 edition, U. S. A. and got the award of 2017 the Albert Nelson Marquis Lifetime Achievement, U.S.A.