The STEAM Journal

Volume 2
Issue 2 *Pitfire*

Article 14

November 2016

Museum 4.0 as the Future of STEAM in Museums

Mark Walhimer
Tecnológico de Monterrey

STEAM is a bi-annual journal published by the Claremont Colleges Library | ISSN 2327-2074 | http://scholarship.claremont.edu/steam

Museum 4.0 as the Future of STEAM in Museums

Abstract
Informal STEAM (Science, Technology, Engineering, Art and Math) activities (programs) and exhibits are common in science centers, children's museums and natural history museums. As museums change to Museum 4.0 models (1), the STEAM exhibits and programs in museums also change. Museums 4.0 is the transformation of museums from a monolithic fixed location institution to a nimble community driven event driven organization. The Museum 4.0 becomes personalized to the visitor without fixed outcomes and without the physical restrictions of a single fixed location. As museums evolve to a Museum 4.0 model with visitor lead activities, STEAM activities within museums also change to peer to peer activities that begin outside the museum and continue as part of activities. Museum 4.0 STEAM will be a "host" connecting communities that existed before, during and after a museum's "bricks and mortar" experience. Instead of "cookbook" experiences where you follow a specific pattern, STEAM activities become experiences that grow and change depending on the user and community involvement. Museum STEAM experiences are transitioning from workbench activities to workbench and smartphone experiences where tactile, and digital involvement are integrated. The future of STEAM Museum 4.0 experiences are opened-ended community based experiences that are customized to a user's interests, knowledge and skills.

(1) Museum Generations 1.0, 2.0, 3.0, 4.0 http://museumplanner.org/future-of-interactivity/

Author/Artist Bio
Mark Walhimer is an Industrial Design professor at Tecnológico de Monterrey and a museum consultant. Mark's company, Museum Planning, LLC, specializes in the planning, design, and management of interactive educational experiences. Walhimer started his firm in 1999 to assist startup and expanding museums with museum master planning, exhibition design and museum project management. His firm has completed more than 40 projects worldwide for an international clientele that includes science centers, art museums, history museums, libraries, and corporations. Projects include Museo Interactivo de Economía (MIDE) in Mexico City, "Alcatraz: Life on the Rock," traveling exhibition and Trans Studio Science Center in Bandung, Indonesia. Prior to starting his company, Walhimer held positions at Discovery Science Center in Santa Ana, California, the Children's Museum of Indianapolis, and Liberty Science Center. Mark is author of Museums 101 how-to guide for creating and organizing all varieties of museums and the editor of Museum Planner http://museumplanner.org/. Walhimer has a bachelor's degree in studio art from Skidmore College in Saratoga Springs, New York, and a master's degree in industrial design and exhibition design from Pratt Institute in Brooklyn, New York.

Keywords
Future of Museums, STEAM in Museums, Human Computer Interaction, HCI, Museum 4.0, Museum Maker Spaces, Museum Programs, Tangible User Interface

Cover Page Footnote
Thank you to Professor. Luis A. Trejo Rodríguez, Tecnológico de Monterrey, Estado de Mexico, Professor Raúl Monroy, Tecnológico de Monterrey, Estado de Mexico and Professor. Carl Haddrell, International University of Sarajevo for their feedback and guidance

Museum 4.0 as the Future of STEAM in Museums STEAM: Science, Technology, Engineering, Art and Math

Mark Walhimer

Introduction – Museum generations

Below is a list of each museum generation by number, a) name, b) time period, c) main characteristics and d) representative example museum.

Museum Generations[1]:

Museum 1.0

a). "Cabinet of Curiosity"

b). 530BCE-1899 Collection of objects on display for study by scholars and the wealthy, not until 1660 did museums become public institutions.

b). Collection cases, static displays, dioramas, object centric, "collector vision driven"

c). Mutter Museum http://muttermuseum.org/

Museum 2.0

a). Interactive; Children's Museum / Science Museum / Science Center

b). 1899-1969 "Interactive Museum" 1899 Brooklyn Children's Museum[2] is opened with a "teaching collection" of art and objects for handling by children. In 1908, Deutsches Museum[3] visitors encouraged to manipulate "interactive" exhibits.

[1] Museum Generations, 1.0, 2.0, 3.0, 4.0 http://museumplanner.org/future-of-interactivity/
[2] http://www.brooklynkids.org/index.php/whoweare/history
[3] http://www.deutsches-museum.de/en/verkehrszentrum/information/history/

c). Collection cases with push buttons and cranks, teaching collection with objects visitors can touch.

d). Museum of Science, Boston http://www.mos.o

Museum 3.0

a). Open Ended, Constructivist

b). 1969-1987 "Open Ended", 1969 with the opening of the Exploratorium, multilayered and inquiry based exhibits, based on constructivist learning theory.

b). Open ended, multi-layered, visitor centric, informal education and encourages conversations

c). Exploratorium http://www.exploratorium.edu/

Museum 4.0

a). "Museum" with Walls

b). 1987[4] - Present

b). The Museum is without walls; the museum experience starts prior to the visit to the physical location and continues through digital means and resources. Museums of the fourth generation can use the techniques of museums 1.0, 2.0 and 3.0, plus the museum experience is customized to the visitor (similar to Web 3.0).[5]

[4] Start date still being defined

[5] http://hyperallergic.com/267096/the-evolution-of-the-museum-visit-from-privilege-to-personalized-experience/ website accessed July 14, 2016

c). "Semantic Museum", difficult to date, 1987 "Body Works" of the Pacific Science Center[6], visitors enter their information and the exhibits are "customized" to their needs and exhibition gathers data of the current participants. [7]

Museum 4.0 STEAM

It is difficult to separate project based learning, STEAM and Museum 4.0 as each is developing simultaneously and are interlinked. Below is a list of the five attributes of STEAM informal education in Museum 4.0. Each attribute is than expanded in sections one through five below.

Attributes of Museum 4.0 STEAM

- Without "Walls" (pre-visit, in-person visit and post-visit)
- Visitor Predicative and Customized
- Community Based
- Open Source
- Project based, Haptic and Digital HCI

Museum Without "Walls"

Museums are moving from monolithic institutions reliant solely upon visits[8] from tourist and community members toward global community based institutions that extend beyond their physical location. The *museum walls* are coming down; museums now create online digital pre-visits,

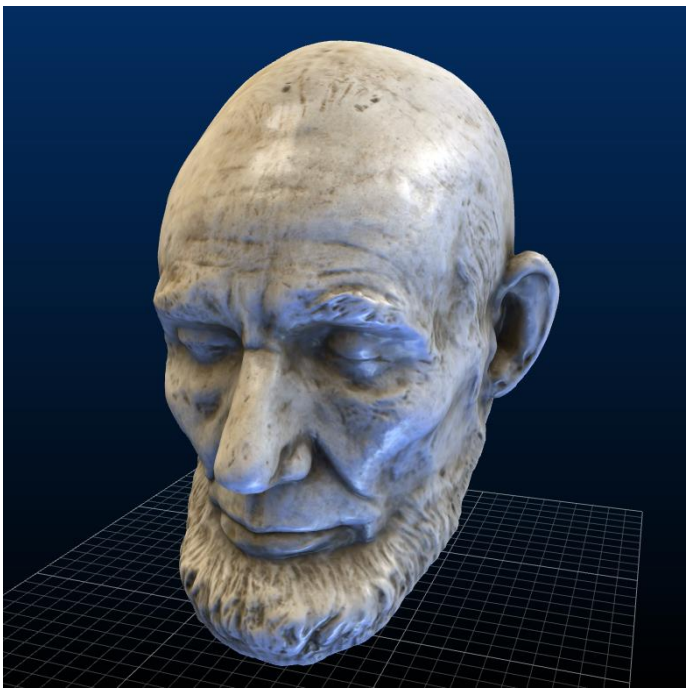
[6] http://www.pacificsciencecenter.org/Exhibits/exhibits

[7] Science centers / science museums tend to be early adaptors to new trends in museums and the trends spread to other types of museums.

[8] Museums becoming visitor-centric http://www.wallacefoundation.org/knowledge-center/Documents/How-Museums-Can-Become-Visitor-Centered.pdf

brick and mortar in-person visits and digital post-visits. Millennials[9] are no longer content to participate in activities with known outcomes and instead desire experiences with multiple outcomes to create emotional connections between user and content. Millennials learning styles[10] also demand inquiry based learning instead of didactic "cookbook" activities.

Example: Smithsonian Life Mask Cast a 3D scan of a life mask of Abraham Lincoln, museum visitors can print a 3D model of the life mask before their museum visit[11]. The Smithsonian now has a program of digitizing objects of the collection and visitors can 3D print the object at home prior to their museum in-person visit, potentially bring the print to the museum with them as part of a museum program and have as an object for study after the museum visit.



[9] Millennials http://www.pewresearch.org/topics/millennials/
[10] The Millennials learning styles https://www.nyu.edu/frn/publications/millennial.student/Challenges%20and%20Implications.html
[11]http://3d.si.edu/explorer?modelid=27

Web 3.0 / Museum 4.0 predictive experiences

STEAM museum activities are incorporated into the change as museums move to Museum 4.0, which is similar to Web 3.0, a predictive web that knows background, interests and skills. Additionally, Museum 4.0 *knows* who the visitor are and can provide a true authentic experience specific to each user and the differing interests of multiple groups of users. Using Radio Frequency Identification RFID, Interior Mapping of the museum gallery layout, Social Media, Bluetooth mesh technologies[12], the museum building becomes part of the STEAM experience.[13]

Example: Rijksmuseum ibeacon system[14] that works with visitors smartphones, as visitors approach objects additional layers of content appear on their smartphone.[15]. The content shown on the smartphone can be specific to the user; a family might have different content on family members device depending on age, interests and path through the museum.

Community based without walls

As museums include forms of crowd curation, the dynamic of interaction changes to peer to peer engagement between museums and visitor. The visitor becomes an active participant in the mu-

[12] Bluetooth Mesh https://www.bluetooth.com/news/pressreleases/2015/11/11/bluetooth-technology-to-gain-longer-range-faster-speed-mesh-networking-in-2016

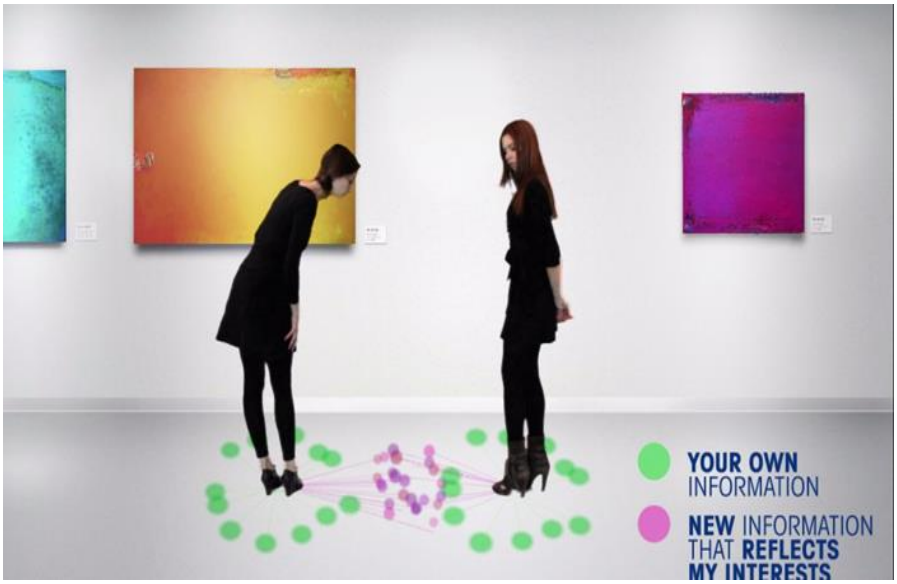
[13] Museums and the internet of things http://www.fastcompany.com/3040451/elasticity/the-internet-of-things-plan-to-make-libraries-and-museums-awesomer

[14] http://mw2015.museumsandtheweb.com/proposal/social-augmentation-using-ibeacons-augmenting-masterpieces-in-the-rijksmuseum-hide-your-story/ website accessed July 14, 2016

[15] http://mw2015.museumsandtheweb.com/proposal/social-augmentation-using-ibeacons-augmenting-masterpieces-in-the-rijksmuseum-hide-your-story/

seum content development and visitor engagement increases through use of surveys, tweeter follower count, Instagram photos, trip advisor and Snapchat story telling amongst other forms of feedback. The museum now becomes a community based around the vision and values of the museum itself (museum brand) without the constraints of location. A visitor to a museum might be interacting with a *visitor* in their home anywhere in the world. The museum's communities are built on typical innovative cycles (Rogers innovation adoption curve[16]) of early adopters, early majority, late majority and laggards. Now, the segmentation within a community is defined by community member interests[17].

Example: Cecile Bernard thesis describing "in-person" social interaction in museum and post-museum visitation[18]. Visitors become visually aware of the interests of other visitors through floor projections, virtual pop-up screens and can chose to enter into a dialogue with other community members with shared interests.



[16] Rogers innovation adoption curve https://www.researchgate.net/profile/Anja_Christinck/publication/225616414_Farmers_and_researchers_How_can_collaborative_advantages_be_created_in_participatory_research_and_technology_development/links/00b4953a92931a6fae000000.pdf#page=37

[17] Visitor segmentation similar to consumer segmentation http://www.bloomsbury.com/us/fashion-trends-9781847882936/

[18] http://cecilebernard.com/projects/museum/

Open-source exhibit & activity development

Following an open source computer software model, activities and exhibits are iterated and shared within the community. With peer to peer relationships between the museum and visitors, STEAM programming can manifest from the community and not just the museum. With a github[19] type of tracking and attribution STEAM activities and exhibits are now shared amongst like minded museums. Museum STEAM programs are also continuously iterated within the public forum as community users now have a sense of ownership of activities.

Project based, Haptic and Digital HCI

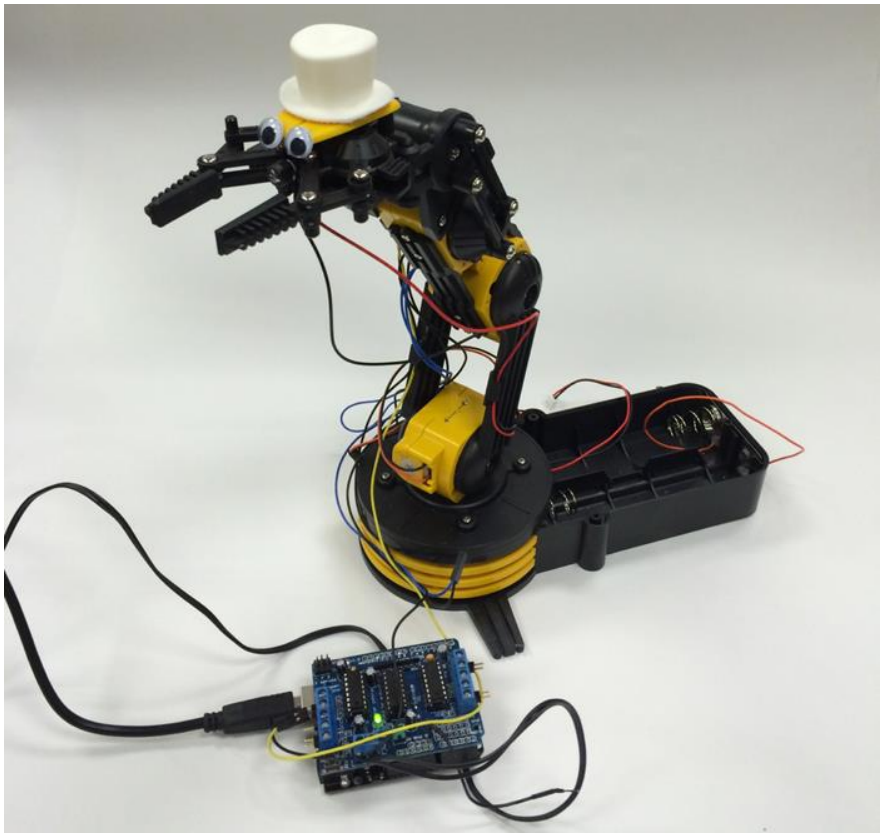
Museum Maker Spaces have become the model of STEAM programming as an expanding number of museums have involvement in the Maker Movement. With the new "without walls model" the museum has developed into an internet of things[20]; [21] model STEAM activities are moving toward a mix of tactile and digital before, during and after a museum visit. The types of interaction also changes from simple push buttons, cranks and levers to a combination of digital, haptic and tangible user interfaces. Social interaction is predominantly facilitated through social media channels such as Snapchat, Instagram, Twitter and Facebook. Social media becomes a "digital layer" of visitor participation that has never existed before and only helps to extend areas of interest and knowledge to visitors. Social media also becomes a bridge for dialogue in the

[19]Github as open source https://guides.github.com/activities/hello-world/
[20] Museums and the internet of things http://museum-2015.wiki.nmc.org/The+Internet+of+Things
[21] Museums and the internet of things http://futureofmuseums.blogspot.mx/2013/09/trendswatch-update-internet-of-things.html

museum, and online as visitors can converse around shared interests both in the museum and outside the museum.

Example: KidsMakers[22]

At KidsMakers[23] visitors can learn programming languages such as Scratch from home on the museum's website, prepare their program at home for the robot they will build in the museum, at the museum using their smartphone, can program the robot they have built, and then continue to build new projects at home in preparation for their next in-person museum visit. Arduino Controlled Robot from the Children's Museum of Houston KidsMakers[24], [25] Also includes MIT Scratch[26] at home programming



\

[22]http://www.kidmakers.org/arduino-controlled-robots/
[23]http://www.kidmakers.org/arduino-controlled-robots/
[24]http://www.kidmakers.org/arduino-controlled-robots/
[25]http://makered.org/wp-content/uploads/2015/09/YMSPB-Childrens-Museum-of-Houston-Site-Survey.pdf
[26]https://scratch.mit.edu/

Conclusion

As societies become more complex so does their culture. As museums move into their next phase of development, they are changing from warehouses of objects that narrate a history to communities that explore multiple histories and perspectives. Museum 4.0 takes advantage of technologies including STEAM programming that can become predictive and customized to the visitor's interest and abilities. As schools move toward project based learning, so do museums and STEAM programming align with the project based learning itself. As our ability to distinguish real from virtual becomes more difficult, the authenticity of museum objects grow in importance and STEAM programming gains value to engage visitors in authentic artifacts of history and culture.

References

British Museum Chris Michaels Digital. (n.d.). Retrieved June 6, 2016, from http://www.blooloop.com/features/british-museum-chris-michaels-digital/37680

Gamerman, E. (n.d.). A Look at the Museum of the Future. Retrieved June 06, 2016, from http://www.wsj.com/articles/a-look-at-the-museum-of-the-future-1444940447

HYPER-REALITY. (n.d.). Retrieved June 6, 2016, from https://vimeo.com/166807261

Index. (n.d.). Retrieved June 06, 2016, from http://www.ou.edu/deptcomm/dodjcc/groups/99A2/theories.htm

Kim, E., Fiore, A. M., & Kim, H. (2011). *Fashion trends: Analysis and forecasting*. Oxford: Berg.

M. (n.d.). What's So Special About Maker Spaces, Anyway? Retrieved June 6, 2016, from http://museummaking.com/post/97592623345/whats-so-special-about-maker-spaces-anyway

Maker Space - Arts at MIT. (n.d.). Retrieved June 6, 2016, from http://arts.mit.edu/maker-space/

Makerspaces (Rep.). (n.d.). Retrieved June 6, 2016, from IMLS website: https://www.imls.gov/assets/1/AssetManager/Makerspaces.pdf

Museum Analytics beta. (n.d.). Retrieved June 06, 2016, from http://www.museum-analytics.org/museums/

MUSEUM OF THE FUTURE (Unpublished master's thesis). (n.d.). Retrieved June 6, 2016, from http://cecilebernard.com/wp-content/uploads/2012/05/MUSEUM-OF-THE-FUTURE.pdf

Museums on Twitter: Three case studies of the relationship between a museum and its environment (Rep.). (n.d.). Retrieved June 6, 2016, from Museums and the Web website: http://mw2015.museumsandtheweb.com/paper/museums-on-twitter-three-case-studies-of-the-relationship-between-a-museum-and-its-environment-museum-professionals-on-twitter/

The Future of Authority: Platform Power. (n.d.). Retrieved June 6, 2016, from http://museumtwo.blogspot.mx/2008/10/future-of-authority-platform-power.html

The Shop - The Discovery. (n.d.). Retrieved June 6, 2016, from https://www.nvdm.org/exhibitions-and-events/permanent-exhibitions/the-shop/

The Tinkering Studio. (n.d.). Retrieved June 6, 2016, from http://tinkering.exploratorium.edu/

Trendswatch 2016 (Rep.). (n.d.). Retrieved June 6, 2016, from Center for the Future of Museums website: https://aam-us.org/docs/default-source/center-for-the-future-of-museums/2016_trendswatch_final_hyperlinked.pdf

Van Gogh vs. Candy Crush: How museums are fighting tech with tech to win your eyes. (2015). Retrieved June 06, 2016, from http://www.digitaltrends.com/cool-tech/how-museums-are-using-technology/

Victoria and Albert Museum Maker Spaces. (n.d.). Retrieved June 6, 2016, from http://www.vam.ac.uk/shekou/from-maker-spaces-to-making-culture/

Walhimer, M. (n.d.). The Future of Interactivity? Retrieved June 6, 2016, from http://museumplanner.org/future-of-interactivity/

Walhimer, M. (2015). *Museums 101*. Lanham: Rowman & Littlefield.

Welcome to Maker Faire. (n.d.). Retrieved June 6, 2016, from http://makerfaire.com/