NMC

Horizon Report > 2012 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. This volume, the *NMC Horizon Report: 2012 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: 2012 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.

ISBN 978-0-9883762-4-3

Citation

Johnson, L., Adams Becker, S., Witchey, H., Cummins, M., Estrada V., Freeman, A., and Ludgate, H., (2012). *The NMC Horizon Report: 2012 Museum Edition*. Austin, Texas: The New Media Consortium.

Cover photograph

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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 coming five years in education around the globe. This volume, the *NMC Horizon Report: 2012 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: 2012 Museum Edition* is the third in an annual series of museum-focused reports co-produced by the NMC and the Marcus Institute for Digital Education in the Arts (MIDEA).

To create the report, an international body of experts in museums, education, technology, and other fields was convened as an advisory board. 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 influential technologies for the report. This dialog was enriched by a diverse 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. The interactions and discussions among the advisory board are the focus of the *NMC Horizon Report* research, and this report details the areas in which these experts were in strong agreement.

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 with their focus sectors within three adoption horizons over the next five years. Key trends and challenges that will affect current practice over the same period frame these discussions. Over the course of just a few weeks in the fall of 2012, the advisory board came to a consensus about the six topics that appear here in the *NMC Horizon Report: 2012 Museum Edition.* The examples and readings under each topic area are meant to provide practical models as well as access to more detailed information. The precise research methodology employed is detailed in the closing section of this report.

The six technologies featured in the *NMC Horizon Report: 2012 Museum Edition* are placed within three adoption horizons that indicate likely timeframes for their entrance into mainstream use.

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 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 within museums are also 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 — the NMC Horizon Project Navigator (navigator.nmc.org) — and in the NMC Horizon EdTech Weekly App for the iPhone and iPad (go.nmc.org/app). All the background materials for the *NMC Horizon Report: 2012 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).

Technologies to Watch

The six technologies featured in the *NMC Horizon Report: 2012 Museum Edition* are placed within three adoption horizons that indicate likely timeframes for their entrance into mainstream use for museum professionals working in museum education and digital 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 around the world, and the projects we showcase here carry the promise of wider impact and adoption.

Near-term Horizon

On the near-term horizon — that is, within the next 12 months — are two categories that are changing the way museums interact with their patrons and global community: *mobile apps* and *social media*. These two sets of technologies have become prevalent parts of everyday life in much of the world, and are used ubiquitously. As a result, visitors expect to be able to access information about collections wherever they are through their mobile devices and increasingly, museums are making that possible via mobile apps and social media channels.

> **Mobile apps** pervade our everyday lives in communication, information, education and entertainment. Always-connected Internet devices that make use of broadband cellular networks, embedded sensors, cameras, and GPS have inspired thousands of applications. In contrast to desktop applications that have several features bundled, mobile apps generally do one thing, or a small list of tightly related things, extraordinarily well. The most effective apps are tightly integrated with the capabilities of the device itself, using location data, motion detection, gestures, access to social networks, and web search, to seamlessly create a full-featured experience. The potential of mobile applications is vast for museums, and can range from educating the general public with rich content about specific exhibitions to helping visitors conceptualize and contextualize cultural artifacts and objects within the museum. Whether visitors are choosing to bring their own device or museums are providing mobiles for their patrons, mobile apps supply users with serendipitous moments of discovery wherever they happen to be.

> **Social media** began with specialized online platforms used to store, aggregate, and share images and video within online communities, but has evolved to be a component of virtually every major social networking service. Videos, images, audio, and news can be easily pushed out from the point of capture to a wide range of social media platforms. Users can interact with content by sharing, tagging, commenting on, and producing their own, or they can interact with each other and the institutions that provide the content. Social media has proven especially beneficial for bringing like-minded people together, allowing them to build meaningful relationships based on an exchange of personal information and content, all online. This is a technology that is evolving on a daily

basis with implications for the future of individuals and organizations. Museums are particularly well suited to take advantage of social media platforms because their highly visual nature makes it easy to collect and display rich media.

Mid-term Horizon

The second adoption horizon, two to three years out, is where we will begin to see widespread support of two technologies that are experiencing growing popularity within museum education and interpretation: *augmented reality* (AR) and *open content*. By nature, museum educators create bridges between objects, ideas, and visitors, and augmented reality can allow this to happen more fluidly and easily than ever. Open content is changing the way museums make images, documents, and other ephemera from exhibits and collections available, with the goal of placing rich media and information online that is licensed for sharing, reuse or even (if licensed for derivative works), for remixing.

> **Augmented reality** is a technology that is readily available and easy to use, thanks to the convergence of three technologies — GPS, video, and pattern recognition. AR has been noted in previous editions of the *NMC Horizon Report: Museum Edition*, but what makes it especially interesting today is its widespread integration with mobile technology. Many mobile applications rely on augmented reality to enable users to see images or information layered over landscapes or cityscapes through their smartphone or tablet cameras. Anyone who owns a smartphone has a veritable universe of possibility in their pocket, and this notion is inspiring developers of AR software to experiment with practical and innovative concepts in both small and large formats. These developments have made augmented reality a portable tool for discovery-based learning that can enhance the information available to patrons when visiting galleries, exploring outdoor installations, or interacting with real-world objects.

> **Open content** is a movement among scholars and learning-focused institutions to make content freely available via online platforms. There is a growing desire in museums to provide open access to their collections, exhibits, historic photographs, and other resources in order to reach and educate a broader audience. New forms of legal licensing, such as the Creative Commons, are making it more possible than ever before to disseminate rich media in the public domain. Nonetheless, open content is still two to three years away from widespread adoption in museums due to concerns around intellectual property and copyright, as well as the potential loss of revenue from image licensing.

Far-term Horizon

On the far-term horizon, set at four to five years away from widespread adoption, are *the Internet of Things* and *natural user interfaces* (NUIs). Both technologies create opportunities for interaction. The Internet of Things, a notion first outlined by Vint Cerf, is fueling considerable innovation in how devices communicate with each other and with us. Exhibits that will 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 collections. These technologies are several years away from mainstream use, but already it is clear that their impact will be significant, despite the lack of well-documented museum project examples. The high level of interest and investment in both areas are clear indicators that they are worth following closely.

> **The Internet of Things** is the next phase in the evolution of smart objects — a category of small devices or methods that enable an object to be assigned a unique identifier; contain small bits of information, such as the object's age, shelf life, or environmental data; and then communicate the status of that information on demand. With the advent of IPv6, those objects can now have an Internet address, allowing their information store to be accessed in real-time from anywhere. At the same time, new wireless communication strategies, such as near field communications (NFC), are making it easier for smart objects to securely connect to networks. There are very few concrete applications in museums so far, but it is evident that hundreds of billions of devices — from delicate lab equipment to refrigerators to next-generation museum security

systems — will soon be designed to take advantage of such connections.

> **Natural user interfaces** allow computers to respond to gestures, motions of the body, facial expressions, voice, sound, and other environmental cues, and are replacing the keyboard and mouse as the standard for computer-human interaction. The various technologies that enable natural user interfaces are making interactions with computational devices far more intuitive, and often so simple that no instructions are even needed to use them. The device teaches you as you interact with it. From the touchscreens on smartphones and tablets, to the gesture and voice interactions built into the latest gaming systems (Xbox Kinect and Nintendo Wii, for example), to capable virtual assistants like Siri on the iPhone, natural user interfaces enable users to learn by doing and seamlessly convert thought to action. Currently, one of the most visible uses of NUIs is seen with the incorporation of large multi-touch displays and tables at museums, which support content exploration and collaborative work, allowing multiple users to interact with content simultaneously.

Museums are particularly well suited to take advantage of social media platforms because their highly visual nature makes it easy to collect and display rich media.

Each of these technologies is described in detail in the main body of the report, where a discussion of what the 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 and immediate potential for museums, and this report aims to document that in a simple and compelling manner.

The advisory board of 49 technology experts spanned nine countries this year, and their names are listed at the end of this report. In spite of their diverse backgrounds and experience, they share a consensus view that each of the profiled topics will have a significant impact on museum education and interpretation around the globe over the next five years. The key trends driving interest in technology adoption, and the challenges museums will need to address if those selected are to reach their potential, also represent the advisory board's perspective, and are the focus of the next sections of the *NMC Horizon Report: 2012 Museum Edition,* where each is detailed in the context of museum education and interpretation.

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 2012 through 2017. They are listed here in the order in which the advisory board ranked them.

1 The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators. Access to educational materials of all kinds has never been so easy or so open as it is today, and this trend is only increasing. The model of the museum curator or educator who stands in front of an object and interprets meaning for a passive audience is simply no longer realistic in this world of instant access. Museum professionals must respond by changing their roles to reflect the new need to guide and coach visitors in finding, interpreting, and making their own connections with collections and ideas. Museums are also more willing now to see themselves as learners, taking advantage of user-generated content to enhance the overall understanding of collections.

2 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.

3 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.

4 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.

5 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 gigantic, 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.

Museums are also more willing now to see themselves as learners, taking advantage of user-generated content to enhance the overall understanding of collections.

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 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 web site, 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.

The challenge for content producers within museums is to revamp production workflows and content licenses so that they simultaneously support any possible use.

2 Funding for technology projects, even those for interpretation and exhibition, continues to fall outside core operational budgets. The recent recession virtually brought to an end what had been a promising trend in museums allocating ongoing operational funds (as opposed to capital or project funds) for both experimental and sustained technology projects. Museums need institutionalized strategic planning initiatives for technology infrastructure and technology-related projects, and information technology staff need better skills and opportunities to communicate the importance of a proper digital strategy. Open lines of communication and a common vocabulary might give administrators a clearer understanding of exactly what should be operationalized rather than left to project funds.

3 Museum educators do not have the training, resources, or support to address the technological opportunities and challenges they face. There are very few examples of best practices for development of educational technology for museums, and the most progressive examples are being developed outside of education departments. Professional development and training in how new technologies can be used to further interpretation goals and enhance visitor experiences is needed at all levels of museum education.

4 Boards of Trustees and executive management too often do not recognize the importance of technology in generating financial or mission return on investment. Integrating and recognizing the role of technology in garnering visitors, keeping their interest, and financially supporting the enterprise is critical to every museum's success. There is an audible fear amongst Boards of Trustees and executive management teams that the cost of investing in emerging technologies (training, implementation, etc.) will not be repaid. However, practical and creative applications such as distance learning courses, digital collections, apps, and more have the proven ability to generate new audiences and potential new streams of revenue — and the costs of training are falling at the same time as new, easier-to-use devices become more of the norm.

5 Content production has failed to keep up with technology in an era when audiences expect to consume information whenever and wherever they want. Museums too often face additional costs to repurpose information created for museum catalogs or even websites as they try to meet demands of content from the growing array of potential media formats. It is not enough today for a museum to put content into web and print forms — also needed are electronic versions of major publications crafted for Kindles, iPads and other electronic publication readers. Added to that is the need for social media content. The challenge for content producers within museums is to revamp production workflows and content licenses so that they simultaneously support any possible use. The pressure on museums to do this will increase as the commercial publishers continue to solve their own similar issues, creating expectations for other parts of the economy, including museums.

These trends and challenges are a reflection of the impact of technology in almost every aspect of our lives. 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.

Mobile Apps

Time-to-Adoption Horizon: One Year or Less

There is a revolution that is taking place in software development that parallels the changes in recent years in the music, publishing, and retail industries. Mass market is giving way to niche market, and with it, the era of highly priced large suites of integrated software is giving way to a new view of what software should be. Smartphones such as the Galaxy, iPhone, and Android have redefined what we mean by mobile computing, and in the past three to four years, the small, often simple, low-cost software extensions to these devices — apps — have become a hotbed of development. New tools are free or sell for as little as 99 cents, making it easier for people to develop apps. A popular app can see millions of downloads in a very short time, and that potential market has spawned a flood of creativity that is instantly apparent in the extensive collections available in the app stores. These retail phenomena provide an easy, fast, and totally new way to deliver software that reduces distribution and marketing costs significantly. Apple's app store opened in July 2008; Google's followed in October of that year. By September 2012, more than 55 billion apps had been sold or downloaded; simple but useful apps have found their way into almost every form of human endeavor. Mobile apps are particularly useful for learning as they enable people to learn and experience new concepts wherever they are, often across multiple devices.

Overview

With the advent of mobile apps, the way we think about software itself is changing, and whole industries are adjusting to a new world in which simple but sophisticated tools routinely sell for 99 cents. In contrast to desktop applications that stack feature upon feature in a one-size-fits-all approach, mobile apps generally do one thing, or a small list of tightly related things, extraordinarily well. They cost so little that trial versions are unnecessary, and outfitting a tablet or mobile phone with exactly the feature set of apps you want is both less expensive and less complicated than installing typical desktop software.

Anyone who can build or produce an app can reach a market that today includes over 1 billion smartphone users and counting, according to a study by Strategy Analytics published in October 2012 (go.nmc.org/uhrpy).

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The app software model is clearly thriving: In September 2012, Apple reported that over 30 billion apps had been downloaded from the Apple marketplace, while Google saw 25 billion apps downloaded from the Android marketplace. A recent study by analyst firm Berg Insight predicts that 98 billion apps will have been downloaded by the end of 2015 — or, around 14 apps per person across the entire population of the earth. This is double the amount of downloads Distimo predicted just over a year ago in a projection for the year 2016; the numbers continue to grow at an unprecedented rate.

Moreover, as cellular networks optimize their data capabilities and more operations take place in the cloud, the capabilities of apps are becoming more diverse and useful, which means there is an app for every purpose. Today's apps can recognize text and translate it from another language ("myLanguage"),

compare prices of the same goods between retailers ("ShopSavvy"), or complete tasks such as calculating calorie burn ("MyFitnessPal"), and finding Scrabble words ("PowerVocab") — all of it instantaneously. Apps are also embraced in crucial contexts such as healthcare by helping diabetes patients connect wirelessly to their glucose monitors ("BGluMon"), or aid doctors as they formulate their diagnoses ("Isabel App").

The most effective apps are tightly integrated with the capabilities of the device itself, using location data, motion detection, gestures, access to social networks, and web search, to seamlessly create a full-featured experience. For example, a typical newspaper app will foreground an article based on the subscriber's location, and allow readers to share it with their social networks, make comments, swipe over an image to see more, and store specific content to read at a later date.

The flexibility and scalability of mobile applications has museums re-thinking the way they tailor the museum experience.

A growing number of organizations and enterprises have designed apps to increase their visibility and serve a larger share of their demographics. Museums and other cultural institutions aligning with this trend are discovering that the humanities blend well with app functionality. A preliminary purpose of mobile apps in the museum world has been to help visitors conceptualize and contextualize cultural artifacts and objects, by giving them access to histories, biographies, images, and games designed to enrich their understanding.

The mobile app marketplace represents an expanding world of resources that fits into the palm of a hand. While the adoption of apps has been especially apparent in the consumer sector, there has also been a great interest in apps that integrate social media, illustrate complex concepts and facilitate virtual tours. As museums begin integrating mobile software into the museum experience, the function of apps will continue to evolve toward satisfying the practical and aesthetic demands of visitors.

Relevance for Museum Education and Interpretation

The placement of mobile apps on the near-term horizon for museums reflects a shift away from a focus on the specific means used to deliver and receive content, and towards how museums are actively more engaged in responding to what their users desire and, in many cases, require. Service and reach are the two overarching themes of the numerous benefits of the proliferation of museum-related mobile apps in the past two years. The marketplace for mobile devices has matured to a point where, in North America at least, museums can rely on visitors to bring their own device with them, and for it to be their preferred tool for accessing and exchanging information. This trend, known as BYOD (Bring Your Own Device), means that fewer museums are finding it necessary to supply devices for their users, and resources saved in this area can be redistributed elsewhere in the museum.

The ease with which social apps are used often leads to serendipitous moments of discovery, a transformation that occurs both in the galleries and outside of physical spaces. The Tate's "Magic Tate Ball" (go.nmc.org/qfjgy), for example, stands out as a model for what museums can accomplish by blending humor with great content. In this location-based app, players shake an on-screen 8-Ball to solve one of life's mysteries. "Magic Tate Ball" takes the museum experience outside the museum and transforms the experience of looking at art into a wonderful spare time interaction connected with the viewer's geographic location, the weather, ambient noise levels, and time of day

The flexibility and scalability of mobile applications has museums re-thinking the way they tailor the museum experience. A personal device provides museums with that rare opportunity to make one-to-one connections with visitors, engaging with each individual. They also allow museums to better serve audiences who have been traditionally underrepresented. For example,

the Smithsonian's "Access American Stories" (go.nmc.org/acce) app, which is available on iOS and Android platforms, provides a crowd-sourced audio experience that is designed to increase accessibility for visitors with low vision. In this sense, mobile apps are tools for museums to meet needs that are aspirational as well as functional.

Some museum professionals have compiled suites of artistic apps that include digital paint tools ("Procreate") and photo filters ("Hipstamatic") to inspire invention among museum-goers during workshops or activities. Beyond museum walls, apps can be purposeful in providing the general public with experiences rich in meaning and aesthetic wherever that user happens to be, whether they are standing in line at the grocery store or waiting for the next train.

A sampling of mobile app functions in museums includes the following:

> **Education and Interpretation.** For visitors, engaging with an artwork by re-enacting the creative process of the artist has been limited in terms of the type of media permissible in the gallery. Mobile apps such as "Andy Warhol DIY" not only allow a deeper engagement with the art-making process in front of a work of art, but also enable the viewer to share their learning with friends and family.

> **Exhibitions and Collections.** The availability of printed didactic material relating to exhibitions and collections is on the decline, while the demand for accessing additional content about artwork from multiple devices and geographic locations is steadily increasing. Mobile apps allow users to access multimedia content digitally, and even through QR codes placed throughout the museum's exhibitions.

> **Marketing and Communications.** Museums are thinking creatively about how to reach more people outside of the physical museum space by developing sophisticated mobile content strategies. In many cases, the type of engagement they provide via apps leverages an exhibition or collection as a point of departure for activities that reinforce the museum's brand as contemporary and innovative.

Mobile Apps in Practice

The following links provide examples of mobile apps use in museum settings:

DAM_SCOUT App
go.nmc.org/wmyym
Visitors of the Denver Art Museum can use the "DAM_SCOUT" app to uncover hidden layers of multimedia content for collections and exhibits. QR codes placed around the museum allow visitors to get more information on an object with a swipe of their smartphone.

IWM Scan and Share
go.nmc.org/ogcft
The Imperial War Museum's "Scan and Share" app allows users to create their own collections with objects found in the museum's collections. When users scan an object's QR code, more information is displayed with interactive options.

Maurizio Cattelan: All HD, at the Guggenheim Museum
go.nmc.org/mauri
The Maurizio Cattelan app recreates the Guggenheim installation by showing all of the artist's works with zooming capabilities so the user can see where each is in the full installation. It also provides extensive context, including behind-the-scenes info on the installation and conservation process, as well as audio clips of Cattelan's reflections on his work.

MoMA Art Lab App
go.nmc.org/gqzck
The "MoMA Art Lab" iPad app provides a digital canvas to experiment with artistic techniques and exercises while supplying users with context and historical facts. Users can create a sound composition, shape poem, group drawing, and more, and then share their work.

National Naval Aviation Museum App
go.nmc.org/navala
This National Naval Aviation Museum app gives visitors

the option to explore the museum with a pre-built tour or build their own. A full Blue Angels roster introduces the members of the U.S. Navy Flight Demonstration Squadron, and graphics and in-flight footage with narration describe demonstration maneuvers so users can understand and visualize the piloting of the aircrafts.

Smithsonian: Artists in Dialogue 2
go.nmc.org/fcwrv
The "Smithsonian: Artists in Dialogue 2" app shows an exhibit by two Brazilian artists through a virtual tour with commentary from the artists. Also included in the app is an art-making game that enables users to experiment with the same techniques the artists used.

Vistory
go.nmc.org/vist
This crowdsourcing app uses a phone's geolocation to show users historic events that happened in the Netherlands based on a user's location, and pulls up corresponding documentaries and films that were shot there. Users can freeze the video at any point and take a photograph of the location as it currently is, creating a time-stamped tag that helps others find the same historic locations and corresponding multimedia.

For Further Reading

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

Apps Bring Museum Studies to Life
go.nmc.org/nzvfb
(Liz Lightfoot, *The Guardian*, 19 June 2012.) This article discusses how apps are being used in the post-graduate program at the University of Leicester's School of Museum Studies to teach ethical considerations of curators. Students visit museums with pre-loaded tablets containing videos of curators explaining their decision-making process in regards to each piece. Using apps, students can make notes, take pictures, and email presentations to their lecturers before even leaving the building.

Engaging Children With the Siren Call of the App
go.nmc.org/jyski
(Geraldine Fabrikant, *The New York Times*, 26 October 2012.) This article discusses how young museum visitors naturally gravitate towards interactive apps. The American Museum of Natural History, J. Paul Getty Museum in Los Angeles, the Philadelphia Museum of Art, and many others have created successful youth-directed apps.

How Tech Is Changing the Museum Experience
go.nmc.org/bnerk
(Aliza Sherman, *Mashable*, 14 September 2011.) More museums are developing mobile strategies that incorporate the use or creation of apps. This article cites several successful examples, including the Museum of Jewish Heritage's free mobile walking tour app that enables users to view New York through the eyes of poet Emma Lazarus.

Mobile Apps for Museums
go.nmc.org/hrbxp
(Jane Burton, Allegra Burnette, Ted Forbes, Kate Haley Goldman, Ann Isaacson, Sheila McGuire, Nancy Proctor, Ed Rodley, Peter Samis, Scott Sayre, Margriet Schavemaker, Koven Smith, Robert Stein, and Kris Wetterlund, American Association of Museums, accessed 26 October 2012.) This website is a knowledge-sharing platform that explores the uses of mobile apps for museums, incorporating perspectives from several museum experts.

My Teacher Is an App
go.nmc.org/mytea
(Stephanie Banchero and Stephanie Simon, *Wall Street Journal*, 12 November 2011.) This article explores how more than ever, people are learning complex concepts through mobile apps. The technology supports and encourages informal learning, which makes learners more excited about the process.

Social Media

Time-to-Adoption Horizon: One Year or Less

Today's web users are prolific creators of content, and they upload photographs, audio, and video to the cloud by the billions. Producing, commenting, and classifying these media have become just as important as the more passive tasks of searching, reading, watching, and listening. Sites such as Facebook, Twitter, Pinterest, Flickr, YouTube, Tumblr, Instagram, Four Square, and many others make it easy to share and find stories, images, videos, and audio clips. In addition to interacting with the content, social media makes it easy to interact with friends and institutions that produced the content. Relationships are ultimately the lifeblood of social media as people share information about themselves, find out what their peers and favorite organizations think about topics of interest, and exchange messages. The experience augments already-established relationships while providing spaces for people who are separated by physical distance or other barriers to connect with each other. This helps institutions to garner broader audiences while communicating conveniently with existing ones.

Overview

Human beings have an intrinsic desire to share revelations and information with each other, and social media provides a growing array of forums to do so instantaneously. The most effective social media services encompass the aspects of face-to-face interactions that we cherish — revealing exciting news, debating, poring over photographs, and more. Videos, images, news, and more can be shared in just a few clicks; those that go "viral" can reach millions of people.

With such reach, the origination of major breaking news stories has shifted from television networks and news outlets to everyday people. A 2011 report from Reuters recounts five prominent events that entered the world consciousness via Twitter, including the death of Osama Bin Laden and the Hudson River plane crash in New York (go.nmc.org/sslkj). Sites such as YouTube, Vimeo, Flickr, and Instagram enable anyone with a smartphone camera to be a reporter, photographer, videographer, and author.

Until this year, social media and social networking were listed as two distinct topics in the Horizon Project research. In the past year, as social networking sites like Facebook made it easy to also share pictures and video, the distinction between these categories has become irrelevant. It is no longer sufficient just to be able to upload a photograph or video somewhere public like YouTube, Vimeo, or Flickr — social media users want to be able to start or join discussions around the media, and seamlessly share both the media and the discussions with their own networks. Increasingly, social media platforms are device-agnostic and able to be accessed from anywhere on virtually any Internet-capable device.

The most effective social media services encompass the aspects of face-to-face interactions that we cherish.

Leading the social media charge is Facebook, with the most users of any social media outlet, touting one billion according to an official statement from CEO Mark Zuckerberg in October 2012. As of March 2012, approximately 140 billion photos had been uploaded to Facebook, which is 10,000 times greater than the number

of photos in the Library of Congress. In 2007, Facebook was also one of the first social media platforms to allow businesses and organizations to create their own pages and communities. Major corporations and brands, such as Target, Starbucks, and Coca-Cola were quick to jump on the bandwagon and begin to measure their companies' marketing ROI in terms of number of Facebook followers.

Relevance for Museum Education and Interpretation

In just a few short years museums have shifted from wary bystanders to energized and invigorated participants in the landscape of social media. Even the smallest museums have a Facebook page, and many museums use a variety of platforms to host collection-related content, including Instagram, Tumblr, YouTube, Vimeo, and Pinterest. The San Francisco Museum of Modern Art and the Brooklyn Museum were among the early adopters of Instagram as a way to communicate with their audiences.

The increased use of social media in museums has the potential to substantially supplement museums' traditional audience base with new audiences that could only be imagined a decade ago.

In the past, information, image, and video-sharing sites were regarded primarily as broadcast mechanisms for museum exhibitions and programming, or as a relatively low cost means of engaging young professionals and youthful visitors. Now, these services are increasingly recognized as ways to encourage and support visitor engagement, as well as provide an efficient and effective way to house vital digital content.

Pinterest, for example, a relatively new arrival on the social media scene, is a highly visual platform that allows users to organize content and "pin" images on their pinboards according to themes, a functionality that naturally lends itself to museum use. Pinterest is now the third most popular social networking site in the United States behind Facebook and Twitter, according to Experian Hitwise. Earlier this year, the Los Angeles County Museum of Art earned a place as one of the "Top Ten Museums On Pinterest" (go.nmc.org/pinlacma), and scrolling through the variety of items they pinned reflects the depth and breadth of interest available in the museum, which would be hard to capture in a traditional marketing campaign.

Any residual fears that social media experiences will diminish the desire of museum audiences to engage with the authentic object are quickly disappearing, which represents a progressive shift in the culture of the institution. Museums have come to acknowledge that for some experiences, physical proximity is less important than it used to be — and social media has become the means of providing real world, real-time points of connection for visitor engagement. The increased use of social media in museums, far from displacing audiences, has the potential to substantially supplement museums' traditional audience base with new audiences that could only be imagined a decade ago.

A sampling of social media applications in museums includes the following:

> **Education and Interpretation.** For the exhibition *John Martin's Underworld*, the Tate Museum created an online interactive storytelling game where visitors engage with the artist's biography and exhibition through Twitter.

> **Exhibitions and Collections.** Museums are becoming more comfortable showcasing their digital collections on social media sites and engaging with user-generated content and comments. Pinterest has allowed museum fans and visitors to engage in rich conversations around objects in a collection. SoundCloud lets users generate comments on top of existing audio wave files in synchronous time.

> **Marketing and Communications.** As marketing budgets shrink and visitors expect deeper engagement, museums are relying heavily on the immediacy and inexpensive nature of social media platforms to attract and retain members. Museums are creating customizable membership portals like the Philadelphia Museum of Art's My Museum, a program that allows members to collect and share their favorite artworks with each other.

Social Media in Practice

The following links provide examples of social media use in museum settings:

ArtClix
go.nmc.org/azman
Created by the High Museum of Art, Atlanta, ArtClix joins photo-recognition and social media to provide visitors with an interactive experience. Artworks are automatically recognized and the photos taken by visitors are shared as part of an online community.

The Chicago Architecture Foundation on Pinterest
go.nmc.org/arch
The Chicago Architecture Foundation uses Pinterest to interact and collaborate with visitors as well as to share photos from workshops and display publications and gift shop items. One collaborative board where anyone can post an image of an inspiring building has garnered nearly 2.2 million followers. To contribute a post, visitors just send a tweet to @chiarchitecture.

The Digital Dead Sea Scrolls
go.nmc.org/deadse
The Israel Museum's Digital Dead Sea Scrolls website contains high-resolution images of ancient manuscripts available to the public in greater detail than one could get even by holding the physical artifacts. A comments box incorporated on each scroll's web page has instigated compelling conversation about the manuscripts and their meaning.

LBJ Time Machine
go.nmc.org/lbjti
The LBJ Presidential Library uses a Tumblr blog to post multimedia content daily from the museum's collections. This LBJ Time Machine blog tells the story of former US president Lyndon B. Johnson, one day at a time from his birth to the new redesign of the LBJ Library and Museum reopening in 2012.

Museum of Science, Boston on Facebook
go.nmc.org/scie
The Museum of Science uses Facebook as a platform to share photos and videos that introduce new animals, exhibits, and events or capture visitors in action at the museum. They also interact with their page's fans, often sharing interesting projects, photos, and links from visitor or fan profiles and holding giveaways or free entry for visitors who respond to posts.

The Participatory Museum of Denmark
go.nmc.org/reayx
The Danish National Gallery, along with nine other museums in Denmark, is adopting Twitter as a way to actively engage patrons while they view artwork. The platform also connects artworks across the various museums, categorized by theme.

For Further Reading

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

The Art of Social: Users Share Artwork on ArtStack
go.nmc.org/suxlk
(Olivia B. Waxman, *TIME*, 3 October 2012.) London-based ArtStack is a social platform that enables users to share and discover artwork. This article discusses how the social networking components of ArtStack make it more successful than similar projects.

The Participatory Museum
go.nmc.org/ikksw
(Nina Simon, *The Participatory Museum*, accessed 26 October 2012.) This is a practical guide for museum directors who want to investigate and implement participatory practices in their museums, some based off social media. It can be read online for free.

Sharing the Museum: Social Media and Curatorial Practice
go.nmc.org/sharin
(Michela Sarzotti, *Interventions*, 26 January 2012.) New York's Museum of Modern Art showcased an exhibition that explored how different technological innovations transform the way we live. The exhibition invited visitors to interact with the works of art through QR codes, Twitter, and Facebook. This article explores the exhibit and the impact of using social media tools for visitor interaction.

Six Ways Boston's Museums are Utilizing Social Media to Bring Their Exhibits to Life
go.nmc.org/nwofd
(Lisa DeCanio, *BostInno*, 21 February 2012.) The Museum of Fine Arts is among six cultural institutions in Boston that found success building connections with their patrons through social media platforms including Flickr, Pinterest, Facebook, and YouTube.

The Spirit of Sharing
go.nmc.org/pursu
(Carol Vogel, *The New York Times*, 16 March 2011.) Museums are finding creative ways to leverage social media in the museum space. This article explores how the Brooklyn Museum deployed a quiz on their website for visitors to select which pieces they would like to see on display in an upcoming exhibition.

Using Social Media to Bring Museum Exhibits to Life
go.nmc.org/zoo
(Frank Barry, *NP Engage*, 11 April 2012.) This article highlights the importance of video content in giving people a taste of an exhibit or event and explains how the San Diego Zoo directs its audience to its video content through more than one platform: Facebook, Twitter, YouTube, and Pinterest.

Augmented Reality

Time-to-Adoption Horizon: Two to Three Years

Augmented reality (AR), a capability that has been around for decades, has shifted from what was once seen as a gimmick to a tool with tremendous potential. The layering of information over 3D space produces a new experience of the world, sometimes referred to as "blended reality," and is fueling the broader migration of computing from the desktop to the mobile device, bringing with it new expectations regarding access to information and new opportunities for learning. While the most prevalent uses of augmented reality so far have been in the consumer sector (for marketing, social engagement, amusement, or location-based information), new uses seem to emerge almost daily, as tools for creating new applications become even easier to use. A key characteristic of augmented reality is its ability to respond to user input. This interactivity confers significant potential for learning and assessment; with it, learners can construct new understanding based on interactions with virtual objects that bring underlying data to life. Dynamic processes, extensive datasets, and objects too large or too small to be manipulated can be brought into a learner's personal space at a scale and in a form easy to understand and work with.

Overview

The concept of blending, or augmenting, what we see in the real world with data, media, and even live action is a powerful one. Augmented reality aims to enhance what we can perceive with our senses, and introduce us to another dimension of experience. The first modern application of augmented reality was in 1962, when cinematographer and pioneer in virtual reality, Morton Heilig, patented the Sensorama, a simulator that incorporated visuals, smells, and vibrations. This first step into machine-mediated reality began a progression of thought and development that ultimately led to the concept of AR as we know it today.

The growing number of AR applications is likely due to the ubiquity of mobile devices, a technology that is consistently innovated to perform better and offer more for consumers. With exceptional displays, high-speed data networks, capable processors, intuitive user interfaces, and GPS sensors, today's handheld computers are perfectly equipped to support AR mobile applications. Now, the technologies that make AR possible, although powerful, are compact enough to live in personal laptops and mobile phones and tablets.

Augmented reality aims to enhance what we can perceive with our senses, and introduce us to another dimension of experience.

One form of augmented reality is marker-based which means that the camera must 'see' a specific visual cue in order for the software to retrieve accurate information. Layar (go.nmc.org/layar), for example, was one of the emerging leaders in the marker-based AR mobile software industry with their efforts to make print media "clickable," by creating a platform for companies to incorporate AR into their publications. Markerless applications, on the other hand, use geolocation-based or GPS data, which has wider applicability because external labels or supplemental reference points are not necessary for the visualizations to appear.

Launched in 2009, Yelp's iPhone app, "Monocle," was the first popular application of AR for a mobile device, despite its AR capabilities being a hidden feature of the software. With Monocle's AR function activated, a user

can point an iPhone at their surroundings, and by using GPS data, the device overlays reviews and ratings of the establishments around them. More recently, AR has been in the spotlight because of Google Glasses — a prototype developed by Google's Project Glass, which will be available for purchase in 2014. With Google Glasses on, a user can see messages and maps projected onto their lenses, watch videos and chat, and even take pictures without using a handheld device.

Augmented reality can help museums accomplish one of their most fundamental purposes: helping visitors see the world around them in new ways.

Augmented reality appeared in the mid-term horizon in the previous editions of the *NMC Horizon Report: Museum Edition* in both 2010 and 2011, and remains there for 2012. While the use of augmented reality is increasingly common in children's and science museums where interacting with exhibits is an expected part of the visitor experience, it has been slower to find applications in art and historical museums where the objects on display are often fragile or very rare.

Relevance for Museum Education and Interpretation

Augmented reality can help museums accomplish one of their most fundamental purposes: helping visitors see the world around them in new ways. The essential ability of AR to create an "interpretation layer" that overlies our sensory experience offers profound potential for interpretation, especially for fragile objects.

Museums are most successful when they engage audiences intellectually and emotionally. Whether the experiences are created for small or large displays, AR has the power to impact learning and discovery in ways only imagined for us up to now in literary and cinematic fiction. The potential for augmented reality projects to fundamentally change museum practices is widely seen.

Augmented reality experiences can be individual and intimate, or larger events that are experienced in a group. An example of the power of AR on a monumental scale is the 3D projection-mapping experience created for the Clifford Still Museum in Colorado (go.nmc.org/cliff). The Museum of London's "StreetMuseum" (go.nmc.org/youarehere) is a classic example of an early, successful augmented reality tool for use on both iOS and Android platforms. A more recent example, "Around Sydney," a mobile app designed by Powerhouse Museum, allows users to snap pictures and see the city as it appeared one hundred years ago (go.nmc.org/xjety).

AR also has the potential to impact museum research and scholarship as researchers and students begin to explore this technology as a simple and effective way to put complex data into context. In many ways, AR can be seen as an intuitive doorway through which data can be easily attached to real world objects, settings, and processes that facilitates a deeper meaning and understanding of what is being seen. Adding to the experience, most of the current tools do this in ways that the user can control and manipulate in real time.

A sampling of applications of augmented reality in museums includes the following:

> **Education and Interpretation.** The advancement in screen-based technology has enabled new types of interpretation through augmented experiences inside and outside gallery spaces. The field of education benefits from augmented reality by allowing access to material that is otherwise hidden or too fragile to interact with.

> **Exhibitions and Collections.** Artists are extending the locations of exhibitions into site-specific virtual realms. For example, using the augmented reality software Layar, artist Will Pappenheimer designed an exhibition throughout interstitial spaces at the Los Angeles County Museum of Art. Viewable only by smartphone, he placed multi-colored digital funnels

and videos on rostrums throughout the museum's courtyard and corridors.

> **Marketing and Communications.** Museum fundraisers are heavily produced events that use digital innovations to create highly dramatic visual environments. At the Clifford Still Museum's First Light Gala, the museum created an immersive 3D mapping projection on the exterior walls of the newly opened building, transforming the way patrons experienced the museum's architecture.

Augmented Reality in Practice

The following links provide examples of augmented reality use in museums:

Beyond Planet Earth Augmented Reality App
go.nmc.org/ynxgx
The American Museum of Natural History's augmented reality app serves as a companion to the exhibit *Beyond Planet Earth: The Future of Space Exploration*. Users may download the free app before the exhibit and any time they notice one of the 11 augmented reality icons throughout, they can use the camera on their devices to unlock 3D animations.

Making the Modern World
go.nmc.org/zfoml
At the Science Museum in London, the *Making the Modern World* exhibition showcases objects that represent new departures in technology and science. The museum built an app to accompany the exhibit in which BBC television personality James May narrates an exhibit as an augmented reality avatar.

Mind the Fish
go.nmc.org/aqua
At the Cinekid festival in Amsterdam, this exhibit enabled visitors to see conversations between fish in a real fish bowl. Augmented reality and tracking software followed the fish and displayed their thoughts as text bubbles on a screen that could be maneuvered around the bowl.

Project O-rator
go.nmc.org/tyuod
Project O-rator at the Los Angeles County Museum of Art uses location-based AR technology to show interactive 3D images to visitors that draw on the early Russian avant-garde and their experiments with emerging sound and projection technology.

Pure Land Augmented Reality Edition (2012)
go.nmc.org/alive
On invitation of the Hong Kong International Art Fair, City University of Hong Kong presented *Pure Land: Inside the Magao Grottoes at Dunhuang*, which recreates cave wall paintings found in an inaccessible cave in Dunhuang. A wall initially displays only the basic outlines of the paintings, but when users look through the screen of an iPad they can see the full color and detail.

AR has the potential to impact museum research and scholarship as researchers and students begin to explore this technology as a simple and effective way to put complex data into context.

(Un)seen Sculptures 2012
go.nmc.org/unse
dLux MediaArts presented its second edition of (Un)seen Sculptures, a mobile 3D augmented reality art show in which hidden works of art are stationed throughout the Callian Park precinct in New South Wales, Australia. The sculptures can only be seen through smartphones with an app called the "Layar Reality Browser."

WorldWide Telescope
go.nmc.org/wwte
Microsoft Research's WorldWide Telescope enables a computer to function as a virtual telescope by combining imagery from the world's best ground and

space-based telescopes with information and stories so that users can take online guided astronomy tours.

For Further Reading

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

Augmented Reality in the Museum
go.nmc.org/mgicj
(Scott Billings, MuseumNext, 31 January 2011.) This post explores several museums' projects that are incorporating augmented reality through mobile apps, virtual buildings, and more. The author poses the issue of whether AR enhances the museum experience or becomes the experience itself.

Augmented Reality Livens up Museums
go.nmc.org/live
(*Smithsonian Magazine*, 14 August 2012.) The authors believe that gallery space is conducive to augmented reality technology and that wearable technology makes AR even more functional. This article cites some current exhibits that effectively integrate augmented reality.

Augmented Reality — What Reality Can We Learn From It?
go.nmc.org/xtmqb
(Cherry Thian, *Museums and the Web*, March 24, 2012.) This paper presents findings from the Asian Civilisations Museum's pilot of an augmented reality-enhanced, location-based gaming iPhone app, called "Terracotta Warriors." The researchers found that while many of the users were not initially familiar with AR, they did not need help using the app.

How to Augment Your Reality with AR
go.nmc.org/funig
(Margriet Schavemaker, *edgital*, 12 October 2012.) The author of this post discusses how to make a custom augmented reality experience by explaining the process behind an augmented reality-enhanced exhibit at the Royal Ontario Museum.

Implementing Mobile Augmented Reality Technology for Viewing Historic Images (PDF)
go.nmc.org/efhqb
(City of Philadelphia Department of Records and Azavea, 2011.) In this paper by geographic services company, Azavea, and the Philadelphia Department of Records, the authors describe how they used augmented reality as an immersive way for users to access over 93,000 images and maps available in the Philly History database: go.nmc.org/jwqpq.

The World Is Not Enough: Google and the Future of Augmented Reality
go.nmc.org/yvgbu
(Alexis C. Madrigal, *The Atlantic*, 25 October 2012.) Between Google Glass and the Field Trip app that is currently in development, Google is incorporating augmented reality into new tools that have clear applications in the museum setting.

Open Content

Time-to-Adoption Horizon: Two to Three Years

The movement toward open content reflects a growing shift in the way scholars in many parts of the world are conceptualizing education to a view that is more about the process of learning than the information conveyed. Information is everywhere; the challenge is to make effective use of it. Open content uses Creative Commons and other forms of alternative licensing to encourage not only the sharing of information, but the sharing of pedagogies and experiences as well. Part of the appeal of open content is that it is a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions. As this open, customizable content — and insights about how to teach and learn with it — are increasingly made available for free over the Internet, people are learning not only the material, but also the skills related to finding, evaluating, interpreting, and repurposing the resources. There is a notable transformation in the culture surrounding open content that will continue to impact how we think about content production, sharing, and learning, and there is a shift in attitude that embraces content becoming more open.

Overview

Open content has its roots in a number of seminal efforts, including the Open Content Project, MIT's Open Courseware Initiative, the Open Knowledge Foundation, work by the William and Flora Hewlett Foundation, and others. Many of these projects focused on creating collections of sharable resources and on devising metadata schemata.

The notion of sharing is inherent to the philosophy of open content, and in 2002, the non-profit organization Creative Commons began to address the need for alternative licensing so that people could legally share and adapt creative works. The result was a set of content licenses that fulfilled the void between "all rights reserved" and no rights at all. The *NMC Horizon Report* series itself is published under a Creative Commons 3.0 Attribution License, which allows readers to repurpose, remix, and adapt the reports freely, as long as the source and authors are cited. Other forms of licensing have also been developed, such as Copyleft, but none has enjoyed the success of Creative Commons.

It is now the mark — and social responsibility — of world-class institutions to develop and share free cultural and educational resources.

Over the last decade, both universities and schools have paved the way for open content to become an accepted source of useful material. In the world of higher education, open content is transforming the intellectual landscape through the formation of Open Educational Resources (OER), a concept coined by UNESCO in 2002. Founded on the belief that open courseware can alleviate the digital divide, OER is a movement that is gaining international traction as governments acknowledge the potential of this model to educate a 21st century workforce. A growing number of universities now offer open, high-quality content, allowing learners to study advanced materials at a fraction of the cost. Additionally, institutions like MIT have won wide recognition and increased visibility because of their commitment to sharing scholarly and academic content, setting a standard among institutions of equal caliber.

The role of content producers has evolved as well, away from the idea of authoritative repositories of content and towards the broader notion of content being both free and ubiquitous. It is now the mark — and social responsibility — of world-class institutions to develop and share free cultural and educational resources. Potential abounds for a museum's open content to be dispersed, repurposed, and curated all over the web.

A benefit of sharing knowledge and resources is that the museums using and repurposing open content can better inform the provider museum, or the original source. In this sense, opening up content is a viable and cost-effective method to improve the quality and quantity of resources available to museums, providing more support for a cultural shift toward museums collaborating through online platforms.

For museums, open content is a way collections and exhibition materials representing the world's natural and cultural common wealth can be more easily shared.

The adoption of open content faces substantial challenges in the museum sector before it can be considered as a widespread strategy, but it is being aided by the rise of social media platforms where the frictionless exchange of rich media is common, as well as the growing sentiment among museum leaders that cultural objects and important artworks are meant to be shared with as broad of an audience as possible.

Relevance for Museum Education and Interpretation

At the center of many museum discussions of open content are the challenges of sharing, repurposing, and reusing scholarly works; related to those discussions are concerns about artist ownership, intellectual property, and copyright. While Creative Commons and others have done much to address these concerns, there are still significant challenges in the museum sector. Museums are under pressure from their Boards of Trustees and other stakeholders to capitalize on their intellectual property and content, a notion that is not incompatible with that of open content but neither is it obvious how the two should coexist.

Most museum leaders would argue that a primary responsibility of museums is to encourage scholarship and discovery by creating opportunities for people to learn about culture, history, art, science, and beyond. These activities, however, are often restricted by the original artists or donors through complex license agreements and copyrights, especially for modern and contemporary works.

Efforts to strike a balance between the desire to share images of art and related materials, and the equal desire to respect the rights of creators and owners fall largely on the shoulders of individuals at museums who are charged with creating digital interpretation materials. Museums around the world are beginning to rethink previously held notions about what can and should be shared. One global, large-scale effort is the GLAM-Wiki Project (Galleries, Libraries, Archives, Museums) (go.nmc.org/fpomh), which is made up of a community that assists museums and other institutions in freely sharing their cultural expertise and content through the biggest open content platform, Wikipedia.

For museums, open content is a way collections and exhibition materials representing the world's natural and cultural common wealth can be more easily shared. Providing online public access to assets — images and metadata — can increase the public value of collections and facilitate teaching, learning, and other core activities associated with the institutional missions of museums. Open content is a path for museums to take advantage of the increasingly interconnected web by making collections and materials as widely accessible and as reusable as possible, while preserving IP ownership and basic copyrights.

New intellectual property licensing options have resulted in some museums rethinking the dissemination

of content. Many in museums believe that they should be at the forefront of open content modeling — illustrating how best to share content, establish standards, and take part in the global conversations about policy, the Creative Commons, and open culture.

A sampling of applications of open content in museums includes the following:

> **Education and Interpretation.** Educators often note the need to access materials outside their collections. As more images, resources, and ephemera related to museum objects become shareable, this need will be obviated.

> **Exhibitions and Collections.** Open content has radically changed how individuals engage with a museum's online collection. At the Smithsonian's Cooper-Hewitt National Design Museum, for example, rather than interacting with a static list of images and descriptions, individuals are invited to engage with collections by sharing their Instagram photos and Thingiverse 3D renderings through a unifying tagging system.

> **Marketing and Communications.** Access to videos, photos, and other rich media that are shared in the public domain provide marketing professionals with a wide range of assets to use when an event or exhibition opens.

Open Content in Practice

The following links provide examples of open content use in museums and other settings:

Europeana
go.nmc.org/eur
Europeana is a search platform allowing users to access millions of digitized books, paintings, films, museum objects and archival records from European cultural and scientific institutions. The platform not only helps the institutions and organizations reach out to a wider audience, but promotes knowledge exchange between librarians, curators, archivists, and the creative industries.

Google Art Project
go.nmc.org/affom
This project allows users to virtually explore museum content from partner museums. Images of the artwork are accompanied by supplementary information. Users compile their favorite pieces from different places into their own virtual museum.

Online Scholarly Catalogue Initiative Tool Kit
go.nmc.org/osc
The Indianapolis Museum of Art is working with the OSCI consortium of nine museums to create a suite of open source tools called the OSCI Toolkit. These tools will facilitate the design, publishing, and distribution of online scholarly catalogs.

Open Knowledge Foundation
go.nmc.org/okfn
The Open Knowledge Foundation is a not-for-profit organization that brings together data experts, archivists, academics, entrepreneurs, and web developers to promote free and open access to learning materials and the freedom to distribute and reuse those materials.

Smithsonian Cooper-Hewitt Collections Data
go.nmc.org/coo
The Smithsonian Cooper-Hewitt Museum released the collection data for 60% of its documented collection into the public domain online under a Creative Commons Zero dedication, permitting any kind of reuse. They have a web interface for searching the collection and are also making the raw data set available for public download so that researchers and developers can find new patterns or applications from the data.

TAP Open Source Tool for Mobile Tours
go.nmc.org/tap
TAP is a collection of free open source tools for creating mobile tour applications that is being leveraged by Balboa Park Online Collaborative, Gemeentemuseum Den Haag, Indianapolis Museum of Art, and Museum of Fine Arts Boston. TAP uses a common language called TourML that works across content management systems, kiosks, and mobile applications.

For Further Reading

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

Are Open Educational Resources the Key to Global Economic Growth?
go.nmc.org/oer
(David Killion, *The Guardian*, 4 July 2012.) Open educational resources have the potential to bolster an institution's reputation by publicly displaying some of the content it has produced.

Case Study: Powerhouse Museum, Sydney
go.nmc.org/power
(Creative Commons, Accessed 12 November 2012.) Creative Commons presents a case study describing how the Powerhouse Museum became the first museum in the world to use the Flickr Commons for publishing historic photographs.

Khan Academy and the Revolution in Online Free Choice Learning
go.nmc.org/felfh
(Nina Simon, *Museum 2.0*, 3 October 2012). This post discusses how museums are in a great position to deliver learning content in a similar manner to some of the leading educational startups like Khan Academy.

Open Authority & the Future of Museum Ethics
go.nmc.org/futr
(Lori Byrd Phillips, Center for the Future of Museums, 21 February 2012.) The author addresses the struggle between a culture embracing crowd-sourcing and user-generated content and the traditional model of scholarly authority. She argues that the two do not have to be at odds, as they can be both a temple and a forum, facilitating collaborative platforms but stepping in to clarify as needed.

Open Resources: Transforming the Way Knowledge Is Spread
go.nmc.org/openre
(D. D. Guttenplan, *The New York Times*, 18 March 2012.) This article examines the state of open content in learning environments. Open education resources are considered by many to be vital in extending literacy and opportunity while cutting costs for museums and learners.

Why the Google Art Project is Important
go.nmc.org/goar
(Steven Zucker and Beth Harris, *eLiterate*, 29 May 2012.) There is a growing importance placed on the conversation and collaboration between museums to give the public a more complete understanding of art and its context. The authors cite an example of how the three canvases of Vincent Van Gogh's bedroom in Arles now reside in three different museums, but collaborative digital platforms like Google Art Project can bring the artworks together for the public to study side by side.

The Internet of Things

Time-to-Adoption Horizon: Four to Five Years

The Internet of Things has become a sort of shorthand for network-aware smart objects that connect the physical world with the world of information. A smart object has four key attributes: it is small, and thus easy to attach to almost anything; it has a unique identifier; it has a small store of data or information; and it has a way to communicate that information to an external device on demand. The Internet of Things extends that concept by using TCP/IP as the means to convey the information, thus making objects addressable (and findable) on the Internet. Objects that carry information with them have long been used for the monitoring of sensitive equipment or materials, point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. Smart objects are the next generation of those technologies — they "know" about a certain kind of information, such as cost, age, temperature, color, pressure, or humidity — and can pass that information along easily and instantly upon electronic request. They are ideal for digital management of physical objects, monitoring their status, tracking them throughout their lifespan, alerting someone when they are in danger of being damaged or spoiled — or even annotating them with descriptions, instructions, warranties, tutorials, photographs, connections to other objects, and any other kind of contextual information imaginable. Connecting such devices to cultural objects would make it as easy to access information about them as it is now to use the web.

Overview

The Internet of Things, a concept advanced by IP co-creator Vint Cerf, is the next step in the evolution of smart objects — interconnected items in which the line between the physical object and digital information about it is blurred. The advent of IPv6 has extended the Internet address space significantly, thus providing an avenue for any object, similar to today's web cams or shared printers that use the Internet, to transmit and receive data and information. On the consumer side, we already have Internet-enabled phones, appliances, picture frames, and office equipment. It is not a large step to envision Internet-enabled electric meters that use the Smart Grid to let your house know to raise the ambient temperature a degree to help offset a peak load. Indeed, internet pioneer Vint Cerf sees the Smart Grid as an accelerator for the Internet of Things.

The Internet of Things fosters a museum environment in which objects create actionable data, allowing other systems to adjust variables as necessary in compensation.

While there are many examples of what the Internet of Things might look like as it unfolds, it is still today more concept than reality, although that is changing rapidly. At the same time, the underlying technologies that will make it possible — smart sensors that can easily be attached to everyday objects to monitor their environment or status; new forms of low-energy radio transmission that can enable the sensor to send its information wirelessly or via electric lines to a network hub; and an expanded address space for the Internet — are all well understood, easily mass-produced, and inexpensive.

Smart objects have appeared in several previous editions of the *NMC Horizon Report*, and are described in the opening paragraph as having the attributes of being easy to attach, often much like a sticker; uniquely identifiable; a small data store; and a way to read and write to that store of data. Several radio-based technologies are being explored as the first point of transmission, from the simple and ubiquitous RFID approach broadly used for inventory control to the proximity-based secure data exchange made possible via Nokia's near field communication (NFC) technology. NFC was designed to allow users to make secure payments to kiosks, gas pumps, or dispensing machines via smartphones, but it will also allow smart objects to communicate securely over small distances.

While there are many examples of what the Internet of Things might look like as it unfolds, it is still today more concept than reality, although that is changing rapidly.

Today, NFC is optimized for payment data, and thus works over distances of just a few inches, but when that is extended to a few feet, as RFID is today, secure wireless communications between objects in a room and a wireless hub will be possible.

Relevance for Museum Education and Interpretation

In museums currently, most discussion related to the "Internet of Things" revolves around applying the concept of being "data aware" to portions of jobs and tasks that have not been data aware in the past. The educational and commercial value-added proposition for museums is in allowing collections to communicate information and opportunities directly to the visitor via their own smart device of choice. Objects in collections can be the keepers of their own data, and can communicate with other objects as well.

It is not inconceivable to imagine the day when a visitor to the Art Institute of Chicago will be alerted to the location of Georges Seurat's *Sunday Afternoon on the Island of La Grande Jatte* — an artist whose works the visitor has viewed at other museums. Once in front of the painting, a tiny sensor would supply the visitor with rich, layered information, offer the opportunity to buy a reproduction of the painting or a 3D model and have it shipped home, or reserve a seat at a free lecture on Seurat's works — all with a swipe of their NFC-enabled mobile. Some museum leaders are encouraging museums to consider how they can harness the data that is being created all the time and use it to improve the public experience, as seen in this video: go.nmc.org/neaqt.

There is, however, a practical component to the Internet of Things, as well. Museums have to do more with less these days and it is entirely reasonable for museums to look for efficiencies that allow staff to reduce the number of high-touch, routine activities, in favor of more specialized tasks. For example, the Internet of Things allows us to automate processes that have been historically human-centered, such as the daily monitoring of temperature and humidity in storage areas, the number of people who walk through the front door of an exhibition, or the light levels in a gallery space.

The Internet of Things fosters a museum environment in which objects create actionable data, allowing other systems to adjust variables as necessary in compensation. Smart objects can alert humans to long-term problems associated with changes in condition, or better yet, alert other systems to initiate change that will ameliorate or reverse environmental conditions that are detrimental.

As this technology gains traction, museums will have a persistent window into the condition of the objects, with the Internet being the mechanism for real-time monitoring of current location, environment, and even movement of an object in their care or collections. Once such information is accessible, it is easy to imagine it being attached to other sorts of information in ways that will blur the line between the object itself and

content related to it. For example, every bone in an Allosaurus skeleton has a story —its position in the body at the time of discovery, the temperature at which it is being stored, its provenance info, and more. An Internet of Things would make it simple to attach all that information directly to the bones themselves via an IP-enabled smart object that adds a constant stream of monitoring information about the physical object.

A sampling of applications of the Internet of Things in museums includes the following:

> **Education and Interpretation.** Access to all kinds of interpretive materials will only increase as we move closer to the Internet of Things. The technology makes it a simple matter to link physical objects with data on their physical condition and location, as well as with related scholarship, media, and other materials, bringing an immediacy and currency to the materials, and rich background to the objects.

> **Conservation.** By placing smart sensors behind paintings and other works of arts, museum professionals can be alerted if the piece has been exposed to too much humidity or if the temperature needs to be changed. This alleviates the risk of art being ruined by environmental conditions and aids with the preservation of important objects.

> **Marketing and Communications.** Advancements in near field communication will have a dramatic effect on how museums market their products and services. Sensors placed on objects and artworks within a museum space may be able to one day offer the visitor or patron a catalog of goods, services, and information with the swipe of a finger or a click on a webpage.

The Internet of Things in Practice

The following links provide examples of the Internet of Things in use that have direct implications for museums:

Cosm
go.nmc.org/kzhep
Cosm is a platform that uses an open API to connect devices and apps so they can store and exchange data. Developers are using it to create their own smart products without having to build any backend infrastructure.

NFC at the Museum of London
go.nmc.org/nfclon
The Museum of London partnered with Nokia so that if visitors are carrying NFC-enabled devices, they can book exhibition tickets, access vouchers for the museum's café and gift shop, purchase prints, check-in on Facebook and Foursquare, and more.

Smart Muse
go.nmc.org/rkhbl
Centre Pompidou in Paris launched an NFC-enabled pilot tour where visitors can access and share location- and time-based information with each other by waving their smartphones over NFC tags.

Ubi The Ubiquitous Computer
go.nmc.org/ubi
Ubi is a device with sensors that monitor temperature, humidity, air pressure, and ambient light and also contains a microphone and speakers to plug into a wall outlet and listen for commands. Saying "Ubi" wakes it up to respond to the user's voice.

Visualight
go.nmc.org/visua
Visualight is an open-source, WiFi-enabled light bulb that visualizes data as colored light so that each user can customize their Visualight to turn a color corresponding to a specific alert.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about the Internet of Things:

Connected Environment
go.nmc.org/musne
(Jason daPonte, MuseumNext, September 2012.) The author, in his keynote from the MuseumNext conference, discusses how Internet-connected wearable technology and objects can give visitors a way to interact with the museum space.

Futurist's Cheat Sheet: Internet of Things
go.nmc.org/cpfez
(Dan Rowinski, *Read Write Web*, 31 August 2012.) The author explores a world where objects have their own IP addresses and communicate with each other through WiFi or cellular networks.

How the "Internet of Things" Is Turning Cities Into Living Organisms
go.nmc.org/cxmqs
(Christopher Mims, *Scientific American*, 6 December 2011.) If city systems are able to react to information stored in the cloud, they can respond to new environmental conditions.

How Museums Will Look in the Future
go.nmc.org/utigt
(Gareth Beavis, techradar, 22 August 2011.) TechRadar examines one successful museum application of NFC, where NFC tags have been deployed to provide patrons with quick information on museum exhibits, access to social networks, and more.

The Internet Gets Physical
go.nmc.org/yirhc
(Steve Lohr, *The New York Times*, 17 December 2011.) Smart devices are already a major link in human interaction, but they are further linking humans to their environment in ways that will benefit energy conservation, transportation, health care, food distribution, and more.

The Internet of Things: How It'll Revolutionise Your Devices
go.nmc.org/devi
(Jamie Carter, techradar, 4 July 2012.) This article discusses the potential of sensors and smart objects in monitoring and responding in ways that take over some of the frustrating tasks of daily life like grocery shopping and in self-repairing gadgets and more.

Would an Internet of Things Threaten the Internet of People?
go.nmc.org/inter
(Scott M. Fulton, III, *Read Write Web*, February 27, 2012.) This article brings up implications of the "Internet of Things" like security and how different precautions will need to be taken with machine-to-machine networks than the current protocols in place that are designed for humans.

Natural User Interfaces

Time-to-Adoption Horizon: Four to Five Years

It is already common to interact with a new class of devices entirely by using natural movements and gestures. Smartphones, tablets, game consoles, and the new class of "smart TVs" are part of a growing list of other devices built with natural user interfaces (NUIs) that 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 alternative input devices that allow computers to recognize and interpret natural physical gestures as a means of control. Natural user interfaces allow users to engage in virtual activities with movements similar to what they would use in the real world, manipulating content intuitively. The idea of being able to have a completely natural interaction with your device is not new, but neither has its full potential been realized. What makes natural user interfaces especially interesting 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, 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 other scientists and designers to adapt this innovation to new technologies.

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

Natural user interfaces allow users to engage in virtual activities with movements similar to what they would use in the real world, manipulating content intuitively.

graphics. The appeal of this innovation is that a person 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.

In educational contexts, NUIs have had profound effects on learners. Children working on multi-touch interfaces appear to adapt to the mechanism without thinking about it, which has increased support for using tools like touch screen tablets in the classroom. Indeed, these days it is not uncommon to see a very young child playing a game or solving a puzzle on a parent's iPhone, without help or instruction. NUIs also cater to the blind and deaf, 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.

Games and other leisure activities have been a major focus of natural user interfaces, especially in the

consumer sector. Launched in 2006, the Nintendo Wii was the first gaming console to popularize NUI and offered players the ability to play tennis, golf, and baseball from the comfort of their homes. The motion detection and gesture-based technology creates an experience that closely mimics the real experience of playing sports, even with the possibility of injury included.

When Microsoft introduced its NUI gaming system counterpart, Kinect, in 2010, it appeared to be a simple motion-detecting add-on to the Xbox. Yet with its video camera, 3D depth sensor, and data sensitive microphone, the Kinect was an excellent platform for experimenting with NUIs — the result of which are projects that represent all manner of human ingenuity. From the "tongue interface" (go.nmc.org/tongue) at The University of Electro-Communications in Japan to the TeleHuman (go.nmc.org/tele), a 3D video conference device developed by researchers at Queen's University, these projects point to the great potential NUIs have in myriad contexts. Museums today are just beginning to integrate gesture-based technology to create immersive experiences that intrigue and engage visitors. Installations that react to visitor movements or vocal commands are becoming more common, and museums are seeking out these types of exhibits to add interactive elements to their galleries.

Through NUIs like motion sensors and voice recognition, artists and designers are creating objects and installations that respond to our presence and speech patterns.

Relevance for Museum Education and Interpretation

Natural user interfaces render technology transparent and have the potential to transform the way we work with our collections and the way visitors interact with us and with our content. The 2009 film *Night at the Museum: Battle for the Smithsonian* mocks the museum's "don't touch" rule by displacing it with actual hands-on activity when the objects come alive. The desire to touch and manipulate collections is inherent in museum audiences, and though preservation and conservation issues may limit interactions with the authentic work, NUIs can compensate by allowing the visitor a measure of interaction directly with the environment and the content.

In recent years museum visitors have experienced a proliferation of multi-touch tables and interactive walls, long familiar to the fans of science fiction, in museums, aquaria, science centers, and historic sites across the world — from the Vancouver Aquarium in Canada (go.nmc.org/extable) to the National Museum of Australia (go.nmc.org/grass). Multi-touch tables allow visitors to access multimedia assets, practicing a form of open-ended exploration. Museums have discovered that simultaneous interactions of different groups of visitors with virtual assets provide the same opportunities and pitfalls that a similar experiment with objects on a real table would present: delight in discovery and jockeying for position.

Multi-touch tables are not the only source of NUI interactions. The British Museum's "Magnificent Maps" exhibition (go.nmc.org/sujqf) featured a hands-on interactive activity which allowed visitors to manipulate oversized magnifying glasses that used Microsoft's Deep Zoom technology to enlarge areas of the map into greater detail revealing layers of information. Transparency of the magnifying glass led to the disappointment of one visitor who took the tool to the wall hoping to coax the same information from the authentic object.

Several museums have begun to explore the potential of NUIs to enable museums to better serve audiences. Voice recognition is more and more based on statistical translation that might be leveraged by museums to provide better information to non-English speaking visitors at a fraction of the cost.

New kinds of sensing technologies — vision, ambient sensors, tangible object based interfaces, etc. — which

allow for natural interactions might result in a museum where any surface is the potential home for a virtual interaction. At this time there is probably more utility for NUI's in science centers, natural history museums, and children's museums — museums that are essentially experiential and idea-driven rather than object-based.

NUIs are crucial to facilitating experience, namely for disabled visitors who lack the faculties to enjoy traditionally designed exhibits. The Boston Museum of Science, for example, has already developed a NUI platform in collaboration with advocates for the blind to facilitate cultural experiences using touchscreen tabletops and voice-activated stations (go.nmc.org/rujcc).

The discovery-based learning opportunities for museums were more limited two years ago when this technology first appeared, also in the far-term horizon but categorized as gesture-based computing. Despite these experiments, NUIs are still four to five years away for most museums, but recently there has been a shift in the way museums are discussing this technology; three years ago, reservations were primarily about the tools and technologies; today, the discussion is about learning and interpretation outcomes. The push is being driven by advances in the commercial market and the proliferation of mobile apps that have creatively leveraged simple NUIs and made them available to all smartphone users.

A sampling of applications for natural user interfaces in museums includes the following:

> **Collections Management.** Touchscreen mobile devices along with multi-touch tables and walls are revolutionizing how visitors engage with educational materials within an exhibition. These alternative input devices respond to tapping, pinching, and swiping, and other gestures and movements.

> **Exhibitions and Collections.** Through NUIs like motion sensors and voice recognition, artists and designers are creating objects and installations that respond to our presence and speech patterns. The Tate Museum's "Hello Cube" is a sculptural video installation in the middle of a gallery that projects colorful kaleidoscopic images on a large adjacent wall. Through physical gestures and voice commands from visitors, the colors and patterns emanating from the piece can be altered.

New kinds of sensing technologies — vision, ambient sensors, tangible object based interfaces, etc. — which allow for natural interactions might result in a museum where any surface is the potential home for a virtual interaction.

> **Visitor Services and Accessibility.** NUIs aid in museum accessibility particularly for the blind/low vision community. Voice and gesture-sensing technology can pinpoint when a visitor has entered a space and immediately begin reciting information to them about an object or artwork.

Natural User Interfaces in Practice

The following links provide examples of natural user interfaces in use that have direct implications for museums:

100 Years of State & Federal Policy: The Impact on Pueblo Nations
go.nmc.org/dtiio
Housed in the Indian Pueblo Cultural Center in Albuquerque, this exhibit includes "The Document Table," a multi-touch table that allows visitors to explore significant events in the last hundred years of Pueblo history. A touch presenter surface is also used to display an interactive timeline that presents stories, videos, and photos at the visitor's request.

Brian Knep: Exempla
go.nmc.org/hgkdk
In this current exhibit at the Denver Art Museum, time-based media artist Brian Knep uses a combination of scientific tools and software to create interactive installations that respond to human behavior and activity.

The Digital Graffiti Wall
go.nmc.org/pxdox
The Digital Graffiti Wall enables users to paint on any surface and make a screen capture of the artwork that can be uploaded online and to social media platforms. It is portable, customizable, and can be installed in a variety of settings.

Gestureworks
go.nmc.org/zkysn
Initiated by a grant from the National Science Foundation as part of Open Exhibits, Gestureworks develops cutting-edge hardware and software for gesture-based applications in interactive exhibits.

Museum Night - Kinect Installation
go.nmc.org/musen
Based out of France, the Tazas Project is a group of new media artists who developed a Kinect installation called "Digital Interlude" for the Petiet Museum in Limoux. The exhibition uses Kinect sensors and a giant LED screen to project unique holograms of visitors onto the walls.

Soapbox! The Audience Speaks
go.nmc.org/soapb
In the summer of 2012, Museum of Photographic Arts launched the exhibit Soapbox! in which they used a touchscreen interface installed in the galleries along with a website interactive to collect user ratings on 120 works from the permanent collection.

For Further Reading

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

Freaks, Geeks and Microsoft: How Kinect Spawned a Commercial Ecosystem
go.nmc.org/kine
(Rob Walker, *The New York Times*, 31 May 2012.) The author follows the emergence and evolution of Kinect, explaining how it has spurned new inventions as a cost-effective tool to add 3D-sensing to other projects and devices. People everywhere are still experimenting with Kinect and sharing code and strategies to allow others to build on their advancements.

Gestures in the Wild: Studying Multi-Touch GestureSequences on Interactive Tabletop Exhibits
go.nmc.org/ctgdm
(Uta Hinrichs and Sheelagh Carpendale, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, p. 3023-3032, 2011.) This paper discusses findings from a field study at the Vancouver Aquarium that explore how patrons interact with a gesture-enabled table exhibit. One conclusion was that people not only used gestures to manipulate media objects, but to support social encounters with other visitors around the exhibit.

Gesture Recognition Moves Beyond Gaming
go.nmc.org/auimq
(Steve Sechrist, *Software Quality Connection*, 23 May 2011.) In the context of the major developments in gesture recognition, the author discusses the potential for Kinect-style natural user interfaces for academia to promote creativity and experimentation among students and researchers.

The Human Voice, as Game Changer
go.nmc.org/voice
(Natasha Singer, *The New York Times*, 31 March 2012.) The author paints a picture of how the voice-enabled future will materialize as we begin to interact in new ways with everyday objects, such as refrigerators, thermostats, alarm systems, and other devices.

Leap Motion's High-Resolution Natural User Interface Will Make Today's Touch A 'Legacy'
go.nmc.org/leap
(Anthony Wing Kosner, *Forbes*, 16 July 2012.) Leap Motion, a device that when plugged into a computer's USB port, allows users to control their computers with their three-dimensional hand and finger movements.

Natural User Interfaces
go.nmc.org/cvtqw
(Charles Xie, *The Advanced Educational Modeling Laboratory*, 21 August 2012.) The head of the Mixed Reality Labs project explains Natural Learning Interfaces, NUIs that allow users to interact with simulations on a computer.

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 600 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 49 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.

The NMC Horizon Project is currently in its tenth 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, Iberoamerica, Singapore, and Brazil, and has plans in place to expand that research to Europe, India and Asia. This report, the *NMC Horizon Report: 2012 Museum Edition*, is the third in the series focusing on museum education and interpretation. The flagship *NMC Horizon Report*, focused on higher education, is translated into multiple languages every year. Over all editions, the readership of the reports is estimated at over one million worldwide, with readers in over 100 countries.

The 49 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: 2012 Museum Edition* began in October 2012, and concluded when the report was released in December 2012, a period of just over two 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: 2012 Museum Edition,* and will fuel the work of the NMC Horizon Project throughout 2013. 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.

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

Methodology

The process used to research and create the *NMC Horizon Report: 2012 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.

All editions in the *NMC Horizon Report* series are produced using a carefully constructed process that is informed by both primary and secondary research.

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: 2012 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 600 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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ISBN 978-0-9883762-4-3

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