NMC Horizon Project
2010 Museum Short List

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Critical Challenges

These interim results are part of the workflow for the 2010 Horizon Report: Museum Edition and are not intended for public release.

Time-to-Adoption: One Year or Less

Cloud Computing

It has become common for companies with vast computing networks to rent spare cycles and space to others. Each of these networks is known as a cloud and can support multiple services. Applications like Gmail use a cloud as their platform, in the way that programs on a desktop computer use that single computer as a platform. Cloud-based applications do not run on a single computer; instead they are spread over a distributed cluster, using storage space and computing resources from many available machines as needed. There are many computing clouds, and "the cloud" has come to denote any group of computers used in this way. Improved infrastructure has made cloud computing robust and reliable; as usage grows, the cloud is fundamentally changing our notions of computing and communication. Many emerging technologies are supported in some way by the cloud: collaborative environments, online communication tools, web-based counterparts to mobile applications, and many, many personal web tools are cloud-based. Data storage is cheap in these environments — pennies per gigabyte — so cheap that it is often provided in surprising quantities for free. To the end user, the cloud is invisible, and the technology that supports the applications does not matter — the fact that the applications are always available is key.

Relevance for Museum Education and Interpretation

- Using cloud services, high-quality digital content including videos, images, and audio files can be stored and made available to audiences at a distance.
- Cloud computing can decrease, and in some cases eliminate, the need for museums to spend large capital sums for hardware, proprietary software, and the staff to provide expertise in these areas.

Cloud Computing in Practice

- The Indianapolis Museum of art created ArtBabble in late 2008 an on-line video website dedicated to art related content that runs entirely in the cloud and allows streaming of high definition video content in a scalable and cost-effective manner: http://www.artbabble.org
- The Steve project uses Google Docs and other shared applications in the cloud to foster collaboration and working in teams: http://steve.museum

For Further Reading

Above the Clouds: A Berkeley View of Cloud Computing
http://d1smfj0g31qzek.cloudfront.net/abovetheclouds.pdf

(Armburst, et al., UC Berkeley Reliable Adaptive Distributed Systems Laboratory, February 10, 2009.) This white paper takes an in-depth, scientific look at cloud computing.

Cloud Migrations Trigger Organizational Challenges
http://www.informationweek.com/cloud-computing/blog/archives/2010/02/cloud_migration.html

(Vanessa Alvarez, *InformationWeek.com*, February 9, 2010.) This article discusses how cloud computing can work if organizations are well structured in advance to take advantage of its affordances.

Time-to-Adoption: One Year or Less

Geolocation

Everything on the Earth's surface has a location that can be expressed with just two coordinates. Using the new classes of geolocation tools, it is very easy to determine and capture the exact location of physical objects — as well as capturing the location where digital media such as photographs and video are taken. The other side of this coin is that it is also becoming easier to work with the geolocative data thus captured: it can be plotted on maps; combined with data about other events, objects, or people; graphed; charted; or manipulated in myriad ways. Indeed, such data are leading to entirely new forms of mapping. Devices we commonly carry with us increasingly have the ability to know where they (and, consequently, we) are, and to record our coordinates as we take photographs, talk to friends, or post updates to social networking websites. The transparency of this group of technologies — they are increasingly imbedded in all sorts of devices and technologies — is making them very much an essential part of our lives.

Relevance for Museum Education and Interpretation

- Geolocation provides the opportunity to reconnect concepts, collections, and individuals with the world outside the galleries of the museum by allowing contextualization in place and time.
- Staff and visitors can collect and mine geotagged information for research or personal use and, in doing so, engage more meaningfully with one another in terms of shared experiences and shared authority.
- Mobile learners can receive context-aware information about nearby resources, points of interest, historical sites, and colleagues, connecting all this with online information for just-in-time learning.
- Museums can tailor content delivery based on the geolocation of visitors (physical and virtual).

Examples

- The Powerhouse Museum's Layar experience allows visitors to use their mobile phones to see Sydney, Australia as it was 100 years ago: http://www.powerhousemuseum.com/layar/
- The Brooklyn Museum is promoting the use of Foursquare, a popular geolocation app, by offering "mayors" a membership for a year: http://www.brooklynmuseum.org/community/blogosphere/bloggers/2009/12/29/calling-the-mayor/

For Further Reading

Mapping Ancient Civilization, in a Matter of Days
http://www.nytimes.com/2010/05/11/science/11maya.html

(John Noble Wilford, *The New York Times*, 10 May 2010.) This article provides an overview of how LIDAR (Light Detection and Ranging) is being used by archaeologists to map out sites covered by dense jungle.

What's Next for Geolocation? Apps, Apps, Apps
http://www.readwriteweb.com/archives/whats_next_for_geolocation_apps_apps_apps.php

(Simon Salt, guest author, *ReadWriteWeb*, 8 February 2010.) This short post gives a quick summary of where geolocation based social networks are heading and what to expect in the near future.

Time-to-Adoption: One Year or Less

Mobiles

Mobiles as a category have proven more interesting and more capable with each passing year, and continue to be a technology with new surprises. The mobile market today has nearly 4 billion subscribers, more than two-thirds of whom live in developing countries. Well over a billion new phones are produced each year, a flow of continuous enhancement and innovation that is unprecedented in modern times. The fastest-growing sales segment belongs to smart phones — which means that a massive and increasing number of people all over the world now own and use a computer that fits in their hand and is able to connect to the network wirelessly from virtually anywhere. Thousands of applications designed to support a wide range of tasks on virtually any smart-phone operating system are readily available, with more entering the market all the time. These mobile computing tools have become accepted aids in daily life, giving us on-the-go access to tools for business, video/audio capture and basic editing, sensing and measurement, geolocation, social networking, personal productivity, references, just-in-time learning — indeed, virtually anything that can be done on a desktop. Because the threshold for development is lower for today's mobiles, it has become easier and less expensive for museums to develop and serve better content, more quickly.

Relevance for Museum Education and Interpretation

- Increasingly, museums are taking advantage of the devices people carry, reducing overhead costs for services like audio tours.
- Mobiles allow museums to more directly target niche audiences such as teenagers and parents with young children.
- The applications for mobile in museum education are largely untapped, but could be profound. These devices take pictures; allow visitors to view images, video, sound, access the web; check their email; geo-locate, tag, and increasingly even recognize and recreate objects.

Examples

- SFMOMA's Making Sense of Modern Art Mobile brings the rich MSoMA resource to a portable, handheld device: http://www.sfmoma.org/events/1556
- Teenagers from NYC schools created the audio tours for MOMA Teen Audio that are designed to be used on personal mobile devices: http://www.moma.org/explore/multimedia/audios/15
- The Boston Museum of Science uses mobile technologies to facilitate data collection and engage visitors in citizen project to see if the number of fireflies are decreasing in *Firefly Watch*: https://www.mos.org/fireflywatch/

For Further Reading

Mobile for Museums
http://chnm.gmu.edu/labs/mobile-for-museums/

(Sharon Leon, Director of Public Projects at Center for History and New Media, George Mason University, 2010.) This article assesses the current state of mobiles for the museum field.

Teaching with Technology Face-Off: iPhones vs. PCs
https://chronicle.com/blogPost/Teaching-With-Technology/4547

(Jeffrey R. Young, *The Chronicle of Higher Education,* 25 February 2009.) One professor found that mobile devices increased student engagement with learning materials in his class.

Time-to-Adoption: One Year or Less

Social Media

No longer satisfied to be consumers of content, today's audience creates content as well, and is uploading photographs, audio, and video to the cloud by the billions. Producing, commenting, and classifying these media have become just as important as the more passive tasks of searching, reading, watching, and listening. Sites like Flickr, Odeo, YouTube, Google Video, and Ourmedia make it easy to find images, videos, and audio clips, but the real value of these sites lies in the way that users can classify, evaluate, comment upon, and add to the content that is there.

Using simple interfaces, visitors can build shared collections of resources, whether they be links, photos, videos, documents, or almost any other kind of media. They can find and comment on items in other people's lists, sharing not only the resources themselves but also information and descriptive details about them. As a result, over the past few years, the ways we produce, use, and share our media have undergone a profound transformation.

Relevance for Museum Education and Interpretation

- Museums can create conversations around videos and photographs of art, objects, and even the galleries and museums themselves.
- Social media offers museums a way to reach out to new audiences in a two-way conversation.
- Audiences can be encouraged to share comments, images, and videos of the museums they visit as well as, in some cases, their own artwork.

Examples

- The Brooklyn Museum uses a social media game to correct questionable tags applied to its online collection: http://www.brooklynmuseum.org/opencollection/freeze_tag/start.php
- The Victoria and Albert Museum's "World Beach Project" is an online global art project open to everyone: http://www.vam.ac.uk/collections/textiles/lawty/world_beach/

For Further Reading

Social Media Strategies for Museums
http://westmuse.wordpress.com/2009/09/22/social-media-strategies-for-museums/

(Stephanie Weaver, *Western Museums Association Blog,* 22 September 2009.) This post gives an overview of some of the social media challenges and trends as discussed at the Social Media Strategy for Museums conference held in September 2009.

The Social Web in 2010: The Emerging Standards and Technologies to Watch
http://blogs.zdnet.com/Hinchcliffe/?p=1152

(Dion Hinchcliffe, *ZDNet.com*, 20 January 2010.) This analyst gives an in-depth look at the technologies and integration of social media into our daily lives, especially as they relate to the work environment.

Time-to-Adoption: Two to Three Years

Augmented Reality

The idea behind the term augmented reality (AR) is to blend, or augment, primarily location-based data accessed on the web with what we see in the real world. While the capability to deliver augmented reality experiences has been around for decades, it is only very recently that those experiences have become easy and portable. Advances in mobile devices as well as in the different technologies that combine the real world with virtual information have led to augmented reality applications that are as near to hand as any other application on a laptop or a smart phone. New uses for augmented reality are being explored and new experiments undertaken now that it is easy to do so. Emerging augmented reality tools to date have been mainly designed for marketing, social purposes, amusement, or location-based information, but new ones continue to appear as the technology becomes more popular. Augmented reality has become simple, and is now poised to enter the mainstream in the consumer sector.

Relevance for Museum Education and Interpretation

- Within a culture in which visitors can rarely touch the objects in the collections, augmented reality has strong potential to provide powerful contextual, in situ learning experiences and serendipitous exploration.
- Augmented reality can enhance interpretation by offering more, and more diverse, levels of interpretation.
- Augmented reality has the ability to radically reconfigure the visitor experience both on-site and beyond. Coupled with location-based services, AR will be an important tool in taking museums' collections and content beyond the institution's walls.

Examples

- Culture Clic offers a mobile AR experience of Paris that allows visitors to explore 500 geolocated paintings, photos and engravings: http://www.cultureclic.fr/
- The Powerhouse Museum has developed an augmented reality application that allows visitors to use their mobile phones to see Sydney, Australia as it appeared one hundred years ago: http://www.powerhousemuseum.com/layar/

For Further Reading

If You Are Not Seeing Data, You Are Not Seeing
http://www.wired.com/gadgetlab/2009/08/augmented-reality/

(Brian Chen, *Wired Gadget Lab*, 25 August 2009.) This article gives a good overview of augmented reality, including where it currently is situated and what to expect in the future.

Visual Time Machine Offers Tourists a Glimpse of the Past
http://www.sciencedaily.com/releases/2009/08/090812104219.htm

(*ScienceDaily*, 17 August 2009.) New apps for smartphones offer augmented reality on the go. While on location, users view historical sites as they were hundreds of years ago.

Time-to-Adoption: Two to Three Years

Game-Based Learning

The interest in game-based learning has accelerated considerably in recent years, driven by clear successes in military and industrial training as well as by emerging research into the cognitive benefits of game play. Developers and researchers are working in every area of game-based learning, including games that are goal-oriented; social game environments; non-digital games that are easy to construct and play; games developed expressly for education; and commercial games that lend themselves to refining team and group skills. At the low end of game technology, there are literally thousands of ways games can be, and are being, applied in learning contexts. More complex approaches like role-playing, collaborative problem solving, and other forms of simulated experiences have broad applicability across a wide range of disciplines, and are beginning to be explored in more classrooms and other places where learning takes place. Skill-building games and small group games that foster discussion and teambuilding are not difficult to fit into existing curricula, and many examples of their use can be found. Their engaging nature makes them excellent learning aids. The category of game-based learning that is still two to three years away, but one that has tremendous potential to transform education, includes open-ended, challenge-based, truly collaborative games. Games like these, which occur in both massively multiplayer online (MMO) and non-digital forms, can draw on skills for research, writing, collaboration, problem-solving, public speaking, leadership, digital literacy, and media-making.

Relevance for Museum Education and Interpretation

- Game-based learning leverages the physical and virtual nature of collections and provides opportunities for understanding context.
- Museums can use game-based learning to establish dialogue, to introduce complex or controversial topics, and to break down social and cultural boundaries.
- Game-based learning presents a new opportunity for museums to partner with schools, and blurs the distinction between formal and informal learning.

Examples

- "Ghosts of a Chance" allows visitors to the Smithsonian American Art Museum a chance to decipher codes, follow treasure maps, send text messages, and uncover hidden objects in this multimedia scavenger hunt: http://ghostsofachance.com/
- World without Oil is a collaborative imagining of the first 32 weeks of a global oil crisis: http://worldwithoutoil.org/

For Further Reading

Deep Learning Properties of Good Digital Games: How Far Can They Go?
http://www.jamespaulgee.com/node/37

(James Paul Gee, Arizona State University, January 2009.) This study by noted educational gaming researcher James Paul Gee discusses the merits of good digital games and their design along with the learning that can accompany them.

Reality is Broken, Game Designers Can Fix It (video)
http://www.avantgame.com/

(Jane McGonigal, Institute for the Future, 2010.) This TED talk advocates incorporating principles of game design into the real world to effect social change.

Time-to-Adoption: Two to Three Years

Location-Based Services

Location-based services provide content that is dynamically customized according to the user's location. These services are commonly delivered to mobile devices, but can also be accessed from other portable computers, handhelds, or any Internet-capable device. Current common applications for location-based services include advertising, news, social networking, and similar services. An increasing number of mobile applications are taking advantage of the built-in geolocation capability that is increasingly a standard feature in mobile devices.

Location-based services can be used to deliver information as well as commerce, so for example, a museum visitor interested in a painting could easily discover if the museum store contains a poster of the work or a book about an artist. Rich media like photos and video, because they can be easily geo-tagged, are important aspects of location-based services as they continue to develop.

Relevance for Museum Education and Interpretation

- Museums can used location-based services to push information to audiences based on where they are within the building or grounds.
- Location-based services in museums could be used to "pin" information to a given location and have it pushed to a user once he/she has reached that location (geocaching).
- Location-based services allow a museum to extend its collection into the world beyond the walls. For example, public artworks could be "tagged" in ways that lead the visitor to the museum's website, with the interaction triggered via the act of photographing the art.

Examples

- Layar helps users locate clubs, restaurants, theaters, museums, and more by layering digital information over the image on a mobile's camera, showing where to find venues nearby: http://www2.layar.com/
- Tourists to Holland can access information about nearby cultural attractions, museums, and other points of interest using their mobiles: http://www.holland.com/global/layar/
- QR Code Artist Pedro Morales uses raffia mesh and fabric shapes to create organic works of art with content that can be read by pointing your phone at them: http://2d-code.co.uk/qr-code-artist-pedro-morales/

For Further Reading

7 Things You Should Know about Location-Aware Applications
http://www.educause.edu/ELI/7ThingsYouShouldKnowAboutLocat/163839

(Educause, March 2009.) Location-aware applications have many uses, and enhance a variety of disciplines. This brief report discusses location-based services for education.

2009: The Year of LBS (Location-Based Services)
http://www.readwriteweb.com/archives/2009_the_year_of_lbs_location-based_services.php

(Sarah Perez, *ReadWriteWeb*, 7 July 2009.) From finding the nearest coffee shop to tracking your children, location-based services offer a host of solutions to everyday problems.

Time-to-Adoption: Two to Three Years

Open Content

Open content is a growing movement that focuses on sharing and reusability and thrives on the ready availability of a wide range of content. Open content offers museums a potential alternative to traditionally published materials such as catalogues and coffee-table books, monographs and thematic studies that is highly customizable and cost-effective. The open content movement depends on a community of contributors and users who are willing to create and release high-quality educational and interpretive content in a variety of media under licenses that make it easy to reuse the materials. With increased access to information enabled by open content and other means, the role of the museum is undergoing a slow but definite change from the guardian of cultural or intellectual authority and dispenser of knowledge, to the guide and coach for audiences faced with an overabundance of resources. People have unparalleled access to information; what is needed from museums is help cultivating the skills of finding, assessing, interpreting, and synthesizing information.

Relevance for Museum Education and Interpretation

- Open content is sharable, thus opening the door both to cross-institutional sharing and to new interpretations of cultural heritage materials.
- Museums can use open content as a way to transition themselves away from unprofitable rights-and-reproductions practices.
- Visitors to museums possess enormous expertise. When museums make the intellectual assets of collecting institutions available without unnecessary restrictions on reuse, this can catalyze unexpected discoveries and knowledge creation outside the walls of the institution.
- Communities of practice and learner groups that form around open content provide a source of support for independent or life-long learners.

Examples

- Open Content Alliance is a collaborative effort on the part of cultural, technology, non-profit, and governmental organizations to build a digital archive of global content for universal access: http://www.opencontentalliance.org/about/
- The Victoria & Albert Museum offers access to free images for personal use and academic use: http://www.vam.ac.uk/resources/buying/index.html
- MIT's OpenCourseWare—which provides free, online access to all of MIT's courses—serves as a model for other providers: http://ocw.mit.edu/OcwWeb/web/home/home/index.htm

For Further Reading

Center for Social Media Publishes New Code of Best Practices in OCW
http://criticalcommons.org/blog/content/center-for-social-media-publishes-new-code-of-best-practices-in-ocw

(Critical Commons, 25 October 2009.) Critical Commons' *Code of Best Practices in Fair Use for OpenCourseWare* is a guide for content developers using fair-use material in their offerings.

Creative Commons
http://www.creativecommons.org

Creative Commons has created a set of legal tools consistent with the rules of copyright that make it not only possible but easy for people to share and build upon the work of others. The organization provides free licenses that allow anyone to create, share, and use open content.

Time-to-Adoption: Four to Five Years

Gesture-Based Computing

Devices that can accept multiple simultaneous inputs (like using two fingers on the Apple iPhone to zoom in or out) and gesture-based inputs like those used on the Nintendo Wii or Microsoft's Project Natal have begun to change the way we interact with computers. We are seeing a gradual shift towards interfaces that adapt to — or are built for — humans and human gestures. The idea that natural, comfortable movements can be used to control computers is opening the way to a host of input devices that look and feel very different from the keyboard and mouse.

Gesture-based computing allows users to engage in virtual activities with motion and movement similar to what they would use in the real world. Content is manipulated intuitively, making it much easier to interact with, particularly for the very young or for those with poor motor control. The intuitive feel of gesture-based computing is leading to new kinds of teaching or training simulations that look, feel, and operate almost exactly like their real-world counterparts. Larger multi-touch displays support collaborative work, allowing multiple users to interact with content simultaneously, unlike a single-user mouse.

Relevance for Museum Education and Interpretation

- Gesture-based computing will allow for much more intuitive ways for visitors to navigate content, especially image-based content.
- Gesture-based computing will allow visitors to more intuitively understand the operational aesthetic of objects including: how objects function, how colors mix together, the stages in a multi-block print.
- Gesture-based tools can be used to create educational games and virtual playgrounds that allow visitors to explore techniques, actions, and interactions in a playful manner.
- Gesture-based tools can allow the very young, and, on the other end of the spectrum, the elderly and infirm to participate in activities and increase accessibility to collections.

Examples

- The Museo Archeologico Virtuale, in Ercolano, Italy, features several gesture-based technologies: http://www.youtube.com/user/MuseoMavTV#p/a/u/1/muDBWr0AP8g
- The EyeWriter project uses low cost eye tracking hardware and custom software to allow ALS sufferers and graffiti artists to write with their eyes: http://www.eyewriter.org/

For Further Reading

The Best Computer Interfaces: Past, Present, and Future
http://www.technologyreview.com/computing/22393/page1

(Duncan Graham-Rowe, *Technology Review*, 6 April 2009.) This article discusses a variety of interfaces, including gesture-sensing, voice recognition, and multi-touch surfaces.

Why Desktop Touch Screens Don't Really Work Well For Humans
http://www.washingtonpost.com/wp-dyn/content/article/2009/10/13/AR2009101300113.html

(Michael Arrington, *The Washington Post*, 12 October 2009.) Desktop touch screens are available but difficult to use over long periods. This article suggests another design approach.

Time-to-Adoption: Four to Five Years

Statistical Machine Translation

Over the past few years, a transformation has taken place in machine translation tools as rule-based translation systems have given way to statistical language analysis techniques that use known translations (e.g., United Nations archives and other open content) to derive nuances and meanings not easily addressed by rule-based systems. Tools like Google Translate have used statistical methods to move machine translation to the point where it is now a viable, low-cost, and easy option for automated, rapid translation on web content. While the translation tools are not yet perfect, they are fairly accurate in most cases, and are well-suited for credible on-the-fly translations.

The ability to embed translation tools quickly and easily into websites such that the viewer may choose a preferred language removes the need to prepare individual copies of online material in different languages. This simplifies upkeep and maintenance as well as making it easier to deploy new content quickly. Statistical machine translation is an increasingly robust and low-cost option that has developed to the point where it is a viable and easy solution for museums looking to make general information easily available in multiple languages.

Relevance for Museum Education and Interpretation

- As museums extend their collections to global audiences, support for multiple languages is critical.
- As work progresses in this area, we may see machine translation expanding to the point where it can manage discipline-specific vocabulary translations and reduce the need for thesauri.
- Statistical machine translation offers the promise of automated translations that, while not perfect, are "good enough" for most applications. Where engagement with the audience is the key outcome, providing a way to reach speakers of other languages will open the door to wider audiences.

Examples

- MOLTO Multilingual Online Translation is a project funded by the European Union with the goal of providing robust, real-time translation tools: http://www.molto-project.eu/
- The Institute of Texan Cultures Museum offers translations of its website into 12 languages using Yahoo!'s Babelfish: http://www.texancultures.utsa.edu/museum/translations.html

For Further Reading

Google Translate
http://translate.google.com/

Google Translate is an online translation tool provided by the search company. It can be used directly at this URL but it can also be used to embed into to other websites to help with translations.

MOLTO Translation and Retrieval Systems for Museum Objects
http://www.molto-project.eu/node/944

This portion of MOLTO has not been built out yet, but it demonstrates that this project is specifically thinking about incorporating museums into the translation tool. The focus appears to be translations for museum object descriptions.

Time-to-Adoption: Four to Five Years

Semantic Web

An increasing number of semantic-aware applications continue to emerge, bringing the web closer to Tim Berners-Lee's vision of a medium that not only allows people to share information, but to make sense of it. Applications for searching and finding, social networking, and focused research are appearing, and a new category of "smart" productivity applications has begun to emerge. These applications use the context of information as well as the content to make determinations about relationships between bits of data; examples like TripIt, SemaPlorer, and Xobni organize information about travel plans, places, or email contacts and display it in convenient formats based on semantic connections.

Semantic searching is being applied for scientific inquiries, allowing researchers to find relevant information without having to deal with apparently similar, but irrelevant, information. For instance, Noesis, a new semantic web search engine developed at the University of Alabama in Huntsville, is designed to filter out search hits that are off-topic. The search engine uses a discipline-specific semantic ontology to match search terms with relevant results, ensuring that a search on "tropical cyclones" will not turn up information on sports teams or roller coasters.

Relevance for Museum Education and Interpretation

- Museums have vast quantities of information about their collections that visitors want to access, and semantic web applications offer some promise in solving issues related to exploiting this rich knowledge.
- Museums are a logical place for semantic web related work to occur — their collections are bounded and increasingly being enriched with tags that expand the ways in which objects with in them can be found.
- Museums have developed systems and ontologies with regard to collections that might be applied universally to objects across museums to accomplish some of the goals of sense-making.

Examples

- CultureSampo is a semantic web 2.0 portal and a publication channel for Finnish cultural heritage based on semantic web: http://www.seco.tkk.fi/applications/kulttuurisampo/
- Stanford graduates created a free semantic application that allows users to find and add relevant multimedia to their blogs with ease: http://www.apture.com

For Further Reading

Tim Berners-Lee on the Next Web
http://www.ted.com/talks/tim_berners_lee_on_the_next_web.html
(*TED Talks*, February 2009.) Sir Tim Berners-Lee discusses the history and future of the web.

Wolfram|Alpha: Not a Google Killer, but Not Meant to Be
http://www.connected-science.com/?p=230
(Darin L. Stewart PhD, *Connected Science*, 18 May 2009.) Wolfram|Alpha uses semantic approaches to assemble answers to questions rather than returning a list of search results or hits.

Time-to-Adoption: Four to Five Years

Visual Data Analysis

Visual data analysis blends highly advanced computational methods with sophisticated graphics engines to tap the extraordinary ability of humans to see patterns and structure in even the most complex visual presentations. Currently applied to massive, heterogeneous, and dynamic datasets, such as those generated in studies of astrophysical, fluidic, biological, and other complex processes, the techniques have become sophisticated enough to allow the interactive manipulation of variables in real time. Ultra high-resolution displays allow teams of researchers to zoom into interesting aspects of the renderings, or to navigate along interesting visual pathways, following their intuitions and even hunches to see where they may lead. New research is now beginning to apply these sorts of tools to the social sciences as well, and the techniques offer considerable promise in helping us understand complex social processes like learning, political and organizational change, and the diffusion of knowledge.

Relevance for Museum Education and Interpretation

- The applications of visual data analysis for science museums are myriad, and can expose visitors to the emerging science made possible by extremely large data sets, such as those found in studies of climate, astrophysical, or geological processes. The ability of these tools to represent changing dynamics in these processes visually is also an opportunity to highlight the human brain enormous capacity for pattern matching.
- Historical, art and other museums might use these tools to examine the effects of their own microclimates on the objects in their collections.
- Visual data analysis could be a useful tool for curators to understand the nature of "gaps" in collecting areas and use them to tell stories about art history in local collections.

Examples

- From simulating the way waves break against a ship to visualizing seasonal carbon dioxide accumulation in North America, these videos demonstrate the diversity of data visualization: http://www.wired.com/wiredscience/2009/08/visualizations/all/1
- Analytics and data visualization allowed researchers at the University of Pennsylvania to visually model (in real time) the response of the body's immune system to a parasitic infection: http://www.upenn.edu/pennnews/article.php?id=1531

For Further Reading

FlowingData Graphs Your Life Via Twitter
http://www.fastcompany.com/blog/clay-dillow/culture-buffet/flowingdata-graphs-your-life-twitter

(Clay Dillow, *Fast Company*, 15 July 2009.) Track anything you like via a private Twitter address: every time you have a cup of coffee, blood sugar readings, chocolate cravings, workout time or distances. A graph builds over time of all the data sent in.

New Visualization Techniques Yield Star Formation Insights: Gravity Plays Larger Role Than Thought
http://www.sciencedaily.com/releases/2008/12/081231152305.htm

(*Science Daily*, 4 January 2009.) Early in 2009, a new computer algorithm developed at the Harvard Initiative in Innovative Computing demonstrated that data visualization is critical in the discovery of new information, not just in the final presentation of data.

Key Trends

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

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

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

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

Increasingly, the expectation is for a seamless experience across devices. Whether viewing curated galleries centered around objects and ideas or making a virtual visit to a museum's website, visitors expect museums to provide content. More and more, patrons want the experience of interacting with that content using the device of their choice, wherever and whenever they choose to do so. Virtual visitors in particular expect to be able to perform certain tasks online, and to be able to accomplish them on the device of their — and not the museum's — choosing, but this is increasingly true of visitors to the physical space as well.

Increasingly, we expect to be connected wherever we go. Wireless network access, mobile networks, and personal portable networks have made it easy to remain connected almost anywhere. We are increasingly impatient of places where it is not possible, or where it is prohibitively expensive, to be connected, such as airplanes in flight and countries outside our own mobile networks. The places where we cannot connect are shrinking — some flights provide wireless access, for instance — and our expectations of immediate access to our personal information, multi-level communication, and interaction with the world are more frequently met.

Momentum is building for linked data/semantic web and open data. Many museum professionals, albeit primarily those in information technology departments, are beginning to understand that there is a role for museums in helping to make sense of the vast amount of data available to us all. Museums have ever been places of ideas, but until recently the use-cases and examples for what can be done with linked data have been limited. Momentum will increase as more in the field, particularly those involved in content creation and interpretation, have a better understanding of the opportunities offered by the semantic web. Perhaps of more importance than museum data is the matrix of contextual data in which it sits and which can then inspire museum professionals, educators, and visitors alike to think of new things to do with cultural heritage information.

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

Critical Challenges

Content production has failed to keep up with technology. Audiences expect to consume information whenever and wherever they want. Museums have been scurrying to repurpose information already created to try and meet demands. The challenge and the opportunity for museums is to stop for a moment and look at ways to meet the current demands for existing raw data and to look at research about the uses of media in multimodal learning in order to create real, valuable, interesting, and engaging content. While there is currently a lot of pressure on museums to acknowledge user-generated content, this does not preclude museum professionals continuing as content generators.

Creating a digital strategy is critical for institutions today. Museums need to think about creating digital strategies for long-term institutional sustainability. Creating digital learning is only one part of a comprehensive digital strategy, which should also include e-marketing, e-philanthropy, revenue generation, digitization, digital preservation, and issues with regard to general technology infrastructure. Digital learning has linkages to many of these other areas of museum operation.

Embracing change as a constant remains a challenge. Museums are, in general, conservative institutions and because of this, and a variety of other reasons, they often lag behind commercial entities and educational institutions in the adoption of new technologies. Money and staff resources are always cited as reasons for not participating, yet in general the reluctance has more to do with the fear of change. Adopting technologies may well enable museums to better accomplish their missions and serve their audiences but the community needs to become more flexible in its response to emerging trends.

Greater understanding of the relationships and synergies between onsite technology, offsite technology use, and online access to museum resources is needed. Many in museum administration still fail to grasp the notion that a virtual museum visitor is indeed a museum visitor and that our audiences have high expectations with regard to online access to services and information. It is often difficult enough for museums with scarce resources to serve their physical visitors and to keep audiences in their geographical region satisfied; the notion that museums must, in addition, provide information and services to the entire world is often too big a project to contemplate. Museums need help to better understand these mutable relationships.

Improving our ability to measure impact using new digital technologies is a critical need. Museums are good at traditional program evaluation, but determining the impact of new technologies on knowledge, attitudes, skills is more challenging, especially when museum educators are attempting to measure the success of technologies that are unfamiliar to them, are a part of the standard tool-kit to the digital native. In order to improve our ability to measure, we need to be willing to learn as well as to teach.

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

Museum educators do not have the training, resources or support to address the technological opportunities and challenges they face. There are very few examples of best practices for development of educational technology for museums and most progressive examples are being developed outside of the education departments. Professional development and training in how new technologies can be used to further interpretation goals and enhance visitor experiences is needed at all levels of museum education. Without this training the disconnect between museum education programs and the audiences they are intended to serve will increase and museums will be called upon to further justify their declining importance in the lives of students and teachers.

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

The public perception of the value of copyright is diminishing. The challenge of providing the broadest possible access to content, without depriving artists, authors, and other content creators of their intellectual property and income, continues to be one of the largest issues faced by museums today. Creative Commons and other alternative forms of licensing are quickly becoming mainstream; new business models must be developed that take these forms of licensing into account. And to a large extent, these new business models depend on new content development strategies.

We need to find ways to integrate visitor knowledge into exhibits and objects. We need to stop being afraid of user-generated content, and instead become knowledgeable consumers of information brought to us by our visitors. This is not to suggest that the visitor's point of view always needs to be the primary point of view, but museum professionals do need to recognize that niche visitor groups and individuals can provide museums with insights that enrich our collections and enhance the interpretive value of an exhibit or objects from collections. The challenge is to provide effective mechanisms to allow for input, review, rankings, and appropriate dissemination of such content.

We should be doing more evaluation, and better, both qualitative and quantitative. Evaluation is critical and should be the starting point of every content/experience design process. Audience evaluation skills are fundamental to the museum profession and should be part of all of our toolkits and standard practices, and not something we do merely to secure funding. Good evaluation practices and meaningful metrics, agreed upon and broadly accepted by the museum community, will enable us to recognize and build upon successes, and learn from our mistakes and failures.