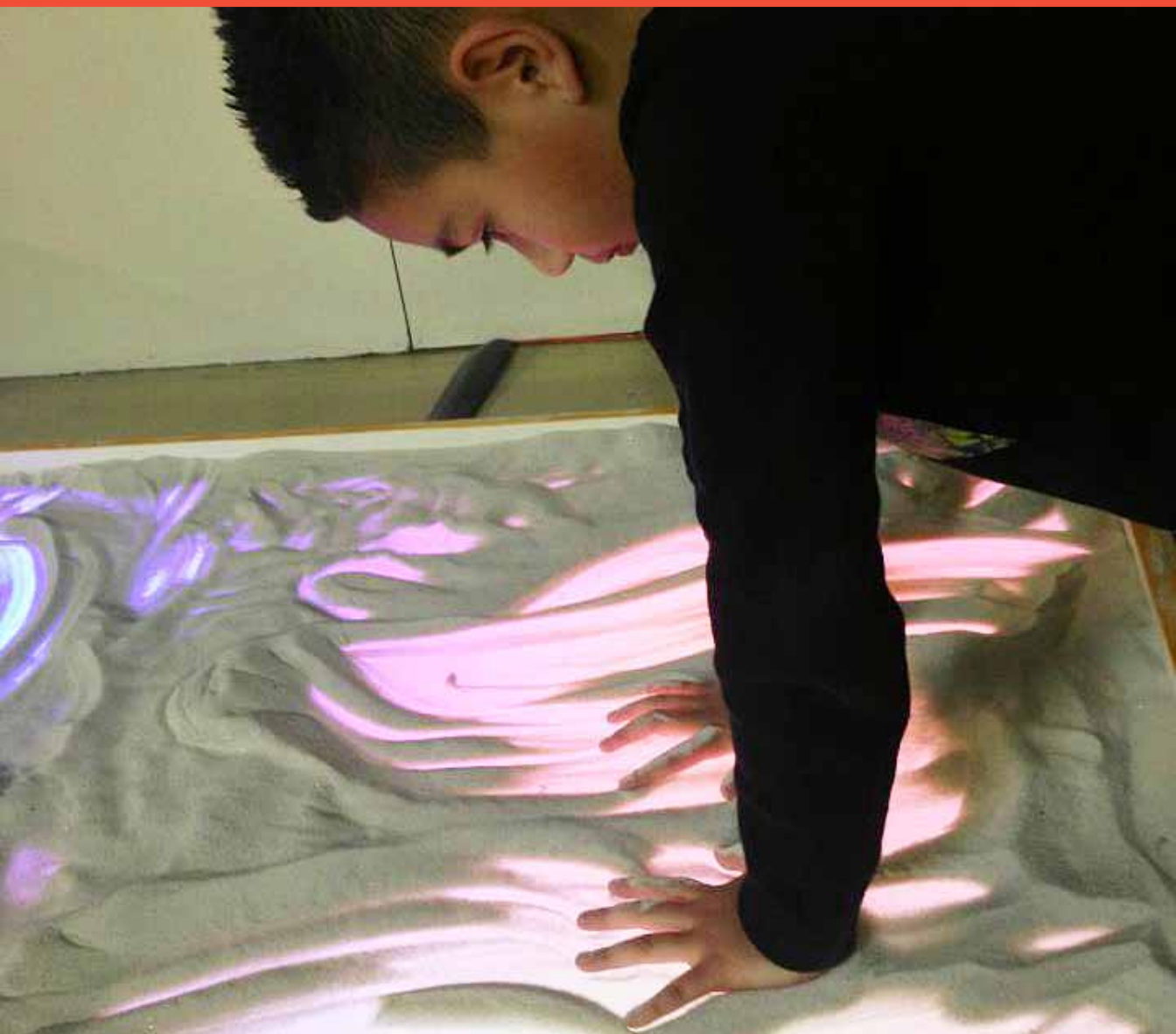
NMC

Horizon Report > 2013 Museum Edition



The internationally recognized *NMC Horizon Report* series of global analyses and the regionally-focused *NMC Technology Outlook* series are part of the NMC Horizon Project, a research effort established in 2002 that identifies and describes emerging technologies likely to have a large impact over the five years following the publication of each edition in formal and informal education around the globe. The *NMC Horizon Report: 2013 Museum Edition*, examines emerging technologies for their potential impact on and use in education and interpretation within the museum environment.

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The *NMC Horizon Report: 2013 Museum Edition* is a publication of the New Media Consortium and the Marcus Institute for Digital Education in the Arts.

The Edward and Betty Marcus Institute for Digital Education in the Arts (MIDEA) provides timely, succinct and practical knowledge about emerging technologies that museums can use to advance their missions. Learn more at midea.nmc.org.

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Executive Summary

The internationally recognized *NMC Horizon Report* series of global analyses and the regionally-focused *NMC Technology Outlook* series are part of the NMC Horizon Project, a research effort established in 2002 that identifies and describes emerging technologies likely to have a large impact over the five years following the publication of each edition in formal and informal education around the globe. This volume, the *NMC Horizon Report: 2013 Museum Edition*, examines emerging technologies for their potential impact on and use in education and interpretation within the museum environment. The hope is that the report is useful to museums worldwide, and the international composition of the advisory board reflects the care with which a global perspective was assembled. While there are many localized factors affecting the adoption and use of emerging technologies in museums, there are also issues that transcend regional boundaries, and this report was created with these challenges in mind. The *NMC Horizon Report: 2013 Museum Edition* is the fourth in an annual series of museum-focused reports co-produced by the NMC and the Marcus Institute for Digital Education in the Arts (MIDEA).

Each of the three global editions of the *NMC Horizon Report* — higher education, primary and secondary education (K-12), and museum education — highlights six emerging technologies or practices that are likely to enter mainstream use within their focus sectors over the next five years. Key trends and challenges that will affect current practice over the same period frame these discussions.

The six technologies featured in the *NMC Horizon Report: 2013 Museum Edition* are placed along three adoption horizons that indicate likely timeframes for their entrance into mainstream use for museum education and interpretation. The near-term horizon assumes the likelihood of entry into the mainstream for museums within the next 12 months; the mid-term horizon, within two to three years; and the far-term, within four to five years. It should be noted at the outset that the *NMC Horizon Report* is not a predictive tool. It is meant, rather, to highlight emerging technologies with considerable potential for our focus areas of education and interpretation. Each of the six is already the target of work at a number of innovative museums and organizations around the world, and the projects and exhibits we showcase here reveal the promise of a wider impact.

Near-term Horizon

On the near-term horizon — that is, within the next 12 months — are two rapidly unfolding topics: *BYOD* and *crowdsourcing*. Both encompass ways for visitors to engage with museums on a deeper level, whether personalizing their devices with museum content or sharing ideas and observations that could become part of an exhibit. BYOD has largely arisen from staff needs, as museum employees increasingly want to work with their own laptops, which already contain the productivity tools they prefer. Crowdsourcing is not a new concept, but when integrated with social media and crowdfunding websites it is allowing patrons to play a more active role in the development of exhibits, catalogs, and databases.

> **BYOD** or "Bring Your Own Device" is a practice that has emerged as a result of the increasing number of people who take their laptops and other devices with them everywhere they go for maximum productivity. The BYOD movement is an effort by institutions to move away from a top-down system of providing technology to facilitate productivity, and instead simply provide the networks and contextual frameworks to coordinate the use of

personal computing devices. As more people rely on smartphones to navigate in their daily lives, the potential for museums to engage and reach visitors via their devices is vast. Many museums offer mobile apps for wayfinding, sharing, and curating purposes, taking the pressure off of institutions to purchase devices in bulk to lend to patrons. The workflow within cultural institutions has been similarly disrupted by BYOD as museum personnel are conducting their day-to-day work with their own personal computers. In a time when most software is web-based and technology is ubiquitous, the trend toward BYOD is stronger than ever, and best practices for museums are emergent as pioneers set policies and precedence.

> **Crowdsourcing** refers to a set of methods that leverage the ideas and work of a community of individuals around a common goal. Wikipedia is perhaps the most recognizable example of crowdsourcing as it relies on the work of thousands of volunteers who all share the task of compiling and editing historical and contemporary research in an open platform. Many museums use crowdsourcing to promote community engagement through social media, prompting visitors to submit observations and media to add an interactive dimension to events and exhibits. One of the most promising aspects of crowdsourcing has been its ability to reach large numbers of individuals who each contribute a small amount of money to fund a small- or large-scale project. In 2012, money raised for art-related projects through the crowdfunding site Kickstarter surpassed that of the National Endowment for the Arts for the first time. Beyond fundraising, cultural institutions are also crowdsourcing metadata for artworks and artifacts that have yet to be described, including the addition of alt-text to serve the visually impaired.

Mid-term Horizon

In the second adoption horizon, two to three years out, two technologies are expected to pass the 20% adoption point that marks entry into mainstream practice in the Horizon Project framework: these are *electronic publishing* and *location-based services*. Electronic publishing is transforming content workflows at museums across the world, as there is more pressure to share catalogs, apps, and other publication formats that contain rich media and interactive features. Location-based services help visitors navigate the museum space, often based on personal preferences. This topic is poised for rapid growth with major companies, including Apple and Google, purchasing startups that specialize in locational intelligence and indoor GPS.

> **Electronic publishing** is creating a sea change in how people consume media, research, news, and narratives. Major media companies like *The New York Times* and *Newsweek* are setting the standard for what electronic publishing can accomplish. Rich in digital media assets such as video, images, and audio, these digital building blocks can be easily deployed in a variety of media formats aimed at discrete audiences — a notion that has huge implications for expanding the reach of a museum's content. Cultural institutions generally still have much to do to make the conversion to electronic publishing workflows, including adopting design processes that leverage digital media for multiple dissemination channels. The Getty's Online Scholarly Catalogue Initiative has brought online publishing to the forefront for museums by providing them with the tools and framework they need to modernize their media production. The next step is to generate sustainable systems for the management and re-purposing of digital assets, as well as designing content to fit various mobile platforms.

> **Location-based services** are already so integrated into people's daily lives that few think twice before allowing mobile apps on their devices to track their location. Enabled by WiFi access points, GPS, enhanced RFID tags, and crowdsourced positioning technologies like Waze, location-based services are now able to resolve location very precisely, even indoors, and deliver up-to-the-moment information that is related to that particular spot. The social media check-in app FourSquare, now several years old, has become one of the most successful examples of how this technology can be adopted seamlessly into an individual's life, rewarding users for tagging and sharing their location. For museums, location-

based apps and other technologies can knowingly guide visitors through a space, directing them to exhibits that match their preferences, or suggesting routes with accompanying digital displays and features to interact with. Museum professionals and programmers are discovering that location-based services in the museum space can streamline a visitor's cultural experience in memorable and meaningful ways.

Far-term Horizon

On the far-term horizon, set at four to five years away from entry into the mainstream of practice, are *natural user interfaces* and *preservation and conservation technologies*. Exhibits that make use of natural user interfaces that react to touch, movement, voice, and facial expression are going to be more intuitive for museum patrons, providing them ways to interact with artworks and installations. For years, museum professionals have been exploring ways to protect and repair both physical and digital objects that are in peril of becoming obsolete, due to rapidly changing technologies. Establishing workflows for developing and archiving metadata, in addition to documenting the artist's original intent, will be key for the advancement of preservation and conservation. These technologies are several years away from mainstream use, but already it is clear that their impact will be significant. The high level of interest and investment in both areas are indicators that they are worth following closely.

> **Natural user interfaces** (NUIs) are closing the gap between humans and computers as new platforms emerge that incorporate touch, voice, and other gestures. Smartphone and tablet users are most familiar with the ease of a natural user interface, but technologies beyond the touchscreen are rapidly advancing to make human-computer interaction even more intuitive. It is not uncommon for people to use virtual assistants on their smartphones to request and receive information, send texts and email, or use location data, rather than via touchscreen. These technologies are compelling museums to rethink the way visitors engage with art and objects, and there are a fair share of museums that have already incorporated tablets and multi-touch displays that reinvent exhibits and allow visitors to become a part of installations. Microsoft Kinect, a gesture-based technology that uses motion sensors, is being used more frequently, inviting visitors to interact with digital renditions of delicate objects. The latest development in NUIs is the integration of texture into otherwise normal touchscreens that allows users to sense a wide range of tactile stimuli. Ultimately, natural user interfaces offer museums opportunities to leverage emerging technologies to more deeply engage visitors in the artworks and artifacts.

Each of the three global editions of the *NMC Horizon Report* — higher education, primary and secondary education (K-12), and museum education — highlights six emerging technologies or practices that are likely to enter mainstream use within their focus sectors over the next five years.

> **Preservation and conservation technologies** are often used interchangeably in conversation, but they are distinct in their purposes. While preservationists protect artifacts from obsolescence by safeguarding their intention and medium, conservators repair and restore objects that are subject to the trials of time. Digital archives were among the first technological solutions implemented by preservationists, and have since generated a new standard of professionals that specialize in archival theory with technical expertise in developing tools to manage metadata. In addition to digitizing delicate artifacts, those charged with maintaining cultural heritage face a host of considerations when it comes to time-based

media works that were originally executed using a technology that has become obsolete. The main challenge of a modern preservationist is to present content in workable ways that stay true to the artist's intent. As technologies to facilitate the preservation and conservation of digital and physical objects become more sophisticated, institutions such as the Library of Congress are setting the standard in the most innovative methods of upholding the integrity of cultural objects.

To create the report, an international body of experts in museums, education, technology, and other fields was convened as an advisory board. Over the course of August through September of 2013, the 2013 Horizon. Museum advisory board came to a consensus about the topics that appear here in the *NMC Horizon Report: 2013 Museum Edition*. The examples and readings under each topic area are meant to provide practical models as well as access to more detailed information.

Six technologies are described in detail in the main body of the report, where a discussion of what each technology is and why it is relevant to museum education and interpretation can also be found. Our research indicates that all six of these technologies have clear applications in museum learning and interpretation, and this report aims to document that in a simple and compelling fashion.

The group engaged in discussions around a set of research questions intended to surface significant trends and challenges and to identify a wide array of potential technologies for the report. This dialog was enriched by an extensive range of resources, current research, and practices that drew on the expertise of both the NMC community and the communities of the members of the advisory board. These interactions among the advisory board are the focus of the *NMC Horizon Report: 2013 Museum Edition* research, and this report details the areas in which these experts were in strong agreement. The precise research methodology employed is detailed in the closing section of this report.

The advisory board of 44 technology experts spanned six countries this year, and their names are listed at the end of this report. Despite their diversity of backgrounds and experience, they share a consensus view that each of the profiled topics is going to have a significant impact on museum education and interpretation around the globe over the next five years. The key trends driving interest in their adoption, and the challenges museums will need to address if they are to reach their potential, also represent their perspective, and are the focus of the next sections of the *NMC Horizon Report: 2013 Museum Edition*.

To facilitate comparison, the report's format is consistent from year to year and edition to edition, and opens with a discussion of the trends and challenges identified by the advisory board as most important for the next five years. The format of the main section of this edition closely reflects the focus of the NMC Horizon Project itself, centering on the applications of emerging technologies — in this case for museums. Each section is introduced with an overview that describes what the topic is, followed by a discussion of the particular relevance of the topic to museum education and interpretation. Several concrete examples of how the technology is being used are given.

Finally, each section closes with an annotated list of suggested readings and additional examples that expand on the discussion in the report. These resources, along with a wide collection of other helpful projects and readings, can all be found in the project's open content database that is accessible via the NMC Horizon EdTech Weekly App for iOS (go.nmc.org/ios) and Android (go.nmc.org/android) devices. All the background materials for the *NMC Horizon Report: 2013 Museum Edition*, including the research data, the preliminary selections, the topic preview, and this publication, can be downloaded for free on iTunes U (go.nmc.org/itunes-u).

Key Trends

The technologies featured in each edition of the *NMC Horizon Report* are embedded within a contemporary context that reflects the realities of the time, both in the sphere of museum education and in the world at large. To assure this context was well understood, the advisory board engaged in an extensive review of current articles, interviews, papers, and timely research to identify and rank trends that were currently affecting the practice of museum education and interpretation. Once detailed, the list of trends was then ranked according to how significant each was likely to be for museums in the next five years. The highest ranked trends had significant agreement among the advisory board members, who considered them to be key drivers of museum technology adoptions for the period 2013 through 2018. They are listed here in the order in which the advisory board ranked them.

1 Cross-institution collaboration is growing as an important way to share resources. Museums are increasingly aware of the ways in which content, including but not limited to unmediated collections data, may be seen and used in the broader networked environment. The days of large-scale, multi-year, foundation-funded collaborative projects are probably on the wane. Increasingly, multi-institutional collaboration will occur at the data level with institutions being collaborative partners only in a passive sense, and the real work of pulling multiple resources together being accomplished downstream, possibly by third-party organizations.

2 Collection-related rich media are becoming increasingly valuable assets in digital interpretation. Museums are beginning to see the value in developing formal strategies for capturing high-quality media documentation at every opportunity. Curators and content specialists are working more closely than ever with educators and technologists to embrace opportunities provided by using digital resources to enhance multimodal learning both online and in the galleries. Video, audio, and animations are no longer seen as afterthoughts in interpretation but increasingly as necessary components of an interpretive plan. This trend is beneficial to museum professionals and visitors alike as it encourages a deeper understanding of objects, ideas, and audiences.

3 Digitization and cataloguing projects continue to require a significant share of museum resources. Museums are distinguished by the content they keep and interpret. There is an increasing understanding among museum professionals that visitors expect to be able to readily access accurate and interesting information and high-quality media. This requires museums to plan strategically for the digitization and cataloging of collections. These projects frequently require sacrifices in terms of scarce resources (money, personnel, and time) in order to meet long-term goals.

4 Expectations for civic and social engagement are profoundly changing museums' scope, reach, and relationships. More and more, museums are integrating emerging technologies and approaches such as social media, open content, and crowdsourcing as a means of engaging their communities both internally and externally on a deeper level. Embracing these innovations means that museums are providing patrons with more immersive opportunities to become part of the content. Increasingly, people who are unable to make a physical trip to a museum are able to access its collections and respond and contribute meaningfully to conversations about what may be happening in the physical space, redefining what it means to be a museum patron.

5 Increasingly, visitors and staff expect a seamless experience across devices. Whether viewing objects in gallery spaces, ordering tickets, interacting with the online store, or simply browsing the museum's website, visitors expect museums to provide a wide range of digital resources and content, and want the experience of interacting with that content to be consistent across their devices. Virtual visitors in particular expect to be able to perform typical tasks online quickly and easily irrespective of the device they may have at hand. This is true even for visitors in the physical space, where it is common to see people interacting with their smartphones as they decide which part of the gallery to visit next.

Museums are beginning to see the value in developing formal strategies for capturing high-quality media documentation at every opportunity.

6 More and more, people expect to be able to work, learn, study, and connect with their social networks wherever and whenever they want. We are not tied to desks anymore when we wish to use computers. Workers increasingly expect to be able to work from home or from the road, and most everyone expects to be able to get information, addresses, directions, reviews, and answers whenever they want. This is a key trend for both museum professionals and museum visitors. Mobile access to information is changing the way we plan everything from outings to errands. A corollary of this trend is the expectation that people will be available and online, anywhere and anytime.

7 The need for data literacy is increasing in all museum-related fields. Ninety percent of the world's data has been created in the last two years, and, through the exponential growth of hardware, software, and networking, every day we add 2.5 quintillion bytes. Important societal decisions in the near future will be informed by big data, and for individuals, as informed citizens, to fully engage in these conversations the ability to read and interpret large data sets will become increasingly necessary. Additionally, one in five Americans does not use the Internet because of a lack of knowledge, lack of affordable access to computers and the Internet, or because they do not understand its inherent value. These individuals are at risk of being left behind the digital divide, and libraries and museums have the opportunity to reach out to these communities to ensure people gain the digital literacy skills needed to succeed in the 21st century.

Significant Challenges

Any discussion of technology adoption must also consider important constraints and challenges, and the advisory board drew deeply from a careful analysis of current events, papers, articles, and similar sources, as well as from personal experience, in detailing a long list of challenges museums face in adopting any new technology. Several important challenges are detailed below, but it was clear that behind them all was a pervasive sense that constraints existing within museums themselves are likely the most important factors in any decision to adopt — or not to adopt — a given technology.

Even institutions that are eager to adopt new technologies may be critically constrained by the lack of necessary human resources and the financial wherewithal to realize their ideas. Still others are located within buildings that simply were not designed to provide the radio frequency transparency that wireless technologies require, and thus find themselves shut out of many potential technology options. While acknowledging that local barriers to technology adoptions are varied and meaningful, the advisory board focused its discussions on challenges that are common to museums and the museum community as a whole. The highest ranked challenges they identified are listed here, in the order in which the advisory board ranked them.

1 Greater understanding is needed of the relationships, differences, and synergies between technology intended to be used within the museum and public-facing technology such as websites, social media, and mobile apps. Too few in museum administration see the opportunities that virtual museum visitors might be bringing for fundraising, philanthropy, and specialized marketing. The dichotomy between the physical and virtual museum visitor is blurring rapidly, and both audiences have high expectations with regard to online access to services and information. Still, the notion that museums must provide comprehensive information and services online is a genuine challenge, especially for smaller museums. For larger institutions, however, providing such services has risen to an expectation from the visiting public.

2 Museums of all sizes are struggling to adapt to how technology is redefining staff roles and organizational structures. The pervasiveness of technology in almost all aspects of the museum has had a dramatic effect on the importance of digital departments; they now need to work both horizontally (coordinating and interacting with many other departments) and vertically (needing leadership and strategic oversight). Furthermore, as the digital realm increasingly touches all aspects of the museum from education and marketing to research and curating, these activities start to blur and merge into each other. Navigating this shift requires new skills both in the digital team and across the whole organization. At the Tate, for example, they are starting a comprehensive organizational change project centered on the museum's digital strategy.

3 A comprehensive digital strategy has become a critically important part of planning for long-term institutional sustainability. Such a strategy should include not only traditional elements of a technology plan (e.g., hardware, software, networks, etc.) but also e-forms of marketing, philanthropy, and revenue generation, as well as critical tasks like digitization, digital preservation, and long term technology infrastructure. This plan should "future-proof" the museum to every extent possible, by ensuring that they have accounted for all infrastructure needs. Additionally, it is clear that a museum cannot simply

plan a web presence as it might a brochure or catalog — a museum's digital presence today includes not only a website, but also a social media presence, mobile tools and apps, interaction with online communities, electronic fundraising, online sales, and much more. All must be addressed, as will the skill sets that will be required.

4 In many cases, museums may not have the necessary technical infrastructure in place to realize their vision for digital learning. In the United States alone there are around 17,000 institutions that self-identify as museums; many of these institutions have few staff and fewer resources. While it is practically impossible not to recognize the value of digital learning in today's connected world, the reality for museums is that the vast majority of institutions do not have the necessary technical infrastructure to successfully pursue goals for digital learning, and often have little time to dedicate to articulating, much less realizing their vision. Museums that do have resources may have to choose to reallocate funds from non-digital education efforts in order to implement the necessary technical infrastructure.

A comprehensive and sustainable digital asset management strategy is more important than ever to address the need to create, manage, discover, and deliver digital material effectively and productively.

5 As our disabled population increases as a percentage of overall population, and as a percentage of our active, engaged, museum-attending population, accessibility cannot be an afterthought. With more than 50 million Americans with disabilities, museums need to continue to improve the accessibility of facilities, exhibitions, and programs for this important population. In order to reach this audience, museums are investing more thought into the way educational programs and didactic materials are presented. Technology can aid in increasing accessibility by breaking down barriers. Haptic technology, for example, enables blind and partially sighted individuals to touch virtual 3D objects. Additionally, museums can bridge this divide by creating special content for visitors with disabilities who are already bringing advanced technology along with them.

6 Museums are not doing a sufficient job of creating a sustainable environment to manage and deploy collection information and digital assets. The proliferation of destinations and platforms for collection information is becoming increasingly difficult to support and sustain. Collection data and digital assets including text, web, audio, video, and image files exist in multiple and largely unconnected locations, presenting often conflicting information. A comprehensive and sustainable digital asset management strategy is more important than ever to address the need to create, manage, discover, and deliver digital material effectively and productively.

These trends and challenges are a reflection of the impact of technology in almost every aspect of our lives, and across the museum sector. They are indicative of the changing nature of the way we communicate, access information, connect with peers and colleagues, learn, and even socialize.

Taken together in the context of the NMC Horizon Project research, they provided the advisory board a frame through which to consider the potential impacts of nearly 50 emerging technologies and related practices that were analyzed and discussed for potential inclusion in this edition of the *NMC Horizon Report*. Six of those were chosen as key; they are detailed in the main body of the report.

BYOD

Time-to-Adoption Horizon: One Year or Less

The term BYOD, which stands for "Bring Your Own Device," refers to the practice of people bringing their own laptops, tablets, smartphones, or other mobile devices with them to the learning environment. Intel coined the term in 2009, when the company observed that an increasing number of its employees were using their own devices and connecting them to the corporate network. Since then, this type of activity has become commonplace in workplaces all over the globe. The BYOD movement in museums is being driven by a major challenge that many institutions face — a lack of funds and infrastructure to support providing a device to every staff member or volunteer, much less patrons. BYOD leverages the devices that people already have. In early studies, the act of an individual using his or her own device has proven to increase productivity and engagement. With their ever-growing capabilities, tablets (which now include an expanding set of choices, such as the iPad, Galaxy, Nexus, and Surface) are well positioned for BYOD environments.

Overview

For museums and other education institutions, BYOD is less about the devices and more about the personalized content that users have loaded onto them. Rarely do two devices share exactly the same content or settings, and BYOD enables individuals to leverage the tools that make them most efficient and productive. Today, separating a user from their tools and apps has become like separating them from some of their most precious belongings. Devices have become the gateways to personal working and learning environments that are rich with interactive features that facilitate the exploration of new subjects and connect people with each other wherever they go. In this sense, the work environment has transcended the concept of staff being tethered to a desk and confined to a physical space, opening them up to the limitless productivity possibilities that exist across the Internet and its vast array of downloadable apps.

This notion of BYOD originated with Intel when they launched a personal device program in 2010. Today, the initiative supports around 25,000 of their personnel's smartphones, which they report has added nearly an hour more of productivity for employees each day, in addition to boosting morale. Intel has led the move away from institutional decisions and ownership of technology towards individual choice. When applied to museum staff, BYOD policies foster greater freedom and flexibility in the work environment and often eliminate unsecured devices. An increasing number of personnel are opting to bring their own laptops to the museum, which enables them to more seamlessly complete tasks, even when they are outside of the building.

The convenience of BYOD for museum staff has also prompted a shift in how the visitor experience is conceived. While traditionally museums have provided patrons with devices to accompany audio tours, they are now encouraging the use of personal smartphones and tablets in the space. This shift is largely due to the proliferation of mobile apps — perhaps the fastest growing dimension of the mobile space. Apps are key drivers of device personalization as users can choose from an array of educational and productivity resources that speak most to their work and interests.

A recent report from Gartner predicted that 102 billion apps would be downloaded in 2013 — or nearly 15 apps per each human being on Earth. As of October 2013, the regularly updated online app counter 148Apps reveals that there are more than 86,000 active educational apps in the iTunes store alone, making education the second most popular category, behind games.

Most museums, especially the large ones, are taking advantage of this traction and have created their own apps to enhance the BYOD visitor experience with audio tours and supplemental materials, while also extending the learning activities and interactions outside of the physical space.

Relevance for Museum Education and Interpretation

The proliferation of mobile devices, coupled with the growing number of mobile apps, has had a tremendous effect on museums' mobile strategies, whether through the creation of mobile websites and apps, providing free WiFi access, or supplementing guided tours on museum owned devices with content for visitors' devices. This movement is notable because it shifts museum resources from the maintaining and supplying of technology to the content and delivery of high quality multimedia experiences. While not entirely supplanting the traditional museum-provided mobile device, this is an area with a great deal of activity within museums.

While museum visitors expect to seamlessly connect to the Internet whenever and wherever they want, it has been museum staff who have been the primary motivators for museums to provide free WiFi access — the key to making BYOD work. Museums are increasingly working with contract and transient staff who need to provide their own devices to conduct their work, and in the case where museums do offer devices, often the quality of the device an employee owns is superior to what otherwise might be available. There is also a desire for many staff members to work in the gallery space, making an openly accessible WiFi signal of critical importance. Visitors can also easily connect to the web to access their social networks, conduct research outside of the museum, and use mobile apps specifically designed by the museum to enhance their experience on-site.

More museums are seeing the value of enabling visitors to own and customize museum content on their devices, as it is an important step for connecting education and interpretation inside and outside the museum. The Museo del Prado's Official Guide exemplifies the current wave of mobile apps to personalize a visitor's learning experience before, during, and after a visit. The mobile app offers learners with high quality images of artworks, customizable thematic tours, searchable indexes, and direct access to the Museo del Prado's Facebook and Twitter accounts.

The ubiquity of smartphones with professional cameras and social apps has affected how museums are accommodating visitors who use these devices in the museum space. Today, it is not uncommon for museums to feature screens in the gallery spaces that leverage social media feeds to encourage dialog among visitors. The Museum of Contemporary Art in Australia has a formal program called MCA Now that shares the story of the museum through the eyes of visitors and staff, with a stream of Instagram and Twitter feeds displayed on monitors on each floor. The photographic impulse is also being recognized by museums as several large institutions, including the Metropolitan Museum of Art, Indianapolis Museum of Art, and Getty Museum have relaxed their policies to allow photography in some or all of their exhibition spaces — a direct response to the growing BYOD movement.

Though an increasing number of museums have revised their policies to embrace BYOD, it is not yet pervasive. Many museums are locked into long-term contracts with mobile guide vendors or have limitations — because of security, financial, or infrastructure issues — to provide free WiFi for visitors. Some museums still store and supply devices because it is less expensive than building and supporting a robust native app across a number of platforms. Creating effective device-agnostic digital interpretives is a challenge that museums are currently in the midst of solving. Many museums are experimenting with revamping their websites to feature responsive design or building mobile websites to circumvent platform accessibility issues. Ultimately, as museums increasingly cater to BYOD, providing free WiFi will need to be considered an essential step.

A sampling of BYOD functions in museums includes the following:

> **Exhibitions and Collections.** "ArtLens" by the Cleveland Museum of Art is an iPad app that allows visitors to further explore collections in the museum or from home. Included in the app is indoor wayfinding

technology that guides patrons to artworks that have interpretive content such as video and film along with a scanning feature that can recognize an image and offer content for it: go.nmc.org/artl.

> **Marketing and Communications.** Marketing departments are leveraging BYOD at special events by including backdrops and photobooths that encourage visitors to share their museum experience via social media. Mexic-Arte Museum often creates special areas in their exhibition spaces where patrons can take photographs of themselves re-enacting parts of artworks: go.nmc.org/mexic.

> **Visitor Services and Accessibility.** Museums can make their collections more accessible to deaf patrons with specialized apps for mobile devices. "SzépMűSL," an Android and iOS app that was recently created by Budapest's Museum of Fine Arts, features sign-language videos in several international sign languages for around 150 paintings from the museum's collections: go.nmc.org/szep.

BYOD in Practice

The following links provide examples of BYOD use in museum or other settings:

Bring Your Smartphone
go.nmc.org/dmaa
The Dallas Museum of Art website tells patrons to bring their smartphones in order to access content that has been specially developed for selected works in their collection. The institution also has a free WiFi network throughout, and encourages visitors to bring their laptops and other mobile devices to take advantage of the Internet café.

BYOD at Fashion Institute of Technology (PDF)
go.nmc.org/fitnewyork
The Fashion Institute of Technology (FIT) in New York has implemented a robust, secure wireless network that enables BYOD among 10,000+ students, faculty, and staff, and over 100,000 museum visitors annually. The aim was to eliminate the need for wired computer labs while maintaining quality of bandwidth in order to create more productive, flexible workspaces.

BYOD Keeps Hospital Group on Competitive Edge
go.nmc.org/nchhealth
NCH Health Systems, a hospital group in Florida, has implemented a two-part BYOD strategy for its two properties in an effort to promote an efficient, paperless work environment. Administrators are allowing employees to use their own devices for optimal convenience as well as publicizing the BYOD policy to gain a competitive edge when recruiting physicians.

BYOD Saves VMware $2 Million
go.nmc.org/vmware
Software company VMware, Inc. was a pioneer in BYOD, embracing the change in the fourth quarter of 2011. Since then, the company has managed to save $2 million on mobile phones alone due to their effective system for employee IT costs reimbursement. The savings were allocated toward improving infrastructure and R&D projects.

Capture the Museum
go.nmc.org/scot
A program at the National Museum of Scotland asks patrons to download the "Capture the Museum" app to their phones to sign up for a physical team game in which players explore galleries to claim territories. The app was developed to enhance visitor engagement and to engage the newest generation of museum patrons.

MCA Insight
go.nmc.org/mca
The Museum of Contemporary Art Australia developed an app to provide an interactive accompaniment to the museum's collections, encouraging patrons to explore the stories behind installations and artworks through video and image. The app also includes a location awareness system that helps users find their way through the space with a responsive map.

QuizTrail
go.nmc.org/mid
Tate Britain's "QuizTrail" app guides visitors through the London gallery on themed trails ranging from "Animals" to "Myths and Legends," and they can earn prizes and discounts based on the number of questions they answer correctly for each tour. The app was designed

to engage both children and adults in an immersive challenge that educates participants about British art.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about BYOD:

4 Big BYOD Trends for 2013
go.nmc.org/byodinfo
(Michael Endler, *Information Week*, 21 February 2013.) Based on Gartner's evaluation of the uptake and implications of BYOD in enterprise, this author has highlighted four major trends that should concern every IT leader across sectors, including security and the use of BYOD as a recruitment tool.

BYOD: Six Tips for a Successful Implementation
go.nmc.org/success
(Sam Ganga, *Data Center Journal*, 7 October 2013.) There are many factors organizations must consider when developing a successful BYOD policy including security and technical concerns as well as creating a governance model to address new issues as they arise. This article provides a list of questions and points to cover in creating and implementing a BYOD policy.

Dear Museums: The Time is Right to Embrace Mobile
go.nmc.org/vis
(Matthew Petrie, *The Guardian*, 31 May 2013.) A recent study at the New York MoMA found that 74% of visitors brought a mobile device with them. The Victoria and Albert Museum in London commissioned a study that revealed that visitors would rather use their personal devices than a museum-provided device. Reasons included ease and familiarity, hygiene, and the convenience of already possessing an interpretation tool.

Education Efforts Key to Successful BYOD Programs
go.nmc.org/fierce
(David Weldon, Fierce Enterprise Communications, 10 October 2013.) Many organizations are either adopting formal BYOD policies or allowing informal BYOD use, but moving data across a variety of devices and networks means increased risk of leaks or attacks. Therefore, it is vital that each employee understand exactly how BYOD will work and how their behavior could lead to potential risks.

A Self Guided Tour App How-To
go.nmc.org/selfg
(*The Official Whitepoint Blog*, 17 August 2013.) This Whitepoint framework aims to help museums, galleries, and public spaces build and implement their own self-guided tour apps without costly development expenses. Visitors who bring their smartphones or tablets to the space can use the app to navigate through exhibits and collections.

Unavoidable: 62 Percent of Companies to Allow BYOD by Year's End
go.nmc.org/byodreport
(Teena Hammond, *ZDNet*, 4 February 2013.) According to a global survey of over 1,000 ZDNet and TechRepublic members, more than 44% of organizations already allow BYOD and another 18% plan to implement BYOD by the end of 2013. The full report discloses the percentage of employees who participate in the program, the type of personal devices used most often for work, details regarding approaches to security, and the costs of the hardware and service plan.

What do Visitors Say about Using Mobile Devices in Museums?
go.nmc.org/vaml
(Andrew Lewis, Victoria and Albert Museum, 13 March 2013.) A series of surveys were conducted among a number of London museums to learn more about how patrons use their mobile devices and what they want in regards to content and services from museums. Findings from the Victoria and Albert Museum in particular describe a smartphone-toting museum visitor who is enthusiastic about free WiFi and desires content that is tailored to their interests and designed from a user needs perspective.

What is BYOD and Why is It Important?
go.nmc.org/byodtech
(Dean Evans, *Tech Radar*, 23 August 2013.) The consumerization of IT is forcing corporations and companies both large and small to develop strategies that maximize efficiency and reduce security risks. The key points of effective BYOD policy and implementation are outlined in this article for those that want to undertake the novel approach to IT management.

Crowdsourcing

Time-to-Adoption Horizon: One Year or Less

Crowdsourcing refers to a set of methods that can be used to motivate a community to contribute ideas, information, or content that would otherwise remain undiscovered. Its rapidly growing appeal stems from its effectiveness in filling gaps that cannot be bridged by other means. One of the most well-known examples of this is Wikipedia, where volunteers provide information and definitions for subject matter of their expertise. Crowdsourcing capitalizes on the power of explicit collective intelligence, where knowledge is constantly refined through the contributions of thousands of authors. For museum scholars, crowdsourcing is often a way for researchers to draw on public knowledge to provide missing historical or other specific details related to communities or families, complete large-scale tasks, or solve inherently complex issues. For many tasks, institutions are finding that amateur scholars or even people whose lives simply were contemporary to the event, object, images, or other research focus being documented are remarkably effective in providing deep-level detail around a topic or in documenting a large body of materials. Related to crowdsourcing in many ways is crowdfunding, an effort to raise money through a network of people — usually through resources on the Internet. Many organizations, especially start-ups, turn to online tools such as Kickstarter to finance new projects and products. Crowdfunding has been known to support many different activities, from helping communities recover from disasters to free software development.

Overview

Crowdsourcing is compelling to museums and individuals alike; people can engage around ideas and content with others to produce work that none of them alone would have been able to accomplish. Social media communities on platforms such as Facebook, Twitter, and many others have made it even easier for museums to share resources and garner input from large groups of people. However, the notion of crowdsourcing is not new as organizations have long requested input from members, fans, and other key groups. Perhaps the oldest known instance of crowdsourcing in action — without the support of the web — is when the Oxford English Dictionary opened a call for contributions of quotations and example usages of the words. Over 70 years, they received more than six millions submissions.

The millennium also yielded many scientific companies whose very livelihood depends on the results of crowdsourcing. Ancestry.com, 23andme, and others have leveraged the upswing of personal DNA testing to build vast databases of genetic information that help participants gain an understanding of their family histories. Large-scale citizen science projects, such as the Cornell Lab of Ornithology and Journey North, rely on bird and wildlife observations submitted by amateur scientists across the United States to inform their daily research and track migration patterns. Museums have begun conducting similar crowdsourced research for cultural sites and objects for which they are hoping to gather information from knowledgeable individuals.

Not only does crowdsourcing help museums gather explicit information about specific subjects or artifacts, but it also generates a deeper connection between the patron and the institution, building trust and allegiance in innovative ways. German philosopher Walter Benjamin was famous for surmising that true art is a conception between the artist and the audience, and crowdsourcing exemplifies this notion by turning the audience into active participants, as their contributions ultimately become part of the final piece.

Crowdfunding is one of the fastest growing areas of crowdsourcing, particularly due to the advent

of Kickstarter, Crowdfunder, Indiegogo, and similar websites, where anyone with Internet access can be a philanthropist and support exciting new ideas and projects. Museums, artists, and all kinds of users pay a fee to campaign for financial support through these platforms. If they gain enough pledges to meet their fundraising target, the projects are funded, and the people who contributed become a part of the success story. In many cases, these people also get something in return for their support, whether it is the final product that is being funded or other benefits. There are even hierarchies where the more a person invests, the bigger the return for them when the project is funded.

Because they foster communities by nature, museums are well poised to leverage every dimension of crowdsourcing to invite patrons to become part of the experiences they offer. Many have already deployed successful small- and large-scale crowdsourcing programs, and the practice is sure to grow.

Relevance for Museum Education and Interpretation

For the first time in 2012, money raised for art-related projects through the crowdfunding site Kickstarter surpassed that of the National Endowment for the Arts. This signals a major shift in the landscape of fundraising, demonstrating the power of crowds to fundamentally change how people and museums interact with each other. People's opinions and actions are increasingly leveraged by museums, whether it is to inform the content of an exhibition or to help scholars collect data.

In a challenging economic climate, funding museum exhibitions has become more difficult and museums are finding other methods to supplement exhibition budgets. The concept of crowdfunding is not new; small groups of wealthy patrons who see the benefit in furthering a museum's mission often come together to financially support exhibitions. What is new is the method in which this type of fundraising is occurring, and the type of individual who contributes. An online Kickstarter campaign for a yoga exhibition at the Smithsonian's Freer and Sackler Galleries recently generated $170,000 from 600 individuals united by their common interest in a popular topic. Kickstarter anticipates this type of fundraising to grow as they have created a new museum category on their website.

Similar to how museums are asking individuals to invest with dollars, they are also looking to crowds to help inform their exhibitions, whether they are showcasing user-generated content or engaging with audiences in voting for their favorite artworks and artists. The Brooklyn Museum of Art is well known for the latter strategy; they invite their local museum community to visit Brooklyn area artist studios and vote for the artists they would like to see featured in group exhibitions.

Citizen science has converged with crowdsourcing in an interesting way to aid in the research of science museums that double as research centers. For example, Calbug is an effort to crowdsource and digitize information on more than one million insects and spiders contained in nine California natural history museums. Participants earn badges as they help transcribe data so that the information will be accessible to help inform researchers about changes in biodiversity.

The Cooper-Hewitt Museum is using crowdsourcing to generate descriptions for their vast collection of objects that have little to no metadata attached to them. Their new collection website offers the opportunity to provide information about an object through a built-in tagging feature. For example, at the bottom of an object's webpage, there is a note to tag personal photos from Flickr and Instagram or 3D models from SketchUp and Thingiverse to connect their collection to users' content.

Crowdsourcing tangibly reveals the power of collaboration and dialog as visitors increasingly expect to engage with museums in a more personal way. While crowdsourcing is becoming widely used, museums still need to overcome challenges in embracing user-generated content and feedback. A genuine crowdsourcing project requires museums to relax their authority over the content and welcome ideas that deviate from what was expected in order to foster the type of synergy that frequently leads to innovation.

A sampling of crowdsourcing applications in museums includes the following:

> **Exhibitions and Collections.** Map the Museum is an open data project where people go online to virtually place objects from the collections of the Brighton & Hove's Royal Pavilion and Museums on a local map, demonstrating the relationship between the city and the museum, while also creating new data that can become a part of each object's permanent catalog record: go.nmc.org/mapm.

> **Marketing and Communications.** Matthew Inman, famously known as the Oatmeal, raised more than $520,000 over his $850,000 goal to build a Tesla Museum by harnessing the power of social media to share his Indiegogo crowdfunding campaign. The link to his campaign received 12,600 Twitter shares, 47,000 Facebook likes, and 9,700 Google +1's: go.nmc.org/tesla.

> **Visitor Services and Accessibility.** The Museum Victoria in Australia uses an open source, web-based program called Describe Me that crowdsources alt-text in an effort to make the collections online more accessible for people with visual impairments. Volunteers are presented with an image and then write a short description of what they see: go.nmc.org/desau.

Crowdsourcing in Practice

The following links provide examples of crowdsourcing in use in museum settings:

Agricultural Innovation and Heritage Archive
go.nmc.org/ament
The Smithsonian's National Museum of American History is asking visitors to contribute their personal narratives about technologies that have changed the history of farming and ranching in the United States, and to relate how these changes have impacted their communities. The goal is to compile a crowdsourced digital archive that will tell the narrative of American agriculture for the museum's American Enterprise exhibition.

ArtPrize
go.nmc.org/artpz
ArtPrize is an annual open art competition that takes place over 19 days in downtown Grand Rapids, Michigan, where anyone over the age of 18 can submit their work to be judged by the public, with an opportunity to win the first place award of $200,000. The contest is independently organized by a community of artists and sponsors.

Historypin
go.nmc.org/histp
Historypin is a collaboration between non-profit We Are What We Do and Google that asks people to add their media — photos, letters, and memories — to a public archive where artifacts are pinned to a location and searchable on Google Maps. The website also features collections that allow users to explore specific time periods and places through photos.

Marina Abramovic Institute: The Founders
go.nmc.org/abram
In July 2013, the Marina Abramovic Institute kicked off a campaign to crowdfund the $600,000 needed to construct a building to house what renowned performance artist Abramovic calls "long durational work," or the joining of art, science, technology, and spirituality. The campaign reached its goal, and those who contributed more than $1 will receive an embrace from Abramovic in return.

Puffing Gun
go.nmc.org/boom
The Museum of Food and Drink reached its goal of raising $80,000 through Kickstarter in order to fund the development of a puffing gun that turns grains into breakfast cereal, which was on display in Manhattan on three consecutive Saturdays. It was the first exhibition by founder Dave Arnold, a chef, radio host, and restaurateur.

Space Shuttle Enterprise: A Pioneer
go.nmc.org/intrepid
New York's Intrepid Sea, Air, and Space Museum created a crowdsourced exhibit for the space shuttle, Enterprise. The museum has asked the public to upload photographs of their space shuttle moments to the museum's website or post them to Instagram and Twitter with their own captions so that the museum can create a physical as well as online exhibition with the content.

Ten Most Wanted
go.nmc.org/tenmo
Developed for the Museum of Design in Plastics in the UK, Ten Most Wanted is a game-based approach to crowdsourcing the verification of undocumented facts about collection objects, requiring sustained engagement and collaboration among contributors. This model can be applied to other contexts, such as identifying people and places in paintings or photographs.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about crowdsourcing:

Crowdsourcing Museums: Can Big Donors, Curatorial Decisions, and Individual Artists Be Replaced?
go.nmc.org/don
(Paula Newton, *Glasstire*, 31 May 2013.) This article provides examples of how museums are turning to crowdfunding, crowdvoting, and crowdsourcing to help them garner wider support in their efforts. The author suggests that before embarking on a crowdsourcing activity that museums should consider the repercussions of not meeting a funding goal or how general public opinion can affect the outcomes of art in a restrictive manner.

Digital Humanities and Crowdsourcing: An Exploration
go.nmc.org/anex
(Laura Carletti, Gabriella Giannachi, Dominic Price, Derek McAuley, *Museums and the Web*, 2013.) As cultural institutions are progressively exploring crowdsourcing, the authors of this paper drew from a web survey on 36 different crowdsourcing projects promoted by galleries, libraries, archives, museums, and education institutions to shed light on the variety of practices to support the development of crowdsourcing initiatives.

Oh Snap! Experimenting with Open Authority in the Gallery
go.nmc.org/ohsnap
(Nina Simon, *Museum 2.0*, 13 March 2013.) Carnegie Museum of Art's experimental photography project, "Oh Snap! Your Take on Our Photographs," allows in-person and virtual visitors to share their work in their own galleries. This post describes the benefits of this project and how the museum is engaged in an ongoing dialog with participants because of it.

On the Trickiness of Crowdsourcing Competitions: Some Lessons from Sydney Design
go.nmc.org/tricky
(Mia Ridge, *Open Objects*, 27 May 2013.) This article describes lessons learned from a competition held during the Sydney Design festival. The organization's crowdsourcing effort was perceived by some as an unethical way to get spec work from designers.

What is Crowdsourcing? And How does it Apply to Outreach?
go.nmc.org/out
(*idea*, 19 February 2013.) This overview of crowdsourcing breaks down the topic into multiple facets to explain exactly how it can benefit organizational outreach. From cloud labor to collective knowledge, there are many methods of harnessing support from the community.

Yes, Kickstarter Raises More Money for Artists Than the NEA. Here's Why That's Not Really Surprising
go.nmc.org/rai
(Katherine Boyle, *The Washington Post*, 7 July 2013.) Kickstarter has funded more than $600 million in arts projects by providing a platform that simplifies the long-held tradition of individual private donors giving to the arts. Individual donors giving money to the arts is nothing new — only the method of donating.

Electronic Publishing

Time-to-Adoption Horizon: Two to Three Years

Already firmly established in the consumer sector, electronic publishing is redefining the boundaries between print and digital, still image and video, passive and interactive. Modern digital workflows support almost any form in which content might appear, from traditional print to digital, web, video, and even interactive content. Building in the full spectrum of potential publishing avenues — print, web, video, mobiles and tablets, and interactives — from the beginning is not only a way to streamline production overall, but also to increase the reach of the materials produced by leveraging the content over a wide range of media. If the first revolution in electronic publishing was making publishing platforms accessible to anyone, the next phase is the linking of these platforms together to produce new combinations and new types of content. New concepts like the Online Scholarly Catalogue Initiative (OSCI) and Responsive Design will allow that content to be easily archived as well as ported to any device.

Overview

Electronic publishing allows museums to design and produce a piece irrespective of the format in which it may ultimately appear, and thus fosters the flexibility to easily port content into many different formats, providing patrons with a variety of reading options. With each format comes a unique experience that is constantly progressing to include more enhanced features at every turn. Now that electronic publications have become commonplace, all major magazines and periodicals have at least one electronic variant, if not many. Electronic publishing reflects the convergence of several different forms of digital media into a single stream of production — a notion that is now being widely experimented with across the museum sector.

Electronic publishing has developed considerably over the past two years since the topic was featured in the *NMC Horizon Report: 2011 Museum Edition*. In 2012, Pew published a study revealing that half of Americans access their news online, with that number climbing to 60% for people under the age of 25. *The New York Times* website garners over 30 million unique visitors per month, while its print circulation has decreased to one million copies daily. Furthermore, major publications such as Encyclopedia Britannica and *Newsweek* have discontinued their print runs altogether in favor of a digital-only presence. Over 30 years ago, media mogul Rupert Murdoch predicted the death of print publishing, and his premonition is materializing into a reality with each passing year.

Responsive Design is an approach that ensures an optimal viewing experience on any device of an individual's choosing, whether via desktop, laptop, smartphone, or tablet.

In the midst of this rapid growth, the industry has faced the inherent challenge of changing its strategies and workflows while the technology itself is still evolving. Publishing houses are leading the way. Since 2009, these companies have been deploying ever more streamlined processes for generating, producing, and marketing content. Before electronic publishing, there were not as many moving pieces, and the pieces themselves were more easily understood; publishing meant print, words,

and perhaps pictures. Video and multimedia were distinct forms, but now such distinctions are hard to make — and, increasingly, the ultimate published piece includes all of that, as is the case with major newspapers, magazines, and websites.

Today, many museum content and marketing teams see themselves as media companies, producing content for whatever delivery formats will achieve the greatest reach. With the advent of emerging new formats, publishers are able to create different versions of a piece — i.e. an extended version with author interviews or with a "foldout" of glossy images — and tailor them to distinct audiences. Content is captured just once for a variety of potential applications. Additionally, mobile apps have become publications in their own respect, and museums are using them to publish photos and videos from collections and interviews with artists — with interactive features for people to connect with the material on a deeper level.

A new dimension of electronic publishing this year is its connection to new methods and approaches in design. Responsive Design, for example, is an approach that ensures an optimal viewing experience on any device of an individual's choosing, whether via desktop, laptop, smartphone, or tablet. In this approach, navigation adapts instantly to display size and aspect; content automatically resizes or even replaces itself, fluidly adapting what is on the screen to the current browser and screen dimensions.

Relevance for Museum Education and Interpretation

Recent developments, particularly the implementation phase of the Online Scholarly Catalogue Initiative (OSCI), have sparked the rise of more openly accessible content and the increased adoption of electronic publishing strategies by museums and their staffs. While there are many examples of electronic publications in the form of catalogs and mobile apps in larger museums, the development of viable business models is stalling widespread adoption.

When the Getty's Online Scholarly Catalogue Initiative began in 2008 to increase access to collections through the dissemination of scholarly research on the web, museums were just beginning to understand the potential of this new medium. Five years later, the nine museums involved in the project are now actively experimenting with different forms of web-based publishing and sharing their findings with the larger museum community. The new resources and workflows, combined with a formal platform in the OSCI toolkit, have heralded a new way of thinking about catalog production, content management, and digital strategy in museums. As the Art Institute of Chicago has experienced, scholars who may have been reluctant to create electronic publications before the initiative are now embracing the OSCI toolkit as a valuable research tool.

Historically, creating museum publications was an expensive undertaking due primarily to printing and copyright costs, but with the move to digital, image permissions have become more relaxed at institutions including the National Gallery of Art, British Museum, and the Rijksmuseum. Access to once hidden parts of a collection have increased and greatly benefited research.

Traditional publishing was also a time-consuming and compartmentalized process, where activities were primarily "siloed" within individual departments. With the rethinking of workflow, multiple departments are beginning to work together so that the development of web, mobile, print, and in-gallery experiences progress in parallel. A dramatic shift is now taking place as people are becoming more comfortable with the free online publishing world of Instagram and tumblr, and attitudes are changing as museum staff and boards of trustees become more inclusive of technology adoption in museums.

With the increased functionality inherent in electronic publications, individuals with disabilities can garner a greater appreciation of artifacts than ever before. The Umlauf Sculpture Garden and Museum has provided touch tours for students from the Texas School for the Blind since 1991, and recently was able to augment their touch tours with large-print materials on iPads. Using iBooks Author, the museum released an iBook that highlights seven sculptures in the collection by

creating verbal descriptions for selected artwork and wayfinding information for navigating the Garden for blind and low-vision visitors. Additionally, because this form of publication is accessed on a tablet, visitors with moderate central vision are able to read with greater ease and speed because of the ability to adjust the brightness of the written material.

In addition to electronic publishing's embrace of the growing number of digital formats and media, the process makes it very easy to produce variations of a story whether scholarly in nature or for wider appreciation. The evolution of this topic involves thinking about electronic publishing not as a set of products but as a means of delivering resources in new and different ways. Because of the flexibility electronic publishing provides, a growing number of museums are adopting models where they create once and publish everywhere.

A sampling of applications of electronic publishing in museums includes the following:

> **Conservation.** Electronic museum collection catalogs can include more conservation documentation than previously possible in print versions. SFMOMA's Rauschenberg Research Project provides worldwide access to scholarly research and documentation including the back sides of paintings, conservation reports, and informational videos relating to artworks by Robert Rauschenberg in SFMOMA's permanent collection: go.nmc.org/rau.

> **Exhibitions and Collections**. Museum of Fine Arts, Boston brings their instrument collection to life with an e-book for the iPad. Users can see and hear 100 musical instruments of the museum's collection of 1,100, played by musicians in video clips and audio samples. The instruments featured vary from the ancient Greek trumpet and the South Indian lute to the modern American lap steel guitar: go.nmc.org/musical.

> **Marketing and Communications.** The Oakland Museum of California (OMCA) offers a free digital magazine app that is regularly updated with previews of exhibitions and videos of artists and community activists. In addition to museum-specific media, the OMCA app features interactive maps of local sites and parks, and behind-the-scenes images of collections from partner museums: go.nmc.org/omca.

Electronic Publishing in Practice

The following links provide examples of electronic publishing in use in museums:

Catalyst Magazine
go.nmc.org/denmus
The Denver Museum of Nature & Science offers its bi-monthly online publication, *Catalyst*, to museum patrons for free. The electronic magazine includes information on events, programs, and exhibitions that are shareable via Facebook, Twitter, and Pinterest with optimized links for easy web surfing.

College Art Association
go.nmc.org/caa
The Andrew W. Mellon Foundation is sponsoring the College Art Association to develop, publish, and disseminate a code of best practices for fair use in the creation and curation of artworks and scholarly publishing in the visual arts. This will help artists and art historians in securing rights for reproducing works of art electronically or in hard copy.

DallasSITES
go.nmc.org/dmg
The Dallas Museum of Art's digital publication *DallasSITES: A Developing Art Scene, Postwar to Present* traces the development of the contemporary art scene in seven neighborhoods of the city through images, chapter essays, and scholarly pieces. This publication explores the history of over 150 commercial galleries and non-profit organizations in North Texas from the mid-1950s.

Index Magazine
go.nmc.org/harvart
Earlier this year, the Harvard Art Museums launched the digital counterpart to *Index Magazine*, a resource with articles and interviews about their collections. Included on the website are opportunities to interact with museum personnel through events such as "Ask a

Curator Day," wherein several curators answer questions from the public via Twitter.

MetPublications
go.nmc.org/metro
The Metropolitan Museum of Art has launched its collection of MetPublications, which offers access to books, bulletins, and journals from the past five decades in addition to 375 free art books and catalogs. Current books on the market can be previewed through the site, while out-of-print books are made available through print-on-demand.

Played in Britain
go.nmc.org/publ
The Victoria and Albert Museum's "Played in Britain: Modern Theatre in 100 Plays" iPad app guides the viewer through six decades of British theater history with production photographs, original script extracts, and audio clips.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about electronic publishing.

Building an Interpretive Technology Strategy from Zero (Video)
go.nmc.org/ittt
(Koven Smith, *New Media Consortium*, 1 October 2013.) A museum technologist explains how to use the free syndication tool If This Then That to add smart capabilities to a digital publication that make it interactive but self-sufficient.

Create Once, Publish Everywhere — Reusing Museum Collection Content
go.nmc.org/cope
(Paul Rowe, *Collections and their Connections*, 7 June 2013.) A developer for a museum software company describes the content management strategy known as "Create Once, Publish Everywhere," which is currently being implemented by National Public Radio. Rowe applies this strategy to the museum world in an effort to help institutions reuse collection information online.

The Future is Now: Getty Voices Looks Back on OSCI and Towards the Future of Museum Digital Publishing
go.nmc.org/neely
(Liz Neely, *Museum Digital Publishing Bliki*, 14 August 2013.) In this article, the Director of Digital Information and Access at the Art Institute of Chicago highlights the importance of digital publishing based on the perspective of the Getty Foundation's Anne Helmreich. One of her main points is that there must be a community of digital scholarly publishers who contribute to collective knowledge by sharing experiences at conferences and working with developer partners, so that electronic publishing can progress.

The Power of Well-Considered Publishing: Graphite from the IMA
go.nmc.org/graph
(Greg Albers, *Digital Publishing*, 4 April 2013.) Three compelling features of the Indianapolis Museum of Art's GRAPHITE catalog include navigation links at the top of the book, installation shots from the actual physical show to serve as a record of the in-house show, and the ease of watching video within the publication.

The Rise of the Multimedia Authoring Platform
go.nmc.org/multi
(Rich Shivener, *Publisher's Weekly*, 1 February 2013.) Multimedia authoring tools and publishers are making it easier than ever for companies and organizations to produce digital publications that include audio, video, image, animations, and 3D models. The author examines the new generation of publishers including iBooks Author, Vook, and Inkling, and evaluates their approach to this emergent market.

Location-Based Services

Time-to-Adoption Horizon: Two to Three Years

Location-based services (LBS) provide content that is dynamically customized according to the user's location. These services are commonly delivered to mobile devices; cellular tower coordinates are often refined with GPS data to ensure a high level of accuracy in locating mobile devices. New technologies will extend that capability into buildings and interior spaces with remarkable accuracy. Current common applications for location-based services include advertising, news, social networking, and similar services. In the commercial realm, location-based services have become an almost transparent way to generate actions triggered by a user's interest data and matched to his or her location. The next and most compelling development for location-based services is the prospect of indoor geolocation, which could provide visitors with very specific information tailored to their exact location within a building, allowing fine-tuned information or services to be accessed that are very specific to where they are, not only relative to the planet's surface, but in 3D space, so that even different floors of a building can be identified.

Overview

Location-based services digitally pinpoint the precise physical position of an object or individual through WiFi and cellular networks; what makes this topic especially compelling is what the technology does with that information, including mapping efficient routes for travel and making recommendations on museums and exhibits to visit through mobile applications. Because smartphones and tablets automatically include GPS and an array of sensors, LBS enables a frictionless communication stream between people and their locations — a stream that can inform a host of mobile services and applications.

While the category is not entirely new, what has made it a topic of growing interest is its seamless integration with the tools people already commonly use, particularly social networks. Over the past few years, museums have become avid and particularly creative users of social media, making them naturally poised to leverage location-based technologies.

Today, when a user signs up for a new social network, such as Instagram or Facebook, they immediately receive a prompt asking whether the platform has permission to access their current location. In fact, some social networks' entire premise is based on location information. FourSquare, while not new, may be the most well-known example. Over the past several years it has become one of the most enduring applications in the social media space, rewarding users for checking in to places via their mobile devices. Businesses — including museums — have taken a cue from these virtual exchanges and begun giving discounts or special offers to people who tag, check in, or acknowledge the establishment across a plethora of social networks. Location-based services traverse and connect the digital and physical realms more seamlessly than ever before.

When coupled with big data and analytics on people's habits and movements — whether in or outdoors — this same concept can be taken a step further past notions of size and space and onto methods for tailoring the content that is delivered, based on people's interests. The future of location-based services is ultimately less about devices being able to discern where an individual is and more about pushing out helpful information to them before they even ask for it. That is to say, a smartphone knows if its owner has been to several history museums and can use that data to provide recommendations for further exploration.

Apple's recent purchase of two location intelligence startups that specialize in indoor GPS and crowdsourced data, Locationary and WiFiSLAM, signals a new direction for location-based services, with major applications for large museums. Location-based services are now positioned to help people better understand their environments and even contribute their own measurements in an effort to map the entire world, inside and out.

Relevance for Museum Education and Interpretation

Location-based services promise to provide museum visitors with easy access to customized educational experiences. Recently, museums have begun to respond to patrons bringing their own mobile devices by providing free access to WiFi throughout their public spaces. While providing wayfinding and digital interpretive materials on mobile devices through WiFi triangulation is at the core of the latest location-based services advancements, there is further potential to personalize the individual's experience while moving within or around a museum.

Location-based services promise to provide museum visitors with easy access to customized educational experiences.

Although a number of experiments are being conducted with various internal positioning systems such as Bluetooth beacons, locative LED, and active RFID, the development of WiFi triangulation to provide location-based services directly to a user's handheld device is a key strategy. At the Art Institute of Chicago (AIC), the major initiatives of offering reliable connectivity and indoor positioning have ushered in a new way to experience the nearly 150-year-old institution. Over the course of several years, the AIC retrofitted its galleries to provide WiFi in almost all of the public spaces for educational benefit. By carefully planning the placement of WiFi access points, the museum was also able to gauge a visitor's location reliably within a 30-foot radius and guide them to a selected number of artworks with associated digital assets.

The social dimension of location-based services is poised to see substantial growth in the next two to three years within the museum sector. The interplay between social media and physical space through earlier mobile apps like Foursquare and Yelp, and most recently through Locationary and Waze, has initiated a type of engagement where individuals build communities around physical locations. At the deCordova Sculpture Park and Museum, for example, artist Halsey Burgund leveraged the site-specific nature of the sculpture park in her audio installation *Scapes*. Through Roundware, a location sensitive audio platform, museum visitors navigated through the park and encountered sounds in the form of different musical instruments and melodies on their mobile devices. Additionally, visitors were encouraged to engage with the artwork by recording their observations and listening to recordings that other visitors contributed.

Because museums generally have major presences in both online and physical spaces, the increasing ability to accurately pinpoint the location of an individual provides museums with the opportunity to make these two spaces interact more meaningfully than ever before. Under the concept of Geo-fencing, a museum's website would know where a visitor was and would localize information and push it to them. For example, a museum's website would push information to a mobile device about the visiting hours and admission fee if a user was within the vicinity of the institution's entrance, or collections information if he or she was standing directly in front of an artifact.

While many location-based services projects are currently underway, this topic falls on the mid-term horizon mainly because of the costs related to retrofitting galleries with the appropriate technologies and accuracy limitations of current indoor positioning systems.

A sampling of applications of location-based services in museums includes the following:

> **Exhibitions and Collections**. The Timken Museum of Art launched a prototype of a mobile app that serves information about artworks based on visitors' location within the galleries. A PlaceSticker device is assigned to each artwork, sending low-power radio signals to visitors' smartphones and tablets to determine their location and deliver content: go.nmc.org/timken.

> **Marketing and Communications.** With Foursquare now integrated into the Instagram app, museums can use this tool to gather location-based information from geo-tagged photos that visitors share on the platform. By analyzing patrons' behaviors, museums can gain insight into the most popular features of a particular exhibition or event: go.nmc.org/nitro.

> **Visitor Services and Accessibility.** The Royal BC Museum in Canada worked with the company WiFarer to create an app that enables each visitor to personalize their museum exploration based on a map that pinpoints visitors and guides them to preferred artworks and collections. The location-based content adds more in-depth interaction to each exhibit: go.nmc.org/rbc.

Location-Based Services in Practice

The following links provide examples of location-based services in use in museums and other settings:

ByteLight
go.nmc.org/byte
LED light bulbs from the Massachusetts-based company ByteLight send location-specific information to visitors in the Museum of Science, Boston by interacting with their devices' camera, using signals that are invisible to the human eye.

Fernbank Museum App
go.nmc.org/fer
Atlanta's Fernbank Museum of Natural History's app tracks visitors' locations once they enter the museum to deliver a combination of audio, video, touchscreen interactives, animation, sketchbook activities, and question-and-answer challenges, while also encouraging sharing of the experience through social media platforms.

Indoor GPS at AIC
go.nmc.org/indo
The Art Institute of Chicago uses an indoor GPS system powered by Meridian to take visitors on customized tours organized by occasion, theme, collection, and time. Each tour showcases six to ten works of art, with descriptions and turn-by-turn directions.

Kew Gardens App
go.nmc.org/kew
The Royal Botanic Garden, Kew, has developed an Android app that uses GPS and WiFi technology to offer visitors new ways for wayfinding and interpretation. The app guides visitors over 300 acres of outdoor space and through three glass houses, along with offering interactive media about surrounding plants and trees.

Pocket Ranger
go.nmc.org/chal
ParksbyNature Network LLC's "Pocket Ranger" apps invite users to embark on geochallenges, visiting as many of the California state parks and state recreation areas as possible over the next year using their GPS-enabled apps to map out each trip. Participants earn points by visiting state parks and recreation areas, with easy-to-reach parks yielding five points and more distant locales garnering them 20 points.

Wikimedia's Nearby
go.nmc.org/nearby
The Wikimedia Foundation introduced a new "Nearby" page to operate in conjunction with its mobile site, surfacing articles based on a user's location. It is also an easy way for Wikimedia editors to upload photo content for entries that are in need of images or improve articles on topics in close proximity.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about location-based services:

Baseball's Beacon Trials Hint at Apple's Location Revolution
go.nmc.org/ibe
(Roger Cheng, *CNet*, 28 September 2013.) A new feature

of iOS 7, iBeacon, improves the capability of location-based services for the iPhone. MLB.com recently tested its capabilities at Citi Field where visitors received a welcome message and discounts as they entered the premises.

History as an App(arition)
go.nmc.org/hist
(Rhodri Marsden, *ioL travel*, 15 August 2013.) The City of York Hologram Tour is an app backed by the York City Council that displays holograms of actors in costume explaining specific York locations when the visitor arrives at each point. The author of this article describes the experience of using the app, and how it could be amplified in the future when users are able to access it with Google Glass or other wearable devices.

Location Based Guidance Services in a Museum Environment: Deployment Issues and a Proposed Architectural Approach
go.nmc.org/guid
(Nikolaos Konstantinou et al., *Academia.edu*, accessed 1 October 2013.) This paper examines the requirements for deploying location-based guidance services in museums that can react to contextual triggers. This service is built as an open, modular platform with reusable components and interfaces for supporting different types of devices, including Java- and Bluetooth-enabled smartphones.

Mapping and Location-Based Geo Services
go.nmc.org/geo
(Yu-Tzu Chiu, *IEEE Spectrum*, 20 November 2012.) Engineers from STMicroelectronics and CSR modified a Google Nexus One smartphone to integrate an indoor navigation module for visitors to the Museum of Contemporary Art in Taipei. As a visitor approaches an object, its corresponding icon pops up on their device's screen so they can click on it for more information.

This Startup's Cheap Sensors Could Create an OS for Everyday Life
go.nmc.org/star
(Kyle Vanhemert, *WIRED*, 7 August 2013.) Estimote is an attempt to build an operating system for the physical world out of a network of cheap, low-energy transmitters. The creators envision seamless location awareness that will allow interactions and experiences that are tightly integrated with real places, from parks to parking lots.

Why Wifi Networks are the Future of Location-Based Mobile
go.nmc.org/meri
(Nick Farina, nfarina.com, May 2013.) The company Meridian helped the American Museum of Natural History build its "AMNH Explorer" app, which uses a device's WiFi signal to calculate the visitor's position within the museum. The author believes that WiFi is the key to the advancement of location-based services, specifically indoor GPS.

Natural User Interfaces

Time-to-Adoption Horizon: Four to Five Years

It is already common to interact with devices entirely by using natural movements and gestures. The iPad, iPhone and iPod Touch, Xbox Kinect, Nintendo Wii, the new class of "smart TVs," and a host of other devices built with natural user interfaces (NUIs) accept input in the form of taps, swipes, and other ways of touching; hand and arm motions; body movement; and increasingly, natural language. These are the first in a growing array of devices that recognize and interpret natural physical gestures as a means of control. New technologies already extend these capabilities, and even read the emotional state of the user via voice and micro-expressions of the face. Already in prototype are new forms of screen technologies that will convey highly detailed sensations of texture, and provide natural tactile feedback. What makes natural user interfaces especially interesting this year is the burgeoning high fidelity of systems that understand gestures, facial expressions, and their nuances, as well as the convergence of gesture-sensing technology with voice recognition and new forms of tactile feedback like electrovibration, which allows users to interact in an almost natural fashion, with gesture, expression, and voice communicating their intentions to devices.

Overview

Although natural user interfaces were largely popularized with the launch of the iPhone and its touchscreen in 2007, the technology itself was not new at the time. Discussions around the development of interfaces beyond command line interface (CLI) and graphical user interface (GUI) started in the 1970s and 80s when Steve Mann, widely regarded as the father of wearable computing, began experimenting with human-machine interactions. From his work, the idea of natural user interfaces was born, along with the potential for scientists and designers to adapt this innovation to new technologies. Perhaps more so than other learning environments, museum spaces are naturally conducive to incorporating large-scale NUIs into exhibits and collections.

Humans interacting with computers in a natural user interface are not always conscious of the framework because their gestures seamlessly influence their experience, mimicking the real world far more than an interface based on metaphors like commands and graphics. The appeal of this innovation is that a museum patron can experience information presented in a variety of modes without the distance that traditional interfaces impose; in other words, nothing gets in the way between the user and the information. Visitors have the opportunity to truly interact with the artworks.

These types of NUIs can have profound effects on learners within the museum realm. For example, children using multi-touch walls and displays adapt to the mechanism quite naturally, which has increased support for using smartphones, tablets, and Microsoft Kinect for learning. Natural user interfaces also cater to blind and deaf patrons, along with people with autism, dyslexia, or other disabilities, making it easier for the user to communicate and learn through touch, voice, and other gestures.

While touchscreens and video and motion sensor products, including Nintendo Wii and Microsoft Kinect, have now been around for years, they have been critical benchmarks in the path to fostering completely natural interactions. Electrovibration is the next step in making the connections as authentic as possible. First discovered in 1954, this technology refers to the process when a finger is dragged across a conductive, insulated surface, creating an electrostatic force that results in a palpable sensation of touch and texture. Applied

to mobile devices, the phenomenon of electrically induced tactile sensation is expected to herald the next evolution of touchscreen technology, offering the potential to feel the museum works being viewed.

Finnish company Senseg is at the forefront of applying this haptic technology to smartphone and tablets, and Disney Research is also exploring electrovibration. Senseg's electrovibration technology can be applied to any touch interface to create what they call "feel screens," where users can feel textures on the screen. The future of "feel screen"-enhanced devices offers many possibilities for deeper interaction with educational content, and with it an accessibility that caters to users with physical and mental disabilities — making it a particularly exciting technology for museums.

Speech-to-speech translation is also adding more traction around the topic of natural user interfaces. It is already common to see people interacting with voice-activated virtual assistants on their mobile devices. The next steps include new technologies like automatic translation engines — Microsoft engineers have already demoed software that can synthesize an individual's voice in another language, from English to Mandarin. Progress in these machine learning technologies points to a world where people can connect to content — and each other — more effectively.

Relevance for Museum Education and Interpretation

Natural user interfaces render technology transparent and are transforming the way museums can present their collections and exhibitions, as well as the way visitors interact with museums and their content. The desire to touch and manipulate collections is inherent in museum audiences, and although preservation and conservation issues may limit interactions with the authentic work, NUIs can compensate by allowing the visitor the experience of tactile contact or the ability to rotate an object in space. As new user interfaces become increasingly mainstream, museums have the opportunity to use these sorts of developments to create entirely new forms of interpretation and presentation.

Measuring 40 feet wide, the Collection Wall at the Cleveland Museum of Art is the largest multi-touchscreen in the United States, and it stands at the leading edge of thinking about how visitors can interact with a museum's collection in a fundamentally different way. Multi-touch technology enables patrons to move, select, and sort multimedia assets for open-ended exploration in a very intuitive manner. The Collection Wall demonstrates this at a scale never before seen in a museum space.

In addition to multi-touch technology, motion-sensing input devices are radically transforming how museum guests engage with collections. At the New Mexico Museum of Art, marionettes once considered too fragile to even be exhibited are given a new life. After creating digital surrogates of selected marionettes from the museum's collection, students from New Mexico Highlands University are using Kinect to enable visitors to use natural hand gestures to see how these objects function, for the first time in decades.

Yet another dimension of NUIs is beginning to play out in the gallery itself, as artists push the boundaries of this new set of tools to create large-scale immersive environments. In the summer of 2013, the Museum of Modern Art presented the Rain Room, an art installation where visitors could stop simulated rain drops from falling on them by moving about a room outfitted with sensors that recognized the presence of objects and movement.

Emerging sensing technologies, like the electrovibration project headed by Disney Research, could open up a whole new world of interpretation with the ability to understand the rich spatial dimensionality of an object through digital means without having to worry about damaging a fragile object. By generating the simulations of edges, protrusions, and bumps through frictional forces between finger and screen, museum visitors will be able to experience the heavily impastoed surface of a Van Gogh work in an entirely new way.

Discovery-based learning opportunities for museums are steadily increasing since this technology first appeared in the *NMC Horizon Report: 2012 Museum*

Edition, where it was also in the far-term horizon. Despite many experiments, NUIs are still four to five years away because few museums have the in-house skills to develop this kind of technology for educational purposes. Nonetheless, the future for natural user interfaces is promising as special exhibitions begin to build museums' inventories of devices, along with the expertise to use NUIs in more imaginative ways.

A sampling of applications of natural user interfaces in museums and other settings includes the following:

> **Exhibitions and Collections.** The "Spotlight on The Antinoe Veil" exhibition at the Louvre uses Microsoft Kinect's gesture-based sensor technology that enables visitors to interact with an ancient artifact. The Greek tapestry, which is delicate and difficult to decipher, can now be manipulated by museum patrons in its digital form: go.nmc.org/louvre.

> **Marketing and Communications.** The Children's Medical Center in Dallas has an Interactive Donor Wall where each supporter's name is represented in a bubble that users can manipulate with their gestures: go.nmc.org/dono.

> **Visitor Services and Accessibility.** The Manchester Museum developed a way to let blind and partially sighted visitors touch digital models of their exhibits, using a haptic device called a Probos. Visitors sit in front of a device with a screen and a stylus connected via a mechanical arm and the screen displays a 3D model of an object such as a pot, bone, or statue: go.nmc.org/fee.

Natural User Interfaces in Practice

The following links provide examples of natural user interfaces in use in museums and other settings:

3D Bird Animation and Gesture Recognition
go.nmc.org/nati
Unified Field built the "Dance, Dance Evolution" game for National Geographic's "Birds of Paradise" exhibit using a Kinect sensor to allow players to enact movements that control a virtual 3D bird as it performs real mating dance rituals.

The Baumann Marionettes Go 3D
go.nmc.org/mari
Highlands University programming students are using Kinect to create 3D representations of around 75 of Gustave Baumann's marionettes that are owned by the New Mexico Museum of Art. Users will be able to virtually manipulate the marionettes through hand gestures, and the 3D marionette models will also be available in the museum's online database.

Nocturnal Animal Senses
go.nmc.org/natu
The "Nocturnal Animal Senses" exhibit at the Natural Science Museum Complex in Romania demonstrates to visitors how animals thrive at night. The installation is composed of various screens of all sizes that, when touched, reveal information about an animal's environment, hunting habits, and how they navigate in darkness.

Shop Life
go.nmc.org/shoplife
In New York City, the Tenement Museum's "Shop Life" installation is a 25-foot interactive tabletop that provides visitors with the opportunity to explore three immigrant business scenarios from the 1860s to the 1970s. Stories are shared through images, video, and audio.

Sports Hall
go.nmc.org/pero
"Sports Hall," an exhibit at Perot Museum, invites visitors to throw a fastball, kick a soccer ball, or turn cartwheels while a high-speed camera captures it so visitors can review their own movements to learn about motion, how body positioning affects speed, and other factors of sports science.

THINK
go.nmc.org/thinkex
With the aid of a media field of seven-foot interactive touchscreens, the "THINK" exhibit at Schenectady Museum presents visitors with a hands-on way to view the history of technological innovations. The technology behind the exhibit is powered by IBM.

Universe of Sound
go.nmc.org/univ
The "Universe of Sound" installation at the London Science Museum incorporates video rooms, instruments, and pods with 3D motion sensors to create an immersive experience in which visitors learn what it takes to be a musician as well as how to be a conductor in a philharmonic orchestra.

Wearing Many Hats (Video)
go.nmc.org/hats
At The Peabody Essex Museum in Massachusetts, an interactive station called "Wearing Many Hats" encourages visitors to explore generations of hat design. Using touchscreens to capture photos of themselves, visitors scroll through various hats until they find one they like. They can then email or print the photo of themselves wearing the virtual hat.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about natural user interfaces.

5 Lessons In UI Design, from a Breakthrough Museum
go.nmc.org/bre
(Cliff Kuang, *Fast Company*, 6 March 2013.) The Cleveland Museum of Art unveiled a series of revamped galleries to connect visitors with art in a way that emphasizes the content without letting the technology overshadow it. For example, a virtual easel sits in front of a Jackson Pollock painting, loaded with tools that approximate Pollock's own, so visitors can create their own drip painting and compare it to the real thing.

How Helsinki-Based Startup Senseg Creates Touchscreens You Can Feel
go.nmc.org/helsin
(Stephen Kelly, *WIRED*, 11 April 13.) Finnish company Senseg has produced a thin durable material that uses an ultra-low electrical current to create an attractive force that allows the user to feel textures, edges, and vibrations. They plan to "haptify" the whole user interface for smartphones and tablet prototypes.

Leap Motion: 1 Million App Downloads in 3 Weeks
go.nmc.org/leapmo
(John Koetsier, *VentureBeat*, 12 August 2013.) Leap Motion created a keyboard-free computer controller that is 200 times more accurate than the Microsoft Kinect, and allows users to control their computers with midair gestures. Three weeks after their launch, Leap Motion saw over one million downloads of its apps and 25,000 downloads of their software development kit.

Lighting Solutions React to Become More Personal
go.nmc.org/light
(*PSFK*, 22 September 2013.) Richmond Park in London installed a LumiMotion lighting system that is able to detect when a person approaches a light at night and increases brightness accordingly. After the person passes, the lights decrease in intensity to save energy.

Medical Museum Seeks Bucks for Touch Screen Walls, Other High-Tech Goodies
go.nmc.org/doyle
(Lizzie Schiffman, *DNAinfo Chicago*, 8 April 2013.) A computer scientist and museum professional is working on a prototype for a "museum without walls" at the National Museum of Health and Medicine that will inform the construction of a satellite institution in Chicago. For the new space, he envisions floor-to-ceiling interactive screens that can be customized according to the installation or event.

New Disney Technology Can Add Texture to Completely Smooth Touchscreen
go.nmc.org/distech
(PBS, 7 October 2013.) Disney researchers in Pittsburgh have applied electrovibration to smooth touchscreens, resulting in a textured sensation that mimics ridges, depths, and other three dimensional experiences. The new technology also leverages research on how the brain is fooled into perceiving bumps by the stretching of the skin on the fingertip.

Preservation and Conservation Technologies

Time-to-Adoption Horizon: Four to Five Years

As long as there have been museums, their mission has been to preserve and conserve our collective cultural heritage. Preservation refers to the protection of important objects, artifacts, and documents; conservation is the science of maintaining objects in as close to their original form as possible. For both actions, there is a need to ensure that the processes are reversible so that future generations can undo the work or make revisions. As technology evolves, archivists and conservators have encountered a steady stream of new challenges in both of these tasks. Digital objects can be as delicate as ancient objects, requiring special care, and changing technologies put these digital items at great risk. Cultural works that are time-based add a level of complexity in the quest for preservation, due to the added consideration of the artist's intent, context, or movement. Understanding and preserving how media is intended to be experienced while maintaining the integrity of its cultural identity encompasses a number of considerations such as conservation ethics, legal agreements, availability of mechanical and/or digital materials, and historical scholarship. While large museums have long employed specialists in artifact preservation, today new professionals are needed who understand digital and time-based media, and can address preservation and conservation challenges not only from physical, but artistic, cultural, engineering, electronic, and other multi-disciplinary perspectives.

Overview

Although the terms preservation and conservation are often used interchangeably, they are distinct in their purposes; preservation is meant to protect and/or retard the natural disintegrative properties of artifacts, and the act of conservation is intended to stabilize and restore artifacts in so far as that is possible. When practiced concurrently, they future-proof both physical and digital media, while keeping the original meaning behind the objects intact. Preservation and conservation technologies appear here on the far-term horizon, but they are not new topics for educational and cultural institutions. The position of these intertwined topics is an acknowledgement of the challenges involved in protecting and restoring an exponentially increasing number of artifacts — whether analog, digitally native, or time-based in format.

Aside from maintaining the physical state of this media, a major concern is ensuring that the process of the conservation does not eclipse the meaning behind it.

Over the past several decades, a number of key organizations have developed models and standards that continue to shape the practices of preservation. In 1994, the Research Libraries Group and the Commission on Preservation and Access formed the Task Force on Archiving of Digital Information, which ultimately developed a national system of digital archives for long-term storage, and were the first to present digital repositories as part of the solution. To standardize the practice of preservation, they created the Open Archival Information System, a landmark method for authenticating digital documents and objects, which the Online Computer Library Center built upon after the millennium. This framework encompasses the technical aspects of the workflow, from the ingesting of digital

objects to data management and access, along with recommending five types of metadata to accompany each object: reference information, provenance, context, fixity, and representation.

In the museum realm, digital preservation calls for a new type of staff member with skills that span hardware technologies, file structures and formats, storage media, electronic processors and chips, and more, blending the training of an electrical engineer with the skills of an inventor and a computer scientist. Decoding content and recovering material from devices or storage media that may not have been used for decades requires equipment and knowledge that few museums have, outside those specializing in computer technology.

Museums are entering an era where the number of digital artifacts is quickly surpassing that of physical objects within a museum.

While preservation has largely been an ongoing pursuit for archivists, scientists, and libraries, the act of conservation is perhaps most needed in the museum sector, where millions of physical artworks demand constant attention from staff to remain stable and displayable. Furthermore, art installations that incorporate audio, video, moving elements, or require human interactions have added another layer of complexity, blending the physical with the digital. Aside from maintaining the physical state of this media, a major concern is ensuring that the process of the conservation does not eclipse the meaning behind it. This raises the need for curators to consult with the artists, or review the records of deceased artists to make sure that the original intent is interpreted as closely as possible.

Museums across the world also have large collections of electronic media objects, each representing unique challenges from a preservation and conservation standpoint, including antiquated operating systems, hardware, and computer programs. Both optical and magnetic storage fade over time, corrupting once-readable data merely through the passage of time. Furthermore, these challenges still do not address the issues of file formats and run-time use of the files, once they can be accessed via the appropriate hardware. While future technologies cannot be fully foreseen, the fact that conversations about preservation and conservation are increasingly taking place is an indication that they are poised to become better understood and executed over the next four to five years.

Relevance for Museum Education and Interpretation

Museums are entering an era where the number of digital artifacts is quickly surpassing that of physical objects within a museum. Objects created with outdated technologies are at risk of being estranged from the creator's original intent. Although preservation and conservation are of critical importance to the health and educational importance of museum collections, understanding the specific strategies and technologies needed to remedy these issues in museums and the amount of staff trained to address them is an evolving challenge.

University library programs are pioneering the new field of digital curation, and helping to train a generation of future museum staff to address preserving and restoring the most problematic time-based and digital materials. In addition to developing an understanding of archival theory and metadata standards, students are working directly with contemporary artists to determine the best ways to preserve the integrity of artworks for generations to come.

The conservation of time-based media poses a particular challenge for art museums because these objects often consist of special mechanical components or use technologies or formats that are obsolete, combined with a specific intention. For example, deceased video installation artist and sculptor Nam June Paik was best known for creating artworks using cathode ray tube monitors and analog television signals. The continued maintenance and presentation of Paik's artworks have

required museum conservators and preparators to make decisions on how to present them, which often requires deviating from his intent — directly affecting the interpretation of his objects.

While museums have been slow to take up formal strategies and policies for securing and repairing their digital and time-based collections from deterioration, archives and libraries are hard at work on possible technological solutions. Currently the Library of Congress is conducting research on historic sound recordings that have been damaged or are deteriorating. This investigation inspired recent MacArthur Fellow and audio preservationist Carl Haber to create a system using high gigapixel images and specialized image processing to calculate the sound that an analog record would make. In 2012 the cultural significance of his work was highlighted as his technique enabled individuals to hear Alexander Graham Bell's voice for the very first time.

The introduction of preservation and conservation technologies in the *NMC Horizon Report* is significant because it shows that museums are becoming more broadly aware that they are facing major problems in the imminent future if the intricacies of the topic are not more widely understood and acted upon in the field. There are few known initiatives to serve as best practice models for conservation and preservation efforts; however, this topic's placement in the far-term horizon reflects an increased focus from museums.

A sampling of applications for preservation and conservation technologies in museums includes the following:

> **Exhibitions and Collections.** The Dallas Museum of Art is opening its new Paintings Conservation Studio as part of the museum's initiative to establish a more comprehensive in-house conservation program. The Paintings Conservation Studio features state-of-the-art technology — including a digital x-ray system — and will serve as a center for study and treatment of works of art as well as research into cutting-edge conservation methodologies. Visitors will be able to see into the studio through a glass wall to observe the daily activity: go.nmc.org/pai.

> **Marketing and Communications.** Museum blogs are increasingly featuring content from conservation departments as a way to provide behind-the-scenes access to rarely seen activities. The British Museum's blog features scientific images and a YouTube video about the work being done to conserve and display the Beau Street Hoard, a collection of Roman coins: go.nmc.org/beau.

> **Visitor Services and Accessibility.** A media archiving project called XFR STN at the New Museum of Contemporary Art is digitizing and disseminating digitally-native materials whose formats have become obsolete in a publically operating exhibition on archive.org, an Internet library offering permanent access for a variety of audiences, including people with disabilities: go.nmc.org/newm.

Preservation and Conservation Technologies in Practice

The following links provide examples of preservation and conservation technologies in use that have direct implications for museums:

Australia's Oldest Culture Enters the Digital Age
go.nmc.org/samuseum
Remote Aboriginal communities will have access to documented family histories, photos, and artifacts dating back to 1830 as the South Australian Museum digitizes the largest collection of its kind in the world. Some items in the collection will be made available internationally, while other sections will be restricted to ensure their cultural sensitivity.

CHIN's Digital Preservation Toolkit
go.nmc.org/chi
The Canadian Heritage Information Network (CHIN) recently conducted a survey among their members to identify digital preservation issues facing museums, and will soon release its Digital Preservation Toolkit, a suite of documents that offer concrete steps to identify the potential risk and impact of lost material and how to get started in the development of preservation policies, plans, and procedures.

High-Resolution Digital Slides of Einstein's Brain
go.nmc.org/ape
Aperio ePathology has digitized over 550 slides of Einstein's brain that were originally donated to the National Museum of Health and Medicine in Maryland. This will enable researchers, scientists, and enthusiasts around the world to view the original slides prepared by Dr. Thomas Harvey, the pathologist who conducted the autopsy of Albert Einstein in 1955.

Media Conservation Lab at the Guggenheim
go.nmc.org/gug
The Guggenheim launched a Media Conservation Lab to assess and monitor the image and sound content of time-based media works that include video, film, slide, audio or computer-based technologies and therefore have duration as a dimension.

Robot Helps Restore Works
go.nmc.org/rest
A robot in Madrid's Reina Sofia Museum scans artworks by snapping photos that reveal cracks, scratches, creases, underlying preparatory sketches, and all subsequent touch-ups that would be otherwise undetectable to the human eye. The robot can be controlled by a computer from a remote location and work around the clock.

Time-Based Media Conservation at Tate
go.nmc.org/tat
Tate's time-based media department is responsible for a number of conservation activities including documenting artist intention via interviews, along with planning and preparing for future obsolescence of the technologies incorporated in each work.

Walters Art Museum Manuscript Collection at Stanford
go.nmc.org/walt
Walters Art Museum and Stanford University Libraries are working together to preserve more than 100,000 high-resolution images of unique medieval manuscripts in a format that allows scholars to use digital handling tools to analyze the manuscripts.

Wolfsonian Museum Goes Digital
go.nmc.org/wol
In order to make online catalog searches productive, the Wolfsonian Museum in Florida has undertaken the process of photographing the museum's more than 120,000 objects and entering in accompanying data, including the name of the artist or manufacturer, the year and place of origin, and the original media from which it was created.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about preservation and conservation technologies:

Best of Both Worlds (PDF)
go.nmc.org/smin
(G. Wayne Clough, Smithsonian Institution, 2013.) The Smithsonian Institution's free 77-page e-book covers their process of digitizing over 14 million objects from their massive collections. The author illuminates how museums are challenged to evolve with the digital age despite the high cost of digitizing collections.

Conservation and Digital Imaging - Part 1
go.nmc.org/osulab
(Amy McCroy, *University Libraries*, 18 June 2013.) Conservators at The Digital Imaging Unit of the OSU Libraries provide an inside look at what processes are involved in the repair, stabilization, and eventual digitization of books, manuscripts, and artifacts of cultural heritage. Every piece that is digitized is stored in OSU's Knowledge Bank where it can be accessed online.

Science Benefits Art Preservation
go.nmc.org/ben
(Greg Flakus, *Voice of America*, 30 September 2013.) A painting found in someone's attic in Europe was established to be a newly discovered work by Vincent Van Gogh after paint samples were taken from other Van Gogh artworks, and imaging tests were used to compare threads in the canvases.

Towards a Digital Preservation Policy for Museums
go.nmc.org/digsig
(Madeline Sheldon, *The Signal*, 13 June 2013.) A museum researcher describes the current climate of digital preservation as a field in its nascent stage for cultural institutions, with libraries and archives at the forefront of digital preservation planning. She points to time-based media preservation initiatives by Rhizome, the Guggenheim, and Tate that are shaping the strategies other museums can refer to when planning their own preservation policies.

When Artworks Crash: Restorers Face Digital Test
go.nmc.org/digart
(Melena Ryzik, *The New York Times*, 9 June 2013.) When the Whitney Museum of American Art acquired one of the first Internet-made artworks, a piece called "The World's First Collaborative Sentence," conservators were faced with the conceptual debate of how to maintain the work's integrity although its medium — code from the 1990s — was obsolete. Cultural institutions will have to develop specialists in this area as new, digital artworks continue to emerge.

When Homework is Real Work: Digital Curation Students Help Preserve Media Art
go.nmc.org/cur
(Jon Ippolito, *Still Water Blog*, 18 August 2013.) Students in the University of Maine's Digital Curation program are learning how to use free online tools such as Variable Media Questionnaire to record opinions of artists about how to conserve creative works when their current mediums become obsolete. This tool is already in use by the Guggenheim and Whitney, as well as archives including the Langlois Foundation and Rhizome.org.

University library programs are pioneering the new field of digital curation, and helping to train a generation of future museum staff to address preserving and restoring the most problematic time-based and digital materials.

The NMC Horizon Project

This report is part of a longitudinal research study of emerging technologies that began in March 2002. Since that time, under the banner of the Horizon Project, the NMC and its research partners have held an ongoing series of conversations and dialogs with its advisory boards — a group that now numbers over 850 technology professionals, campus technologists, faculty leaders from colleges and universities, museum professionals, teachers and other school professionals, and representatives of leading corporations from all over the world. For more than a decade, these conversations have been mined to provide the insights on emerging technology that are published annually in the *NMC Horizon Report* series.

The NMC Horizon Project is currently in its eleventh year, dedicated to charting the landscape of emerging technologies for teaching, learning, and creative inquiry in education globally.

The NMC Horizon Project is currently in its eleventh year, dedicated to charting the landscape of emerging technologies for teaching, learning, and creative inquiry in education globally. In 2008, the NMC added to the three main *NMC Horizon Reports* a new series of regional and sector-based studies, called the *NMC Technology Outlooks,* with the dual goals of understanding how technology is being absorbed using a smaller lens, and also noting the contrasts between technology use in one area compared to another.

To date, the NMC has conducted studies of technology uptake in Australia, New Zealand, the UK, Latin America, Brazil, Singapore, and Norway, and has extended that research to Europe. In 2012, the *Technology Outlook* series was expanded to include sector analyses, and so far has documented technology uptake across STEM+ education and community, technical, and junior colleges.

The 44 members of this year's advisory board were purposefully chosen to represent a broad spectrum of the museum sector; key writers, thinkers, technologists, and futurists from museums, education, business, and industry rounded out the group. They engaged in a comprehensive review and analysis of research, articles, papers, blogs, and interviews, discussed existing applications, and brainstormed new ones, and ultimately ranked the items on the list of candidate technologies for their potential relevance to museum education and interpretation. This work took place entirely online and may be reviewed on the project wiki at museum.wiki.nmc.org.

The effort to produce the *NMC Horizon Report: 2013 Museum Edition* began in August 2013, and concluded when the report was released in November 2013, a period of just over three months. The six technologies and applications that emerged at the top of the final rankings — two per adoption horizon — are detailed in the preceding chapters.

Each of those chapters includes detailed descriptions, links to active demonstration projects, and a wide array of additional resources related to the six profiled technologies. Those profiles are the heart of the *NMC*

Horizon Report: 2013 Museum Edition, and will fuel the work of the NMC Horizon Project throughout the year. To share your educational technology projects with the NMC to potentially be featured in a future *NMC Horizon Report*, the NMC Horizon Project Navigator database, or the NMC Horizon EdTech Weekly App, visit go.nmc.org/projects. For those wanting to know more about the processes used to generate the *NMC Horizon Report* series, many of which are ongoing and extend the work in the reports, we refer you to the report's final section on the research methodology.

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Methodology

The process used to research and create the *NMC Horizon Report: 2013 Museum Edition* is very much rooted in the methods used across all the research conducted within the NMC Horizon Project. All editions in the *NMC Horizon Report* series are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned advisory board that first considers a broad set of important emerging technologies, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected.

Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition.

This process takes place online, where it is captured and placed in the NMC Horizon Project wiki. The wiki is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions.

The section of the wiki used for the *NMC Horizon Report: 2013 Museum Edition* can be found at museum.wiki.nmc.org.

The procedure for selecting the topics in the report included a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and began with the assembly of the advisory board. The advisory board represents a wide range of backgrounds, nationalities, and interests, yet each member brings a particularly relevant expertise. Over the decade of the NMC Horizon Project research, more than 850 internationally recognized practitioners and experts have participated on project advisory boards; in any given year, a third of advisory board members are new, ensuring a flow of fresh perspectives each year. Nominations to serve on the advisory board are encouraged — see go.nmc.org/horizon-nominate.

Once the advisory board for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Advisory board members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic in this edition is its potential relevance to museum education and interpretation. A carefully selected set of RSS feeds from hundreds of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

Following the review of the literature, the advisory board engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions were designed to elicit

a comprehensive listing of interesting technologies, challenges, and trends from the advisory board:

1 Which of the key technologies catalogued in the NMC Horizon Project Listing will be most important to museum education and interpretation within the next five years?

2 What key technologies are missing from our list? Consider these related questions:

- **What would you list among the established technologies that some institutions are using today that arguably *all* museums should be using broadly to support or enhance museum education and interpretation?**
- **What technologies that have a solid user base in consumer, entertainment, or other industries should museums be actively looking for ways to apply?**
- **What are the key emerging technologies you see developing to the point that museums should begin to take notice during the next four to five years?**

3 What do you see as the key challenges related to education and interpretation that museums will face during the next five years?

4 What trends do you expect will have a significant impact on the ways in which museums use technologies in the service of mission-mandated goals related to education and interpretation?

One of the advisory board's most important tasks is to answer these questions as systematically and broadly as possible, so as to ensure that the range of relevant topics is considered. Once this work is done, a process that moves quickly over just a few days, the advisory board moves to a unique consensus-building process based on an iterative Delphi-based methodology.

In the first step of this approach, the responses to the research questions are systematically ranked and placed into adoption horizons by each advisory board member using a multi-vote system that allows members to weight their selections. Each member is asked to also identify the timeframe during which they feel the technology would enter mainstream use — defined for the purpose of the project as about 20% of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly apparent.

From the comprehensive list of technologies originally considered for any report, the 12 that emerge at the top of the initial ranking process — four per adoption horizon — are further researched and expanded. Once this "Short List" is identified, the group, working with both NMC staff and practitioners in the field, begins to explore the ways in which these twelve important technologies might be used for museum education and interpretation. A significant amount of time is spent researching real and potential applications for each of the areas that would be of interest to practitioners.

For every edition, when that work is done, each of these twelve "Short List" items is written up in the format of the *NMC Horizon Report*. With the benefit of the full picture of how the topic will look in the report, the "Short List" is then ranked yet again, this time in reverse. The six technologies and applications that emerge are those detailed in the *NMC Horizon Report*.

For additional detail on the project methodology or to review the actual instrumentation, the ranking, and the interim products behind the report, please visit museum.wiki.nmc.org.

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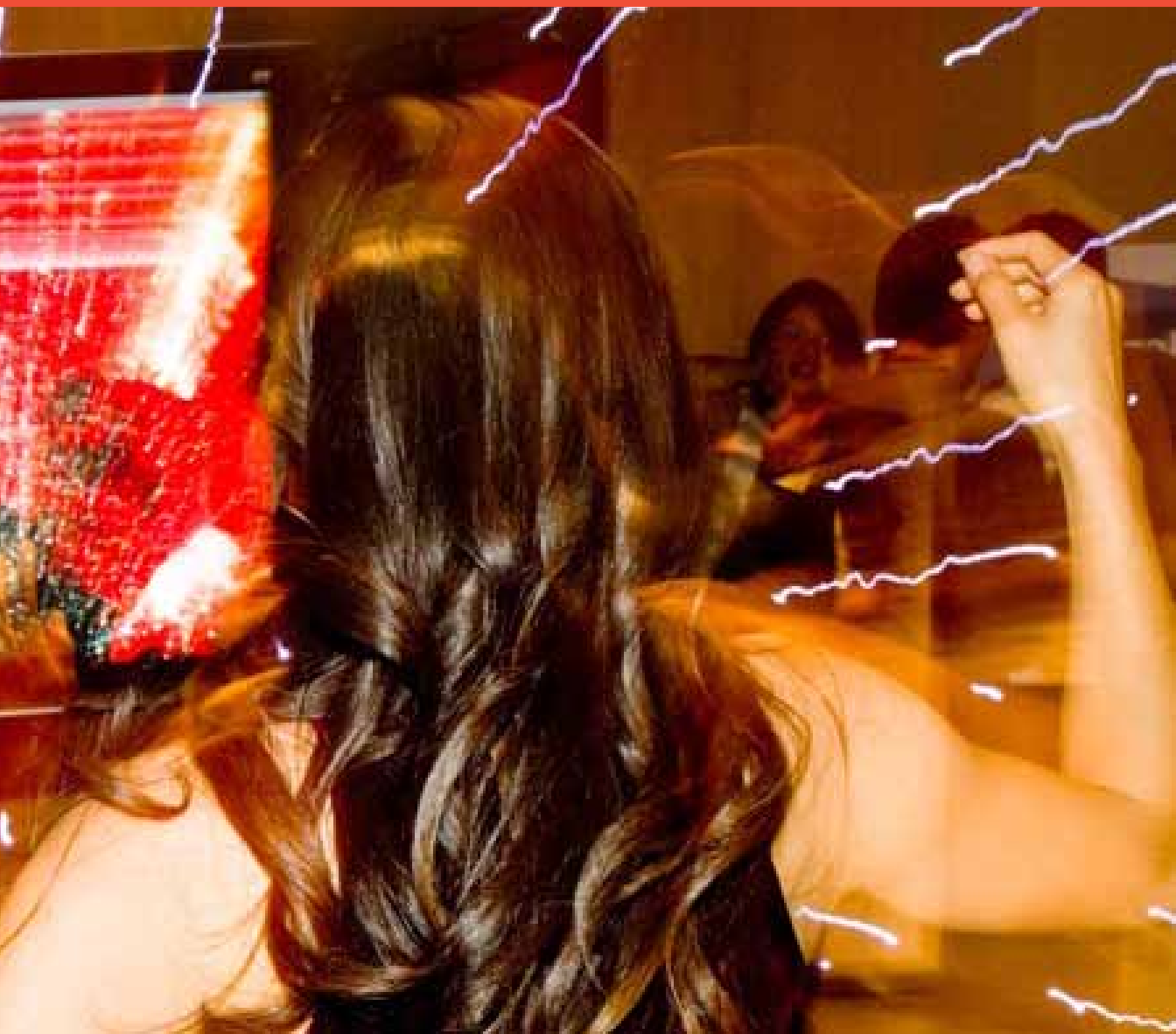

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