NMC

Horizon Report > 2011 Museum Edition

The *NMC Horizon Report: 2011 Museum Edition* is a coproduction with the Marcus Institute for Digital Education in the Arts (MIDEA), and 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: 2011 Museum Edition is a publication of the New Media Consortium and the Marcus Institute for Digital Education in the Arts.

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

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Executive Summary

The internationally recognized series of *NMC Horizon Reports* are part of the New Media Consortium's Horizon Project, a comprehensive research venture established in 2002 that identifies and describes emerging technologies likely to have a large impact over the coming five years in a variety of sectors around the globe. This volume, the *NMC Horizon Report: 2011 Museum Edition*, is a coproduction with the Marcus Institute for Digital Education in the Arts (MIDEA), and 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 local factors affecting the adoption and use of emerging technologies in museums, there are also issues that transcend regional boundaries and questions we all face. It was with these in mind that this report was created. The *NMC Horizon Report: 2011 Museum Edition* is the second in an annual series of museum-focused reports coproduced by the NMC and 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 potential technologies for the report. This dialog was enriched by a wide range of resources, current research, and practice that drew on the expertise of both the NMC community and the communities of the members of the advisory board. These interactions among the advisory board are the focus of the *NMC Horizon Report* research, and this report details the areas in which these experts were in strong agreement.

Each edition of the *NMC Horizon Report* highlights six emerging technologies or practices that are likely to enter mainstream use 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, the advisory board came to a consensus about the six topics that appear here in the *NMC Horizon Report: 2011 Museum Edition*. The examples and readings under each

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topic area are meant to provide practical models as well as access to more detailed information. Wherever possible, an effort was made to highlight the innovative work going on among museums around the world. The precise research methodology employed is detailed in the closing section of this report.

The report's format is consistent from year to year and edition to edition, and opens with a discussion of the trends and challenges identified by the advisory board as most important for the next five years. The format of the main section of this edition closely reflects the focus of the NMC Horizon Project itself, centering on the applications of emerging technologies, in this case for museum settings. Each section is introduced with an

overview that describes what the topic is, followed by a discussion of the particular relevance of the topic to museum education and interpretation. Several concrete examples of how the technology is being used are given. Finally, each section closes with an annotated list of suggested readings and additional examples that expand on the discussion in the report. These resources, along with countless other helpful projects and readings, can all be found in the global, social database — the NMC Horizon Project Navigator (navigator.nmc.org). All the ephemera of the *NMC Horizon Report: 2011 Museum Edition*, including the research questions and preview, can be downloaded for free on iTunes U (go.nmc.org/itunes-u).

Key Trends

The technologies featured in each edition of the *NMC Horizon Report* are embedded within a contemporary context that reflects the realities of the time, both in the sphere of museum education and in the world at large. To assure this context was well understood, the advisory board engaged in an extensive review of current articles, interviews, papers, and new 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 of those trends had significant agreement among the advisory board members, who considered them to be key drivers of museum technology adoptions for the period 2011 through 2016. They are listed here in the order in which the advisory board ranked them.

1 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 — but this is especially true of visitors to the physical space as well, where it is common to see people interacting with their smartphones as they decide which part of the gallery to visit next.

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

3 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 museum 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.

4 There is a growing chorus of voices advocating a more active role for visitors in shaping what museums do. As people become accustomed to tools that allow them to do things that previously required a great deal of expertise (i.e., video editing, or publishing to the web), they begin to appreciate the creative skills involved in actually producing science or art or the like. "Makers" are an emerging category of museum visitors, especially for science museums, who want to not only appreciate what they see in technical, historical or other

contexts, but to also understand how it was created. "Maker" experiences, which engage visitors of all ages in individual and collective experiences of tinkering, making, and discovery are a growing trend, and there is a role for all categories of museums in supporting and encouraging such experiences.

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

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

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 individual museum constraints 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 weren't 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 many and significant, 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 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, which is often in short video format, or short multimedia pieces. The challenge, one that faces content producers in every sector, not just 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.

2 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, 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 social media, mobile tools and apps, interaction with online communities, electronic fundraising, online sales, and much more. All must be addressed, which means new skill sets will often be required.

3 **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 ongoing 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.

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 in financial support of the enterprise is critical to every museum's success in the world today. There is a prominent 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 revenue streams — and the costs of training are falling at the same time as new, easier-to-use devices become more the norm.

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

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

7 **Improving the ability to measure impact using new digital technologies is a largely unmet but critical need.** Museums are good at traditional program evaluation, but determining the impact of new technologies on knowledge, attitudes, and skills is more challenging, especially when museum educators are attempting to measure the success of technologies that may be as yet unfamiliar to them. At the same time, there is also a bit of the "chicken and the egg" in understanding the rapidly changing technological environment. A balance must be struck between

trying new things, and the very prudent and sensible desire to invest in proven strategies. There must be demonstration projects to evaluate; in some cases, the data to establish efficacy are simply not yet available, and other criteria, such as a desire to be first to market with a new idea, must be allowed room in the decision framework.

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 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 *Horizon Report*. Six of those were chosen as key; they are summarized below and detailed in the main body of the report.

Technologies to Watch

The six technologies featured in the *NMC Horizon Report: 2011 Museum Edition* are placed along three adoption horizons that indicate likely time frames for their entrance into mainstream use for museum education and interpretation. The near-term horizon assumes the likelihood of entry into the mainstream for museums within the next twelve 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 organizations around the world, and the projects we showcase here reveal the promise of a wider impact.

Near-term Horizon

On the near-term horizon — that is, within the next 12 months — are mobile apps and tablets. These two topics have become pervasive in everyday life, at least in the developed world, and museum audiences have ever-increasing expectations of being able to learn on these devices whenever and wherever they may be. This year, for the first time, tablets have been separated from mobiles as a distinct category, preserving mobiles as a category for typical hand-held devices designed to make calls.

> **Mobile Apps** are the most relevant features of mobiles for museums right now. Mobiles appeared on the near-term horizon in the *NMC Horizon Report: 2010 Museum Edition*, with an emphasis on always-connected Internet devices using 3G and similar cellular networks. This year, the driving interest is in "apps" — particularly apps that take advantage of recent developments in location awareness and GPS. Museums and galleries are now able to design mobile experiences tailored to the physical location of their visitors. The introduction of near field communication (NFC) capabilities to some new mobile devices ensures that this technology will remain interesting for some time.

> **Tablets** present new opportunities to enhance in- and out-of-gallery experiences in ways simply not possible with other devices. High-resolution screens allow users of tablets such as the iPad to easily share content with each other and pore over images and videos on the screen. As people tend to use tablets to supplement and not replace smartphones, tablets are viewed as less disruptive tools — no phone ringing, no incoming text messages, etc. — which makes them ideal tools for learning opportunities. Docents, for example, are beginning to use tablets on small group tours instead of relying on information kiosks, and museums are experimenting with iPad apps that are child-friendly for family days.

Mid-term Horizon

The second adoption horizon is set two to three years out, where we will begin to see widespread adoptions of two technologies that are growing in popularity within the museum community: augmented reality and electronic publishing. Museum educators arguably have always been in the business of augmenting reality, creating bridges between objects, ideas, and visitors, but augmented reality technologies are now allowing this to happen more fluidly and easily than ever.

Electronic publishing allows museums to share content with their patrons while reaching an entirely different audience. By establishing e-publishing workflows, museums can easily update their e-books and release different versions of publications without having to go through the costly and arduous print cycle.

> **Augmented Reality** has become something anyone can use, thanks to the convergence of three technologies — GPS, video, and pattern recognition — and the application opportunities seem endless. Already on a path of convergence with mobile technology, augmented reality is not bound to the desktop, but is also 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.

> **Electronic Publishing** has fostered both new opportunities and new challenges for museums. New digital formats such as HTML5 are enabling museums to disseminate dynamic, multimedia content across a wide variety of devices, alleviating the time and resources it takes to create multiple formats. Museums are increasingly expected to experiment with these new forms, and with the sorts of publishing workflows that are part of the commercial publishing world.

Far-term Horizon

On the far-term horizon, set at four to five years away from widespread adoption, are digital preservation and smart objects. For years, museum professionals have been exploring ways to conserve digital objects and documents that are in peril of becoming obsolete, due to rapidly changing technologies. While the theory of digital preservation is increasingly well established, the practice is slow in taking root among cultural heritage institutions. Smart objects — the mechanisms behind Vint Cerf's "Internet of Things" — are already well established in the commercial sector and range along a continuum from QR codes on the simplest end to near field communication (NFC) on the more complex end. The entire spectrum has clear applications for museums, and it is only a matter of time before the Internet of Things begins to include objects in museum collections. These technology topics do not yet have well documented project examples or museum-specific research, but the high level of interest found in both areas indicates that they are worth following closely.

Digital preservation is not a new subject, but its systematic application in practice is.

> **Digital Preservation** is not a new subject, but its systematic application in practice is. A good deal of research in the 1990s served to provide a solid theoretical basis for the field, but museum professionals still face major challenges in not only keeping up with technology as it evolves, but also in taking steps to "future-proof" digital objects, documents, and works of art. Over the next five years, as more professionals become better educated in this area of conservation, museums will begin to systematically incorporate preservation metadata when they digitize their collections, so that each piece of digital content is supported by important details that will facilitate its long-term preservation.

> **Smart Objects** are a category of small devices or methods that enable three things: first, they allow an object to be assigned a unique identifier; second, they are able to attach small bits of information, such as its age, shelf life, environmental data like temperature or humidity, and much more. Third, they are able to communicate the status of that information on demand, whether optically or via electromagnetic frequencies. Advancements in smart object technology are bringing very low cost sensors and proximity-based communications into the spotlight. As these new micro-devices become commonplace, museums will be able to easily monitor conditions in the gallery, in storage, and in real time. Smart object technology is becoming more integrated with mobile phones, and the ecommerce potential of near field communication will allow visitors to seamlessly

make a purchase from the gift shop, and even have it shipped home with a click on their NFC-enabled mobiles.

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 may also be found. Given the practical focus of the report, a listing of examples of the technology in use, especially in museums, is a key component of each of the six main topics. Our research indicates that all six of these technologies, taken together, will have a significant impact on museums and other cultural institutions within the next five years.

The NMC Horizon Project

Since March 2002, under the banner of the NMC Horizon Project, the New Media Consortium has held an ongoing series of conversations and dialogs with hundreds of technology professionals, campus technologists, faculty leaders from colleges and universities, museum professionals, teachers and other school professionals, and representatives of leading corporations from dozens of countries. In the ensuing years, these conversations have provided the insights on emerging technology that are published annually in the *NMC Horizon Report* series.

In 2008, the NMC embarked on a new series of regional and sector-based companion editions of the *NMC Horizon Report*, 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. This report, the *NMC Horizon Report: 2011 Museum Edition*, is the second in the series focusing on museum education and interpretation. To date, companion editions have been prepared that center on Australia and New Zealand, tertiary education in the UK, Iberoamerica, the K-12 sector, and small- to medium-sized businesses. 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 more than one million worldwide, with readers in some 100 countries.

Like the university-focused effort from which it emerged, the museum project used qualitative research methods to identify the technologies selected for inclusion in the report. The process began with a survey of the work of other organizations, a close examination of topics previously detailed in the *NMC Horizon Report* series, and a review of the literature with an eye toward spotting interesting emerging technologies.

The 42 members of this year's advisory board were purposely chosen to represent a broad spectrum of the museum sector; key writers and thinkers from 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: 2011 Museum Edition* began in August 2011 and concluded when the report was released in November 2011, a period of just over four months. The six technologies and applications that emerged at the top of the final rankings — two per adoption horizon — are detailed in the chapters that follow.

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: 2011 Museum Edition,* and will fuel the work of the NMC Horizon Project throughout 2011-2012. 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.

Mobile Apps

Time-to-Adoption Horizon: One Year or Less

Mobile phones — distinct from new sorts of larger format mobile devices such as tablets — have as a category proven more interesting and more capable with each passing year. According to a report from mobile manufacturer Ericsson, by 2015 80% of people accessing the Internet worldwide will be doing so from a mobile device. At the 2011 Mobile World Congress, Google CEO Eric Schmidt noted that for every baby born that year, 30 Android phones would be activated. Mobiles are becoming better understood by museums; there has been a significant amount of time spent finding creative ways to incorporate them both in the physical space and as a tool to help patrons stay connected to exhibits from a distance. As museums become more adept at developing and using mobile apps, their utility and pervasiveness is only due to increase. Current examples of mobile apps used in museums span functions from interpretation and education, to marketing and promotion, to specialized apps tied to specific exhibitions.

Overview

Over 1.2 billion new phones are produced every year in what has proven to be an unprecedented flow of continuous enhancement and innovation in the capabilities of handheld devices. With each passing year, mobiles have become more convenient, more powerful, and more useful; their communication capabilities include the Internet, multimedia, games, sensor and motion technologies, and location awareness. An outgrowth of this explosion of new devices is that museum visitors expect to be able to use them anywhere — including the public spaces and galleries at museums. Indeed, practically every visitor who walks into a museum or gallery today is carrying a smartphone.

The new classes of mobiles are increasingly "always-connected" devices that make accessing web resources on the Internet as simple as sending a text message, and it was their ability to seamlessly connect via 3G and similar cellular networks that placed them on the near-term horizon in last year's report. This year, they reappear because their capabilities are being expanded in geometric terms through the proliferation of mobile applications — "apps" — that extend the capability and utility of mobiles in a seemingly infinite variety.

Distinct from tablets such as the iPad and Samsung Galaxy, mobiles are in many ways a mature technology, but they keep evolving and converging with other devices. Museum professionals have long explored creative applications of mobiles, at times lamenting the relatively small screens, but recognizing that higher resolution displays have alleviated much of the early concerns related to screen size. With the advent of apps, there has been a burst of truly creative energy as museums use mobiles to extend the museum experience to locations both within and beyond the gallery. The ease with which a developer can access tools like video, location sensing, motion awareness, and more is generating a wide variety of museum-specific applications that are very different than the traditional audio tour. One of the earliest of these, "Streets of London," allowed users to take a video of a location and see historical facts, photos, and more overlaid on the screen at locations all over the city.

New apps are using location awareness to reach out to patrons who may be nearby the museum, at a coffee shop or other location, to let them know about new exhibits or other timely news. A new collaboration between Google and the Getty museums uses the photographic and search capabilities of mobiles to provide users a simple way to access and save detailed

background information by taking a photo of a painting, sculpture, or other artwork. Similarly, the app can translate wall labels from a photo as well. The app, "Google Goggles," is free, and currently includes more than 350 pieces of art.

Relevance for Museum Education and Interpretation

Conversations surrounding mobiles and the utility of smartphones for museums are often less about the devices themselves and more about the variety of content and services that they deliver. The range of technologies converging in mobile devices is very broad, as is the variety of ways they can be applied: GPS and compasses allow sophisticated location and positioning; accelerometers and motion sensors enable completely new forms of control and interaction; digital capture and editing bring rich tools for high-resolution video, audio, and image capture and even editing. More and more, mobile apps make use of all this technology, and the apps that museums are creating are no exception.

Over the past couple of years, museums have primarily seen mobile apps as serving one of two purposes: to provide supplemental information about an exhibit or the museum itself; or as a mobile guide through the collection or gallery space. Both serve as extensions of the physical space; creating opportunities for people to become patrons no matter where they may be. Musée du Louvre's free iPhone app is a good example of an app that contains extremely detailed information about many of their exhibits, and includes robust images (go.nmc.org/gddts). Not only is it informative, but it also serves as compelling promotion for people to visit. London National Gallery's app (go.nmc.org/vnzvd) allows users to browse by artistic themes, including light and vanity, and contains 250 video and audio clips.

Museums are just beginning to explore ways to weave in more interactive and social features, like allowing users to recommend specific collections or works of art to their friends. While much emphasis has been placed on apps that expand the experience outside of the museum, there has also been considerable thought on how to use them in-gallery, especially in science museums. Apps that utilize location awareness help personalize the experience for the user, providing insight and new information around every corner. The Powerhouse Museum recently launched a project to build an indoor mobile app with location-based tracking (go.nmc.org/xdeke) that will deliver customized content to visitors based on their location, as well as providing spatial analytics to the museum for consideration when they plan their next exhibits.

Though many museums now have several years of experience with mobiles behind them, the technology continues to evolve rapidly. Most museums are still experimenting with ways to utilize mobile apps, even as other industries have found myriad ways to do so. The emergence of a wide variety of apps, along with some notably creative initial experiences, have opened the thinking in many museums to the potential of the device for other sorts of experiences beyond simply accessing deeper information about an exhibition or object. Museums need strategies for mobile content, just as they have strategies in place for use of the galleries, programming, marketing, and web content. In the short term, museums may struggle to find good developers conversant in the potential of mobiles, but one thing is clear: the more robust mobile devices and apps become, the more important they will be for museums.

As museums become more adept at developing and using mobile apps, their utility and pervasiveness is only due to increase.

A sampling of mobile applications includes the following:

> **Education and Interpretation.** Mobile games are increasingly seen as an engaging way to foster learning experiences outside the museum that relate to current exhibits or collections therein. The first

forays into this have typically used "Scavengr," which is a tool for developing quests or alternate reality games, to extend the museum beyond its walls.

> **Exhibits and Collections.** Museums are exploring how mobiles can be used to establish and recognize the identity of visitors and provide location-based services that anticipate the wants and needs of visitors, such as allowing them access to additional content, or even simple tasks such as making payments or finding their way to an exhibit.

With the advent of apps, there has been a burst of truly creative energy as museums use mobiles to extend the museum experience to locations both within and beyond the gallery.

> **Marketing and Communications.** Multimedia mobile apps have become an increasingly useful tactic to promote a new collection or wing of a museum. They offer a more interactive peek at what's new to drive interest in current and prospective patrons, and ultimately, more traffic to their physical spaces. The "Explorer" app by the American Museum of Natural History, for example, is comprised of all the museum's collections and provides users with recommended tours.

Mobile Apps in Practice

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

Balboa Park's Mobile Apps
go.nmc.org/zievx
Balboa Park's collection of mobile apps contains everything from turn-by-turn directions to immersive adventure games. Using location awareness, the "Balboa Park on the Meridian" app guides users to other similar cultural destinations around the U.S.

Explore 9/11
go.nmc.org/ehhkf
This app from the National September 11th Memorial and Museum is a mobile guide to understanding 9/11 through the eyes of those who witnessed it. The app features a seven stop walking tour of the area around the World Trade Center, accompanied by audio and photo narration.

Mobile Guide
go.nmc.org/lcqme
Aided by the IMLS Museums for America grant, The Nelson-Atkins Museum of Art created a mobile-optimized website that allows users to more easily browse collections and other pertinent information on their smartphones.

MuseumMobile
go.nmc.org/efgzf
An outgrowth of Tate Modern's Handheld Conference Wiki, The MuseumMobile Wiki is a free, public space for museum professionals to share best practices and new ideas on the use of mobiles. It also includes helpful "Mobile Interpretation & Strategy" worksheets.

A Picture Worth a Thousand Links
go.nmc.org/urtlu
"Google Goggles" has partnered with the Getty Museums to enable visitors to snap pictures of paintings on their smartphones to access insightful information on the work of art. This new tool is intended to supplement audio guides.

For Further Reading

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

Mobile for Museums
go.nmc.org/tnltm
(Sharon Leon, George Mason University, 2010.) The director of public projects at the Center for History and New Media assesses the current state of the mobile for museums field. The article also makes research-based suggestions for museum professionals considering mobile integration.

Mobile Media for Cultural and Historical Heritage, Guidelines and Pilot Projects
go.nmc.org/jokod
(Jasper Visser, The Museum of the Future, 2 May 2010.) This blog post describes some guidelines for museum staff to consider when planning a mobile project. The guidelines emerged from a brainstorming meeting of the European staff from Dutch Digital Heritage, the Dutch Museum Association, the Stedelijk Museum (Denmark) and the Beeld en Geluid.

Monterey Bay Aquarium's Integrated Mobile Strategy
go.nmc.org/olpit
(Beth Kanter, Beth's Blog, 26 January 2011.) Beth Kanter's interview of the Senior Manager of Online Communications at the Monterey Bay Aquarium. The aquarium worked closely with food service companies and restaurateurs to develop an iPhone app promoting sustainable seafood.

Multimedia Tour Guides on Your Smartphone
go.nmc.org/wpkee
(Sam Grobart, *The New York Times*, 16 March 2011.) This article discusses the successful transitions of some museums from kiosks to multimedia tours optimized for smartphones for visitors who are seeking more information on collections.

The Museum *Is* Mobile: Cross-Platform Content Design for Audiences on the Go
go.nmc.org/edekv
(Nancy Proctor, *Museums and the Web 2010: Proceedings*. Toronto: Archives & Museum Informatics, 31 March 2010.) This paper, presented at Museums and the Web 2010, takes an in-depth look at how museums can design mobile projects for their institutions.

Smartphones and Apps Research Findings
go.nmc.org/anyeh
(Lynda Kelly, AustralianMuseum.net, 12 August 2011.) The Australian Museum conducted research on their visitors' use of smartphones and apps to gain insight into the demographics of people who are using mobiles and how they are being used. One interesting finding was peoples' different definitions of a smartphone.

Museums are just beginning to explore ways to weave in more interactive and social features, like allowing users to recommend specific collections or works of art to their friends.

Tablet Computing

Time-to-Adoption Horizon: One Year or Less

In the past year, advances in tablet computers have captured the imagination of educators and museum professionals around the world. Led by the incredible success of the iPad, which in 2011 was selling at the rate of more than 3 million units a month, other similar devices such as the Samsung Galaxy and Sony's Tablet S also have begun to enter this rapidly growing new market. In the process, tablets (a form that is distinct from tablet PCs) have come to be viewed as not just a new category of mobile devices, but indeed a new technology in their own right, one that blends features of laptops, smartphones, and earlier tablet computers with always-connected Internet, and thousands of apps with which to personalize the experience. As these new devices have become more used and understood, it is clear that they are independent and distinct from other mobile devices such as smartphones, eReaders, or tablet PCs. With significantly larger screens and richer gestured-based interfaces than their smartphone predecessors, they are ideal tools for sharing content, videos, images and presentations because they are easy for anyone to use, visually compelling, and highly portable.

Overview

Led by the category-defining phenomenon that is the Apple iPad, tablets have earned their own emerging niche, completely distinct from mobiles. According to a recent study from comScore, the iPad now accounts for 97% of all tablet-based web traffic in the U.S. and 46.8% of all mobile web traffic. Similar statistics show tablets are increasingly the device of choice not just for web browsing, but also social networking and news. Competing models, including Motorola's Xoom and Samsung's Galaxy Tab have not yet enjoyed the success of the iPad, but together, these companies have solidified tablets as the new family of devices to watch. Immensely portable, tablets are well positioned to replace magazines in print, and iOS 5 even includes a newsstand that allows quick and easy access to newspapers and magazines — and new subscriptions with a mere touch. Tablets serve as e-readers, photo and video repositories, web browsers, and game platforms with instant access to thousands of apps — all in a slim, lightweight, portable package that easily fits in a purse or briefcase.

Screen technology has advanced to the point that tablets are exceptionally effective at displaying visual content such as photographs and video; similar advances in gesture-based computing have moved tablets far beyond the point and click capabilities of touch screens, and tablets are engagingly intuitive devices to use. These combinations of features are especially enticing to museums, and a growing number of institutions are experimenting with tablet-based ideas.

San Francisco Museum of Modern Art's Rooftop Garden app (go.nmc.org/nnfqu), for example, provides 360-degree views of the garden, commentary about the sculptures, plan drawings, remarks from SFMOMA Director Neal Benezra on the finished space, and much more — the app even lets users tweet about their experience as they are having it. These types of social media enhanced experiences allow users to share their thoughts on the experience they are having, and generate word of mouth for the museum at the same time. The portability and rich feature set tablets bring offers museums a fresh new way to think about supplementing physical exhibits.

Relevance for Museum Education and Interpretation

While much of the emphasis with mobiles is currently on creating opportunities for patrons outside of the physical space, the appeal of tablets is their potential

to enhance in-gallery experiences. Tablets are designed to be easily passed around, and their larger screen sizes lend themselves as excellent tools for small-group experiences. When users view content on tablets, the technology tends to disappear and what remains is clear, high-resolution edge-to-edge imagery.

Tablets are excellent for docent tours in particular — and they are child-friendly. Built-in geolocation can help visitors with wayfinding and provide proximity-based links to content; large display areas and applications make the devices ideal for addressing issues of accessibility; and, with an evolving set of features developed with each new release of the devices and their operating systems, the list of potential benefits continues to grow steadily. The devices provide a comparatively elegant, small way to deliver video precisely where it is needed, and can easily hold a considerable library of content. The range of interpretive possibilities for these relatively inexpensive, dependable, easy-to-use multimedia delivery devices is only beginning to be explored, but the potential is easy to see.

Adding to their interpretive promise, the easily portable tablets can support individual exhibits and the museum as a whole at once. The design and installation industry has been quick off the mark to recognize the potential for museums, and there are already dozens of different commercial mounts available for "installing" these devices in museums, such as the iPad Kiosk Mount (go.nmc.org/rzqmj).

Museums are currently investigating ways to utilize iPads to create products that supplement their exhibits and make them feel more personal. The Southwest School of Art is creating a mobile podcasting studio with the help of an iPad and an iPad camera adapter kit. The podcasts will include conversations with the artists behind the exhibits and provide viewers with a more intimate perspective of their work. The Sid Richardson Museum is also taking advantage of the usefulness of tablets by creating iPad videos that serve as tour guides for select paintings. Visitors can easily carry the hand-held device with them as they move through the space to learn new information about the artwork in front of them.

A sampling of tablet computing applications includes the following:

> **Education and Interpretation.** Tablets present museums with new avenues for interpretive and educational media that take advantage of their large screens and gesture-based interfaces. The American Museum of Natural History's Dinosaur app, for example, uses the high-resolution capabilities of the iPad to share some of its extensive collection of dinosaur fossils and renderings of prehistoric times.

Screen technology has advanced to the point that tablets are exceptionally effective at displaying visual content such as photographs and video.

> **Exhibitions and Collections.** A number of museums are experimenting with the use of iPads and other tablets as in-gallery resources that either extend the exhibit or add ways for visitors to explore the concepts on display in more depth. The New Walk Museum & Art Gallery in Leicester, England, for example, is using iPads to provide visitors to an exhibition of works by Gerhard Richter with visual interpretations by four digital artists.

> **Marketing and Communications.** Apps that highlight aspects of museums' collections or upcoming exhibitions are increasingly being seen as a way to generate interest — and visits. The Museum of Modern Art, for example, has created an app that allows users to find out about current and upcoming exhibitions, film schedules, and program dates, plan a tour, or browse or search the thousands of art works in the collection.

Tablet Computing in Practice

The following links provide examples of tablet computing in use in museum settings.

Drawing the Buddha
go.nmc.org/mylbq
As part of their Family Day series, the San Antonio Museum of Art designed a set of hands-on activities around the iPad where participants used a drawing app to create their perceptions of Buddha. Participants are then able to print out these drawings and take them home.

The portability and rich feature set tablets bring offers museums a fresh new way to think about supplementing physical exhibits.

Go Figure
go.nmc.org/fmjgj
The University of Chicago's Smart Museum of Art's exhibit, *Go Figure*, incorporates several wall-mounted tablets that are pre-loaded with curatorial videos that feature talks from the artists, enabling patrons to get a more personal sense of the people behind the objects.

Me Draw on iPad
go.nmc.org/omefg
This exhibit at the Louisiana Museum of Modern Art features complex drawings created by artist David Hockney on his iPad. The installation showcases slides of his work across 20 iPads. In many of the pieces, he uses only his fingers to create full-color images with layered brushstrokes.

Tour Arctic Museum Exhibition with Student-Designed iPad App
go.nmc.org/mksmx
Designed by two students from Bowdoin University, The Peary-MacMillan Arctic Museum's interactive iPad tour is targeted at children to teach them about animals in the Arctic through games and quizzes.

WaterWorx
go.nmc.org/whnwm
The Powerhouse Museum's WaterWorx in-gallery interactive allows visitors to learn about managing urban water systems through a game that is specially designed for the iPad. Users are able to control water management tasks through the touchscreen.

Wikipop iPads
go.nmc.org/vmwhw
During Brooklyn Museum's Wikipop project, they installed several iPads both inside and outside the gallery to determine where and how visitors preferred to use them. They found that many patrons using the iPads did so for lengthy periods of time.

For Further Reading

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

The Avatar and the iPad
go.nmc.org/dpijm
(Jennifer Bantz, Brooklyn Museum, 6 July 2011.) This post is a behind-the-scenes look at the preparation and analysis stages for a Brooklyn Museum exhibit that includes iPad kiosks. Using the iPads, visitors can choose and connect with avatars that become their identifiers as they explore the exhibit.

Educators Evaluate Learning Benefits of iPad
go.nmc.org/whlnr
(Ian Quillen, *Education Week*, 15 June 2011.) This article discusses the use of iPads as learning tools, and delves into the ongoing discourse about whether they are more viable for one-to-one solutions or as part of a group of shared devices.

Find Out How an iPad Might Get People Back into Museums
go.nmc.org/znvvi
(Douglas Britt, *Houston Chronicle*, 23 May 2011.) Through exploring several successful iPad projects, this article builds the case that this blockbuster tablet will help create more engagement among museum patrons and even entice new ones.

Using the iPad in Museum Work
go.nmc.org/lyuxv
(Mark Wilson, Wooster Geologists, 8 August 2011.) This article explores the benefits of museum professionals using iPad camera apps and features to capture photographs of very small specimens. The author also discusses various reading and writing programs for scientific papers.

Using the iPad with Group Tours
go.nmc.org/tnjkv
(Scott Sayre, MIDEA, 3 May 2011.) One museum scholar shares creative ideas and best practices on integrating the iPad into docent tours. One of his best practice recommendations includes limiting the group size to 10-12 people.

What Can the iPad do for Museums?
go.nmc.org/zlzlq
(Scott Billings, MuseumNext, 4 January 2011.) This article explores how museums and galleries can exploit iPad technology to create more interactive experiences for patrons, both inside and outside of the physical space.

When users view content on tablets, the technology tends to disappear and what remains is clear, high-resolution edge-to-edge imagery.

Augmented Reality

Time-to-Adoption Horizon: Two to Three Years

Augmented reality (AR), a capability that has been around for decades, is shifting 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. Specifically in the museum sector, AR provides patrons the opportunity to see how something is being done instead of listening to a docent's explanation. As AR technologies and platforms become more readily available and affordable, museums will see the use of augmented reality and 3D technologies increase dramatically. Museums will need to consider how the level of immersion offered to patrons can be balanced against the desire of many visitors to have a quieter experience.

Overview

The concept of blending — or augmenting — what we see in the real world with related information, data, media, and even live action is a powerful one. Augmented reality aims to do just that as a means to enhance the information we can perceive with our senses. The first modern application of augmented reality was when a cinematographer developed a simulator in the early 1960s that incorporated visuals, smells, and vibrations. By the 1990s, augmented reality was being put to use by a number of major companies for visualization, training, and other purposes. Now, the technologies that make AR possible are powerful and compact enough to deliver augmented reality experiences to personal computers — and even mobile devices. Early mobile applications began to appear in 2008, and now many AR applications and tools for mobiles are on the market.

Augmented reality applications can either be marker-based, which means that the camera must perceive a specific visual cue in order for the software to call up the correct information, or markerless. Markerless applications use positional data, such as a mobile's GPS and compass, or image recognition, where input to the camera is compared against a library of images to find a match. Markerless applications have wider applicability since they function anywhere without the need for special labeling or supplemental reference points. Layar (go.nmc.org/rfomi) has been a leader in this space with augmented reality applications for the Android and iPhone platforms. Layar Vision is a markerless application of AR that makes it easy to develop apps that can recognize real world objects and overlay information on top of them.

In the commercial and entertainment sectors, augmented reality has been used so effectively, it is often not even noticed by the casual observer. For example, the floating yellow line that appears in telecasts of American football games is an AR application that represents where a team must drive to reach a "first down." Games were quick to integrate the technology, and early examples such as *Halo* and *Rainbow Six* made the presentation of "heads up" data commonplace. In both of these examples, the added information is seen by most observers as simply part of the experience.

Today, advancements both in AR technology and mobile capabilities are increasingly driving this technology

into the handheld space. The cameras and screens in smartphones, tablets and other mobile devices now serve as uniquely convenient tools to combine real world data with virtual data. Sensor-based AR uses GPS capability, image recognition, and the devices' built-in compasses to pinpoint where a mobile device is on the planet and where its camera is pointing, and then uses that information to overlay relevant facts, data, or visuals at appropriate points on the screen.

Augmented reality appeared in the mid-term horizon in the *NMC Horizon Report: 2010 Museum Edition* primarily for its convergence with mobiles, and remains there for 2011. 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. Nonetheless, an application that is finding increasing traction is the use of augmented reality to extend the museum and its mission beyond its physical setting.

One of the first success stories of this type of augmented reality app was Museum of London's "Streetmuseum," (go.nmc.org/pwpkr) which encourages users to learn London history simply by pointing their mobiles at historical buildings and sites; the video feed from the camera is overlaid with notable tidbits and even archival photos that illuminate the history of the city. The Hull History Viewer for Android phones (go.nmc.org/zdnq) uses a similar approach to display artist renderings of Kingston Upon Hull as it appeared before it was largely destroyed in the Blitz campaign of World War II.

The most common uses of augmented reality currently are in entertainment and marketing, but museums are quickly following as the technology matures and becomes even more simplified. The broad appeal of augmented reality resides within its diverse applications — the ability to incorporate the technology into games, activities, presentations, movies, and even investigative tools.

Relevance for Museum Education and Interpretation

Augmented reality is a technology perfectly suited for one of the key functions of museums: interpretation. As AR technologies and platforms become more readily available and affordable, history and science museums are quickly finding uses for augmented reality both inside and outside the exhibit floor that incorporate additional detail and information right into the experience. Art museums have been slower to adopt augmented reality, as they grapple with balancing the level of immersion offered to museum visitors through AR technologies against the needs of what Rob Stein of the Indianapolis Museum of Art has described as the "solace-seeking visitor who desires a quiet experience with art," but early experiments show tremendous promise for museum and art education.

Providing visitors layered information about an object or exhibition is a simple, non-invasive approach to giving users a deeper experience.

One of the easiest ways to visualize the potential of augmented reality is the ease with which it can make invisible things visible, such as the X-ray pictures or the preparatory drawings of a centuries-old painting, or to restore things to a previous state, such as illustrating the way the Berlin Wall appeared before it was torn down, *in situ*. Using simple off-the-shelf tools, museums are easily able to provide straightforward, yet engaging visuals and facts that are "layered" over objects or physical settings when viewed through their phones or tablets. Providing visitors layered information about an object or exhibition is a simple, non-invasive approach to giving users a deeper experience.

A groundbreaking project by the City of Philadelphia Department of Public Records has used sensor-based augmented reality as a way to showcase some 93,000 historic photographs from the city's archives. Working with geographic services company, Azavea, they

mapped the entire PhillyHistory collection using sensor-based augmented reality. Not only did they create a richly detailed resource available to anyone with an Android or iOS-based device, but they also captured the entire development process in a white paper. (See the "For Further Reading" section below.)

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.

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.

A sampling of applications of augmented reality includes the following:

> **Education and Interpretation.** Augmented reality offers visitors the ability to call up structural, x-ray, or other scientific information related to an object on demand, while having almost no impact on the physical space.

> **Exhibitions and Collections.** Within a culture in which visitors can rarely touch the objects in the collections, augmented reality has strong potential to provide a form of interaction with objects that otherwise would not be possible.

> **Marketing and Communications.** Coupled with location-based services, augmented reality is an important tool in taking a museum's collections and content beyond the institution's walls. AR is progressively being used as a marketing strategy to immerse a prospective visitor in an exhibit from their computer or mobile to pique their interest in the physical collection.

Augmented Reality in Practice

The following links provide examples of augmented reality in use in museums and other settings.

Browsing the Powerhouse Museum Around Sydney
go.nmc.org/xjety
The Powerhouse Museum has developed an augmented reality application that captures the history of Sydney, Australia, by allowing visitors to use their mobile phones to snap pictures and see the city as it appeared one hundred years ago.

Chicago Museum of Science and Industry
go.nmc.org/tcvdd
An augmented reality musical game, featured in the Chicago Museum of Science and Industry's permanent exhibition *YOU! The Experience,* turns a 2D card into a virtual keyboard. The user repeats three rounds of increasingly difficult note sequences. Afterward, the card calls up a visualization of the brain, showing its activity during the game.

CultureClic
go.nmc.org/uxiqm
CultureClic is a free iPhone augmented reality application that allows visitors to explore more than 500 paintings, photographs, and engravings in Paris, Bordeaux, Lyon, and Marseilles — while standing in the location depicted in the artwork.

A Future for the Past (Video)
go.nmc.org/dcmiz
In 2009, the Allard Pierson Museum in Amsterdam presented an exhibition entitled *A Future for the Past* which included two prototype augmented reality applications: A virtual reconstruction of Satricum, and an annotated landscape on an 1855 photograph of Forum Romanum. This video describes the exhibition.

Getty Museum: Augmented Reality of the Augsburg Display Cabinet
go.nmc.org/arskw
This augmented reality project enables viewers to take a detailed look at the intricately carved and decorated Augsburg Cabinet (1630), bringing this unique piece closer to visitors without risking harm to the object.

Metaio and Louvre-DNP Museum Lab (Video)
go.nmc.org/mlyjb
This joint project between the Louvre and augmented reality development firm Metaio is developing material to enhance exhibits and collections. This video demonstrates a prototype device that overlays augmented reality content onto the museum's gallery spaces.

Who Do You Think You Really Are?
go.nmc.org/uqthc
The London Natural History Museum developed an interactive dinosaur film optimized for tablets that incorporates gesture-based manipulation and augmented reality, where extinct creatures appear to roam the Attenborough Studio space.

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. He poses the issue of whether AR enhances the museum experience or becomes the experience itself.

'Augmented Reality' on Smartphones Brings Teaching Down to Earth
go.nmc.org/vgjyv
(Sophia Li, *Chronicle of Higher Education*, 20 June 2010.) This article showcases some learning projects that incorporate augmented reality on smartphones, including the University of Wisconsin – Madison's ARIS, which allows users to link text, audio, and video to physical location.

Getting Started with AR
go.nmc.org/frqcb
(Craig Kapp, *The Pixel Farm*, July 2010.) Augmented reality developer Craig Kapp has compiled an excellent list of resources aimed at beginners who are interested in experimenting with augmented reality applications, including "mixed reality textbooks" and 3D baseball cards.

If You Are Not Seeing Data, You Are Not Seeing
go.nmc.org/exkwl
(Brian Chen, *Wired Gadget Lab*, 25 August 2009.) This article gives a good overview of augmented reality, including what new applications to expect in the future. The author notes that advertising agencies have been among the first industries to most innovatively use the technology and cites specific examples.

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 PhillyHistory database: go.nmc.org/jwqpq.

Mixing Realities to Connect People, Places, and Exhibits Using Mobile Augmented Reality Applications
go.nmc.org/wnmbq
(Rob Rothfarb, Museum Virtual Worlds, 14 April 2011.) This article is a great resource for discovering the current most effective AR programs at museums. The author shares background information on how AR-based exhibits were planned and prototyped.

Electronic Publishing

Time-to-Adoption Horizon: Two to Three Years

Now that it is firmly established in the consumer sector, electronic publishing is beginning to demonstrate capabilities that challenge the boundaries between print and digital, still image and video, passive and interactive. Modern digital workflows support all manner of possible publication, from traditional print to digital, web, video, and even interactive content. Building in the full spectrum of potential publishing avenues — print, web, video, mobiles and tablets, and interactives — from the beginning is not only a way to streamline production overall, but also to increase the reach of the materials produced by leveraging the content over a wide range of media. Modern media companies have been at the vanguard of this conversion. Magazine writers, for example, will produce a piece so that it will work in the magazine, on the web, and in video — and the finished product may appear in any or all of those outlets. The reason electronic publishing resides on the mid-term horizon is because museums and their publishing arms generally do not have sufficient staff, infrastructure, and systems in place to manage the workflows for simultaneous publication across multiple media, nor do they typically see the potential in ways that commercial publishers do.

Overview

Electronic publishing allows content creators to design and produce a piece irrespective of the format in which it may ultimately appear, and thus fosters the flexibility to easily port content into many different formats, providing people with a variety of reading options. With each format comes a unique experience that is constantly progressing to include more enhanced features at every turn. Not meant to replace more traditional print materials, but instead, to supplement and expand the offerings available to readers and consumers, electronic publications have become commonplace, and all major magazines and periodicals have at least one electronic variant, if not many. Electronic publishing reflects the convergence of several different forms of digital media into a single stream of production.

In the midst of the rapid growth of electronic publications over the past few years, commercial publishers, not unlike the music industry in years past, have seen their business models tested by the emergence of high quality digital materials. As a result, they also faced the inherent challenge of changing their strategies and workflows — all at the speed at which technology was evolving. Since 2009, publishing houses have given a great deal of consideration to deploying the most streamlined processes for generating, producing, and marketing content. Before electronic publishing, there weren't as many moving pieces, and the pieces themselves were more easily understood; publishing meant print, words, and perhaps pictures. Video and multimedia were distinct forms, but such distinctions are increasingly hard to make.

Today's publishers see themselves as media companies, producing content for whatever delivery formats will achieve the greatest reach. With the advent of emerging new formats, publishers are able to create different versions of a piece — i.e. an extended version with author interviews or with a "foldout" of glossy images — and tailor them to distinct audiences. Content is captured just once for a variety of potential applications. Today, it is not uncommon for the same promotional video clip for a book to be embedded in the electronic publication, uploaded to YouTube, and published on the author's website.

The increasing expansion of HTML5 in the past year is possibly the most significant recent development for electronic publishing workflows. Publishers view HTML5

as the solution to the jungle of proprietary electronic publishing formats that limited the growth of electronic publishing initially. HTML5 enables a page in a document to render as a web page in the fullest sense of that concept, and to render that page in whatever fashion optimizes the original design for a particular platform. HTML5 also uses the same coding to display that same page across any other platforms and devices that support HTML5 — an ever-expanding assortment, including iPads, iPhones, laptops, and desktops. Even video and images will display more vibrantly under the new standard.

Over the past few years, commercial publishers have embraced electronic publishing and proven its worth — at Amazon, e-books now outsell printed books, and magazines are one of the top content categories for the iPad. Consumers have come to expect that they can read a catalog, brochure, or book on whatever device they happen to be carrying.

Museums have been slow to join the move to electronic publishing, both in terms of workflow, and in terms of output. It is rare to see a printed museum publication in a digital format other than Acrobat, which is based on treating content as images as opposed to the fluid and dynamic approaches used in HTML5. Likewise, museums rarely have a production staff that is able to capture content in ways that support multiple distribution formats; indeed, it is quite common for museums to simply outsource production and design, an approach that locks in the product at the outset. Adding in new notions about content capture that will support electronic publishing is forcing museums to rethink their processes, and currently many of them are still in the strategizing and conceptual phases. Ultimately, electronic publishing resides in the mid-term horizon because best practice workflows have not yet been implemented to any discernible degree in museum publishing; a search for museum case studies of electronic publishing projects did not yield many concrete examples.

Relevance for Museum Education and Interpretation

Electronic publishing has become the norm in commercial publishing over the past few years, and museum professionals, long accustomed to producing publications with rich imagery and content, have begun to consider the affordances of moving broadly to electronic publishing models. Adapting workflows that fully embrace electronic publishing, however, are often challenging for most museums, for which publishing generally means printing, and video generally means preparing content for DVD.

Electronic publishing allows content creators to design and produce a piece irrespective of the format in which it may ultimately appear, and thus fosters the flexibility to easily port content into many different formats, providing people with a variety of reading options.

There is currently a common process for most museum workflows: an end product is visualized and defines how the project proceeds. A catalog project, for example, would be defined in print terms, and while museums regularly create beautiful and very inventive catalogs, the medium excludes features such as video, animations, or interactive multimedia, which would make for a compelling electronic version. Web projects and video projects are conceived in a similar fashion. Because of this, in most cases, the copy and design for print and web projects are managed as completely separate processes, each driving toward their own predefined end product. In this scenario, adding new media, such as e-pubs or other new formats, is essentially adding another project, as well as the additional costs to support it.

Electronic publishing turns that model end over end, and separates content production and design from

the medium in which that content may ultimately appear. While specialization has its merits, the missed opportunity in the "old school" model is to look at content in a way that could support any potential use. The idea is not to bolt electronic publications onto existing publishing workflows, or to add them as separate processes, but rather to integrate all interrelated content production into a single workflow that offers the possibility of publishing in many formats — including print and the web — but also video, social media, e-pubs, mobile apps and interactives, and to do so in ways that work across the range of devices.

When the notion of content is separated from the notion of medium, it is far easier to consider how and where to capture video, imagery, text, audio, and so forth, because the idea is to ensure all of those forms are captured at the beginning of the process. The benefits for museums are the same as they are for commercial publishers — it minimizes the incremental cost of supporting new forms of publication by integrating their content production and design. For example, once the decision is made to support HTML5, a print design, a web design, and an e-pub design all flow from the same basic design work, enabling not only publications in a variety of formats, but a minimum of additional work to make all three render that design optimally.

Consumers have come to expect that they can read a catalog, brochure, or book on whatever device they happen to be carrying.

In addition to electronic publishing's embrace of the growing number of digital formats and media, the process makes it very easy to produce variations of a story, customized for a particular audience. Because of the compelling flexibility electronic publishing provides, a growing number of museums are beginning to think about adopting an electronic publishing model.

A sampling of applications of electronic publishing includes the following:

> **Education and Interpretation.** Publishing content in a variety of formats will allow educators to easily create specialized versions of exhibition content for distance learning and other forums, while curators will be able to easily modify an electronic publication to suit specific audiences, such as art historians or students of techniques.

> **Exhibitions and Collections.** The use of electronic publishing approaches in the production of supporting content for traveling or special exhibitions would greatly enhance the options a receiving museum would have for the creation of specialized publications.

> **Marketing and Communications.** An electronic publishing workflow gives marketing professionals access to a wide range of options for promoting an event or exhibition, and makes it easy for museums to have a uniform design across the print publications, web, social media, and e-marketing materials associated with the campaign.

Electronic Publishing in Practice

The following links provide examples of electronic publishing.

Book Creator
go.nmc.org/xprew
Book Creator is an iPad app that allows users with minimal development experience to design, create, and produce e-books on their iPads. Users can then export them to be placed and even sold in the iBook store.

The British Library's Turning the Pages
go.nmc.org/lvufj
"Turning the Pages" is an interactive display system that uses Adobe Shockwave to share its electronic publications with the public. People are able to actually turn the pages of manuscripts via their touchscreens.

National Museums Scotland
go.nmc.org/fokvf
National Museums Scotland recently rebuilt their website in HTML5, which has allowed them to more easily and dynamically share hi-resolution images and videos across all viewing platforms, including the iPad.

Online Scholarly Catalogue Initiative (OSCI)
go.nmc.org/zgxwn
Led by the J. Paul Getty Foundation and J. Paul Getty Museum, OSCI is the collaborative effort between nine museums to devise innovative strategies and a framework for disseminating scholarly information across the web and other digital platforms such as the iPad.

Treesaver
go.nmc.org/vkehz
Treesaver has recently expanded their do-it-yourself services to include HTML5 app-building so that even smaller museums and organizations can create content once and easily publish it to multiple devices.

For Further Reading

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

Building a Magazine for the Digital Age
go.nmc.org/jkzgw
(Lauren Indvik, Mashable, 31 July 2011.) While this article is focused on digitizing magazines, it has implications for the museum world, which shares challenges around accurate image rendering, embedded video, and other features of digital formats.

How Yale Press Took Over Art Publishing
go.nmc.org/lricf
(Edmund Downie, Yale Daily News, 13 April 2011.) This article discusses the art of electronic publishing and how Yale Press has successfully transitioned into the digital age by finding a way to produce electronic content that captures the glossy images from print materials.

New Adobe Digital Publishing Suite, Single Edition Announced
go.nmc.org/kezxi
(Adobe, 3 October 2011). Learn about Single Edition, a new Adobe Program that allows users, in a do-it-yourself fashion, to create digital magazines and magazine apps for publication specifically on the iPad.

Online Platforms Begin to Test the Market for University-Press E-Books
go.nmc.org/jzczb
(Jennifer Howard, *The Chronicle of Higher Education*, 3 October 2011.) This article explores several e-book projects in their initial phases at universities, and discusses the implications of electronic publishing as it relates to contracts with publishing houses.

Electronic publishing reflects the convergence of several different forms of digital media into a single stream of production.

Digital Preservation

Time-to-Adoption Horizon: Four to Five Years

At the most basic level, digital preservation refers to the conservation of important objects, artifacts, and documents that exist in digital form. As technology continues to rapidly evolve and new software is propelled into mainstream use nearly every day, continued innovation leads to planned obsolescence for hardware and software, all too often rendering content created with older versions unusable. Museums have vast amounts of electronic media in their collections, and each item of digital content represents a unique challenge from a conservation standpoint. While museums have long employed art historians with specialties in artifact preservation, there is now the looming issue of finding professionals who understand preservation from a computer science perspective. Just like ancient objects, digital objects can be fragile and require special care, and the museum sector's growing dependence on changing technologies puts these digital items at great risk. As museums, universities, libraries, and other organizations start to support and develop processes and resources for digital preservation, a new science and toolset is emerging to support and inform the work.

Overview

Digital preservation of information is becoming an increasingly important topic everywhere. As new technologies enter the marketplace, and old ones are improved, our digital heritage is in jeopardy of being lost. The museum's very mission centers on the long-term access to and related preservation of objects both physical and digital, so this issue is especially pressing, yet the science to address it — digital preservation — is not well understood. Digital preservation is less about updating content to work with the newest releases of software — a common misconception — and more about future-proofing digital works of art, documents, and media. The latter aspect involves an advanced understanding of preservation metadata. Few museums have staff with an in-depth understanding of how to craft and understand technical data to accompany digital content that documents its digital details, instructions, file structure, format, history, and so forth.

Scientists and art historians have spent hundreds of years mastering the process of conserving physical artifacts. Digital preservation calls for a new type of conservationist with skills that span hardware technologies, file structures and formats, storage media, electronic processors and chips, and more, blending the training of an electrical engineer with the skills of an inventor and a computer scientist. Decoding content and recovering material from devices or storage media that may not have been used for decades requires equipment and knowledge that few museums outside those specializing in computer technology would have on staff.

There are two parts to the challenge. One is arguably manageable by museums because they control the processes, and that involves developing best practice workflows to establish proper protocol and standards when initially digitizing content that exists in a physical, non-digital form. The second and harder challenge is to be able to keep digital content produced by others in a form in which it can be viewed or used, whether the original producers were artists, scholars, publishers, manufacturers, or inventors. In both cases, there are not well-understood and accepted practices that a typical conservator would recognize. While a great deal of work has taken place in the area of digital preservation, that work is still largely theoretical, rather than practical. Where digital preservation processes do exist, they are, by and large, either not well-documented or are highly experimental — although that is beginning to change.

Perhaps the most well-known works in digital preservation to date are the Online Computer Library Center's four-point strategy, developed in 2006 (go.nmc.org/twpvl), and the Internet Archive, created before the millennium to preserve snapshots of the dynamic and changing landscape of the world wide web (go.nmc.org/qlwyp).

The Open Archival Information System is clarifying best practices via a framework of archival concepts needed for long-term preservation of digital information and access to it (go.nmc.org/speui), along with developing methods for authenticating digital documents and objects. Additionally, the Library of Congress has done landmark work to establish a national strategy to collect, preserve and make available significant digital content (see the National Digital Information Infrastructure and Preservation Program: go.nmc.org/qfkou). Taken together, these projects define the current state of the art in the field of digital preservation.

Relevance for Museum Education and Interpretation

Though digital preservation appears on the far-term horizon, it is not by any means a new topic for museums. The placement of the topic on the four-to-five year horizon is an acknowledgement of the small amount of time and effort museums are currently able to dedicate to the topic. Digital preservation has long been the concern of a small, but ever-growing cadre of cultural heritage professionals, who recognized early on the inherent conservation issues in the cycle of rapid implementation, adoption, and ultimate abandonment of new technologies. It is a testament to the efforts of these conservation pioneers that the topic is now to the point where it is on the radar of most museum technologists.

Museums across the world have large collections of electronic media objects, each representing unique challenges from a conservation/preservation standpoint, including antiquated operating systems and hardware and computer programs written in now-defunct programming languages. Storage media like floppy disks are already challenging to read at all, given that few computers have floppy drives in the first place, and the hardware challenges are only part of the issue. Both optical and magnetic storage fade over time, corrupting once-readable data merely through the passage of time. Neither of these challenges addresses the issues of file formats and run-time use of the files, once they can be accessed via the appropriate hardware.

Digital works of art, which commonly push the boundaries of commercially available technology, present additional challenges. Often, custom hardware is at the heart of a digital installation, and few artists are interested in or able to document the intricacies of the machines they use. The number of conservators who understand this kind of work from the perspective of the computer scientist and electrical engineer, as opposed to that of a traditional conservation specialist, is small and not growing fast enough. The demand for trained professionals continues to outstrip the resources of the higher education and museum communities that would educate and train a new generation of digital conservators and digital curators.

As museums, universities, libraries, and other organizations start to support and develop processes and resources for digital preservation, a new science and toolset is emerging to support and inform the work.

Helen Tibbo at the School of Library and Information Science at the University of North Carolina at Chapel Hill began offering a course in Digital Preservation and Access in 2000 and that institution is one of the few in the country offering MA candidates the opportunity to specialize in Digital Curation. While this certificate deals primarily with the management of all digital resources, as opposed to focusing on those objects in museums that might be described as "digital works of art," the goals and principles of the program are applicable to

the specific needs of the curators and conservators charged with caring for these new art forms.

The debut appearance of digital preservation in the *NMC Horizon Report* at this juncture is significant because it shows that museums are becoming more broadly aware that they are facing significant problems in the near future if the intricacies of digital curation and preservation are not more widely understood in the community. To date, very few known and well-documented projects exist to serve as best practice models for digital preservation efforts.

Digital preservation calls for a new type of conservationist with skills that span hardware technologies, file structures and formats, storage media, electronic processors and chips, and more, blending the training of an electrical engineer with the skills of an inventor and a computer scientist.

A sampling of applications for digital preservation includes the following:

> **Cross-Institutional Collaboration.** Advances in digital preservation can and must be shared between institutions. The opportunities for large-scale collaboration are significant, and many.

> **Education and Interpretation.** Investing in digital preservation provides museums with a stronger guarantee that important electronic media objects will be available for visitors, students, and researchers into the foreseeable future.

> **Exhibitions and Collections.** Digital objects — which include both works of art, objects of historical significance, as well as supporting materials — are also objects of cultural heritage. By establishing effective conservation protocols, museums will minimize the danger of losing the contributions of contemporary digital creators.

Digital Preservation in Practice

The following links provide examples of digital preservation work and relevant projects.

CHIN's Professional Exchange: Digitization
go.nmc.org/awugn
The Canadian Heritage Information Network's Professional Exchange tracks best practices and helpful documents for digitizing and preserving content from across their member institutions.

The Digital Preservation Coalition
go.nmc.org/qtfng
The Digital Preservation Coalition is raising awareness on the importance of digital preservation and the accompanying cultural and technological issues. Among other publications, they publish case studies that chronicle digital preservation experiences at various organizations and institutions.

DigitalPreservation.gov
go.nmc.org/apavy
Launched by the Library of Congress, DigitalPreservation.gov is an online repository of resources, including video tutorials, tools, and services, to better educate people on digital preservation.

Northeast Document Conservation Center
go.nmc.org/fmknw
Northeast Document Conservation Center is a non-profit devoted to the conservation of paper documents. They provide training to organizations embarking on preservation projects, including webinars and workshops.

For Further Reading

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

Digital Archaeology: Recovering Digital Objects from Audio Waveforms (PDF)
go.nmc.org/bjgot
(Mark Guttenbrunner, Mihai Ghete, Annu John, Chrisanth Lederer, Andreas Rauber, Vienna University of Technology, 5 October 2009.) This paper addresses the preparation necessary to store and extract media as technology advances. The research conveys that by re-engineering the format of the "waveform," data can be captured from a digital audio stream.

Digital Preservation and Workflows for Museums
go.nmc.org/vyurt
(Michael Ashley, Life Is Not Still, 2010.) This video explores the digital preservation framework and demonstrates proven workflows. The producer points to open source software and preservation metadata as integral tools for preservation.

Digital Preservation Management: Implementing Short-term Strategies for Long-term Problems
go.nmc.org/yofoz
(University of Michigan, 2004). This guide to digital preservation won an award from the Society of American Archivists. It explores the foundations and challenges that go hand-in-hand with the conservation process.

Race to Save Digital Art from the Rapid Pace of Technological Change
go.nmc.org/fwboi
(Vanessa Thorpe, *The Observer*, 7 May 2011.) This article follows scientists' searches for methods to preserve today's digital artwork and issues a serious warning about the future state of digital objects if conservationists cannot effectively archive them.

Small Steps: Long View
go.nmc.org/ptvgd
(Glasgow Museum, September 2010.) This case study illustrates digital preservation in practice at Glasgow Museum's Resource Centre and their task of conserving 1.2 million historic objects, including the audio from over 600 cassette tapes.

Sustainability of Digital Collections
go.nmc.org/pjcqy
(TASI: Technical Advisory Service for Images, 10 November 2008.) This paper provides an overview of how to sustain a collection long-term, including the financing details and how to provide ongoing maintenance to the collection.

When Data Disappears
go.nmc.org/gsskz
(Kari Kraus, *The New York Times*, 6 August 2011.) When the University of Texas, Austin, received papers from science fiction writer Bruce Sterling with no digital back-ups, they faced a major challenge. With that case in mind, the article explores different possibilities for digital preservation, including emulation.

A Window on the Archives of the Future
go.nmc.org/npfab
(Randall Hand, Vizworld.com, 8 February 2011.) The National Archives is working to catalog everything from presidential speeches to Tweets. They are currently exploring ways to store all the multimedia content generated across the Internet each day.

Smart Objects

Time-to-Adoption Horizon: Four to Five Years

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. 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. Smart objects connect the physical world with the world of information; it is that linkage that will enable the "Internet of Things" described by Vint Cerf. They can be used to digitally manage physical objects, monitor their status, track them throughout their lifespan, alert someone when they are in danger of being damaged or spoiled — or even to annotate them with descriptions, instructions, warranties, tutorials, photographs, connections to other objects, and any other kind of contextual information imaginable.

Overview

The vision behind smart objects is a world of interconnected items in which the line between the physical object and digital information is blurred. Applications tap into the "Internet of Things" to check in on articles in the physical world in the same way that someone might look in on a friend's blog or Facebook page. From reference materials to household goods to sports equipment, anything a person might need would be discoverable using search tools on computers or mobile devices.

Smart objects have appeared in several previous *NMC Horizon Reports*, but what is most interesting about smart objects this year is the growth of near field communication (NFC) in the consumer sector. Developed in 2006 by Nokia, NFC enables a proximity-based secure data exchange between devices, and the early applications are focused on allowing users to make payments to kiosks, gas pumps, or dispensing machines via smartphones. People are able to make transactions, exchange digital content, and connect electronic devices with a simple swipe or touch. In a similar fashion, companies like Yale Locks and Hardware are creating security programs that allow people access to secure spaces based on the information stored in NFC-enabled phones.

Social networking and gaming platforms are also beginning to utilize NFC so that simple proximity to a friend with the same device can initialize a multiplayer game, or update a social media connection if desired. Besides Nokia, Google and a handful of companies are already producing NFC-enabled smartphones, and Apple is expected to follow suit with their next release. As NFC becomes a standard feature of mobile phones, these devices will begin to function in ways that combine a credit card with a secure identification system, opening the doorway to a wide range of interactions and transactions between museums and their visitors.

While the potential offered by near field communication makes the smart object category even more interesting, there are a number of technologies that support smart objects: on one end of the continuum are passive technologies such as quick response (QR) codes; near field communication, which can be either active or passive, is on the other end. Other smart object technologies, including RFID and a number of sensor technologies, fall in between.

RFID is a very basic wireless technology that is nonetheless quite robust. The tags contain a small chip that can be programmed with a fairly wide range of information about the object, including its identifier, description, creation date, origin, modifications, transit points, and more. Major chains such as Walmart have been using RFID chips for years, attaching them to inventory discretely. Employees can simply walk down an aisle in the store, with each chip communicating with the RFID scanner and updating the store's inventory records instantly as he or she passes. Items that have exceeded their shelf life are instantly identified.

Sensors can be coupled with RFID chips to create a wide variety of smart objects. These hybrid smart devices can be attached to an object and monitor humidity, pressure, temperature, altitude, and much more — features with a clear utility for museum conservators.

Relevance for Museum Education and Interpretation

One of the major advantages for museums is that smart objects are, at their core, a non-intrusive technology that will have uses throughout the museum. The devices are small, do not require batteries or external power, can communicate wirelessly, and are inexpensive. They can be attached to an artwork or object very discretely, and then used to track, monitor, maintain, and keep records about the object. While the more advanced categories of smart objects are still far from mainstream use in museums, more basic ones like QR codes are already fairly well established.

The Denver Art Museum (DAM), for example, has used QR codes in a number of ways. Initially they were deployed as an efficient way to trigger additional content, but a new purpose emerged as museum staff found they were able to capture information about their visitors from their interactions with the codes. Without having to build an app, DAM was able to determine what types of phones their visitors were using, where in the gallery people were more likely to use their phones, and what content provoked the most response — all from the web analytics generated as people translated the codes' visual information into a web URL that their browsers could access. The use of the technology is expanding at DAM — QR codes are hidden in parts of the building for scavenger hunts, pasted on staff members' t-shirts during events, and utilized as a means of triggering information about DAM content outside of the building.

RFID and sensors have found their way into some museums as part of collections management, security, and conservation efforts. Over the next few years, it is likely that such use will become standard practice across the sector, as the affordances are many and clear. Near field communication will also see broad adoption in museums because of its simplicity and the variety of uses it supports, from data, image, audio, and video sharing; to electronic payments, ticketing, and touring; to mobile gaming and social networking.

Smart objects connect the physical world with the world of information.

A sampling of applications of smart objects includes the following:

> **Collections Management.** RFID tags can be used with collections management to track an object as it moves from one department in a museum to another, or in and out of secure storage. Additionally, RFID makes it easy to determine that objects are where they are expected to be, when key dates for treatments or cleaning are pending.

> **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.

> **Visitor Purchases.** Near field communication is non-intrusive, inherently secure technology that allows easy payment and identification — and is increasingly included in mobile devices. Museums can make use of the technology to identify a museum member, or

to allow visitors to make cashless purchases from the gift shop or a kiosk.

Smart Objects in Practice

The following links provide use-case examples for smart objects.

A'dam
go.nmc.org/lbras
In this self-titled exhibit at Amsterdam Historical Museum about a fashion designer, patrons create a personal profile that links to their A'dam ID card.

The vision behind smart objects is a world of interconnected items in which the line between the physical object and digital information is blurred.

Throughout the experience, this card communicates to RFID readers each user's style preferences. At the end of the exhibit, visitors can see how their profiles compare with that of others.

ikPod RFID Multimedia Guide
go.nmc.org/znpcl
The Hollandsche Schouwburg is using an RFID-enabled hand-held device called an ikPod to make their World War II memorial monument interactive. The ikPod is connected to their online database, so when visitors wave it over the monument, background information about the individuals and families listed is revealed.

New York Metropolitan Museum of Art Adopts RFID
go.nmc.org/fgeip
The MET is deploying RFID sensor tags across their collections in order to obtain information about the physical conditions in which their artwork is displayed. This will enable them to make changes to the environment to better sustain and preserve the objects.

NFC at the Museum of London
go.nmc.org/jfydz
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.

Otago Museum Radio Tracking System
go.nmc.org/pjouu
In an effort to increase security, Otago Museum launched a project that entails the installation of a radio tracking system to monitor all of its objects. Each artifact will be tagged, and RFID readers will track the items as they move around the museum space.

Pedro Morales
go.nmc.org/pqrpj
QR Code Artist Pedro Morales uses raffia mesh and fabric shapes to create organic works of art with content that can be read by simply pointing your mobile camera at them. Some of his most popular QR art includes floral arrangements made from ones and zeroes.

Picasso + QR Codes
go.nmc.org/aqdtz
To promote its Picasso exhibit, the Virginia Museum of Fine Arts created a portrait of the artist comprised of QR codes, which direct users with smartphone cameras to a web page featuring his work and other exhibit information.

QRator
go.nmc.org/knmjp
University College of London's Grant Museum of Zoology has developed the QRator project, which incorporates QR codes into exhibits that link to a rich database of curated content and allow users to document and share their own interpretations of the collections with each other.

Smart Muse
go.nmc.org/rkhbl
Centre Pompidou in Paris launched a 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.

For Further Reading

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

How Museums Will Look in the Future
go.nmc.org/utigt
(Gareth Beavis, techradar.com, 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.

Launching Google Wallet on Sprint
go.nmc.org/hurhd
(Google Mobile Blog, 19 September 2011.) This announcement from Google explores Google Wallet — a new method of ecommerce that allows people to make purchases from their phones with near field communication as the secure mechanism for storing and transmitting user payment information.

Near Field Communication Adds a New Layer to Museums
go.nmc.org/bxprg
(Kristen Winkler, BigThink, 18 August 2011.) This article explores the possibility of embedding NFC chips in signs outside of museums, so with the flick of their mobile phone, passers-by can view the sign in other languages or find out additional information.

NFC Technology: 6 Ways it Could Change Our Daily Lives
go.nmc.org/ipitu
(Sarah Kessler, Mashable, 6 May 2010). Contactless payment and infotags containing schedules and announcements are both cited in this article as two of the most potentially transformative features of near field communication.

RFID and the Museum
go.nmc.org/pswnw
(Scott Billings, MuseumNext, 4 January 2011.) The author cites cost-effectiveness and simplicity among the reasons why RFID is relatively easy for museums to integrate. He provides several examples, including an exhibit that involves visitors dropping ID cards in a cup and having their information projected on a nearby screen.

Smart objects can be attached to an artwork or object very discretely, and then used to track, monitor, maintain, and keep records about the object.

Methodology

The process used to research and create the *NMC Horizon Report: 2011 Museum Edition* is very much rooted in the methods used across all the research conducted within the NMC Horizon Project. All editions of the *NMC Horizon Report* 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.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This 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 *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 *NMC Horizon Reports*, and began with the assembly of the advisory board. The board represents a wide range of backgrounds, nationalities, and interests, yet each member brings a particularly relevant expertise. To date, hundreds of internationally recognized practitioners and experts have participated on the NMC Horizon 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 or interpretation. A carefully selected set of RSS feeds from dozens 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 twelve 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.

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

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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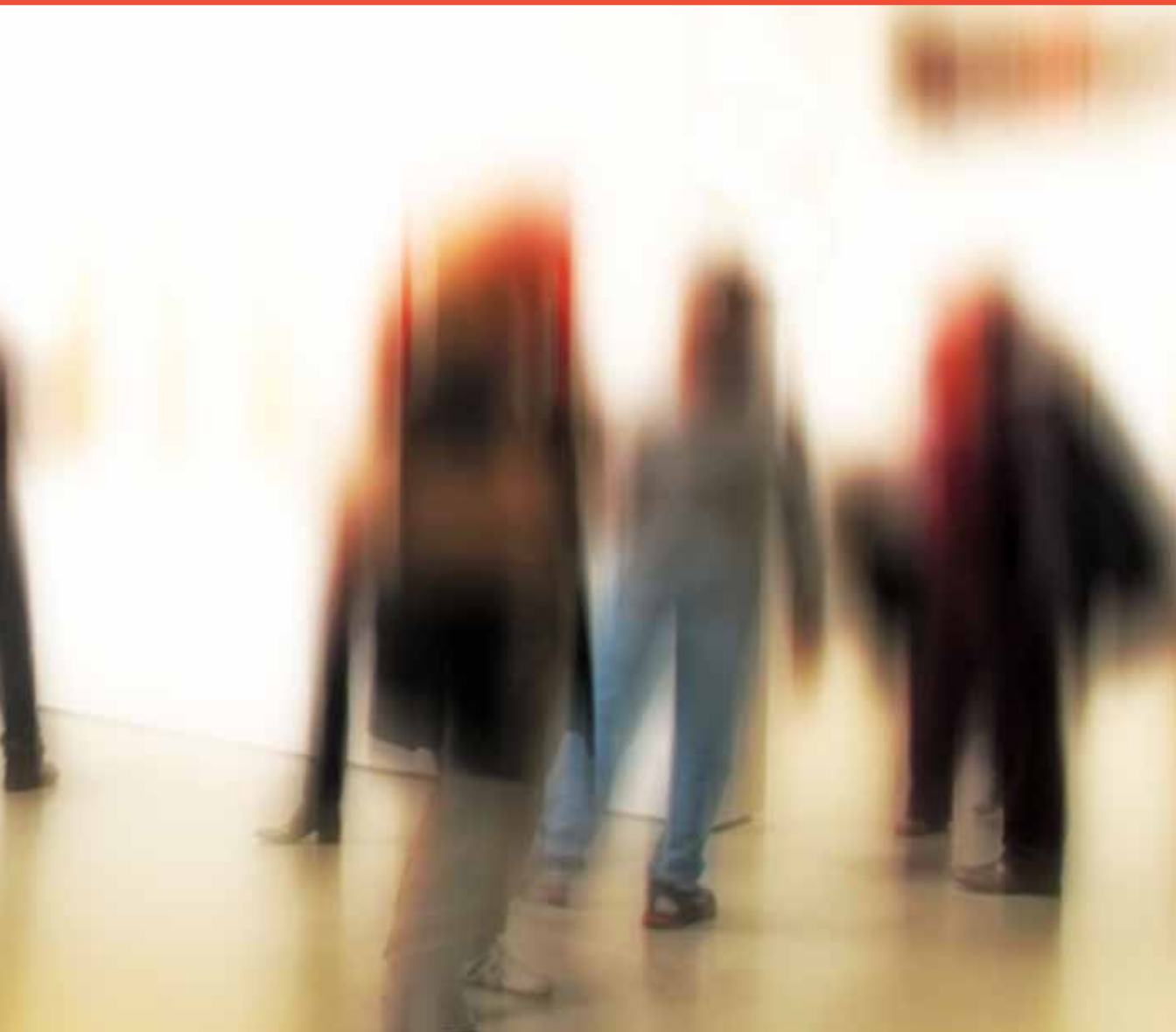
The New Media Consortium has held an ongoing series of conversations and dialogs with hundreds of technology professionals, campus technologists, faculty leaders from colleges and universities, museum professionals, teachers and other school professionals, and representatives of leading corporations from dozens of countries.



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