Article

The Story of the Markham Car Collection: A Cross-Platform Panoramic Tour of Contested Heritage

Beata Dawson[1], Pauline Joseph[1], and Erik Champion[1]

Abstract

In this article, we share our experiences of using digital technologies and various media to present historical narratives of a museum object collection aiming to provide an engaging experience on multiple platforms. Based on P. Joseph's article, Dawson presented multiple interpretations and historical views of the Markham car collection across various platforms using multimedia resources. Through her creative production, she explored how to use cylindrical panoramas and rich media to offer new ways of telling the controversial story of the contested heritage of a museum's veteran and vintage car collection. The production's usability was investigated involving five experts before it was published online and the general users' experience was investigated. In this article, we present an important component of findings which indicates that virtual panorama tours featuring multimedia elements could be successful in attracting new audiences and that using this type of storytelling technique can be effective in the museum sector. The storyteller panorama tour presented here may stimulate GLAM (galleries, libraries, archives, and museums) professionals to think of new approaches, implement new strategies or services to engage their audiences more effectively. The research may ameliorate the education of future professionals as well.

Keywords

Virtual panorama tour, multimedia, interactive digital storytelling, visualization, veteran cars

The information age offers a variety of digital platforms and tools that enable cultural institutions to provide audiences interactive experiences with physical museum objects

[1]Curtin University, Perth, Western Australia, Australia

Corresponding Author:
Beata Dawson, PhD Candidate at School of Media Creative Arts and Social Inquiry, Curtin University, Perth, Western Australia, Australia.
Email: beata_dawson@me.com

via virtual museum settings. P. Joseph's research investigated what caused conflicts between the Western Australia Museum and the motoring community, exposing what happened to a prestigious veteran and vintage car collection between 1967 and 2014 in Western Australia. We expanded the research by using panoramas to represent the Markham car collection and its spatial settings through the creation of a panorama tour that yielded imaginary and authentic museum environments.

The panorama tour was designed for multiple platforms: large cylinder screen, web interface, and mobile application; each required different navigation resulting different experiences for users. To unfold the story, and to present the milestones of the history of the car collection, rich media components were embedded into the panoramas, which are accessible through various hotspots (interactive icons or buttons). The user could access information (pictorial, textual, audio, and video) by placing/navigating the cursor over these hotspots.

To develop *The Story of the Markham Car Collection*, a storytelling panorama tour, the PanoTour Pro 2.5 software ("Virtual Tour Software: Panotour/Panotour Pro 2.5 Beta 1" 2015) was chosen. The software was a cost-effective and easy-to-learn application, required only beginner-level of programming skills, had the capacity to include various media components, and was capable of enabling user control through individual navigation.

The Story of the Markham Car Collection provided a new/unique way on how to integrate various media sources, panoramas, interactivity, and immersive technologies to tell stories of museum objects or collections, and how to attract audiences in innovative ways. Following the development of the virtual panorama tour, we investigated its usability involving expert testers, the users' experience among the general public, and its effectiveness and usefulness in museum environments. The findings confirmed that the use of various, new, unique, or special digital technologies is necessary and indispensable, and the utilization of cross-platform panorama tours, presented in this article, would be effective in the museum sector and appropriate to attract new audiences.

Educational institutions are investing and taking giant strides in using digital technologies with their online teaching deliveries. As our example shows, this panorama storytelling method can be used in an educational setting, offering new dimensions in interpretation and understanding of educational contexts. Developed for multiple platforms (cylindrical widescreen, web, and mobile application), the tour can be used in various settings including face-to-face and online teaching. The version built for the widescreen cylinder, specifically for the Cylinder of Curtin University's HIVE (Hub for Immersive Visualization and eResearch; Curtin University Humanities 2015), meets many current face-to-face teaching requirements and is conducive to facilitating group discussions. The web version can be used on desktop or laptop computers and on mobile devices (e.g., smartphones or tablets). Users/students are able to access it at any time and from anywhere, making

it suitable for online teaching. The standalone/offline mobile application might also be applicable in online teaching; however, this version was not employed nor tested because of the limitations to be discussed later.

Leveraging Digital Technologies in Museum Environments

Although digital technologies are critical in the Digital Humanities (DH) discipline and have a strong influence on, and play a crucial role in, arts and cultural institutions, research by the Arts Council England, Arts and Humanities Research Council, and Nesta ("Digital Culture 2015: How Arts and Cultural Organizations in England Use Technology" 2015) showed that the heritage (including museums) sector—specifically in England—is less active in using digital technologies than other cultural organizations ("Digital Culture 2015: How Arts and Cultural Organizations in England Use Technology" 2015).

Museums are aware of the power of harnessing new technologies to develop various contents and services for their visitors (Rizvić et al. 2011, 421) to enhance their visitors' understanding of museum collections (Erlick 2017). These cultural institutions know that they have to "expand their thinking of what constitutes a visitor" (Dodge 2017) and remember that "the key role for museums is always to serve its visitors" (Waltl 2006).

In general, museum visitors seek a wealth of novel and thematically engaging experiences (Degotardi et al. 2017; Forrest 2015; Henry, McLean, and Oakland Museum of California 2010; Kelly 2011). They are seeking immersive and interactive experiences with the museum exhibits showcasing collections using multimedia tools featuring bright narratives and greater contextual information to tell the story about the collection or exhibition (Nickerson 2002, 2004). So, it is essential for the museum professionals to be aware of the opportunities they can take to enhance their exhibitions and attract new audiences. The application of advanced technologies (e.g., audio-guide devices, interactive applications for mobile phones, information kiosks with touch screens, virtual tours or discovery rooms) enhances the educational role of cultural institutions. While different techniques and tools "support the interpretation and understanding of museum exhibits, attracting the public and facilitating the social interaction and communication between exhibits and visitors" (Alexandri and Tzanavara 2014, 317), immersive digital heritage projects require more appropriate evaluation methods (Barbieri, Bruno, and Muzzupappa 2017; Champion 2015; Kabassi 2017; Pujol and Champion 2012).

Digital technologies empower the cultural and heritage sectors to bring their museum collections closer to the audience; digital collections can be explored at their leisure in their comfortable home environments. In the following sections, technolo-

gies and tools that museums could use to provide visitors with an immersive interactive experience will be introduced.

Multimedia Applications in Museums

Museum environments often include presentations using multimedia technology (Hsu and Lin 2014). Multimedia applications can enhance the museum experience and provide "the value for money that visitors expect" (Alexandri and Tzanavara 2014, 320). However, multimedia applications should not be the focus of the exhibits, but rather they should complement it. New and existing content can be enhanced by focusing on user-friendly and efficient communication.

Interactive Media in Museums

Another opportunity to enhance museum exhibitions is by applying interactive technologies. Leading international museums offer visitors unique experiences by applying online virtual and mobile multimedia tours; furthermore, the number of institutions that includes advanced interactive systems (e.g., augmented experience) is also increasing (Karaman et al. 2016, 3790). Sayre's study reported that museum visitors are generally interested in interactive media, and they feel it enhances their experience rather than clashing with it. The minority that did not engage with the interactive elements cited reasons such as "time restrictions, lack of interest in that form of interpretation . . . , and intimidation" (Sayre 2005) which suggests that the interaction provided should offer a range of modes to suit a variety of learning preferences.

Museums Are Places for Storytelling

Throughout history, storytelling has been used to share knowledge, wisdom, and values. Museums exist as places for storytelling, "because once upon a time some person or group believed there was a story worth telling, over and over, for generations to come" (Bedford 2001, 7). "Meaningful narratives for collections and displays, story-led interpretation" (Masters 2012), are important features of all museums, and "sophisticated, multi-layered" stories can be successfully presented through digital media in the museum environment (Mastoris 2012). Innovative options for storytelling, such as digital storytelling or interactive storytelling, open new ways to communicate and convey stories to share information. Three types of digital storytelling can be distinguished: personal narratives, instructional materials, and stories recounting historical events (Tiba et al. 2015). Museums have discovered that digital storytelling can be "an effective method to capture the attention of visitors," and that the use of digital storytelling to support exhibitions and artworks can also "lead to other innovative uses of

technology, such as mobile devices and augmented reality, to extend the museum visitor experience" (Robin 2016).

Digital Storytelling and Interactivity

The popularity and importance of digital storytelling are increasing in the humanities and science disciplines. It is the modern expression of the ancient art of storytelling and combines the traditional storytelling with digital tools and components, such as digital images, video clips, sound components, and audio narration.

Digital storytelling or interactive narrative of digital media products can be applied over a broad area, including DH, and can play a significant role in the preservation of our culture and heritage. Emerging technologies place cultural institutions under a spotlight to adopt "new ways to make their collections more engaging" (Dierickx, Brouillard, and Loucopoulos 2013, 14). According to Dierickx, Brouillard, and Loucopoulos (2013), "digital storytelling has a great potential for engaging visitors with museums exhibitions and collections."

Traditionally, museums have focused on the "collection, display, and storage of objects," but contemporary visitors demand a more interactive, and potentially educational, experience. Interactive storytelling has "great potential for assisting both the education and entertainment of visitors in museums, and to enhance the interaction between the visitor and his/her surroundings" (Dierickx, Brouillard, and Loucopoulos 2013).

Using various digital technologies, storytellers can create rich stories to "leave a legacy of cultural history for future generations" (L. C. Joseph 2006, 13). Stories provide a clarifying narrative, but interactivity adds agency, and potentially, personalization, and customization. Digital media "provide the infrastructure for new techniques of storytelling" (von Grafenstein, Schneider, and Richter 2015) and digital stories "do not need to consist only of text but can function in any kind of multimedia" (Lugmayr et al. 2017). Interactive storytelling engages the audience more intimately and to a higher degree because it "allows the audience to influence the story" in various ways and at various levels of interaction (Spierling 2005).

Using Digital Technologies in Research, Related to Museum Studies

Dawson's PhD research (Dawson 2018) investigated how interactive digital multimedia technologies, specifically, panorama tours, could be leveraged in museum environments to determine the suitability of specific multimedia technologies for audience development. Her study involved the design and development of a creative production that employed modern digital technologies and media-rich resources.
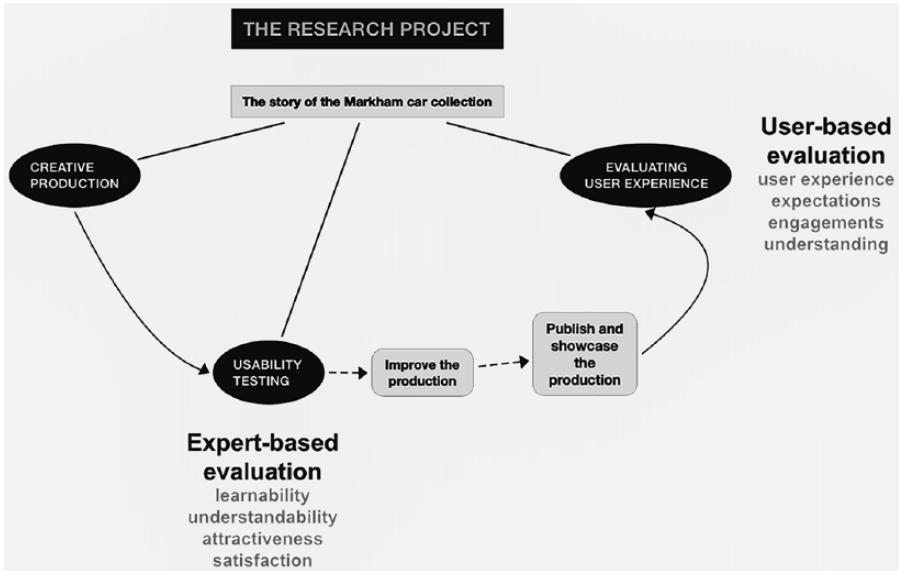
Figure 1. The structure of Dawson's research.
Source: Courtesy of Beata Dawson.

A virtual panorama tour was created to tell the story of a museum collection consisting of very large 3D (three-dimensional) objects revered for their aesthetics, comfort, aural character, engineering, and history: veteran and vintage cars. Once the creative production was developed for multiple platforms, the web version was used to investigate the users' experience: how the general public, the real users, interact with the production. A snapshot of the research strategy is presented in Figure 1.

A Digital Story about the Markham Family's Veteran and Vintage Car Collection

The Story of the Markham Car Collection is a panorama tour featuring interactive digital multimedia elements and demonstrates how to tell the story of a heritage collection using imaginary museum environments (Figure 2) and authentic panoramas. Rich media resources—videos and sounds of veteran and vintage cars, 2D (two-dimensional) display of archival records (photos and documents)—support the understanding of the story and provide visual and audio experience and enable a deep engagement with the content for audiences.

This interactive digital multimedia production (IDMMP) offers an easy-to-learn solution in how to attract audiences innovatively, improve community engagement,

Figure 2. An imaginary showroom from the production.
Source: Courtesy of Beata Dawson.

and implement new practices in the museum environment. It can facilitate the presentation and preservation of our cultural heritage and museum objects or collections. Furthermore, the story and its technology (IDMMP) could be applied in an educational context, as well.

The Background of the Digital Story

The Story of the Markham Car Collection is based on the following research: "Heritage of the Markham Car Collection: Estrangement from the West Australian Motoring Community" (P. Joseph 2016). Joseph provided a historical account of what happened to the twenty-two Markham cars between 1969 and 2014 that were advantageously sold to the Western Australia Museum, which later auctioned ten of these cars. However, one car, the 1898 Star vis-á-vis, survived the auction and remained in Western Australia. Joseph concludes the article with a thought-provoking discussion about the role of cultural institutions as "keepers or traders of our collections" and about ethics, community engagement, and collection management.

The uniqueness of the collection, the controversial history attached to it, the strong emotions it generated among the motoring community, and the fact that they can no longer be viewed made it a good subject for a digital storytelling presentation. The panorama tour tells the story of the Markham car collection and digitally showcases these world-class veteran and vintage cars—online. Thereby, the story gains more publicity, and the younger generation who are interested in cars and are not able to see the collection anymore can meet such a magnificent array of vehicles—digitally.

The Structure of the Digital Production

A variety of information sources (e.g., photographs, old manuscripts, and original copies of archival records, paper-based newspaper clippings, magazines, books, digital photos, and panoramas) in different media formats and modals (e.g., texts and pictures, videos and audio elements) were combined into one complex digital production.

Figure 3. The panoramas' thumbnails in the production.
Source: Courtesy of Beata Dawson.

The production consists of thirteen partial 180-degree panoramas and eight spherical 360-degree panoramic pictures (Figure 3). The partial panoramas were created as the virtual representation of a museum environment with various imaginary gallery showrooms. Each room represents a significant aspect and milestone in the history of the Markham car collection story narrative. Stock photos, images, and vectors (e.g., doors, chambers, objects) were used to model the fictional museum rooms. From these elements and different sources (e.g., archives, albums, photographs of antique cars provided by the Markham family, Christie's auction catalog), seven showrooms with 3D objects and six other supporting panoramas (information and closing parts of the tour) were generated.

The panoramas for the imaginary museum rooms and the other information sections were designed and developed through applying design principles such as harmony, balance, hierarchy, proportion, dominance, and contrast. Fitting with the ambience, the design of the imaginary museum rooms followed an antique, veteran style, using simple colors, forms, and shapes, and the main colors of the key figure of the story (Star 1898 Vis-à-Vis), the red and black combination, frequently emerged during the digital production's design. The full spherical panoramas were filmed and developed with the assistance of Paul Bourke (iVEC@UWA) and employed in the tour's authentic environment sections.

The user experience is interactive; the audience can navigate and interact with it to a certain degree, as the story itself is linear, and the events are presented in a preset path, in a predefined sequence. Users cannot alter the storyline. The order of scenes is interchangeable; however, the comprehensibility is better if the user follows the sequencing. Users, when walking through the different museum rooms, can interact with various media elements. The media (text, pictures, photographs, audio, and video components) appearing within the scenes can be read, listened to, or viewed by clicking on various interactive buttons or flashing icons in any preference.

The Development of the Digital Production

The development of the digital production commenced in 2015 and 2016 and involved many stages (Figure 4). It included information management, managing information
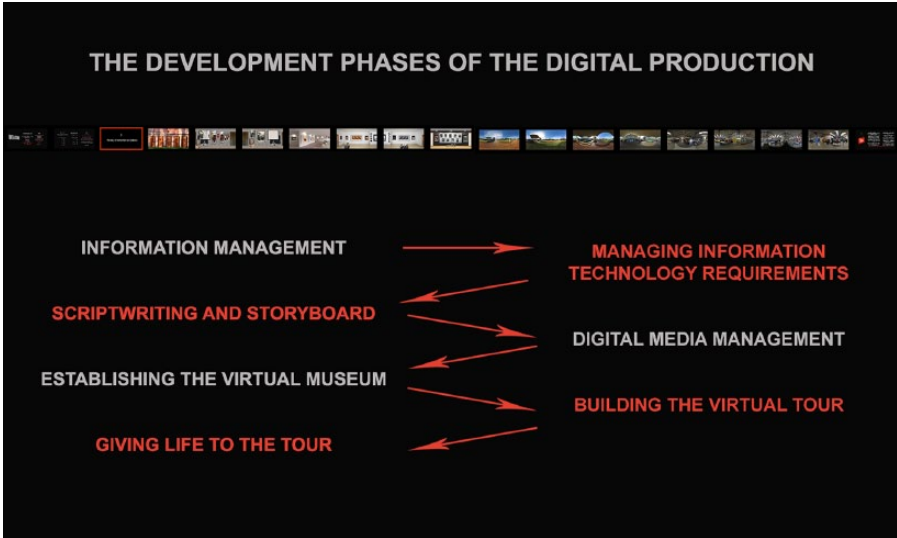
Figure 4. The development phases of the digital production.
Source: Courtesy of Beata Dawson.

technology requirements, scriptwriting and storyboard, digital media management, establishing virtual museum environment, building the virtual tour for different platforms, and finally giving life to the tour to make the virtual museum experience engaging for users.

A range of different skill sets and technological knowledge were required in a variety of disciplines to develop this digital multimedia production. These skill sets covered three broad areas:

1. Information management, including archiving processes;
2. Information technology, including web technologies and basic markup languages; and
3. Multimedia design and development, including filmmaking, screenplay writing, being aware of design elements and principles, different terms related to audio and video technology.

Altogether seventeen computing software and applications were used in the production design and development, including Adobe Photoshop, Audition, Premier Pro, iMovie, Photos, and Sublime Text 2. The key software used to combine panoramas with multimedia to create multimodal and spatial narratives was the Kolor PanoTour

Pro 2.5. It was primarily chosen owing to its features and functions suitable for and capable of creating a museum environment and for building an immersive virtual panorama tour for multiple platforms. It provided features to insert different hotspots (e.g., navigation icons, buttons), which enabled the creation of the virtual museum to be interactive.

The virtual panorama tour was built for three platforms (Figure 5):

1. Cylinder, with a size of $5,048 \times 1,200$ pixels to fit on the eight-meter-wide Cylinder screen located in Curtin University's HIVE in Perth, Western Australia;
2. Web interface (for desktop computers and mobile devices); and
3. Mobile application.

Consequently, the three platforms required different ways of navigation and allowing users/visitors to engage in various ways.

Strengths and Weaknesses of Technology

First, the production was primarily designed and developed for the widescreen cylinder of Curtin University's HIVE.

The advantages of this version were as follows:

- The cylinder interface allowed users to have an immersive experience, with a more engaging and satisfying graphical interpretation of the story.
- This technology of virtual panorama tours built for large widescreen utilization can be an alternative to the expensive and complicated active stereo and virtual reality (VR) displays.
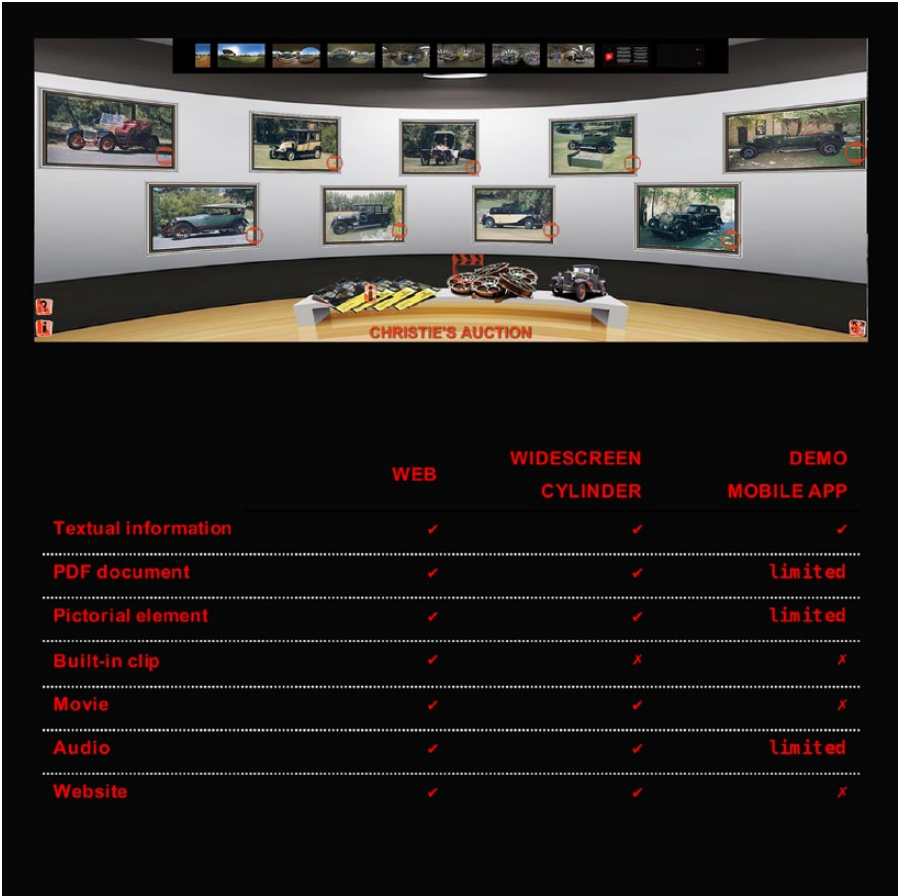
The disadvantage of this version was that

- The technology omitted built-in video clips.

Second, a full version of the tour was built for the web interface. Although the PanoTour software generated the tour in .html format, some parts of the source code, specifically the various links, needed to be improved and modified for the seamless navigation.

The advantages of this version were as follows:

- It contained the full range of multimedia elements and can be navigated on desktop computers and mobile devices.

	WEB	WIDESCREEN CYLINDER	DEMO MOBILE APP
Textual information	✔	✔	✔
PDF document	✔	✔	limited
Pictorial element	✔	✔	limited
Built-in clip	✔	✗	✗
Movie	✔	✔	✗
Audio	✔	✔	limited
Website	✔	✔	✗

Figure 5. The differences between the three platforms.
Source: Courtesy of Beata Dawson.

- Users/visitors were allowed to access the virtual panorama tour at any time and from anywhere.
- The production was accessible to a wider geographically dispersed audience, which improved the publicity of the digital story.
- Using the web version on mobile devices, in the case of full spherical panoramas, users wearing a VR headset could enjoy the authentic museum rooms in VR.

The disadvantage of this version was that

- Poor network, bandwidth, or Internet connections can result in uploading, downloading, and streaming problems.

Third, a version for mobile application was developed. This version was limited as was unable to display various high-quality media components. The PanoTour software generated the tour in a different file format (.pvt), which could be used on iOS and Android devices if the users download the free PanoViewer application. This version needs further improvements, and only a demo version is currently available.

The advantage of this version was

- Offline navigation of the panorama tour.

The disadvantages of this version were as follows:

- Cannot present the full production or a large amount of data.
- Inability to display various high-quality pictorial, video, and textual elements.

Use of the Digital Production in the Later Stages of the Research

When designing and developing virtual museum tours, an awareness and understanding of user requirements are essential. A key criterion for the usability of interactive digital productions is that the user interfaces are user-friendly, immersive, and entertaining. Also, the design needs to be intuitive and captivating for the users to explore an interactive, digital or multimedia production and the story it conveys. Therefore, in the second stage of the study, usability tests were conducted involving five expert testers to evaluate the interface design and examine and determine the digital multimedia production's usability before finalizing it for public access. The testing was conducted to investigate the production's usability against four criteria: learnability, understandability, attractiveness, and satisfaction. Also, it was conducted to seek the experts' advice on how it could be improved concerning these conditions. These experts were researchers and practitioners in digital design, media and film, user interface, user experience, visualization analysis, VR, augmented reality, and human-computer interaction. The feedback from the experts' testing process led to the improvement and refinement of the production; then the virtual tour was published online on a public website.

The third stage of the study investigated the general public users' interactions to the production using a user-based evaluation method. It required users first to watch the digital story and second to complete an online questionnaire (developed using the Qualtrics™ software) providing feedback about their user experience. The survey measured the real users' experience and satisfaction levels regarding the multimedia

production; it also assessed the production's usability as a whole. In addition, the use and effectiveness of digital technologies, in general, in museum environments and their impact on community engagement, audience attraction, and development were also assessed.

Findings

The study involved 166 participants from the wider public, of which 57 percent ($n = 95$) were male and 43 percent ($n = 71$) were female; 45 percent ($n = 75$) were below forty years and 55 percent ($n = 91$) were more than forty years. In total, 48 percent ($n = 80$) of the participants were from the *general public*, the other 52 percent ($n = 86$) included academics, professionals, students, motorsport-related participants, and veteran and vintage car enthusiasts.

We assessed the participants' computer-related experience: in general use, in virtual environments, and in gaming. Good or excellent experience were stated by 84 percent ($n = 140$) in general computer use, 55 percent ($n = 92$) in virtual environment, and 51 percent ($n = 85$) in gaming.

The general interest in cars and the overall happiness level (regarding the panorama tour) were also measured (on a 10-point gauge and on a 5-point emoji meter, respectively). Both the average interest in cars and the average happiness level were high ($M = 7.15$; $M = 4.54$, respectively), but the differences in interest and happiness level between male and female participants were highly significant (p values $< .000$ at $\alpha = .05$) suggesting correlation between interest and overall happiness.

Regarding the usability and user experience, the experts and the significant majority of the general users found the virtual panorama tour attractive, easy-to-use, and they understood the content. Although the majority of real users were satisfied with the digital production, significant differences were found between various groups: the gender, age, and gaming skills highly influenced the participants' user experience. Users who were male, below forty years, or with high-level gaming experience were "better" users of the virtual panorama tour and should be the target audience for similar types of production, rather than female participants, the above-forty age groups, or users with low-level gaming skills. Considerable differences were not observed between the evaluations of the participants with and without motorsport background.

In this study, 164 of 166 participants responded to the survey question about the production's effectiveness. The significant majority of the survey participants, as shown in Table 1, found the panorama tour *The Story of the Markham Car Collection* effective in telling the story (Figure 6), providing information about the cars (Figure 7) and showcasing the collection (Figure 8). For this question, neither the gender, age, or computer-related experience nor the motorsport background significantly influenced the participants' opinion.

Table 1. Summary of Data: How Effective Was the Digital Production *The Story of the Markham Car Collection*.

How effective was the digital production	Extremely effective	Very effective	Moderately effective	Slightly effective	Not effective at all	
	n	*n*	*n*	*n*	*n*	*N*
To tell the story of the Markham car collection	82	76	6	0	0	164
To provide information about the cars of the Markham car collection	48	91	25	0	0	164
To showcase the Markham car collection	58	93	13	0	0	164
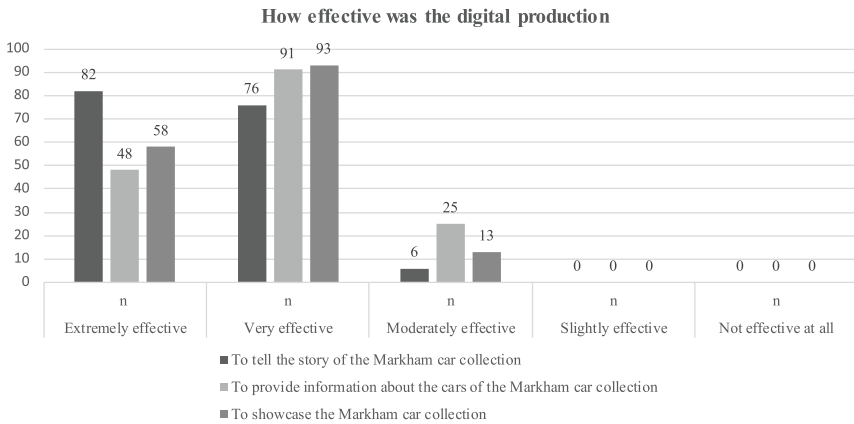
Source: Courtesy by Beata Dawson.
Note: *n* = number of responses; *N* = Total number of participants.

The use and effectiveness of digital technologies in the future of museums were also investigated. A total 162 of the 166 survey participants responded to these parts of the questionnaire. The research showed that both the below-forty age groups' and male users' expectations about the future of museums were slightly higher than female users' expectations and those above forty years.

- In total, 48 percent of the participants (*n* = 77) agreed with the statement that "Museums using 21st century's technologies are more popular" than the

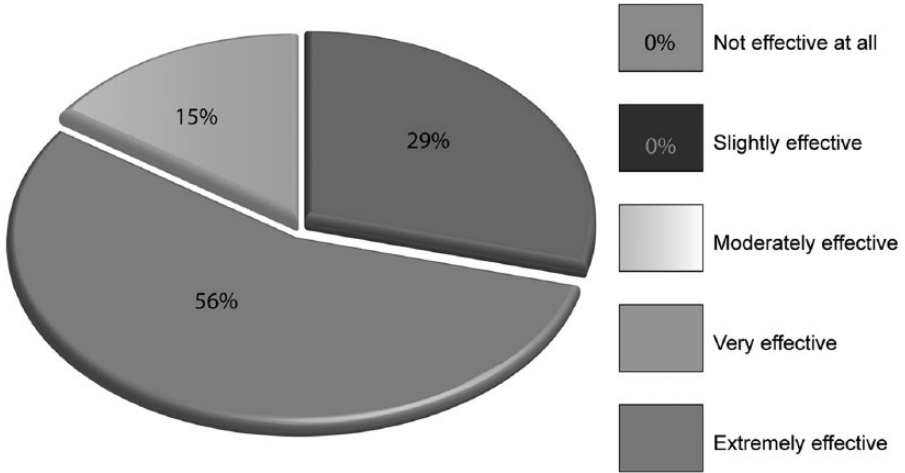## To tell the story of
the Markham car collection
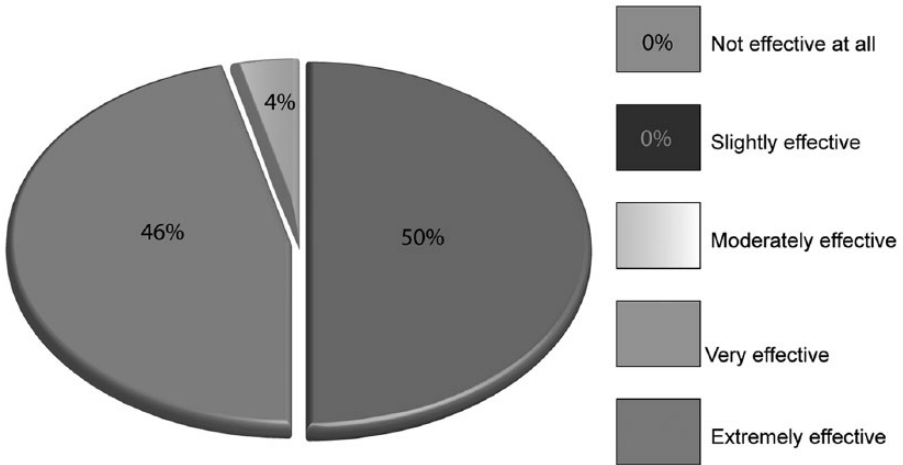
Figure 6. Percentage distribution: How effective was the digital production *The Story of the Markham Car Collection* to tell the story.
Source: Courtesy of Beata Dawson.

traditional museums; 3 percent (*n* = 5) disagreed with this statement and 49 percent (*n* = 80) had a neutral opinion (neither agreed nor disagreed). Three (two males and one female) in the below-forty age group disagreed that "Museums using 21st century's technologies are more popular" (than traditional museums) and a significant number of below-forty male survey participants (66%, *n* = 39) neither agreed nor disagreed with that statement.

- What is notable is that 66 percent of the participants (*n* = 107) disagreed with the statement that "Traditional museums are popular" and 13 percent (*n* = 21) agreed with it. A total of 21 percent (*n* = 34) indicated neutral opinion. The results also showed that only three (one male and two female) participants from the below-forty age group found that "Traditional museums are popular." A significant number of below-forty male respondents (86%, *n* = 51) disagreed with this statement.
- Ninety-six percent of the participants (*n* = 156) indicated (agreed) that "Museums should offer 21st century's technologies to showcase their collections," 4 percent (*n* = 6; one male above forty years, one female below forty years, four females above forty years) gave neutral feedback, and none disagreed.

To provide information about the cars of the Markham car collection

Figure 7. Percentage distribution: How effective was the digital production *The Story of the Markham Car Collection* to provide information about the cars of the collection.
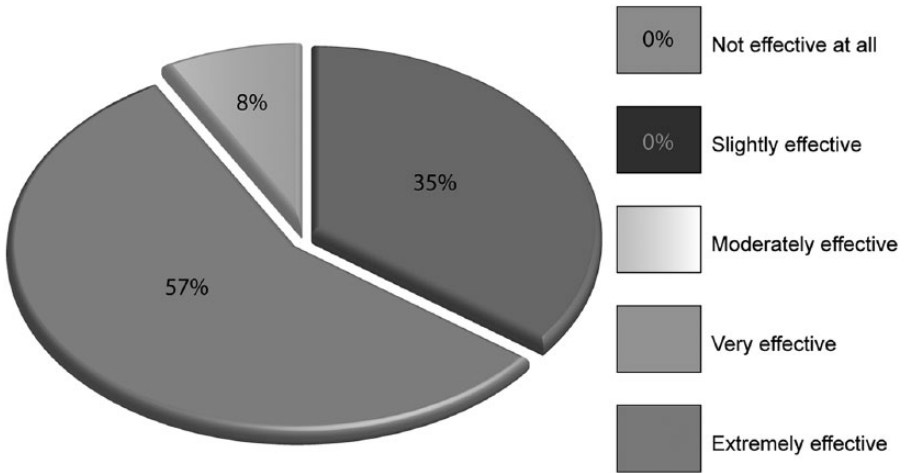Source: Courtesy of Beata Dawson.

- Seventy-two percent of the participants ($n = 117$) agreed that "Immersive exhibits, unique museum experiences attract the audience," and 1 percent ($n = 2$; two male participants below forty years) disagreed with this statement, while 27 percent ($n = 43$) had a neutral view.
- Eighty-eight percent of the participants ($n = 142$) agreed that "Advanced technologies can revolutionize the museum experience," 12 percent ($n = 20$) neither agreed nor disagreed, and none disagreed.
- Eighty-nine percent of the participants ($n = 145$) agreed that "Digital technologies are efficient tools in enhancing museum exhibitions," 11 percent ($n = 17$) were neutral (neither agreed nor disagreed).

The research also measured the participants' agreement level about the use of interactive virtual technologies (specifically panorama tours, similar to *The Story of the Markham Car Collection*).

- Seventy-four percent ($n = 120$) agreed that using virtual tour and/or interactive multimedia to convey a story of a collection, display, or exhibit could increase

To showcase
the Markham car collection

Figure 8. Percentage distribution: How effective was the digital production *The Story of the Markham Car Collection* to showcase the car collection.
Source: Courtesy of Beata Dawson.

the number of visitors to a museum. In total, 25 percent had a neutral opinion (neither agreed nor disagreed) and one male below forty years disagreed with the statement.

- Sixty-xix percent ($n = 116$) agreed that stories told through panorama tours could effectively impact the cultural institutions' community engagement, 33 percent ($n = 54$) neither agreed nor disagreed, and two males disagreed with that.
- Seventy-six percent ($n = 123$) agreed that exhibitions with interactive panorama tours are up to contemporary standard and effectively attract more visitors. In total, 21 percent ($n = 37$) had a neutral opinion, and two males showed disagreement with this.
- Eighty-eight percent ($n = 142$) also agreed that panorama tours combined with multimedia elements could be enjoyed by visitors. In total, 11 percent ($n = 19$) were neutral, and one male participant in the above-forty age group disagreed.

The survey findings indicated that virtual panorama tours featuring multimedia elements could effectively be used to increase the number of visitors, impact community engagement, and attract more visitors to the museum. The majority of the participants

thought that such types of technology would be considered enjoyable by visitors. In this case (regarding the use of interactive virtual technologies), neither gender, age, nor computer-related experience considerably affect the participants' opinions.

Using the Digital Production in Museum(s)

The 1898 Star vis-á-vis, the only surviving car from the 1990 auction of the ten Markham cars, is on display at the Motor Museum of Western Australia. One of the aims of the creative production was to tell the story of this physical museum object and to link it to the entire Markham car collection using an online virtual museum setting.

The online publishing enabled the digital story to be accessible to a wider audience. Several opportunities were available to publicize the story for extensive public engagement and awareness. The panorama tour (the digital production) was showcased at Curtin's HIVE (Figures 9 and 10), published online (Dawson 2016) and exhibited at the 2017 Western Australia State Heritage & History Conference.

There are a variety of options for delivering the content of the IDMMP using different digital tools and applications on site at museum locations to provide personalized experiences to museum visitors. For example, QR codes could be attached to a museum

Figure 9. Opening scene of *The Story of the Markham Car Collection*, showcased at the GLAM-VR symposium in Curtin University's HIVE, in August 2016.
Source: Courtesy of Beata Dawson.
Note: GLAM = galleries, libraries, archives, and museums; VR = virtual reality; HIVE = Hub for Immersive Visualization and eResearch.

Figure 10. Authors with the Markham family and representatives of the motor museum of Western Australia at a showcase in Curtin University's HIVE, in July 2018.
Source: Courtesy of Beata Dawson.
Note: HIVE = Hub for Immersive Visualization and eResearch.

object with links to access the full virtual tour online. This enables museum visitors to navigate the virtual tour and have an interactive experience learning about the story behind the exhibited physical museum object. QR codes offer museums a simple and cost-free option to showcase their collections using IDMMP technologies.

Museums could also attach the proximity beacon technology onto a museum object. It requires visitors to download an application on their mobile devices so that when the visitor approaches a point of interest, relevant media can be displayed. The immersive experience delivered by the IDMMP enables visitors to fully understand the story.

Employing Digital Tools in Education

Apart from museums, the education sector is also embarking on using technologies to deliver online teaching and learning experience for students. Educational institutions are creating unique strategies and taking actions to deliver future innovations. As such, radically and rapidly changing digital technologies have become popular tools in a broad range of professional contexts, including education.

Modern digital tools and learning environments bring exciting opportunities to educational institutions. As "technology can be a powerful tool for transforming learning" (Carlson 2016), and the future of education will be shaped by technology (van Hooijdonk 2018), educators have to be more knowledgeable about technologies (Purcell et al. 2013). Evolving technologies and digital tools are already influencing educational institutions "in teaching/learning processes for a variety of purposes: information retrieval from various resources; simulations and multimedia presentations; communication with instructors in- and after classes; communication amongst students; drilling exercises and sample tests; class administration" (Guri-Rosenblit 2009). The digital world is part of our everyday life in the twenty-first century. Hence, students' and citizens' expectations to have ready access to digital information is valid and not new.

One of the most important aspects of utilization and wider implementation of twenty-first-century digital technologies in education is to teach and learn in innovative ways, bring computing powers to answer traditional questions and allow students to come up with their own ideas (University Wire 2016). Digital technologies, specifically digital storytelling, "can be a powerful educational tool for students of all ages and grade levels" (Robin 2016, 20). According to Robin (2016), different types of digital storytelling can be used in education as "instructional tool" and can be "effective activity in schools." More importantly, interactive digital multimedia technologies involve students in their learning experience; hence, it makes Benjamin Franklin's teaching mantra "tell me and I forget, teach me and I may remember, involve me and I learn" achievable for educators!

The Educational Value of Panoramic Tours: An Example

Auctioning ten cars from the Markham car collection evoked some tension between the Western Australian motoring community and the Western Australia Museum, and raised questions about "how WA museums are funded, and whether there is a requirement for cultural institutions . . . to be independent of the government in the power" and "accountable to the community who entrusts them with personal and cultural treasures, or to the government that funds them from that same community's taxes?" (P. Joseph 2016).

In her article, P. Joseph (2016) argued that by the controversial decision of the museum, a "valuable, world-class collection of cars has been lost to the state." Visitors entrust cultural institutions with the long-term preservation of their valuable collections, which is why they gift or deposit or sell their treasures for insubstantial funds. Is it fair or ethical that cultural institutions later decide to sell or dispose of these treasures because they no longer align with a new collection policy or are no longer part of their significant collections? The role of cultural institutions as keepers or traders of national treasures is questioned (P. Joseph 2016).

Currently in her teaching of information studies, Joseph uses the digital production, *The Story of the Markham Car Collection*, as an educational resource for her students to explore lessons learned from this empirical case study. Employing this panorama
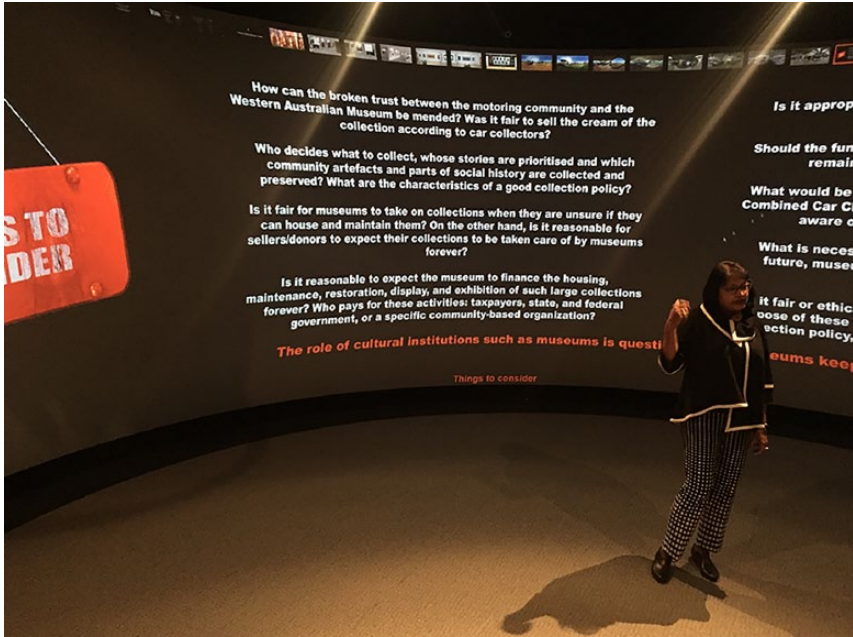
Figure 11. Educational use of the interactive digital multimedia production to discuss the role of cultural institutions.
Source: Courtesy of Beata Dawson.

tour in her teaching, pedagogy topics concerning ethics, the role of cultural institutions, and community engagement issues are discussed (Figure 11). The storytelling design of the panorama tour and its delivery on various platforms allow for easy use of this work for educational purposes both when teaching online and face-to-face. Other academics may also see the potential for using this panorama tour in an educational context for pedagogy reasons.

Conclusion

This article introduced the development and use of digital storytelling and multimedia technologies to create a virtual panorama tour. This tour's specialty is not only the use of panoramas to tell a story but also its presentation across multiple platforms, in different ways through multimedia, allowing individual navigation, and affording interactions across various platforms.

The creative production presented in this article demonstrates how digital storytelling served to showcase the controversial story of a car collection to the wider public.

The research findings and our experiences confirm that using and employing advanced, new, unique, or specialized digital technologies are essential.

Positive correlations were found between an interest in cars and overall happiness, and between gender, age, computer literacy level, and user experience (including understanding, engagement, and satisfaction).

We studied the general public's opinion about the of virtual panorama tour and confirmed its usefulness and effectiveness. The research findings indicated that the use of digital technologies, specifically panorama tours, are appropriate and effective tools to attract audiences in museums.

The technology, as well as the design and development techniques employed in the research, can be used in a specific development program for current and future GLAM (galleries, libraries, archives, and museums) professionals. We are planning to investigate what GLAM professionals think about the use of panorama tours presented on large screens.

Future research could include further improvement of the production. The team plans to investigate how the current 180-degree imaginary museum showrooms can be redesigned to improve users' engagement in a more immersive 360-degree VR experience. A higher interactivity level also needs further research, in collaboration with other professionals and researchers from various disciplines, specifically computer programming, software development, and machine/supervised learning.

Further research could also involve GLAM and educational professionals in focus group discussions to investigate the efficacy of such type of productions from different, professional viewpoints.

Acknowledgments

Declaration of Conflicting Interests

References

Alexandri, Eleni, and Antonia Tzanavara. 2014. "New Technologies in the Service of Museum Education." *World Transactions on Engineering and Technology Education* 12 (2): 317–20.

Barbieri, Loris, Fabio Bruno, and Maurizio Muzzupappa. 2017. "Virtual Museum System Evaluation through User Studies." *Journal of Cultural Heritage* 26 (July–August):101–08.

Bedford, Leslie. 2001. "Storytelling: The Real Work of Museums." *Curator: The Museum Journal* 44 (1): 27–34.

Carlson, Austin. 2016. *Technology in Education: Future Ready Learning and Schools*. Education in a Competitive and Globalizing World. Hauppauge: Nova Science Publishers. http://ebookcentral.proquest.com/lib/curtin/detail.action?docID=4730542.

Champion, Erik. 2015. *Critical Gaming: Interactive History and Virtual Heritage*. London: Ashgate.

Curtin University Humanities. 2015. "Visualisation Systems." https://humanities.curtin.edu.au /research/centres-institutes-groups/hive/visualisation-systems/.

Dawson, Beata. 2016. "The Story of the Markham Car Collection." Interactive Digital Multimedia Production, Perth, WA.

Dawson, Beata. 2018. "Designing a Storyteller Panorama Tour and the User Experience." PhD diss., Curtin University, Perth.

Degotardi, Sheila, Fay Hadley, Helen Little, Yeshe Colliver, and Kate Highfield. 2017. "'Let's Go to the Museum': An Investigation of the Expectations and Learning Engagement of Prior-to-School Aged Children and Their Families." Department of Educational Studies, Macquarie University, Sydney, Australia.

Dierickx, Barbara, Julien Brouillard, and Claire Loucopoulos. 2013. "Access to Cultural Heritage Networks for Europeana: Report on Existing Tools and Devices Related to Narrative Approaches and Requirement Functionalities." Public D5.2. Istituto centrale per il catalogo unico delle biblioteche italiane, Roma, Italy. www.athenaplus.eu/getFile. php?id=178

"Digital Culture 2015: How Arts and Cultural Organisations in England Use Technology." 2015. London: Arts Council England, Arts and Humanities Research Council, and Nesta. http://bufvc.ac.uk/copyright-guidance/mlr/index.php/site/648.

Dodge, Ryan. 2017. "Sharable Experience and Added Value. The #FutureMuseum Project: What Will Museums Be like in the Future?" https://museum-id.com/the-futuremuseum-project-what-will-museums-be-like-in-the-future-essay-collection/.

Erlick, Nikki. 2017. "20,000-year-old Artifacts, 21st-century Technology." *The Verge*. https:// www.theverge.com/2017/5/6/15563922/museums-vr-ar-apps-digital-technology.

Forrest, Regan. 2015. "Design Factors in the Museum Visitor Experience." PhD diss., University of Queensland, Brisbane, Australia.

Guri-Rosenblit, Sarah. 2009. "Distance Education in the Digital Age: Common Misconceptions and Challenging Tasks." *Journal of Distance Education* 23 (2): 105–22. http://search. proquest.com/openview/2ba422f03b38a0d311993a2453c3d7a4/1?pq-origsite=gscholar& cbl=446313.

Henry, Barbara, and Kathleen McLean, and Oakland Museum of California. 2010. *How Visitors Changed Our Museum: Transforming the Gallery of California Art at the Oakland Museum of California*. Oakland: Oakland Museum of California.

Hsu, Fu-Song, and Wei-Yang Lin. 2014. "A Multimedia Presentation System Using a 3D Gesture Interface in Museums." *Multimedia Tools and Applications* 69 (1): 53–77. doi:10.1007/s11042-012-1205-y.

Joseph, Linda C. 2006. "Digital Storytelling." *MultiMedia & Internet@Schools* 13 (4): 13.

Joseph, Pauline. 2016. "Heritage of the Markham Car Collection: Estrangement from the West Australian Motoring Community." *Collections: A Journal for Museum and Archives Professionals* 12 (1): 21–44.

Kabassi, Katerina. 2017. "Evaluating Websites of Museums: State of the Art." *Journal of Cultural Heritage* 24 (March–April): 184–96.

Karaman, Svebor, Andrew D. Bagdanov, Lea Landucci, Gianpaolo D'Amico, Andrea Ferracani, Daniele Pezzatini, and Alberto Del Bimbo. 2016. "Personalized Multimedia Content Delivery on an Interactive Table by Passive Observation of Museum Visitors." *Multimedia Tools and Applications* 75:3787–811. doi:10.1007/s11042-014-2192-y.

Kelly, Lynda. 2011. "Family Visitors to Museums in Australia." In *Understanding Museums: Australian Museums and Museology*, edited by Des Griffin and Leon Paroissien. National Museum of Australia. http://nma.gov.au/research/understanding-museums/LKelly_2011.html.

Lugmayr, Artur, Erkki Sutinen, Jarkko Suhonen, Carolina Islas Sedano, Helmut Hlavacs, and Calkin Suero Montero. 2017. "Serious Storytelling: A First Definition and Review." *Multimedia Tools and Applications* 76:15707–33. doi:10.1007/s11042-016-3865-5.

Masters, David. 2012. "Digital Impact on Museums." *Museum/ID the International Magazine for Museums*, February 1. https://issuu.com/museumid/docs/museumid_issue10.

Mastoris, Steph. 2012. "Culture of Digital Creativity." *Museum/ID The International Magazine for Museums*, February 1. https://issuu.com/museumid/docs/museumid_issue10.

Nickerson, Matthew. 2002. "Voices: Bringing Multimedia Museum Exhibits to the World Wide Web." *First Monday* 7 (5). http://www.firstmonday.org/ojs/index.php/fm/article/view/951.

Nickerson, Matthew. 2004. "Online Multimedia Museum Exhibits: A Case Study in Technology and Collaboration." *Library Hi Tech* 22 (3): 270–76.

Pujol, Laia, and Erik Champion. 2012. "Evaluating Presence in Cultural Heritage Projects." *International Journal of Heritage Studies* 18 (1): 83–102. doi:10.1080/13527258.2011.577796.

Purcell, Kristen, Alan Heaps, Judy Buchanan, and Linda Friedrich. 2013. "How Teachers Are Using Technology at Home and in Their Classrooms." Pew Research Center, National Writing Project College Board. https://www.issuelab.org/resource/how-teachers-are-using-technology-at-home-and-in-their-classrooms.html.

Rizvić, Selma, Aida Sadžak, Belma Ramić-Brkić, and Vedad Hulusic. 2011. "Virtual Museums and Their Public Perception in Bosnia and Herzegovina." *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* 3816:421–27.

Robin, Bernard R. 2016. "The Power of Digital Storytelling to Support Teaching and Learning." *Digital Education Review* 30:17–29.

Sayre, Scott. 2005. "Multimedia That Matters: Gallery-Based Technology and the Museum Visitor." *First Monday* 10 (5). http://firstmonday.org/ojs/index.php/fm/article/view/1244.

Spierling, Ulrike. 2005. "Interactive Digital Storytelling: Towards a Hybrid Conceptual Approach." *DiGRA: Changing Views: Worlds in Play, International Conference*, *Vancouver, Canada*, May 31.

Tiba, Chantyclaire A., Janet Condy, Agnes Chigona, and Nyarai Tunjera. 2015. "Digital Storytelling as a Tool for Teaching: Perceptions of Pre-Service Teachers." *TD: The Journal for Transdisciplinary Research in Southern Africa* 11 (1): 82–97.

University Wire. 2016. "Lecture Spotlights How to Use Digital Tools in Education." https://search-proquest-com.dbgw.lis.curtin.edu.au/docview/1761602956?accountid=10382.

van Hooijdonk, Richard. 2018. *The Future of Education*. Inspiration Series. London, UK | Driebergen Netherlands: Richard van Hooijdonk.

"Virtual Tour Software: Panotour/Panotour Pro 2.5 Beta 1." 2015. "Kolor." http://www.kolor.com/2015/06/29/virtual-tour-software-panotour-panotour-pro-2-5-beta-1/.

von Grafenstein, Maximilian, Eva Schneider, and Nancy Richter. 2015. "MAUERSCHAU: A Mobile Virtual Museum: Postmodern Storytelling through Digital Media." In *EVA '15 Proceedings of the Conference on Electronic Visualisation and the Arts*, 350–51. London: BCS Learning and Development.

Waltl, Christian. 2006. "Museums for Visitors: Audience Development—A Crucial Role for Successful Museum Management Strategies." *Intercom 2006 Conference*, *Taipei, Taiwan*.

Author Biographies

Beata Dawson is a PhD Candidate (her thesis has been passed) and will graduate in August 2019 at the School of Media, Creative Arts and Social Inquiry, in the Humanities Faculty, Curtin University, Perth, Western Australia. She holds a Master's Degree in Information Management from Curtin University (2014), and a Bachelor Degree in Pedagogy from Eszterházy Károly University of Applied Sciences, in Eger, Hungary (2001). Her current research is cross-disciplinary and related to communication technology, digital media, heritage and museum studies.

Pauline Joseph, PhD, is a Senior Lecturer in Records and Archives Management at the School of Media, Creative Arts and Social Inquiry, in the Humanities Faculty, Curtin University, Perth, Western Australia. She completed her PhD at the University of Western Australia in 2011, studying how knowledge workers search for corporate information in the electronic document and records management systems. Her current research interests are about the sustainability of community-based information management practices using the motorsport community as a case study; an aspect of this research investigated how and why the motoring community became estranged with cultural institutions.

Erik Champion, PhD, is UNESCO Chair of Cultural Heritage and Visualisation, and Professor in the Humanities Faculty, Curtin University, Perth, Western Australia. He researches issues in the area of virtual heritage as well as game design, interactive media, and architectural computing. His recent books are *Critical Gaming: Interactive History and Virtual Heritage* (Routledge, 2015), *Playing with the Past* (Springer, 2011), he edited *The Phenomenology of Real and Virtual Places* (Routledge, 2018), *Game Mods: Design, Theory and Criticism* (ETC Press, 2012), and he was co-editor of *Cultural Heritage Infrastructures in Digital Humanities* (Routledge, 2017).