Best of Both Worlds

Museums, Libraries, and Archives in a Digital Age

By G. Wayne Clough, *Secretary*

Smithsonian Institution

Cover: Benjamin Franklin, by Hiram Powers, 1862
Smithsonian American Art Museum, Museum purchase
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By G. Wayne Clough
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Smithsonian Institution

Best of Both Worlds: Executive Summary

Today's digital revolution is providing a dizzying array of tools that offer opportunities for learning institutions all over the world to become more vibrant and accessible. This revolution provides the means to share vital information, enabling people to learn more, shape informed opinions, and make decisions in their daily lives. Suddenly, everybody can have access to information that previously was only available to the experts. Everybody can take part in the creative processes of institutions that once were not even in public view. However, this unprecedented and continuous shift has left many institutions struggling to adapt and is forcing them to rethink how to maintain their unique qualities while at the same time adding value. Today, no organization is immune to the disruptions caused by technological innovation.

We at museums, libraries, and archives must ask: How can we prepare ourselves to reach the generation of digital natives who bring a huge appetite — and aptitude — for the digital world? Are we capitalizing on the limitless possibilities that digital technology creates by applying it in innovative ways across our institutions? We must also consider an even bigger challenge: Are we using our content and new technologies to bridge what *New York Times* columnist David Brooks calls the "opportunity gap," an increasing disparity between the educational opportunities available to children in upper income groups and those from lower income groups?

Actually, for the Smithsonian, and for our peers in other museums, archives, and libraries, technology has created a golden age of opportunity. Online access to digitized objects, images, and records is democratizing knowledge, enhancing the visits of the many who come to us in person, and extending our reach to the millions who cannot. Coupled with social media's powers of connection, digital technology exponentially increases the capacity of individuals to engage with our collections and upload their own stories. It is also closing the gap between formal and informal education, allowing museums, libraries, and archives to step in and assist the K–12

A CHANGING ROLE FOR MUSEUMS, LIBRARIES, AND ARCHIVES

Even before the advent of today's enabling technology, thought leaders in museums, libraries, and archives recognized the need to connect with visitors in ways that prioritized public learning and advanced all forms of literacy. However, it was in the academic world where digital technology began early on to have a transformative impact. Universities were created that exclusively used virtual offerings, computers were required on many campuses for all students, and the old models of the classroom were questioned. Today this evidences itself in innovations like the flipped classroom

educational system with intellectual and physical resources. And by facilitating partnerships and collaborations among institutions, digital technology offers the public a streamlined way to access information and take advantage of powerful, jointly curated exhibitions.

If — as declared by the founding fathers — education is essential to democracy, then it stands to reason that so are museums, libraries, and archives. These institutions are prime providers of informal education and serve as resources for scholars of all ages. Certainly the challenges of digital transformation are formidable, but if museums, archives, and libraries can learn different behaviors, they can take on a new and elevated role. By combining the strengths of our physical collections with the potential afforded by digital technology, we can truly offer the best of both worlds.

We at museums, libraries, and archives must ask: How can we prepare ourselves to reach the generation of digital natives who bring a huge appetite — and aptitude — for the digital world?

concept, which allows faculty to spend less time lecturing and more time interacting with students, and MOOCs, or Massive Open Online Courses, where enrollments swell to more than a hundred thousand participants. At the secondary level, disruptive technologies like the Khan Academy's elegant electronic-blackboard math lessons offer learners everywhere free access, and reinforce building knowledge as opposed to advancing through classes regardless of whether the fundamentals are mastered.

LIBRARIES AND ARCHIVES, which often belong to academic institutions, were among the early adopters of digital technology. With their "open access" ethic, they embraced both digitization and social networking early on and began to ask, "What would the model look like if visitors could explore the collections on their own

Libraries and archives were among the early adopters of digital technology. With their "open access" ethic, they embraced both digitization and social networking early on and began to ask, "What would the model look like if visitors could explore the collections on their own terms?"

terms?" This led to a shift in focus from dispensing information to facilitation and assistance. Documents once hidden in stacks or in storage facilities are suddenly becoming accessible on demand. The Biodiversity Heritage Library, a Smithsonian-led consortium of libraries operating on six continents, is digitizing and making accessible the legacy literature of biodiversity. The European Union-sponsored digital archive Europeana is capturing that continent's cultural heritage. Across the world, large collectives of libraries and archives with overarching collections provide access that spans institutional boundaries and scales the walls of both disciplines and geography. Other impressive examples of success include the Library of Congress, whose priority focus called for digitizing special collections such as presidential papers, and the National Archives, who prioritized the digitization of heavily used records, such as the landmark 1940 census, which captured massive American population shifts caused by the Great Depression, the Dust Bowl, and early mobilization efforts for World War II.

MUSEUMS have had a tougher road, complicated by a low level of technical infrastructure, the complexity of collections, and a culture that is built more around curated exhibitions than open access. Still, there have been successes. The Metropolitan Museum of Art's Heilbrunn

Timeline of Art History, an early digital model for art collections, is today a respected scholarly resource and digital learning vehicle that attracts millions. Maintained through endowment funding, the Timeline makes 5,000 years of art accessible to the public. Impressive regional efforts include the Indianapolis Museum of Art's ArtBabble, a video channel providing documentary videos about art with an interactive component. And more and more high-quality digital collections are being made available online; some museums, notably the National Gallery of Art, the Los Angeles County Museum of Art, and the Rijksmuseum in Amsterdam, place no restriction on the use of their high-definition digital images.

Museums are also building technology into physical spaces to expedite learning. For instance, the nation's science museums are improving virtual field trips by adding interactive components that let presenters talk to students in real time. They employ data visualization methods and interactive tools that allow visitors to explore "what if" scenarios. Cloud technology offers the next quantum leap, helping museums upload their collections and records and enabling visitors to connect to an infinite variety of sources.

The lesson to be learned is that there is a place for both the physical and the digital, with one complementing and leveraging the other. The physical museum offers visitors the opportunity to experience the real object and to share their impressions with family and friends, and also provides the content, expertise, and collections that digital museums draw upon. Digital access can then provide limitless opportunities for engagement and lifelong learning.

THE SMITHSONIAN'S DIGITAL JOURNEY

Since its founding in 1846, the Smithsonian has been free, open to all, and a favorite destination for people the world over. We know that something important happens to individuals when they visit in person. The "Smithsonian experience" is often described as a spark or catalyst that prompts curiosity. But this raises the question: why should such an experience be limited to those who can visit in person?

Within the Smithsonian, some of our museums have been pacesetters in adopting digital technology; as early as the 1970s our National Museum of Natural History began to digitize selected natural history specimens, and the Smithsonian American Art Museum developed the first searchable database of American art. But not until 2009 did the Smithsonian develop a pan-Institutional approach, taking a hard look at prioritizing the 137 million objects to be digitized. Plans include a "charter collection" of objects to be rendered in 3-D, a technology that will allow objects to be viewed in ways not possible when on display in a museum setting.

Digitization is a must for the Smithsonian in a world in which, every day, people should be able to access its treasures through a wider range of electronic and mobile devices. Today's visitors demand a constant supply of fresh material. A website for the National Museum of Natural History's *Human Origins* exhibition connects visitors to related educational materials that are updated daily. Additionally, the Smithsonian is incorporating digital technology into all new exhibitions and museums. When the Cooper-Hewitt, National Design Museum reopens in 2014, visitors can use a digital stylus to generate their own designs, working with images from the Museum collections. And those eager to imagine what the new National Museum of African American History and Culture will look like can download a free app to see a 3-D model of the building.

To encourage innovative thinking, in 2010 the Smithsonian assembled 30 leading lights of the digital world with an equal number of Smithsonian staff members to explore imaginative ways to apply technology and further our reach. From that conference emerged the National Museum of African Art's

Artists in Dialogue, in which two artists on different continents interacted in real time to create two works of art based on a common idea, and Smithsonian Wild, a website that shows the public what scientists see in their research through the use of camera traps — automated cameras with motion sensors that record the diversity of animals and behavior that passes in front of them in real time around the world.

From social media to digital games and from online courses to crowdsourcing, the Smithsonian is taking advantage of digital technology to identify species and verify objects; we are inviting students to participate in scientific exploration and members of the general public to contribute stories of their own. We have done a great deal in the last decade, but recognize that there is much left to do.

UNFINISHED BUSINESS

After years of promise, digital technology is transforming society as we know it. Either institutions embrace it or they risk becoming marginalized. That said, we have to recognize the often formidable challenges of implementation, such as the high cost in dollars and manpower, the question of how to make progress when the technology constantly changes, and the relative lack of standards, just to name a few.
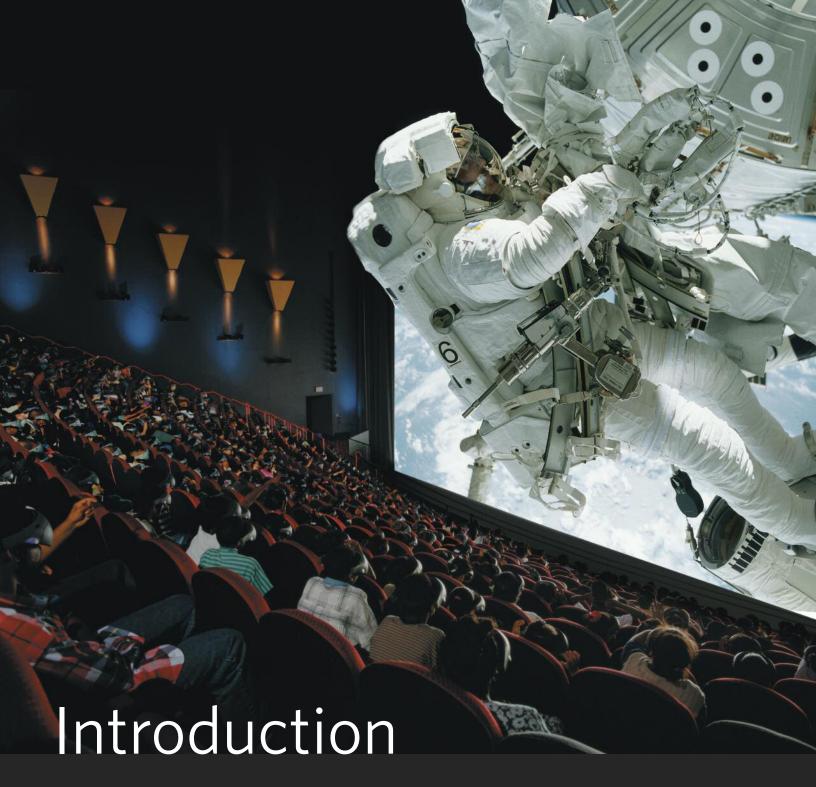
To succeed, we must focus on a few principles. These begin with the use of digital technology to enhance the in-person visitor experience, engage and involve the public, and extend the benefits of our scholarship and collections to audiences not served today. Our organizational structures should emphasize adaptability to speed accommodation to new technology, and our oversight organizations should share best practices, encourage use of common technology, and standardize methods. We should encourage the use of digital volunteers who can help with the large-scale task of converting handwritten records and historical documents to a digital format.

Equally important, museums, libraries, and archives need to adopt a "one for all and all for one" attitude, recognizing that partnerships and collaborations will help us serve the widest possible audiences. Cloud-based technology is critical to these partnerships, allowing us to link digital assets, offer powerful ways for users to search for information across institutions, and curate joint exhibitions.

One of the greatest benefits of digital technology is the opportunity to support K–12 education as never before. Museums in particular can bridge the gap between formal and informal learning with lesson plans, online summits, real-time connections to experts, and better credentialing of informal digital learning. Cultural institutions and museums are here to stay, and they will continue to inspire people by giving them an opportunity for shared learning and the experience of the real thing. But despite the challenges of implementation, digital technology allows us to do what we have never done before: to reach the millions who do not or cannot visit in person; to help all the people, not just a few, understand our culture, the cultures of others, and life in all its dimensions.

Contents

Introduction

Nobody predicted it would come this fast — a world where digital technology has become utterly pervasive, populated by almost 7 billion cell phones and a growing legion of tablets that allow access to information unimagined in the past.[1] In today's environment of continuous and accelerating technological change, organizations are constantly pressed to adapt not only to new technology, but also to the ways people use it.

The ready availability of digital learning resources is enabling a free-form approach to education that empowers individuals and self-forming groups with new opportunities. Consumers of knowledge are coming to view traditional educational institutions differently, even those formed specifically to deliver information via digital technology. Formerly captives of the purveyors of education, consumers now have choices about how to access information, who delivers it to them, and when and where they learn.

Not only is this new flexibility threatening to the orderly world of conventional education delivery, but it has also ushered in a period of experimentation in higher education. Universities increasingly offer traditional courses and degree programs over the Internet and are creating innovations such as free Massive Open Online Courses (MOOCs) with enrollments of 100,000 students or more.[2] K–12 education is confronted with a new generation of kids, including my own grandchildren, who are learning on their own through access to websites with a remarkable array of educational assets. The Khan Academy, with its simple and elegant free math lessons, now touts 6 million users a month.[3] No one really knows how digitization will ultimately reshape education, but a hunger for knowledge and learning clearly exists, and given access, information will be consumed.

Formerly captives of the purveyors of education, consumers now have choices about how to access information, who delivers it to them, and when and where they learn.

Somewhere behind the scenes of this moving circus of digital change you will find museums, libraries, and archives searching for their role. All three of these entities are often hampered by a modest technology infrastructure and resource base. However, archives and libraries, which were founded on the premise of open access for users, have moved into the brave new digital world with more ease than museums, which have been centered on offering carefully curated exhibitions from their collections. Museums have moved slowly — frequently project by project — toward digitization, and there are many good reasons for caution. Nevertheless, the time for toe dipping is ending, since museums can no longer stand aloof from the rising tide of information convergence.

Even before digital communications changed the world, museum thought-leaders recognized that their institutions were at risk of losing relevance, and they called for new approaches that gave more consideration to the needs and interests of users. Now digital technology, used appropriately and well, offers the means for museums not only to create more powerful exhibitions, but also to move beyond serving only the relatively small number of in-person visitors to reach a broader audience with a broader purpose.

In fact, the digital revolution offers museums, archives, and libraries a

golden age of opportunity, because they are ideally suited for a world in which learning is informal and centered on inspiration and self-motivation. Of course, online access to digitized documents and images from their collections opens the doors of these institutions to a much wider audience. But digitization also offers museums, archives, and libraries striking new avenues to engage with those who use their services and to become fuller partners in formal and informal education programs.

Museums, for example, can move beyond merely showcasing collections by offering members of the public an opportunity to engage in their own research, to sort out and access the portions of collections they personally find most interesting, and to interact directly with the museums.

Pursuing such prospects is more than just a matter of considering a nice opportunity; they represent a critical issue given data showing the percentage of Hispanic and African American populations who visit museums dwindling to less than 15 percent.[4] Reaching out to the other 85-plus percent is essential not just to the future viability of museums, libraries, and archives, but also to the future of our nation as a democracy with an educated citizenry.

If we can learn new behaviors and diversify our collections, the opportunity exists for museums, archives, and libraries to take on a new and elevated role, not just in the communities where they are located, but in the world.

As one who has been fortunate to serve in leadership roles at universities, museums, and research centers, I have helped to guide institutions through times of change, including accommodating digital technology. I participated in an initiative to require computers for all engineering students at Virginia Polytechnic Institute and State University, and then guided an initiative to require

computers for all students at Georgia Institute of Technology. Both of these initiatives went beyond technological changes to encompass programmatic enhancements and alter the institutional culture. Now at the Smithsonian, I am proposing a transition to broad-based use of digital technology across the Institution.

This discussion offers my personal perspective on how museums, libraries, and archives, and the Smithsonian in particular, can turn the challenge of the digital revolution into a golden opportunity. I ground my ideas in the fundamental purposes of cultural and science institutions rather than the technology that will drive the change, as I believe technology should serve as an enabler and not as an end in itself. Technology at its best improves our lives and helps humans to comprehend the world in an era of information explosion. Thus I 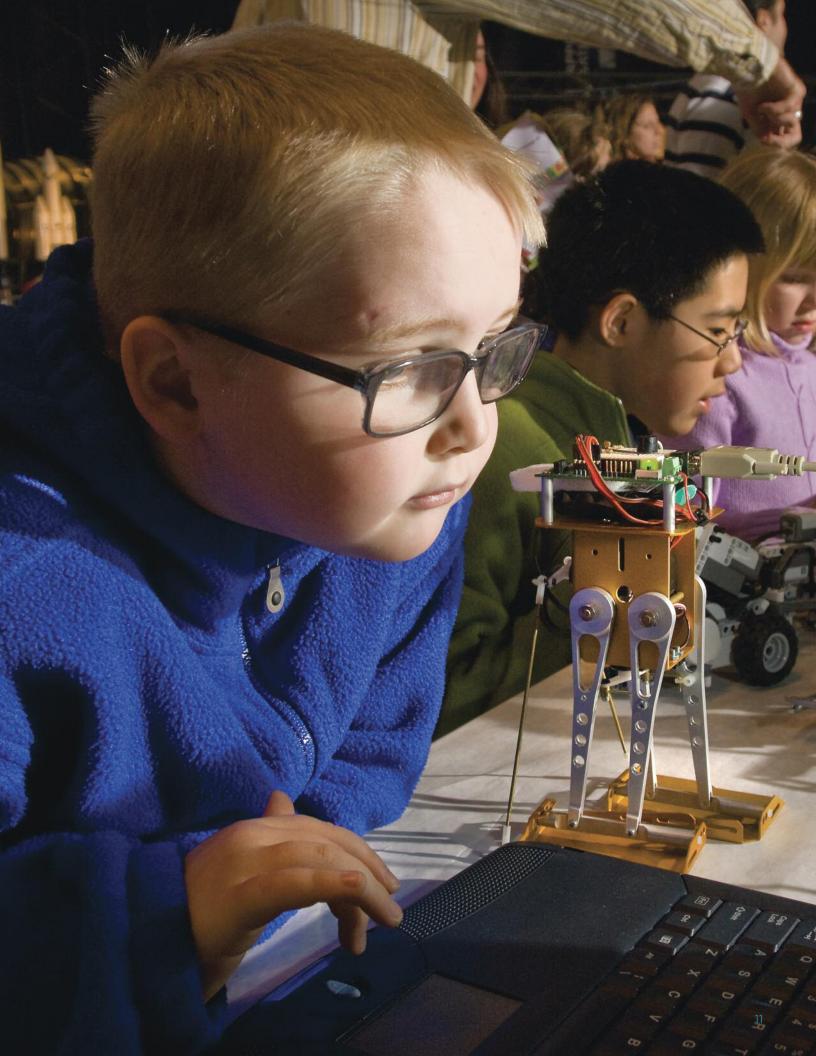begin the discussion of what technology can offer in the future with a look at the role educational institutions serve within our democratic form of government.

1. United Nations International Telecommunication Union, "ITU Releases Latest Global Technology Figures." Press release, 27 February 2013.
http://www.itu.int/net/pressoffice/press_releases/2013/05.aspx#.UT-EYNaG18E

2. Kevin Carey. "Into the Future with MOOC's." *The Chronicle of Higher Education,* 3 September 2012.
http://chronicle.com/article/Into-the-Future-With-MOOCs/134080/

3. Anupama Chandrasekaran. "Lacking Teachers and Textbooks, India's Schools Turn to Khan Academy to Survive." *The New York Times,* 15 October 2012.

4. Betty Farrell and Maria Medvedeva. *Demographic Transformation and the Future of Museums,* Center for the Future of Museums, 2010.
http://culturalpolicy.uchicago.edu/publications/Demographic-Transformation.pdf

Fundamental to a Democracy

CHAPTER 2

The Constitution of the United States created a government like no other in the world at the time — a representative democracy. The founders understood that our nation would not long survive if it did not also have new social constructs to sustain the republic. Among these were education and a system to deliver it. In its early years our nation had no form of public education; universities were largely private and religiously affiliated, and museums and libraries were rare. Washington, Jefferson, Madison, and Adams, among others, wrote about the need for public education, expressing the view that it was necessary to enable citizens to make informed decisions and to protect liberty. They also believed that education should serve all segments of society.

George Washington, in his Farewell Address in 1796: "Promote then, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened."[5]
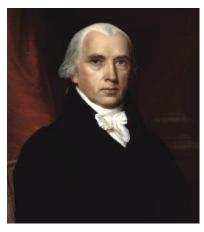
Thomas Jefferson: "If a nation expects to be ignorant and free, in a state of civilization, it expects what never was and never will be."[6]
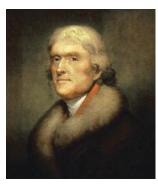
John Adams: "Before any great things are accomplished, a memorable

change must be made in the system of education and knowledge must become so general as to raise the lower ranks of society nearer to the higher. The education of a nation, instead of being confined to a few schools and universities for the instruction of the few, must become the national care and expense for the formation of the many."[7]

James Madison: "The American people owe it to themselves, and to the cause of free government, to prove by their establishments for the advancement and diffusion of knowledge, that their political institutions,

which are attracting observations from every quarter … are as favorable to the intellectual and moral improvement of man as they are conformable to his individual and social rights. What spectacle can be more edifying or more seasonable, than that of liberty and learning, each leaning on the other for their mutual and surest support."[8]

Thomas Jefferson,
James Madison,
George Washington

The founders knew that our nation needed institutions to provide universal access to learning and education, and that education was fundamental not only to individual growth and fulfillment, but also to the viability of the nation itself.

Noah Webster: "In our American republic, where government is in the hands of the people, knowledge should be universally diffused by means of public schools … the more generally knowledge is diffused among the substantial yeomanry, the more perfect will be the laws of a republican state."[9]

The founders knew that our nation needed institutions to provide universal access to learning and education, and that education was fundamental not only to individual growth and fulfillment, but also to the viability of the nation itself. Thomas Jefferson submitted his Bill for the More General Diffusion of Knowledge to the Virginia Assembly in 1778 and again in 1780. It was defeated both times, but he persisted, and in 1796 a version was passed that led to the establishment of elementary schools. He also obtained passage of a bill in 1818 that established the University of Virginia, a public university which he personally designed.[10]

The founding mission of the Smithsonian was "the increase and diffusion of knowledge." For 167 years, it has lived up to its promise by providing exhibitions in its own and affiliate museums, conducting original research, and documenting branches of knowledge in its libraries and archives. Today, digital technology offers the Smithsonian, and the larger community of museums, archives, and libraries, an opportunity not only to build on and improve what they have always done well, but also to serve a larger national role, potentially reaching every state, city, and town, every school, and every single citizen.

5. *George Washington's Papers* at the Library of Congress, 1741-1799: Series 2 Letterbooks, George Washington, 17 September 1796, Farewell Address, p. 233.
http://memory.loc.gov/cgi-bin/ampage?collId=mgw2&fileName=gwpage024.db&recNum=242

6. *Thomas Jefferson, Letter to Colonel Charles Yancey, January 6, 1816.* Series 1 Thomas Jefferson Papers, Image #731-724, Manuscript Division, Library of Congress. http://hdl.loc.gov/loc.mss/mtj.mtjbib022264

7. *John Adams to Mathew Robinson Jr.,* 23 March 1786. Reel 113, Adams Family Papers, Massachusetts Historical Society.
http://www.masshist.org/adams/slipfile/single_slip_viewer.php?id=051738

8. *James Madison letter to W.T. Barry,* 4 August 1822. The James Madison Papers, The Library of Congress: American Memory Collection.
http://hdl.loc.gov/loc.mss/mjm.20_0155_0159

9. Noah Webster. *A Collection of Essays and Fugitiv Writings: On Moral, Historical, Political and Literary Subjects.* Boston, 1790. Reprint (Delmar, N.Y.: Scholars' Facsimiles & Reprints, 1977).

10. Merrill D. Peterson, ed. *Thomas Jefferson: Writings: Autobiography, Notes on the State of Virginia, Public and Private Papers, Addresses, Letters.* The Library of America, Book No. 17 (New York, NY: Literary Classics of the U.S., Inc., 15 August 1984).

Delivering on Education's Promise

CHAPTER 3

During the 1800s, the Founding Fathers' ideas were first manifested in mandatory elementary education, which was subsequently extended to include high school.[11] The 19th century also saw the creation of non-sectarian universities and colleges, and religious affiliations within many private universities were loosened. When Abraham Lincoln signed the Morrill Act in 1862, land grant universities were created to serve the needs of society and the nation's economy by helping advance agriculture and technology.[12] After World War II, the creation of federal agencies such as the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF) energized the research agendas of universities.[13] Federal funding led to explosive growth of research and graduate programs and drove specialization with an ever-expanding set of majors and departments. Specialized research and graduate programs soon became essential components within the umbrella concept of a university campus.

Today the model for universities is again in flux, because the rapid spread of digital technology offers greater opportunity to deliver education to adult learners and traditional students alike.

Today the model for universities is again in flux, because the rapid spread of digital technology offers greater opportunity to deliver education to adult learners and traditional students alike. Although some elements of university culture are tradition-bound, in a larger sense universities have successfully adapted to a series of rapid and substantial changes in society.

Then there are the museums, archives, and libraries that form the third leg of America's public education stool. Museums developed on a slower curve than universities and evolved along a very different path. Their foundation was centered on collections, with one of the first established in Philadelphia in 1786 by Charles Willson Peale as a "Cabinet of Curiosities" using artifacts documenting the seminal moments of discovery in the new world.[14] Museum construction in the United States flourished in the late 19th and early 20th centuries, during what is commonly known as the Museum Age. Their role was to educate and inform the public through exhibitions and dioramas. Conservators maintained the collections and curators developed exhibitions, but neither was commonly visible to the museum-going public. With time, research and scholarship grew in importance, and larger museums developed the resources to maintain sophisticated laboratories and staff for this purpose.

As with universities, early museums were encyclopedic, and specialization became a driving force in their development. Unlike universities, where large campuses provided a single home for dozens of specialties, museums tended to focus around single themes such as art, history, culture, or science. While this approach allowed a clear identity, it limited museums' ability to address issues that cut across disciplines. Universities have also had the advantage of targeting and serving specific groups, while museums aspire to reach a much broader and less well-defined audience.

Museums were largely insulated from the growth engines that changed universities in the 20th century as research and graduate programs expanded rapidly. Given their reliance on collections and their limited ability to grow resources, the nature of museums changed relatively little over the last century, although the focus of their missions recently began to shift from collecting and preserving objects to serving their visitors. Nevertheless, communities and cities continue to value museums, and they serve an essential role in providing places where families can learn about culture, history, and science in an informal setting. According to the American Alliance of Museums, the United States presently has more than 17,500 museums attracting 850 million visits a year.[15]

Archives and libraries preceded the establishment of museums, although in their first incarnation they were largely in private hands. Over time, archives and libraries have evolved into stand-alone entities like the National Archives and the Library of Congress in this country. They have also become integral parts of universities and organizations such as the Smithsonian. The archive and library world and its role are changing rapidly as a result of digital technology, as will be shown in this document.

The looming question is: What is the future role of museums, archives, and libraries in a digital world with an insatiable appetite for information and knowledge? While I have a bias from my own professional career, I believe their role will change, and these entities will be coupled more closely with our nation's other educational institutions. Access to digital information will not respect arbitrary institutional boundaries, and digital delivery will transform them all.

The looming question is: What is the future role of museums, archives, and libraries in a digital world with an insatiable appetite for information and knowledge?

11. Michael S. Katz. *A History of Compulsory Education Laws,* (Bloomington, IN: Phi Delta Kappa Educational Foundation, 1976).

12. "Morrill Act." Primary Documents in American History, Library of Congress. http://www.loc.gov/rr/program/bib/ourdocs/Morrill.html

13. Homer Neal, Tobin Smith and Jennifer McCormick. *Beyond Sputnik: U.S. Science Policy in the 21st Century* (Ann Arbor, MI: The University of Michigan Press, 2008).

14. Sidney Hart, Lillian B. Miller, and David C. Ward, Eds. *Charles Willson Peale: The Artist in His Museum, 1791-1810. The Selected Papers of Charles Willson Peale and His Family,* Vol. 2 (New Haven, CT: Yale University Press, 1988).

15. "About Museums." American Alliance of Museums. http://www.aam-us.org/about-museums/museum-facts

A Smithsonian for One and for All

CHAPTER 4

The Smithsonian Institution was

founded in 1846 at a time when universities, libraries, and museums were growing in importance in the nation. Its origins lay in a will written in 1826 by James Smithson, a prominent English scientist who never set foot in this country. His will left his estate to the United States, and, echoing the words of our founding fathers, he called for the establishment of an institution for the "increase and diffusion of knowledge" to be founded in the nation's capital.[16] The charter for what became the Smithsonian was written by members of Congress and passed in 1846. The Institution was created as a federal trust, with its revenue initially derived from the Smithson endowment. However, when demands from the rapid growth of the collections — in some cases imposed upon the Institution — outstripped funds from the endowment, a federal appropriation was secured. Today, the Smithsonian is funded by a combination of federal and private revenues. It is governed by a Board of Regents composed of the Chief Justice of the United States Supreme Court as Chancellor, the Vice President as Vice Chancellor, three members of the Senate, three members of the House of Representatives, and nine private citizens.

"The worth and importance of the Institution are not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world."
— *JOSEPH HENRY*

With no explicit directions from Mr. Smithson as to the organization of the Institution, it evolved into something unique, with flavors of library, museum, and university mixed into a recipe that ultimately included science, art, history, and culture. In its earliest days, the Smithsonian was one of the nation's first federal entities with a science mission, and the first secretary, Joseph Henry, was the de facto science advisor to President Abraham Lincoln during the Civil War.

Henry was a prominent scientist in his own right and a leader in the field of electromagnetism, which was fundamental to the development of the telegraph. He was also interested in predicting the weather, a science which at the time was in its infancy. These twin interests led to what was likely the first use of an emerging digital technology as a crowdsourcing tool. As telegraph lines were strung westward along railways, Henry realized that if people along the lines had basic tools such as a thermometer and a barometer, they could send him a steady stream of readings by telegraph. With enough such observations, he could plot weather systems moving from west to east, which he displayed on maps in the Great Hall of the Smithsonian Castle. In linking new technology with people power, Henry formed the basis for what became the National Weather Service. He also foreshadowed what we know today about the power of digital technology when he said, "The worth and importance of the Institution are not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world."[17]

James Smithson

Could not the impact of the Smithsonian be even greater if its resources and research activities were more accessible to more people?

Today the Smithsonian Institution consists of 19 museums and galleries, 20 libraries, nine research centers, and the National Zoo. It includes its own considerable historical archives, the Smithsonian Institution Archives, as well as the Archives of American Art, a repository of historical documents from and about great American artists and art collectors, and more than a dozen topical archives and special collections within its museums. The Smithsonian collections now include 137 million objects, specimens, and works of art, and 163,000 cubic feet of archival material. The Institution conducts research on a far-reaching agenda in its museums and research centers as well as in more than 100 countries. Its science agenda is focused on astrophysics, environment and ecology, and natural and physical sciences, and its science collections are the largest in the world.

Over time, the Smithsonian's science role changed, supplanted in some cases by other federal agencies and science-based organizations that emerged to meet growing national needs. Science remains a prominent part of the Institution, but over the years, art, history, and culture have grown in importance as well.

At the Smithsonian, growth was sometimes a matter of choice, but it has also come in response to needs identified by Congress or the Executive Branch. As a result, the Institution came to be an amalgam of entities, encompassing a broad and unusual institutional reach unlike any other in the federal government.

Education has always been at the core of the Smithsonian, but today this role is growing. The Smithsonian provides materials and lesson plans for K–12 curricula, presents courses and entertainment programs for adults and students alike, and partners with universities to offer advanced-level degree programs. At the same time, the museums remain one of the most visible aspects of the Smithsonian, and some 30 million visits are made to them and the National Zoo annually. Many more visitors access the Smithsonian using the Internet, and their numbers are growing.[18]

In 2009 and 2010 the Smithsonian undertook a comprehensive strategic planning process involving more than 1,500 people to shape its focus and set a course for the future. Four Grand Challenges were chosen that framed the majority of the work of the Institution: (1) Unlocking the Mysteries of the Universe; (2) Understanding and Sustaining a Biodiverse Planet; (3) Valuing World Cultures; and (4) Understanding the American Experience.

Institutional goals were set in support of the Grand Challenges. One of these was to become a Smithsonian for one and for all through an aggressive use of digital technology, providing access to the Institution's remarkable resources and reaching far larger audiences than in the past, particularly those who have traditionally not been served. Among other things, the strategic plan called for the Smithsonian to:

• Use new tools and technologies to broaden our worldwide access exponentially.

• Leverage the power of technology using new media and social networking tools to deliver information in customized ways to those who cannot visit in person.

• Digitize the collections and make them accessible online.

• Take advantage of a range of interactive, Web-based technologies to encourage continuous exploration by learners of all ages.

The Smithsonian By Numbers:

19 MUSEUMS AND GALLERIES

20 LIBRARIES

137 MILLION OBJECTS, SPECIMENS & WORKS OF ART

9 RESEARCH CENTERS

137,000 cu.ft. ARCHIVAL MATERIAL

1 NATIONAL ZOO

FOUR GRAND CHALLENGES FRAME
THE MAJORITY OF THE WORK OF
THE INSTITUTION: 1. UNLOCKING
THE MYSTERIES OF THE UNIVERSE

2. UNDERSTANDING AND SUSTAINING
A BIODIVERSE PLANET 3. VALUING
WORLD CULTURES 4. UNDERSTANDING
THE AMERICAN EXPERIENCE

The concept of "reaching new audiences" takes on a new, more personal meaning when you hear people describe their "Smithsonian experience." Most remember their first encounter with the Smithsonian, even if they have not visited in many years. They recall their parents taking them to the Smithsonian, where they saw something that inspired them and changed their life. Some lived in the D.C. area and visited the Smithsonian often. We frequently hear comments like, "Each time was an education. I learned something about the world I did not know, and it was free." That is the Smithsonian experience, and those of us fortunate enough to work there hear such stories frequently.

The Smithsonian experience illustrates the long-lasting impact the Institution has on people, not just when they visit, but throughout their lives. Thus, it is important that Smithsonian museums and galleries remain accessible and free of charge, enabling anyone who lives nearby or can afford to travel there to have their very own Smithsonian experience.

Still, that nagging question remains as to why this experience should be limited just to those two aforementioned groups — the ones who can afford the trip to visit or who have the good fortune to live nearby. Could not the impact of the Smithsonian be even greater if its resources and research activities were more accessible to more people?

We need to allow learners and seekers to access not only our museums but also the marvelous science resources at the Smithsonian.

Today, many thoughtful people rightfully worry about what columnist David Brooks has referred to as the "opportunity gap" in our nation.[19] As he points out, growing evidence demonstrates an increasing disparity in our society between the educational opportunities available to children from upper-income groups and those stranded and increasingly mired in lower-income groups. As Brooks states, "It is not only that richer kids have become more active [in enrichment programs]. Poorer kids have become more pessimistic and detached." He cites Harvard University sociologist Robert Putnam, who said, "It is perfectly understandable that kids from working-class backgrounds have become cynical and paranoid, for virtually all of our major social institutions have failed them."

This dichotomy now extends up the food chain as our nation's public universities, which once offered high-quality education at low tuition rates, have now responded to severe state budget cuts by raising tuition, cutting off economically disadvantaged students. Add in the fact that fewer than 70 percent of our minority youths even graduate from high school,[20] and it becomes clear we are retreating from a society with a strong middle class and a widespread belief that upward societal mobility is possible.

Having grown up in a small rural town in the Deep South, I can appreciate what the lack of cultural enrichment opportunity means. We had no museums and few cultural amenities, but fortunately my parents encouraged our intellectual growth as best they could, and the

availability of affordable, accessible public education gave me a better life. For me, the opportunity to attend the Georgia Institute of Technology to obtain a B.S. and M.S. in civil engineering, and then receive my Ph.D. at the University of California, Berkeley, was transformative. These opportunities were due in part to the fact that I was a reasonably bright kid, but the doors would not have opened without low tuition and a generation of faculty who understood that one of the privileges of working at a research university was encouraging young people to reach their full potential.

My cultural education was largely the result of my being a voracious reader, but I had little guidance in this quest. I consumed William Faulkner, Flannery O'Connor, biographies, and historical novels, and over time learned to appreciate art and culture. Yet my first visit to the Smithsonian did not occur until I was in early adulthood — an all-too-common story for millions of other Americans.

It is time to change this pattern, not only in the interest of equity, but because our country needs it. We need to allow learners and seekers to access not only our museums but also the marvelous science resources at the Smithsonian. Fortunately, our generation has been given a once-in-a-lifetime, golden opportunity to open the Smithsonian's great store of resources to all the American people.

16. Steven Lubar and Kathleen M. Kendrick, *Legacies: Collecting America's History at the Smithsonian* (Washington, D.C.: Smithsonian Press, 2001).

17. "Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1852" (Washington, DC: U.S. Government Printing Office, 1853), p. 20. http://siarchives.si.edu/history/exhibits/henry/joseph-henrys-life

18. "About Us." Smithsonian Institution. http://www.si.edu/About

19. David Brooks. "The Opportunity Gap." *The New York Times.* 9 July 2012.

20. Robert Stillwell and Jennifer Sable. *Public School Graduates and Dropouts from the Common Core of Data: School Year 2009–10: First Look (Provisional Data).* U.S. Department of Education NCES 2013-309rev (Washington, D.C.: National Center for Education Statistics, January 2013). http://nces.ed.gov/pubs2013/2013309rev.pdf

A Changing Role for Museums

Even before the arrival of present-day digital technology, thought leaders among museum professionals recognized the need to make museums more relevant and revitalize their role. Their work provides the philosophical groundwork for the appropriate use of digital technology.

The Smithsonian's Stephen Weil, once the longtime deputy director of the Hirshhorn Museum and Sculpture Garden, was an early leader in seeking to redefine the role of the museum to serve the greater public good, and he wrote extensively on the subject, including his 2002 seminal book, *Making Museums Matter.* As Weil put it, "Museums matter only to the extent that they are perceived to provide communities they serve with something of value beyond their mere existence."[21]

He was also an advocate for a cross-disciplinary approach for museums, and wrote of "two other aspects of American museums that may be considered ripe for compensating changes. One is the way they are divided along disciplinary lines by the types of collections they hold — most typically art, history and science. The other is the way they are staffed and how museum workers are trained. In both respects, the overwhelming majority of American museums and museum training programs continue to operate as if World War II had only just ended and as if collections were still at the center of the museum's concerns."[22]

Weil understood that to change the dynamic required rethinking how museums connected to people, which in turn related to collections, exhibitions, museum curators, and the nature of the museum experience. In questioning the role of the museum, he found it could be strengthened.

David Anderson of the Victoria and Albert Museum argued in a talk in 2005 that "since abandoning their commitment to 'useful learning' a century or so ago, mu-

seums ... have lacked a credible definition of their role." He called for museums to recognize that "cultural democracy can only be achieved if museums and other institutions now give priority to public learning."[23] The 2009 National Science Foundation report on *Learning Science in Informal Environments: People, Places, and Pursuits* (LSIE), provided a new assessment of the significance of the kind of informal learning that occurs in museums, pointing out that its natural advantages are growing in importance given the nature of the challenges faced in educating young people today.[24] Informal environments are perfect for experiential learning, team exercises, and working across disciplines — the very forms of learning that are de-emphasized in formal learning environments.

Over the past few years I have visited dozens of the 178 regional art, history, and science museums that are members of our Smithsonian Affiliations program, and I have been encouraged by an almost universal movement toward more effective use of informal learning. Exhibitions

"Museums matter only to the extent that they are perceived to provide communities they serve with something of value beyond their mere existence."
— *STEPHEN WEIL*

are more engaging, and they provide opportunities for extended, post-visit learning. Many science museums offer schools the opportunity for both physical and digital field trips that include follow-up activities and allow data-sharing and interaction among student groups. These are all positive signs, but this is only a good first step, because the opportunities that are going to be offered through developments in digital technology will go beyond any of our present expectations.

"What if our profession created a museum in which visitors could comfortably search for answers to their own questions regardless of the importance placed on such questions by others?"
— *ELAINE GURIAN*

In a key paper in 2008, Elaine Gurian made the case for what she termed "The Essential Museum," by asking the question, "What if our profession created a museum in which visitors could comfortably search for answers to their own questions regardless of the importance placed on such questions by others?" As she noted, the old museum paradigm appeals largely to a narrow segment of the population that is more and more unlike the changing demographic profile of the United States. She argued for the introduction of new digital search tools that allow users to access collections to meet their own needs, rather than those perceived by the museum, requiring a

change in the role of curator from "teacher and transmitter" to "facilitator and assister." She concluded with a call for museums to "respect each visitor's individual quest … provide access to information systems that are easy to understand and transferable … and include ways for the public to add information to the system and respond to the information left by others."[25] This is a perceptive case, made before the advent of the technology that has the potential to achieve her expectations.

Robert Janes, in his provocative book *Museums in a Troubled World,* published in 2009, stated the call for renewing the relevance of museums: "I will argue that the majority of museums, as social institutions, have largely eschewed on both moral and practical grounds, a broader commitment to the world in which they operate. Instead,

they have allowed themselves to be held increasingly captive by the economic imperatives of the marketplace and their own internally driven agendas." He uses the term resilience to identify "innovative and progressive museum practice," because "resilience … suggests a frame of mind not bound by deadening routine, habit or traditional practices. Most importantly for museums, becoming resilient allows systems and organizations to absorb large disturbances without changing their fundamental natures." He concludes, "I suggest that upholding decency at a time of extraordinary change will also require a new breed of museums grounded in consciousness of the world around them — renouncing complacency and fulfilling their latent potential as community organizers of the highest order."[26]

"The use of digital technology has to be focused on education and learning, some of which should be structured and purpose-driven, and some of which should be open-ended and curiosity-driven."

Another clarion call for a new framework for museums was issued by Nina Simon in 2010, in her book, *The Participatory Museum.* She imagines a future in which a museum is "a place where each person's actions are networked with those of others into cumulative and shifting content for display, sharing, and remix. A place where people discuss the objects on display with friends and strangers, sharing diverse stories and interpretations. A place where people are invited on an ongoing basis to contribute, to collaborate, to co-create, and to co-opt the experiences and content in a designed, intentional environment. … A place that gets better the more people use it."[27]

Weil, Anderson, Simon, Janes, and Gurian all make the case for museums to become more relevant to society, and they provide ideas and insights to accomplish this goal. The challenges for achieving their vision are real, and there is a risk in making choices to get there. But it is clear that digital technology provides an approach that is rich with potential. The use of such technology has to be focused on education and learning, some of which should be structured and purpose-driven, and some of which should be open-ended and curiosity-driven.

The path forward requires making choices. How much time do we have to make them? It would be easy to equate our circumstances with those described by Harvard Business School professor Clayton Christensen in his book, *The Innovator's Dilemma.*[28]

This concern fundamentally goes back to Austrian economist Joseph Schumpeter's "creative destruction" concept, in which one generation of technology displaces another, causing a disruption in the business cycle and the society around it.[29] The Industrial Revolution is replete with such examples, one of the most famous being when steam engines were used to automate textile mills in England. This change was a boon for society at large, since it lowered

the cost of clothing enormously and gave average citizens previously unimagined choices of fabrics and colors. But it also caused thousands of skilled loom workers to lose their jobs, some of whom took matters into their own hands and tried to destroy the steam engines and the automated mills. We came to know these folks as "Luddites," a name that still sticks to those among us who choose to avoid the advantages of new technology because of its detrimental side effects.

Part of the innovator's dilemma is deciding when to implement a full-scale conversion to a new technology, particularly when an existing product line is still eminently successful. The classic story here is that of RCA, which in the 1960s focused on its very successful and profitable business of manufacturing and selling vacuum tubes, and neglected to protect the low end of the electronic consumer market. That provided an opening for a small Japanese company named Sony to enter the market

For today's museums, the institutional question at hand is: Are brick-and-mortar museums, with their curators and expensive collections, going to be victims of the digital museum?

with an inexpensive product called a Walkman based on new transistor technology. The rest of the story is history as Sony ate its way up the electronics food chain, while RCA only realized that its vacuum-tube market had vanished when it was too late to change.

For today's museums, the institutional question at hand is: Are brick-and-mortar museums, with their curators and expensive collections, going to be victims of the digital museum? The answers are no and maybe. People continue to place great value on a physical visit to a museum, as noted by those who have had the "Smithsonian experience." In fact, overall museum visitation is up in recent years, and the experience is one that brings families together. Through their cultural outreach programs and performances, museums also provide far more than exhibitions to their local communities. And in the end, digital museums depend on physical museums for content, expertise, and collections.

However, as digital technology becomes more pervasive and expectations continue to change rapidly, the role of the digital museum will grow. New technology will also continue to enhance the possibilities of digital access. For example, in the not-too-distant future we are likely to be able to pull up holograms in our homes of museum objects that have been rendered in three-dimensional digital image files. Already the Smithsonian is producing such files, which can be used with 3-D printers to allow objects from museums to be copied at schools and homes. Using digitized collections in this way enables members of the public to put together their own stories and exhibitions without the help of the museum that maintains the collections. As they use digital collections, the connections that individuals make will be as diverse as the individuals themselves, which in turn will help museums find new ways to connect to the public they serve. The possibilities for use of digital technology are eye-opening to say the least.

That said, physical museums will always hold their value. As historian and National Museum of American History Board member David McCullough has said, "The thrill — the essential, never-ending fascination — of all to

be found here within these walls ... is that they are all the real thing. There are no facsimiles here, no reproductions, no approxima-tions."[30] People will continue to be drawn to the power of the real thing, and museums serve as destinations for families and the site of generations of shared experiences. At the same time, the growth of the digital museum is inevitable, and its potential for expanded outreach is too important to resist.

Those of us who are presently responsible for physical museums, research centers, libraries, and archives must continually improve them and what they do, while also embracing the opportunities offered by the digital world. In fact, the two can ultimately be mutually reinforcing. If digital linkages elevate an awareness of what museums, libraries, and archives have to offer, then the desire to ac-tually visit them should increase. This is a trend museums, archives, and libraries should rush to encourage.

21. Stephen E. Weil. *Making Museums Matter* (Washington, D.C.: Smithsonian Press, 2002), pp. 4, 5, 41.

22. Ibid.

23. David Anderson. "New Lamps for Old: Museums in the Learning Age." Paper presented at the Museums Australia Conference, 2005. http://audience-research.wikispaces.com/file/view/Anderson+MA+keynote.pdf

24. Philip Bell, Bruce Lewenstein, Andrew Shouse, and Michael Feder, Eds. *Learning Science in Informal Environments: People, Places and Pursuits.* Report of the National Research Council Board on Science Education, Committee on Learning Science in Informal Environments (Washington, D.C.: National Academies Press, January 2009).

25. Elaine Huemann Gurian. "The Essential Museum." *The Informal Learning Review,* No. 89, March–April 2008.

26. Robert R. Janes. *Museums in a Troubled World: Renewal, Irrelevance or Collapse?* (London: Routledge, 2009), pp. 13, 141, 185.

27. Nina Simon. *The Participatory Museum* (Santa Cruz, CA: Museum 2.0, March 2012), p. 350.

28. Clayton Christensen. *The Innovator's Dilemma* (New York: Harper Business, 2000).

29. Joseph Schumpeter. *Capitalism, Socialism and Democracy* (New York: Harper, 1975 [originally published 1942]).

30. David McCullough. Keynote address, National Museum of Ameri-can History re-opening ceremony, 19 November, 2008.

EQUATOR

Putting It
in Perspective

Within a relatively short period of time, digital technology has permeated virtually every aspect of society. The Internet has become central to our lives as an information resource; there are almost 7 billion cell phones in use; human kind generates 1200 exabytes of data annually (each exabyte equals 100 billion gigabytes); and computers are found in the simplest of consumer products.[31] By the end of 2013, 1.4 billion smartphones and 268 million tablets are projected to be in use.[32] Their users are expected to download 56 billion smartphone apps and 14 billion tablet apps this year.[33] Some call the 3.5 billion people born after the onset of the digital age, about 1980, "digital natives" — a generation who think and communicate differently from previous generations.[34] As a result of these differences, there is a huge demand for digital content and learning resources, which universities, museums, libraries, and archives are perfectly positioned to meet.

Learning providers have had an on-again, off-again romance with digital technology. Early adopters often found their efforts frustrating because the hype about the abilities of digital technology exceeded the reality; equipment was less than facile; only a small percentage of the public had access; and an institutional investment in a large-scale software or hardware system took so long to implement that it could often be declared a loss before it was used. Many institutions found themselves caught in a "start-stop" pattern in which their decision to start with a major investment in one generation of technology was overrun by new technology, leading them to stop implementation while a new approach was developed. Today's technology is more robust and pervasive and may be less prone to "start-stop," but it is useful to consider not only where we are, but also the road we travelled to get here.

What follows is a review of the use of digital technology in learning and cultural institutions. It is not intended to be encyclopedic, but rather to illustrate trends and cite

IN THE FALL OF 2002 ABOUT 9% OF THE ENROLLMENT IN DEGREE-GRANTING INSTITUTIONS WAS ONLINE, BUT BY FALL OF 2011 THIS FIGURE HAD RISEN TO 32%.
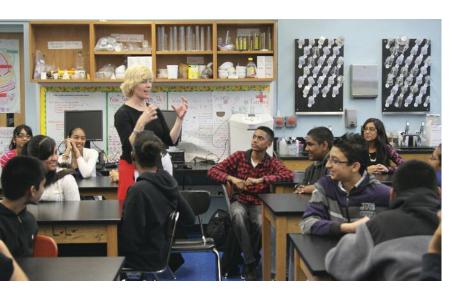
examples, challenges, and best practices. In many cases the information about libraries, archives, and museums was obtained through interviews with colleagues in the United States, Great Britain, and Europe who generously shared their insights about their own experiences with progress and setbacks.

EDUCATIONAL INSTITUTIONS
Educational institutions that are considered to represent formal learning, primary, secondary, and post-secondary, for-profit and nonprofit, are being fundamentally changed by digital technology. A new model merging education with technology seems to be announced each day. Most recently, the two largest providers of what are known as MOOCs (massive open online courses) announced new worldwide partnerships with leading universities in Canada, Mexico, Europe, China, Singapore, Japan, and Australia, in addition to signing more American universities.[35]

iTunes U, the online digital education outlet, recently passed the 1 billion download mark, and Apple claims to have sold more than 8 million iPads directly to educational institutions worldwide. iTunes U actually became a stand-alone app, complete with its own course marketplace and catalog, in June 2012.[36]

Overall, more middle- and high-school teachers are using digital tools in their classrooms and professional lives, according to the most recent study by the Pew Re-

search Center's Internet & American Life Project. Teachers are actually becoming users of advanced technology, and when surveyed, 92 percent of Advanced Placement and National Writing Project teachers across the United States said the Internet has a "major impact on their ability to access content, resources, and materials for … teaching."[37]

The history of digital engagement in the educational establishment is replete with the "start-stop" experiences referenced above, in which large experiments foundered because of technological over-reach, lack of technical support, and lack of resources to refresh content, software, and equipment. Adoption and use of digital technology, especially within secondary education, is irregular, and gaps are found in poorer school districts where there is little access to resources and in rural areas where broadband access is still problematic.

But the old saying, "timing is everything," applies here. For example, the remarkable success of the Khan Academy would not have been possible without a new generation of digital technology and the widespread adoption of mobile technology. Created in 2008 by Salman Khan after his experience mentoring his cousin online in 6th-grade math, the Academy features lessons developed by Khan using an electronic blackboard to lay out concepts of math and science in elegant simplicity. Today the Khan Academy has thousands of such lessons available for free, and millions of satisfied users are accessing them on a regular basis.[38] This approach is particularly effective in allowing students to repeat lessons until they master the subject matter before they move on to a more advanced topic.

The future of approaches like the Khan Academy is still unclear. Thus far it has served as a complement to formal education, but it may replace some formal courses altogether for students who are motivated and given the option to test out of courses and grade levels. To date, the Academy has focused on primary and secondary education, but Khan has indicated he believes there is a role to play in higher education.[39]

While there are a few large-scale success stories such as the Khan Academy, the more common model is a gradual accommodation of digital technology. That is not to imply that educational institutions are intentionally

moving slowly, but rather that it takes time for institutions to change, to find the rightful place for technology in helping teachers do their work, and to ensure that students are actually benefiting from advances in technology.

At the university level, digital technology is changing even the most basic model, beginning with the way the classroom works. Many universities, including my former employer, Georgia Tech, now require computers for each student and have built their curricula around the technology. Recent changes move beyond a simplistic interpolation of technology into the classroom toward enhancing the experience and offering both faculty and students a more meaningful learning environment.

A good example is the flip teaching concept or the flipped classroom, which leverages technology to enhance classroom learning. It is designed to enable a teacher to spend more time interacting with students instead of lecturing. Rather than using the traditional top-down teaching structure, a student is provided with online teacher-created or other educational videos that serve as preparatory materials for the classroom. The student then comes to class to apply the knowledge learned, and the role of the teacher is to tutor students and facilitate class discussion.[40]

Beyond the classroom, higher education has long used digital technology to deliver distance education, and this endeavor is becoming more pervasive and sophisticated. In the fall of 2002 about 9 percent of the enrollment in degree-granting institutions was online, but by fall of 2011 this figure had risen to 32 percent, and all signs point to continuing increases.[41]

In the early days, distance-learning enrollments were often driven by special needs. For example, the University of Maryland University College (UMUC) was founded with a focus on learners who were in the U.S. military, at bases in the United States and overseas, but it has now expanded to a more general population, with a total enrollment today of around 92,000.[42]

In the for-profit world of higher education, distance learning has been embraced by organizations such as the University of Phoenix. In business for about 30 years, it now enrolls more than 300,000 students, with an average age of 36, and offers degrees in a wide range of fields. Tuition for the courses is not cheap, but is offset in many cases by federal government subsidies and loans to students. Recently this particular model has had its challenges. The University of Phoenix has been forced to shutter 25 main campuses and 90 smaller satellite learning centers. Enrollment decline due to competition from other online providers is blamed, but low graduation rates and high default rates are also factors. Similarly, Kaplan Higher Education, a division of The Washington Post Company, announced that it was closing nine of its campuses and consolidating four others.[43]

By the end of 2013, it is projected that:

1.4 SMARTPHONES WILL BE IN USE
BILLION

56
BILLION
SMARTPHONE APPS WILL BE DOWN-LOADED

268 MILLION
TABLETS WILL BE IN USE

14 BILLION
TABLET APPS WILL BE DOWNLOADED

Beyond the for-profit and nonprofit university models that emulate traditional education but use digital delivery, there are others. A prominent pioneer was the MIT OpenCourseWare project which made its debut over a decade ago and allowed anyone to access MIT courses, or some of their content, using video and digital technology. This approach did not lead to a degree but proved very popular with the general public and set the stage for new models that are now emerging.

As mentioned previously, the newest kid on the block is the Massive Open Online Course (MOOC), which can enroll more than 100,000 students at a time, and its opportunities are growing. Recently, a group of top universities agreed to offer free courses working through Coursera[44] while another group has formed around EDx. Coursera and EDx provide the infrastructure to support MOOCs for the participating universities. The courses that have proven most popular are in fields like computer science that are in high demand around the world and do not require sophisticated laboratories. MOOCs open access to far more people than traditional models of education and can serve as a tool to help students have choice and break scheduling log-jams when courses are not offered for them at the time needed on their own campuses. They also potentially can serve as a brake on the spiraling cost of higher education. However, MOOCs are not without issues. Upwards of 50 to 90 percent of the students in some classes drop out; the business

Adoption and use of digital technology, especially within secondary education, is irregular, and gaps are found in poorer school districts where there is little access to resources and in rural areas where broadband access is still problematic.

model is yet to be established; and the approach to credentialing remains to be resolved.[45] Still, the MOOC model illustrates the hunger for learning that spans the globe.

Variations on the MOOC approach are continuing to emerge and meeting with mixed success. On behalf of the California State University System, San Jose State recently partnered with the Silicon Valley start-up Udacity to offer students who needed remedial education a professor-guided course following the MOOC format. After the first term, results were disappointing, with pass rates of 20 to 44 percent, rates that fell below comparable traditional courses. The collaboration with Udacity has been suspended pending review to determine whether the experiment should be continued using a revised format.[46] Udacity has also teamed up with the Georgia Institute of Technology and will offer the first MOOC-based degree program this fall. M.S. degrees are being offered in computer science and the courses can be taken part-time over three years. Students will pay for the degree program although at a reduced amount compared to those working on computer science degrees in the traditional campus-based program. Development costs for the MOOC courses were offset by a $2 million grant from AT&T. There is optimism that this experiment will be successful given Georgia Tech's extensive experience with online courses and ability to attract top students from around the world.[47]

Much is still to be learned about how all of the changes wrought by digital technology will play out in the long run in formal educational settings. However, time and experience have led to improved understanding of the best uses for technology, while at the same time new devices have improved functionality and digital content has increased exponentially. We are approaching a tipping point where

a tool that has played only a marginal role in formal educational settings is now shifting the faculty/teacher role from the authoritative information source to facilitator and mentor.

LIBRARIES AND ARCHIVES

Libraries and archives have had their share of starts and stops along the digital transition path, but overall they were among the early adopters of digital technology. These institutions were founded to be repositories of knowledge and information that users accessed and organized according to their own tastes and desires. In the case of libraries, the librarian has traditionally been a generalist whose job is to help the user find material he or she wants. This model is different from the museum, where information and knowledge are held in largely inaccessible collections, which are organized and offered to the user through exhibitions based on the experience and choices of the curator.

Because of the open access ethic of libraries and archives, it was natural to use whatever means possible to make their information and knowledge available to users. Libraries have been quick to embrace social networking. By the end of 2011, almost 90 percent of American libraries reported using Facebook and almost half were using Twitter to promote their services, provide user updates, and reach potential new users.[48] A second factor allowing libraries and archives to adapt to the digital world is collections that are largely two-dimensional and easier to digitize than complex museum collections. Libraries also have a long history of comprehensive cataloging systems that are standardized across institutions, smoothing the way for digital cataloging, which began in the early 1970s.

THE PROGRESS IN DIGITIZING LIBRARY AND ARCHIVAL MATERIALS BY THE GREAT INSTITUTIONS OF THE UNITED STATES AND EUROPE HAS CREATED ACCESS FOR THE PUBLIC THAT WAS UNIMAGINED ONLY A DECADE AGO.

An impressive example of what can be accomplished by digitization of library resources through a collaborative approach is the Biodiversity Heritage Library project (BHL), founded in 2006 with the goal to "digitize and make accessible the legacy literature of biodiversity" from around the world.[49] The BHL is an effort by a consortium of libraries with significant natural science collections, with the Smithsonian Libraries serving as the lead. The BHL has become a global enterprise with nodes operating in Europe, China, Australia, Egypt, Brazil, and Africa. It now has more than 40 million pages digitized, and they are available through the BHL website. The BHL has also placed content on iTunes U and Flickr.

Perhaps nothing illustrates the power of the BHL better than the goal to digitize Charles Darwin's library; in large part this library is held in trust at Cambridge University, but parts remain in the hands of Darwin family members. Before the BHL, only a few people in the world might see even parts of the library; today all of us can have access.

Individual libraries that have been leaders in the digital movement include the Library of Congress and the New York Public Library. The first digital projects at the Library of Congress date as far back as the late 1980s, when CD ROMs containing digitized manuscripts, photographs, and maps from the original American Memory collection were sent to nearly 60 schools. In 2007 a partnership was established with the National Endowment for the Humanities (NEH), to create the "Chronicling America" website, which provides public access to newspaper archives that have been digitized. The project recently hit a milestone of digitizing nearly 6 million pages. Over the course of the last decade, the Library of Congress has become more targeted in its digitizing efforts, with a focus on special collections such as the presidential papers. The papers of Washington, Jefferson, Lincoln, and Madison have been completed and are online.[50]

The New York City Public Library was an early adopter of digital technology, and today is concentrating on digitization of collections of historical importance. Its website offers access not only to documents but also to a large collection of images and photographs. Our own Smithsonian Libraries began to digitize its collections in the 1990s, and this work continues today.

With growing online access to their resources, the purpose of libraries as physical facilities is changing. When I was at Georgia Tech, we saw that the students were using the library without ever darkening its doorway, because digital access was becoming so easy. Early in the last decade, with the help of an innovative team of digital specialists and the library staff, an experiment was begun to reshape the library into a different kind of place — not just a repository, but also a commons that blended the physical and digital and provided adaptable space for group digital endeavors, from working on team projects and presentations to creative activities such as musical jamming. Today the library even has a coffee bar.

The staffing of the Georgia Tech library commons combined digital specialists and reference librarians. With the help of the furniture company Herman Miller, all of the fixtures were made mobile so that flexibility was the rule of the day. This concept was recognized by the Association of College and Research Libraries' 2007 Excellence in Academic Libraries Award. It led to a tripling of students and faculty using the library facility and ultimately resulted in an entirely new educational commons, which opened in the fall of 2011. Many university libraries have followed this model, and some are even adding simulation rooms or gaming facilities.

As digital technology is transforming libraries, changing the way they serve the public, the way the public accesses collections, and even the design of the physical facilities

There are digitiza-tion success stories within the sector of specialty archives. With funding from the Terra Foundation, the Smithsonian's Archives of American Art created the Terra Founda-tion Center for Digital Collections to develop the virtual repository of its most important collections. To date, the Center has digitized more than 130 collections, together with a substantial subset of images, for a total of more than 1.5 million digital files. The Archives website allows scholars and the public alike to access the papers and writings of famous American artists, along with sup-porting articles and documents about them.

Overseas, the British Library and the National Archives of the United Kingdom have relied heavily and successfully on third-party agreements for their digitization efforts. In 2003 the British Library launched a partnership with ProQuest, a company that develops a customized, revenue-producing online archive for publications, to scan microfilm files of 17th-century books. A partnership with Gale Cengage Learning focused on digitizing 18th-century collections, while another col-laboration with Brightsolid enabled the Library to digitize the British Newspaper Archive. It is estimated that the British Library now has 40 million digital assets.[52]

The National Archives of the United Kingdom began mass digitization in 2002, with the 1901 census as the first project. The U.K. National Archives tracks progress by comparing the number of times documents are down-loaded with the number of times they are accessed in hard copy by visitors to the reading room. To date, for every one document produced for a reader in paper form, 230 are downloaded online.[53]

themselves, it is changing archives as well. The National Archives in Washington is proceeding aggressively to digitize its collections using its own in-house resources, assistance from volunteers, and third-party agreements with organizations such as Ancestry.com. Public partici-pation is encouraged through programs such as the Citizen Archivist initiative, in which volunteers help with special digitization projects, and "scan-a-thons," to scan records for uploading to sites such as Wikipedia. The goal is to provide public access to all of the collections, but their size creates a challenge.

Because the National Archives' collections are so vast, it has chosen to focus its digitization efforts on the records that are most critical and heavily used. Priority was given to digitizing the 1940 census, an important juncture in history that represented the nexus for the impacts of the Great Depression, the Dust Bowl, and the mobilization effort for World War II, which together caused mass migrations from one part of the country to another. It also was the first census with large-scale use of Social Security numbers, providing a means to track people as individuals.[51]

As noted earlier, there is a growing move toward aggregating digital library and archival collections, and in the United States, organizations such as the Internet Archive, HathiTrust, and Google Books have captured millions of digitized documents and resources from the public domain as well as copyrighted materials. These organizations provide the public with access to enormous resources, and the collections are continually growing. However, public access to copyrighted materials has in some cases led to legal action, an issue which remains to be resolved. This matter is of particular interest to the large collaboratives, since they often have interlocking and cross-referenced materials. HathiTrust, for example, does not display large portions of copyrighted works without permission from the copyright holder, but sites that allow users to upload materials can be vulnerable to charges of copyright violation.

The World Digital Library (WDL), which was launched in 2009, is another digital collaborative in the United

digitized resources from 40 foundations, research institutions, cultural institutions, and libraries within a single portal that allows the user to link them through thematic applications. The Smithsonian is a participant and was one of the first institutions to sign an agreement with the DPLA to serve as a digital content hub, with the intent to provide 800,000 records describing the digital holdings of the Institution. An example of use of the portal is an exhibition on the national parks, how they were formed, and what their impact has been. This exhibition draws on resources from many of the 40 institutions and consists of written, visual, and audio materials. In time, DPLA will not only produce many such exhibitions, but also allow classes, affinity groups, and individuals to create exhibitions as well.[54]

In Europe, work began in 2005 on a digital archive to capture its cultural heritage, which in 2009 became known as Europeana. Sponsored by the European Union, Europeana includes a large collection of digital books and library resources, but it also has a strong focus on museum collections, demonstrating that traditional institutional boundaries break down in the digital world.

BY THE END OF 2011, ALMOST 90% OF AMERICAN LIBRARIES REPORTED USING FACEBOOK AND ALMOST HALF WERE USING TWITTER TO PROMOTE THEIR SERVICES, PROVIDE USER UPDATES, AND REACH POTENTIAL NEW USERS.

Europeana provides access to more than 27 million books, films, paintings, museum objects, and archival documents from more than 200 content providers. The content is drawn from 31 countries, and the website had 5.3 million page views in 2012, up from one million in 2010. Europeana recently collaborated with the DPLA on a new virtual exhibition, "Leaving Europe: A new life in America," which tells the story of European emigration to the United States during the 19th and 20th centuries.[55]

States. Although its materials are carefully curated, its collection is relatively small. While a "library" in name, the WDL's digital collections also include audio and visual files and objects.

More recent developments include the Digital Public Library of America (DPLA), the Digital Preservation Network, and the Academic Preservation Trust, with the latter of the two focused on research university libraries and resources. The still-growing DPLA now combines

Another popular Europeana project involving citizen engagement has been a series of road shows in collaboration with Oxford University commemorating the anniversary of the outbreak of World War I. This project uses "Collection Days," on which citizens are invited to bring any stories they have in the form of letters, photographs, films, and newsreels, which are then digitized. So far the Archive has gathered 50,000 files of World War I material — mostly photographs but also uniforms, flags, a cigarette tin with bullet holes in it, and even a postcard from Adolph Hitler. A similar content-gathering initiative is underway focusing on the 25th anniversary of the fall of the Berlin Wall.[56]

Linked Open Data is a new priority for Europeana through the "Europeana Cloud" project, which will produce the infrastructure to support larger digital resources than presently available and provide improved digital linkage to other information sources.[57]

The progress in digitizing library and archival materials by the great institutions of the United States and Europe has created access for the public that was unimagined only a decade ago. The results to date show that institutions and large and small collaboratives all have a role and can fill different niches. Large collaboratives with overarching collections provide access that spans institutional boundaries, allowing users freedom to explore and learn at will. More is yet to come, with greater emphasis on digitization of collections and new access tools, but the early results are impressive.

MUSEUMS

While museums have experimented with digital technology since its early days, they have found it more difficult to bring their efforts up to the scale of other learning institutions. Impediments include the complexity of their collections, a low level of technical infrastructure, and a culture that was not built around open access other than through exhibitions. In spite of the challenges, museums that are willing to make the commitment and to live with the inevitable setbacks have made progress.

Organizations that have provided key assistance along the way include the Institute of Museum and Library Services, which supports the efforts of these institutions to be leaders in building digital communities, and the New Media Consortium in collaboration with the Edward and Betty Marcus Institute for Digital Education in the Arts, which have provided valuable information on new developments in the use of digital technology through their Horizon Report series.[58]

I was pleased to learn that my own institution, the Smithsonian, was one of the early adopters of digital technology and began to digitize its collections in the late 1960s.[59] In 1970, a milestone year for the Smithsonian, the Botany Department of the National Museum of Natural History took steps to create the world's first database for natural history collections, and the Smithsonian American Art Museum (SAAM) developed the first searchable database about American art. The Botany Department was primarily interested in a database that would inventory its collections and make them accessible to scholars. During the first half of the 1970s an early prototype became available. In 1976, SAAM published its digital catalog as the "Inventory of American Paintings," based on public and private collections in the United States and abroad. The catalog, which is still available to the public through the Smithsonian Institution Research Information System, is an early example of the potential of digital technology.

Although both the botany and art projects eventually were overrun by new technology, both of these organizations have built on their early experiences and continue to lead in the creation of digital assets at the Smithsonian to this day.[60] Later in this discussion, I will provide a more comprehensive review of where things now stand at the Smithsonian in its pursuit of the use of digital technology.

The Heilbrunn Timeline of Art History at the Metropolitan Museum of Art provides a successful early digital model for art collections that has had staying power. Since 2000, the Met has made 5,000 years of art history available to the public through online access to assets including 7,000 objects, 930 essays, and 300 timelines. Through the years, the Timeline has been updated, and

today it serves as a scholarly resource and a digital learning vehicle for art history that attracts millions of enthusiasts and students. Thanks to an unprecedented and generous endowment from the Heilbrunn Foundation, New Tamarind Foundation, and Zodiac Fund, it can be continually updated.[61]

In the last decade a number of regional art museums in the United States have committed to digitizing their collections and placing essentially all of their assets online. A leader in this movement was the Indianapolis Museum of Art, which also launched ArtBabble in 2009, a video channel providing documentary videos about art, with an interactive component allowing the general public to participate in describing works of art.[62] Hiring members of the digital team from the Indianapolis Museum of Art has enabled the Dallas Museum of Art to strengthen its role in use of digital technology.

A new step toward higher-quality digital collections involves placement of high-resolution images from art collections online. In the past year the National Gallery of Art and the Los Angeles County Museum of Art each put more than 20,000 high-resolution images from their collections online, and the Getty Museum recently announced their Open Content Program which will provide high-resolution images of their artwork with 4,600 images available initially.[63] In contrast to many museums which prohibit commercial use of images from their collections, these museums placed no restriction on the use of their digital images. Overseas, the Rijksmuseum, the state museum in Amsterdam, started digitizing its collection in 2006, and today 140,000 high-resolution images are available through the Rijksstudio

section of the museum's website. Users are invited to download the images for free, create their own gallery, and even make stationery or t-shirts out of the images. In just seven and a half months online nearly 100,000 Rijksstudio accounts were created and nearly 300,000 images have been downloaded. The intent is to digitize the entire collection, which includes one million artworks spanning eight centuries.[64]

The Cleveland Museum of Art, which has the majority of its collections online and provides digital lessons about them, also used a major renovation project to build technology into the Museum to enhance the visitor experience. A 40-foot-wide screen welcomes the visitor with digital images of the objects displayed at the Museum. With the touch of a hand, an image enlarges and the screen displays information about the object. A second touch allows the information to be downloaded onto a visitor's own tablet or one they have rented from the Museum. The Museum also features a special gallery of interactive digital technology that enables in-depth exploration of works of art from its collection.[65]

In Great Britain, the Tate, which is composed of four separate museums (Tate Modern, Tate Britain, Tate Liverpool, and Tate St Ives), began its digital push in 1998 with funding from the Heritage Lottery Fund. In 2012, after several years of research and planning, Tate re-launched its next-generation digital effort, now providing access to all 69,000 works of art in its collection. Today 7 million people visit the museum facilities each year, while the number of unique visitors to the website totals 14 million.[66] The Victoria and Albert Museum, whose collections include fine arts, furniture, ceramics, tapestry, and glass, began digitization in earnest about 10 years ago, and to date 1.2 million records are available online, with 300,000 images. The Museum's most recent five-year strategic plan cites digital access to the collection as a priority.[67]

Compared to art museums, many science museums have relatively small collections, and their use of digital technology focuses more on experiential activities such as field trips, presentations, and demonstrations than on providing access to digitized collections. One of our nation's oldest and leading science museums, the Museum of Science, Boston, has been a pioneer in creating digital materials for engineering curricula used by 50,000 teachers to instruct nearly five million elementary, middle, and high school students. The Museum is now bolstering its "virtual field trip" experience, which allows online visitors to interact in real time with docents or pre-

Compared to art museums, many science museums have relatively small collections, and their use of digital technology focuses more on experiential activities such as field trips, presentations, and demonstrations than on providing access to digitized collections.

senters. In an innovative collaboration with the Department of Computer Science at the University of Massachusetts Lowell, the Museum is developing mobile robots that will image museum exhibits on demand and transmit them to those who are home or hospital bound.[68]

The New York Hall of Science is preparing an interactive digital exhibit for 2014 that will focus on environmental sustainability. Known as "Connected Worlds," it will offer visitors the opportunity to learn through data visualization tools, interactive digital technologies, "what if" scenarios, and a game experience that considers water as it relates to different habitats and connects to the environment and humans. The museum is also working on new ways to provide virtual field trips for students who are unable to come in person and to offer a greater variety of distance learning opportunities.[69]

Across the Atlantic, the British Museum, which has large science and cultural collections, began its digital efforts early with electronic cataloging in the 1970s. The Museum's physical collections include 8 million objects, materials, and records. Two million digital records are now available online, and more than 700,000 have one or more images. The Museum is readying a push to take its digital work to the next level, and recently created a Department of Digital, Publishing, and Broadcasting to coordinate the work of its different units.[70]

Museums have yet to take advantage of collaboratives as fully as libraries and archives do, but that is beginning to change. Europeana, which combines collections from museums, libraries, and archives, is a leading example, illustrating what can be done if resources are available. Its impressive efforts extend beyond putting collections on-

line to allow participating museums to take the lead in creating innovative digital exhibitions that engage the public via crowdsourcing tools.

The next quantum leap for collaboratives is emerging through cloud technology, which enables digital collections to be connected to an infinite variety of information sources that provide context for them. The Smithsonian American Art Museum is a leader in exploring this model under the rubric of the Linked Data cloud. The American Art Museum is working with computer scientists from the University of Southern California and a group of like-minded institutions, including the Metropolitan Museum of Art in New York, the Indianapolis Museum of Art, the Dallas Museum of Art, and the new Crystal Bridges Museum of American Art to create the tools needed to lift collection-based materials into the cloud and connect them to resources like the *New York Times* archives and Wikipedia. A user interested in a particular artist would not only be able to call up digital collections by the artist from the various museums, but also simultaneously be directed to biographical information about the artist from other archival sources. This powerful concept will change the fundamentals of accessing information not only about art, but about all other fields.

Beyond extending the reach of museum collections and exhibitions, digital technology also offers new opportunities to deepen learning and research about them through online courses and seminars. The Museum of Modern Art (MoMA) in New York City has launched an expanding online program of study focused on modern and contemporary art. The courses explore art from the perspective of the artists, curators and conservators as well as art historians, allowing users to learn how art is made and how the process works. MoMA charges a nominal fee for each course, which supports the development of content. In the sciences, the American Museum of Natural History (AMNH), also in New York City, has developed an online array of seminars and courses, some of which can be used as credit toward graduate degrees at local universities.

Given their leading role in offering online courses, it is not surprising that MoMA and AMNH are among the first museums to offer MOOCs. This new development is in process as this document is written, and the first MoMA offering attracted over 17,000 participants. It is likely a precursor of many more online courses and seminars to be offered by museums in the MOOC format or using alternative approaches.

This review shows that museums are increasingly recognizing the possibilities inherent in using digital technology — both to enhance the physical visit and to provide online access to collections and programs — but getting there is not simple. The challenges reside in lack of sustained resources, complexity of the collections, rapid changes in technology, and the need to adapt museum culture to the expectations of a digital world. While these issues are not insignificant, the museum community can overcome them with sustained commitment and an appreciation for the need to balance the digital with the physical museum experience.

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The Smithsonian's Digital Journey

At the Smithsonian, the creative use of new communication technology goes back to Secretary Joseph Henry's use of the telegraph in his citizen science experiments that led to the creation of the National Weather Service. Henry set the standard for early adoption of technology and exploration of its possibilities, and his lead has been followed by both art and science units within the Smithsonian. The 1995 Smithsonian strategic plan was the first to call for a large-scale effort to digitize collections and create the portals to reach larger audiences. This goal reinforced the early efforts to digitize collections and resulted in the creation of the "Collections Information Systems Pool," which provided funds for equipment and supported digitization at the museum and center level. This small grants program is still going, and has spawned dozens of digitization efforts while providing modest funding for institutionally based infrastructure. It has kept the Smithsonian flirtation with its digital future alive, but has not been focused enough or large enough to move a full pan-Institutional approach forward.

When I arrived as secretary in 2008, digital technology had become pervasive in society, with enormous advancements in power and capacity. Because I came from a university where digital technology was widely used to promote teaching and learning, it was clear to me from the outset that it could greatly increase the reach and relevance of the Smithsonian. Given our position and disciplinary breadth, I believe we should be a leader. I was pleased to find t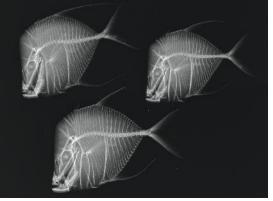hat the Institution had pockets where digital efforts were strong and that interest in ramping up such efforts was substantial.

The strategic plan developed for the Smithsonian in 2009 stated our intent to build on this momentum, and laid out ambitious goals for the digital future of the Smithsonian. Since 2009, remarkable progress has been made, but at the same time, new technological developments have continually raised the bar.
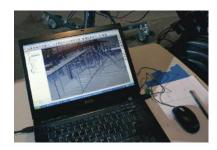
LAUNCHING THE JOURNEY

In 2010, a conference named Smithsonian 2.0 explored the possibilities of Web-based technology at the Smithsonian. It matched 30 of the leading lights of the digital world with an equal number of Smithsonian staff members who had a strong interest in the use of digital technology. This meeting was a revelation as the outside experts learned about the resources provided through our collections, our curators, and our scholars, and our staff learned about new Web technology from our visitors. Everyone agreed that melding the power of digital technology with the resources of the Smithsonian had huge potential.

The conference resulted in a Smithsonian seed grant program to fund innovative applications for digital technology that would engage the public in new ways. It generated

exciting ideas such as the National Museum of African Art's Artists in Dialogue, in which two artists on different continents interacted in real time to create two works of art based on a common idea. Parents and their children could listen in on the creative process and ask questions. The artists and other participants were overjoyed by the experience, and Artists in Dialogue illustrated the power of using digital technology to reinforce the physical museum experience.

A second example from the seed grant program is Smithsonian Wild, a website developed to show camera trap photographs of wild animals from around the world. It came about when researchers from the National Zoo and the National Museum of Natural History realized that they both actively used remote cameras, but in different parts of the world. Combining their photographs on one website provided a new learning resource, and the site transformed research tools formerly used only by scientists into a live resource for the public to explore the behaviors of the wild creatures that share our planet. The website continues to enthrall us because it reports new pictures every day.

Artists in Dialogue and Smithsonian Wild illustrate how digital technology can expand the education role of museums. They demonstrate that members of the public can become engaged in the creative process of art and become participants with our scientists in studying nature as it changes day by day.

DIGITIZATION AND ACCESS

Great buildings begin with strong foundations, and for the future of the digital Smithsonian that foundation consists of digitizing collections and providing avenues for digital access by the public.

At 137 million objects, scientific specimens, and works of art, Smithsonian collections pose a challenge to digitization because of their vastness and complexity. Given the size of our collections, just deciding where to start digitizing is not easy. In part, this decision was made for us by museums that chose on their own to digitize their collections. Exemplars include the Botany Department of the National Museum of Natural History and the Smithsonian American Art Museum. As noted earlier, both of these units began their digitization efforts in the 1970s and they have continued to adapt to new technological platforms. Today, more than 1 million of an estimated 5 million specimens in the botanical collections of the United States National Herbarium have been digitized.[71] SAAM has digital records for its entire art collection, and images for more than 80 percent are available on its website. Beyond our museum collections, our Center for Folklife and Cultural Heritage has digitized 16 percent of its audio recordings (which are available on iTunes). Of our archival material, 24,000 cubic feet, which constitutes 30 percent of what is considered priority material for digitization, is now in digital form. A new agreement with the company Gale Cengage has led to the digitization of the entire back collection of *Smithsonian* and *Air & Space* magazines. We are exploring further use of their services for other archival collections.

At 137 million objects, scientific specimens, and works of art, Smithsonian collections pose a challenge to digitization because of their vastness and complexity.

On the main website for the Smithsonian, the Collections Search Center now provides access to eight million digital records, including more than 800,000 images. More records and images are being added daily through a pan-Institutional system that allows museums to automatically upload their digital assets to the main site.

Even with the progress we have made, however, the task of digitizing our collections remains daunting and will require us to use an array of approaches to cut the job to size. The creation of a formal digitization division within our Office of Information Technology and bringing in talented professionals to staff it has led to a concentrated effort to make strategic choices about digitization efforts. A comprehensive survey and review has concluded that of the 137 million objects in our collections, about 13 million should be considered as priority for digitization. This prioritization reduces the task considerably, but much work remains to be done.

At the top of the digitization ladder, work is underway on three-dimensional imaging. Obviously all objects with shape are candidates, but the process is time consuming and labor intensive, so establishing priorities is essential. The present goal is to create a "Charter Collection" of such images and use these to demonstrate the power of the technique. The high definition of the images and the capability to see them from all angles are already providing new insights into works of art and allowing scientific specimens to be viewed in ways not possible by physical observation. Connecting the files to 3-D computer printers allows the objects to be replicated here at the Smithsonian as well as at remote sites where the capability exists. This new development offers exciting possibilities as the cost of the technology drops and 3-D printers become available to schools and museums around the nation.

In addition to the Collections Search Center on our main website, access to Smithsonian digital assets is available through various museum websites and mobile devices, and digital visitation is increasing substantially:

• More than 102 million unique visits were made to the Smithsonian's websites and blogs in 2012, up from 83 million in 2011.

• Thirty-two mobile apps and 11 mobile websites are available. Some support specific exhibitions while others help people design their visits and locate themselves within our museums. Still others are educational, such as the enormously popular Leafsnap, which allows users to identify a tree by taking a picture of a leaf.

• More than 450,000 downloads were made to mobile devices in 2012, a number that is growing rapidly. Twenty-four percent of Web traffic at the Smithsonian is now from mobile devices — up from eight percent in 2010. By 2014 it is predicted to exceed 50 percent.

- Thousands of teachers have downloaded the more than 2000 lesson plans available on our main website, with most designed to meet state standards.

- *Smithsonian Magazine* is now available in digital form on tablets, and has received more than 100,000 downloads. Smithsonian.com, the Web portal for the magazine, now received more than 2.5 million visits over calendar years 2011 and 2012. Its unique visitor count has more than tripled.

- The Encyclopedia of Life (EOL) project has the goal to provide a Web page for each of the 2 million known species of life on Earth. Today the website has more than 1.2 million species pages, and with the help of volunteers around the world it is rapidly moving toward its ultimate goal. The EOL has also developed new programs to engage students and teachers in interactive activities and to provide information for lesson plans. The content can be downloaded in any one of 13 languages, and the website was visited by more than a million people last year.

All our museums offer applications for smartphones and tablets to assist the visitor in choosing exhibitions and learning about them. The apps also allow our visitors to leave their impressions of their visits.

ENHANCING THE PHYSICAL VISIT WITH DIGITAL TECHNOLOGY

The most opportune way to use digital technology to enhance the physical visit is to build in the technology during the development of a new exhibition or the construction or renovation of a building. The Smithsonian pursues all of these avenues. The design of the "Human Origins" exhibition in the National Museum of Natural History incorporated technology allowing visitors to connect to content not shown in the exhibition itself, and a website was developed to provide educational materials related to the exhibition that are updated daily. A lighthearted touch included a station to allow visitors to morph themselves into a former human species (Neanderthal is the most popular), and an app to do the same is available through iTunes.

The Smithsonian's Cooper-Hewitt, National Design Museum, housed in the Carnegie Mansion in New York City, is building in technology during its facility renovation. Future visitors can become designers on the spot, viewing digital images of objects in the Museum's collection and using a digital stylus to generate their own designs. Their completed designs can be downloaded to their mobile devices to take with them. The renovated Museum will be open in 2014.

The new National Museum of African American History and Culture, now under construction and scheduled to open in 2015, will also incorporate technology into its structure to enhance the visitor experience. The Museum has already developed a new app that uses a form of augmented reality to allow visitors in the vicinity of the construction site on the Mall to see a 3-D model of the building and view information about the building from all angles.

All our museums offer applications for smartphones and tablets to assist the visitor in choosing exhibitions and learning about them. The apps also allow our visitors to leave their impressions of their visits.

Beyond mobile technologies, a number of techniques for augmented reality have emerged that allow visitors to see and hear realistic moving 3-D images of animals, his-

torical figures, or extinct species like dinosaurs in open spaces without need of special glasses. The Smithsonian has more than one such approach in testing, and several of our museums are moving forward with prototypes. Trials of this technique have delighted visitors while complementing the content of exhibitions.
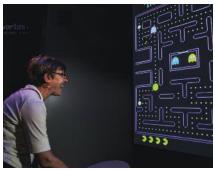
DIGITAL PUBLIC ENGAGEMENT

As Clay Shirky points out in *Here Comes Everybody,* social media are empowering individuals to participate in society in new ways.[72] Ordinary citizens can spawn movements with Twitter or weblogs, or become amateur photojournalists with their smartphone cameras, instantly uploading on-the-scene photos that may be picked up by news media or provide crime scene evidence.

The Smithsonian is finding exciting ways to incorporate this new capacity for public engagement. From a base of zero a few years ago, more than 400 social media accounts are in operation at the Smithsonian, with almost three million Twitter and Facebook followers alone, a number that is climbing at an annual rate of 50 percent.

Digital games have been used at the Smithsonian American Art Museum (Ghost of a Chance, Pheon) in the form of scavenger hunts built around the art collections. Vanished, a digital game developed by the Smithsonian Center for Digital Learning and Access and MIT, was used in middle school competitions to solve problems related

Ordinary citizens can spawn movements with Twitter or weblogs, or become amateur photojournalists with their smartphone cameras, instantly uploading on-the-scene photos that may be picked up by news media or provide crime scene evidence.

to an environmental disaster which unfolds over time, teaching students new science lessons. The 2012 exhibition "The Art of Video Games," at the Smithsonian American Art Museum, was the first of its kind. More than five million people voted on what they deemed the best computer games for the exhibition, and more than 500,000 visitors attended the exhibition itself.

YouTube has proven a popular means to connect with the public, and as of early 2013 the Smithsonian was operating 55 channels with more than 5,000 videos available to the public, which collectively have been viewed more than 23.6 million times.

Crowdsourcing is finding a growing role in both the sciences and the arts. The Encyclopedia of Life conducts "BioBlitzes" that encourage citizen scientists to identify new species not yet covered by the Encyclopedia, and users of the app Leafsnap are helping to identify and map the range of tree species by establishing GPS coordinates when they take pictures of leaves from trees they want to identify. The National Postal Museum is using 160 vetted volunteer researchers to document its artifacts. At the National Museum of American History, the Access American Stories app invites visitors to describe 180 of America's most evocative historical objects, helping the visually impaired to "see" the collections.

ALL OF OUR DIGITAL ACTIVITY
POINTS TO THE PROMISE OF A
NEW AND A MORE DEMOCRATIZED
SMITHSONIAN INSTITUTION,

A SMITHSONIAN FOR ONE AND
FOR ALL.

A new forum for public engagement called MySI uses open-source technology that allows a wide variety of tools to be added and has applications in science, art, and history. One of its first uses has been for an agricultural history project in the National Museum of American History that allows individuals to contribute stories about growing up on farms. A new science website designed for use through MySI allows current events to be used for learning lessons and encourages readers to add blogs and pictures. Many other applications for MySI are in the pipeline.

Astronomy provides yet another means of public engagement, courtesy of the Smithsonian Astrophysical Observatory (SAO), through an innovative project entitled "Youth Capture the Colorful Cosmos." SAO, based in Cambridge, Massachusetts, is involved in the operation of observatories around the world, and even in outer space, working with NASA. In addition to its large telescopes, SAO maintains small land-based telescopes in a number of countries and locations that are operated remotely using digital instructions. The Colorful Cosmos project, funded by our Youth Access Grants program, provides youth groups at regional science museums digital access to SAO's land-based telescopes, allowing them to perform experiments, in many cases with direct help from SAO scientists and staff. The project illustrates how digital connections allow SAO and its scientists and telescopes to become a resource to thousands of students, who before did not even know SAO existed.

This brief review of some of our digital engagement activities is instructive in showing their diversity and impact. It is surprising to realize that most only emerged on the scene in the last three or four years. This area is filled with opportunity for the future.

ONLINE COURSES AND DIGITAL CERTIFICATION

The Smithsonian's online courses and programs began years ago as one-way exercises with little opportunity for interaction. More recently, however, new tools are inviting users to participate through interactive videoconferencing, webinars with blogging, and real-time programming.

For nearly a decade, a partnership between the Smithsonian's American Art Museum and the Department of Defense has provided curriculum resources about art through interactive videoconferencing for K–12 teachers and students in schools for the children of American military personnel and Department of Defense civilian employees around the globe. The lesson plans and curriculum units are created on demand and are based on the Museum's collection. The program has now expanded to reach other schools nationwide.

Using experts from across museums and research centers, the Smithsonian Center for Digital Learning and Access offers monthly, interactive Smithsonian Online Education Conferences on topics from climate change to the presidential inauguration. Upwards of one million students and educators have participated from all 50 states and six continents.[73]

National Youth Summit programs are offered online by the National Museum of American History. While the core content emanates from the Museum, these programs also include complementary live content from Smithsonian Affiliate museums. A recent summit on the Freedom Riders of the 1960s included commentary from Freedom Riders in seven different cities. More than 20,000 students participated.

Our growing portfolio of online courses and other educational offerings raises the question of certification for participants. At present the most promising alternative is "digital badges" earned by students who complete a "mission," which could include taking a series of courses or participating in seminars and/or completing on-line as-

signments. Participants who enroll in Smithsonian Quests — an offering through the Smithsonian Center for Digital Learning and Access that inspires students to explore their interests online — can earn digital badges by completing assignments from online conferences. Those in the badge program have the opportunity for live interaction with experts in the topic area.[74] Other badge-earning programs are offered in Smithsonian museums, and more than 100 badges are now available.

ON THE HORIZON

New digital opportunities continue to arise as this document is being written. An important link to the university world was created recently with a partnership between the Smithsonian and Internet2, which connects more than 220 universities in the United States with a high-capacity network. This collaboration will allow the Smithsonian to deliver content to 24 million college and university students in the United States and provide a link for our growing partnerships with universities and colleges. Because Internet2 is connected to other high-capacity networks in Europe and Asia, Smithsonian content can be delivered to millions of additional students overseas.

The Smithsonian is also actively expanding its use of high-performance computing. In the natural sciences, new work in animal and plant genomics and with ocean observatories will create large-scale databases that require high-performance computing to manipulate. In art, history, and culture, new efforts to link written, digital, audio, and video archives will rely on high-performance computing. Discussions are underway to shape opportunities for future collaboration with the high-performance group at Oak Ridge National Laboratory and with the Institute for Computing in Humanities, Arts, and Social Science at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

SUMMARY

This review of digital activities at the Smithsonian illustrates how extensive the use of digital technology has become and how fast changes are occurring. The rate of adoption of digital technology is increasing as we learn more about its appropriate use. The real beneficiaries are the hundreds of millions of people who can now access Smithsonian resources in ways not possible only a few years ago. Along the way we are also moving beyond the conventional, one-sided communications of the traditional museum and learning how to interact with our digital user community. All of our digital activity points to the promise of a new and a more democratized Smithsonian Institution, a Smithsonian for one and for all.

Yet, while there has been much progress and we can see the possibilities, much remains to be done. Too few of our collections are online; too few opportunities exist for interaction and coordination among our museums, libraries, and research centers, and between the Smithsonian and the public. The capabilities of our search engines must improve and we need to learn to spread the use of new technologies across the Institution at a faster pace.
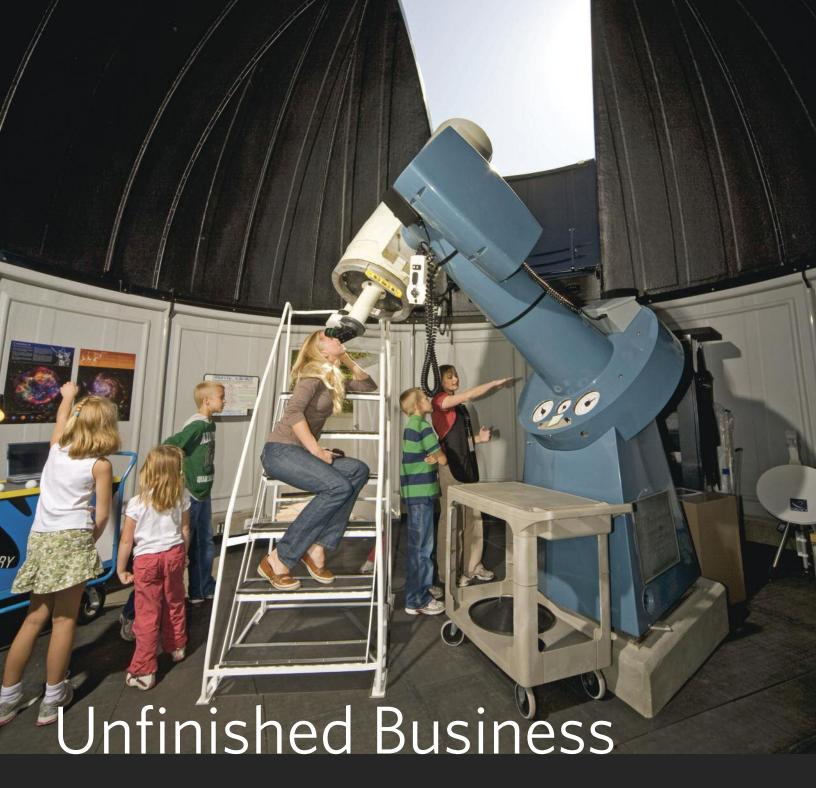
71. Interview with Warren Wagner, Chair, Department of Botany, National Museum of Natural History, by Cynthia Kennard, Smithsonian, 27 June 2013.

72. Clay Shirky. *Here Comes Everybody: The Power of Organizing Without Organizations* (New York: The Penguin Press, 2008).

73. Interview with Lynn-Steven Engelke, Smithsonian Center for Digital Learning and Access, by Cynthia Kennard, Smithsonian, 6 February 2013.

74. Ibid.

Unfinished Business

CHAPTER 8

As has been shown in the previous sections, digital technology is profoundly changing museums, libraries, and archives and the way they reach and interact with people. While the promise for use of digital technology has hovered around these institutions for several decades, the reality has now arrived. Progress has been made, and is being made, on many fronts, but we are only at the beginning of what is to come. The challenge for these institutions is how to make progress on the basics even as the technology continues to change, offering yet more opportunities. This task will require new ideas and approaches.

Every great innovation has ridden a train of inevitability. The introduction of railroads, electric lighting, automobiles, radio, and television transformed society whether society was ready or not, and now digital technology is taking its turn. But this one feels different, because it touches our lives in more ways than any previous innovation and because it is coming at us in rapid waves. While it is true that the traditional role of our cultural institutions is still valued by the public and is needed, they must find ways to accommodate digital technology or risk becoming marginalized. The trick is to find the means to balance what is good about the long-established embodiment of museums, libraries, and archives with the virtues offered by digital technology, and to do it seamlessly. It is easier said than done, given that resources for our cultural institutions are under stress and their bench of digital talent is thin.

How can it be done? I suggest we begin with principles that can guide the change:

1 Digital technology should first and foremost enhance and reinforce the in-person visitor experience.

2 Digitization of collections should be a primary institutional goal.

3 Digital assets should be accessible to the public, within limits set by constraints such as copyright.

4 Digital technology should be used to connect to audiences not served today.

5 The public should have opportunities to be active participants in the creative processes of the institution.

6 Institutional organizational structure should emphasize flexibility and adaptability to speed accommodation to new technology.

7 A systematic approach should be taken to understanding and responding to consumer expectations.

8 Collaborations and partnerships should be the rule, not the exception, and best practices should be widely shared both within the institutional walls and with other institutions.

9 Digital options to serve educational goals for K–12 and adult learning should be emphasized.

10 Digital activities should have aspirational goals and specific performance metrics that are evaluated on a regular basis.

Principles such as these will guide an institution in doing what is needed despite the challenges. Getting the work done will take a combination of reframing strategic approaches, re-budgeting, improving efficiency, obtaining funding from donors and supporters, and creating new revenue streams within the digital framework.

PARTNERSHIPS AND COLLABORATIVES

If museums, libraries, and archives are to serve the widest possible audiences and successfully embrace the possibilities of digital technology, "One for all and all for one" should be their motto. The digital work of museums, libraries, and archives is going to be so large and varied that no one entity or organization is capable of grasping it all. The key to the future is partnerships and collaboratives, ranging from the large — such as Europeana and the Internet Archives, which attempt to encompass collections from hundreds of museums, archives, and libraries — to the tidy and focused, such as the Biodiver-

An unappreciated aspect of partnerships and collaboratives is the possibility they offer for digital curation that can lead both to digital exhibitions and to more powerful physical exhibitions.

sity Heritage Library (BHL) which addresses historical documents in botany and ecology. Not only is there room for them all, but they overlap. The collections of the BHL, for example, are included in the Internet Archives. For the user, two points of access are better than one, since they differ in focus. While the Internet Archives provides access to the information, the BHL is a better resource for assistance with the subject matter. The larger collaboratives are also logical focal points for developing strong search engines that can be updated frequently, which will in turn serve smaller collaboratives.

Although it is early, it is clear that cloud-based technology offers tremendous possibilities for collaboratives and partnerships. Once a set of digital assets is successfully placed in the cloud, it can be linked to just about any other set of digital assets, offering a powerful tool for users to search for connections among not only museums, libraries, and archives, but also universities and information sources like Wikipedia.

An unappreciated aspect of partnerships and collaboratives is the possibility they offer for digital curation that can lead both to digital exhibitions and to more powerful physical exhibitions. The recent joint digital exhibition between Europeana and the DPLA on immigration from Europe to the United States is a good example of the power of the digital exhibition and its ability to allow the public to participate and enrich the exhibition content. When the exhibition is concluded, the stories contributed by the public will provide rich content for archives on the subject of immigration.

Beyond sharing digital collections, collaboratives can also provide an extended reach for cultural institutions. A good example is the new partnership signed between the Smithsonian and Internet2, which will allow content de-

livery to 222 universities in the United States and provide a simple means for the Smithsonian to receive online courses from universities. The Smithsonian is also using its growing digital capability to enable member museums and centers of Smithsonian Affiliations to participate in programs such as Youth Capture the Colorful Cosmos and the Youth Summits of the American History Museum.

PUBLIC ENGAGEMENT

Like weeds, digital tools to allow the public to engage with museums, libraries, and archives are sprouting up every day and becoming more powerful as well. While still too recent to be commonplace, it is nevertheless clear from the enthusiastic response that social media, crowdsourcing, and other engagement platforms are welcomed and will spread quickly. At the Smithsonian, the new open source platform MySI has already demonstrated how this approach can have wide application in arts, history, culture, and sciences.

However, if institutions are to adapt to the possibilities available for public engagement, the present wide variety of approaches will need to settle down into standard methods that can be updated. Organizations like the Institute of Museum and Library Services (IMLS), the American Alliance of Museums (AAM), and the Smithsonian with its Affiliate Museums can help by sharing best practices and encouraging use of common technology.

ONLINE COURSES

Because formal education is not part of their core mission, museums, libraries, and archives do not typically have teaching faculty like a university. However, they do offer their own courses and sometimes contribute experts to university courses. Many scholars at the Smithsonian teach courses offered by local universities and participate in degree programs jointly governed by the Smithsonian and education institutions such as Parsons The New School for Design and George Mason University.

Such arrangements are the exception rather than the rule, so it is not surprising that museums, libraries, and archives are not well represented in the online course business. Yet they appear to have a growing market, whether in more traditional form or as MOOCs or some future variation. If this market is large enough, it will ultimately require that cultural institutions form a teaching staff, possibly hired on contract. This undertaking probably is only feasible for larger institutions or for collaboratives with a number of allied institutions who each agree to put up a certain number of faculty to meet specialty needs. The step beyond courses to degree programs is a long one for most institutions, including the Smithsonian. To date the Smithsonian has chosen to partner with universities to offer degrees and this would appear to continue to be the right

Engage Digitally:

conduct an
EXPERIMENT

contribute
stories

IDENTIFY A
SPECIES

Take a Course

SEE THE
NIGHT SKY

Today our K–12 schools face significant challenges, including access to educational enrichment activities, keeping students engaged and retaining them, and pressure to focus their efforts within the boundaries defined by increased emphasis on standards and testing.

model. In this approach, the Smithsonian, and other like institutions, can bring specialty offerings to the educational table that only they can deliver, while universities can use their broader programmatic menu to give students options they want while taking care of admissions, core courses, and accreditation and degree requirements.

FORMAL K–12 EDUCATION

It has been a dream of many to see the resources of museums, libraries, and archives become more integral to the nation's K–12 education system. When universal education was envisioned in the early days of our republic, it was seen through the lens of a "school." Through the years, only libraries were actually integrated into the concept of an educational institution, while museums and archives remained apart. This evolution had as much to do with the space and staff required to house and maintain museum and archival collections as it did with the separate cultures that developed around them.

Today our K–12 schools face significant challenges, including access to educational enrichment activities, keeping students engaged and retaining them, and pressure to focus their efforts within the boundaries defined by in-

creased emphasis on standards and testing. It is clear that museums in particular offer an intellectual resource that can help to address these issues. Some examples of the useful digital tools the Smithsonian already offers, such as providing lesson plans that meet state standards, were described earlier. However, the gulf is still too wide between "formal education" and "informal education."

Digital technology offers museums, archives, and libraries the means to bridge that gap, but these institutions need to understand what teachers need and students want, and not just assume they know best and proceed blindly. At the Smithsonian, we have engaged the

CLOSING THE GAP BETWEEN FORMAL AND INFORMAL EDUCATION WILL INCREASE RELEVANCY FOR MUSEUMS, LIBRARIES, AND ARCHIVES, GIVING THEM MORE VISIBILITY IN THEIR COMMUNITIES AND AMONG UNDERSERVED POPULATIONS.

teachers named annually as the nation's best by the Council of Chief State School Officers to serve as a focus group that guides the development of our materials for teachers. We now have a cadre of four cohorts of these professionals working with us, and their insights are invaluable. Of course, feedback can be gathered in many ways, but this one is personal and ongoing. One message we have heard is that teachers are less in need of fixed lesson plans and more in need of "plug and play" elements that can be pieced together to form lesson plans tailored by teachers for their particular classes and neighborhood. We are adjusting our approach accordingly.

Beyond formal learning tools, our cultural institutions can use digital technology to give teachers, parents, and students alike the tools to "learn by doing." We already have some of these tools in Smithsonian apps such as Leafsnap and in programs such as Youth Capture the Colorful Cosmos and the Smithsonian interactive online education courses. Much more is on the horizon with platforms like MySI, which will allow participants not only to "like" data from experiments, but also to share stories and ideas. Combining these offerings with those of partner institutions will provide the K–12 schools a rich content source to enhance learning and education.

One of the remaining keys to bringing informal and formal education closer together is the credentialing of informal digital learning through certificates and badges. For a student, a credential provides a means to legitimize and document commitment and achievement in informal learning programs. For example, the transcripts of high school students could show not only their performance in formal courses, but also the badges or other certificates they have received for the informal education exercises they have completed successfully. And informal education programs that provide certification can fill gaps that schools themselves cannot address.

Credentialed digital offerings provide other advantages such as:

• Packaging content in small increments that students can pursue as time allows.

• Focusing on motivation through practical applications and active learning exercises.

• Building an ethic of independent learning outside of the formal process.

• Exploring multidisciplinary topics.

• Encouraging teamwork through collaborative efforts.

• Developing multilingual competency.

For optimal effectiveness, credentialing must be standards-based and utilize a well-designed assessment system.

Closing the gap between formal and informal education will increase relevancy for museums, libraries, and archives, giving them more visibility in their communities and among underserved populations. However, to assume this role, these institutions must move beyond merely posting digital collections online to develop a context for understanding and applying the knowledge those collections contain. In the process, museums, archives, and libraries will become a resource that is infinitely more valuable than a passive set of digital images and will play a larger role in helping our nation meet some of its most pressing educational challenges.

The possibilities for museums, libraries, and archives to serve the public through digital technology are immense, but none of them will become reality without commitment, resources, effort, and innovation. As the swamp philosopher Pogo once said, "We are surrounded by insurmountable opportunities." But we have learned that we can pare the task down to size by making wise choices, working with our partners, and inviting wisdom from the crowd.

Conclusion:
Unlimited Possibilities

You have probably heard the story of the dog that obsessively chases a bus for years, but when he finally catches it, he does not know what to do with it. So it is that after many years of trying, digital technology has become so powerful it has finally overtaken education. Today digital technology is pervasive; its use, particularly by the world's youth, is universal; its possibilities are vast; and everyone in our educational and cultural institutions is trying to figure out what to do with it all. It is mandatory that museums, libraries, and archives join with educational institutions in embracing it.

The review in this document illustrates how many cultural institutions have already found innovative applications for digital technology, but it is more than just a matter of "using." Digital technology will also change the basics of how these institutions work as we move forward. Collections will be shared across institutions through the linked data cloud; the public will participate in the creative activities of cultural institutions through engagement platforms; and informal education will merge with formal education. Cultural change is never easy, and while an institution might be able to avoid it for a while, this time it will be so big that no one will escape in the long run.

The key to making this dramatic transformation work is to stick to the fundamentals of good learning and education. Cultural institutions like museums are not going away and they will continue to inspire people by giving them an opportunity to see the real thing and informing them of its rightful context. They are a singular source for families and friends to learn together and share the experience across generations. So it is essential that the starting point for use of digital technology is in enhancing the physical experience. But beyond in-person visits, digital technology will allow cultural institutions to do something they have not done in their history — reach millions of people who do not visit in person. That offers a once-in-a-lifetime opportunity for cultural institutions to find the relevance they have always wanted and needed.

The adoption of digital technology by museums, libraries, and archives is not going to be easy because of a lack of technical infrastructure, cost, and the pace of change. But the process will be easier if they work together. I have cited many examples of successful collaborations and partnerships in this review, and these are going to be more important in the future. In addition, support will be needed from philanthropic institutions, donors, and corporations who can supply equipment and expertise.

The past has shown that it is almost impossible to predict which technologies will arise in the future to displace those thought to be important today. However, we do know that this disruption will occur and that the world will continue to use whatever is introduced to best advantage. In his book *What Technology Wants,* Kevin Kelley demonstrates that humans are continually seeking new devices to advance the capabilities that nature has granted them through millions of years of evolution — so much so that humans are evolving themselves through technology.[75] Institutions must be able to make their way in a world in which changes occur at a rapid pace that is not only beyond their control, but also offers little in the way of advance notice.

While digital technology poses great challenges, it also offers great possibilities. For the Smithsonian and our nation's other museums, libraries, and archives, today is a time when we can serve the role our founders envisioned for the educational systems of our republic. We can help all the people, not just a few of the people, to understand our culture, the cultures of other countries, and life in all its dimensions.

75. Kevin Kelley. *What Technology Wants* (New York: Penguin Group, 2010).

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