I. Administrative Information

The Art Institute of Chicago
Museum3D: Engaging Audiences Using 3D Printing and Scanning
Awarded: $25,000; Total Project Cost: Grant funds - $17,975.47. Art Institute - $52,702.20.
October 1, 2013 – September 30, 2014
Project Director: Elizabeth Neely

II. Project Summary

In the past few years there has been an explosion surrounding the possibilities of 3D printing. Each day seems to deliver a new story touting the power of 3D printing to revolutionize manufacturing, medicine, fashion and food. From conservation to education, collections access to exhibition planning, a 3D production ecosystem that is broadly accessible both in cost and ease of use makes this technology of particular and immediate interest to museums. Though the use of 3D technologies can be applicable to museums in a variety of areas such as exhibition planning, conservation and scholarly access, Museum3D is specifically interested in evaluating the potential impact of 3D technologies in terms of broader audience engagement with museum collections.

Challenge to be evaluated
Can cutting edge technology such as 3D printing be used to encourage a deeper, more meaningful, engagement with museum collections?

Significance of challenge to be addressed
At this moment in time, 3D printing remains a bit of a novelty and source of wonderment—seeing the technology generally inspires a sense of excitement and possibility. Though far more sophisticated versions of this technology have existed in industrial design studios for decades, the recent popularity is due to a convergence of tools and trends that democratize access for the average consumer, educators and museums, both in terms of price points and learning curves. The Art Institute designed and hosted a series of public programs incorporating 3D technologies. The learnings from our program evaluation provide guidelines allowing museums of different types with varied resources to meaningfully incorporate these new technologies. This report may also be useful to educators interested in using museum collections with 3D in their classrooms, after school programs, or makerspaces.

III. Process

The departments of Digital Experience and Access (DEA) and Museum Education developed five public programs incorporating aspects of 3D printing and scanning technologies. The programs targeted different audiences (family, adult, teen, tween, educator) and varied in design (duration, mode, size) Each program was evaluated for distinct engagement-focused outcomes adhering to overarching guiding questions.

For the duration of the grant period, a Museum3D advisory team met monthly to collaboratively discuss the incorporation of these technologies and address associated challenges. The team was comprised of key stakeholders, evaluation consultant Elory Rozner of Uncommon Classrooms and partners from the School of the Art Institute of Chicago (SAIC) including 3D printing artist/instructor Tom Burtonwood. For inspiration and to broaden the team knowledge, most monthly meetings invited guest speakers who had used 3D technologies in museums.

Program Details
Five programs were supported and evaluated by the Museum3D grant initiative with a final capstone showcase event to share and discuss outcomes.

Program 1: Diwali Family Festival (Families)
The 5th annual Diwali Family Festival took place November 9, 2013, from 10:30AM-3:00PM. The target audience was families with children ages 2-16. The program was drop-in; guests came and went as they pleased. A total of 671 people attended the Museum3D activities. Staff facilitation came from Family Programs and Digital Experience and Access with support from teaching artist Tom Burtonwood and students from the School of the Art Institute of Chicago enrolled in a "cyberpedagogy" class.

The festival included a variety of participatory art activities in the Ryan Education Center (REC) and select Museum galleries. The Museum3D experiences were part of an extensive menu of offerings designed to highlight the museum's collection of Southeast Asian Art, and included clay sculpture, Bollywood Dance Workshops, as well as storytelling and drawing in the galleries. In the REC, participants sat (alone or with a parent, sibling, friend) on a swiveling platform and posed (ideally) in the style a sculpture from the galleries, of which there were posters of artwork on the nearby wall. Facilitators captured the pose, and everyone watched as the digital recreation came to life on an overhead monitor. Many parents photographed or made videos of the process. In an adjoining room, 3D artist Tom Burtonwood manned two MakerBot printers; participants observed the movement while asking Tom questions. In addition, participants made sculptures out of playdough using 3D-printed molds of objects and handled 3D printed objects of Museum collection artwork.

In the Alsdorf Gallery, participants used Art Institute-provided iPods and iPads to photograph Buddha Seated in Meditation (or, if desired, another sculpture) by walking around it and capturing 20-40 images. Then, using Autodesk's 123D Catch software, participants created a 3D image of the sculpture and viewed/manipulated it. Participants also used mobile devices to view images from the gallery and object scans that other participants created.

Program 2: Hands On! Accessibility Tours (Adults)
The Hands On! tours for adults took place March 17 and 18, 2014. The tour on March 17 served visitors with low vision; there were a total of 16 participants. The tour on March 18 served adults living with Alzheimer's disease and other forms of dementia; there were a total of 15 participants. The tours, designed and led by the Assistant Director of Senior Programs at the Museum, were 45 minutes in length.

In advance of the tours, Museum staff selected objects from the collection that would be scanned, 3D-modelled, and printed for participants to hold and touch. Although printed objects were not the same weight, nor materials as the original objects, they were printed (when possible) at a 1:1 scale. For one object (a Chinese bronze bell), the replica was not 3D-printed and was the same material as the original object.

The tours provided a multi-sensory experience, activating sight (when/if possible), sound, and touch. At each stop on the tour, participants handled the object replicas while discussing and learning about the original works of art, listened to music related to the objects, and interacted with the objects by making sounds from them (a bell, a whistle).

Program 3: Teen Lab (Teens)
Teen Lab, designed for students ages 14-18 enrolled in Chicago Public Schools, runs twice a year at the Art Institute, each time for 10 weeks. The spring 2014 Teen Lab program, titled *Objecthood*, ran from January 29-April 3, 2014 and involved 15 participants. Participants met after school three times a week for three hours to explore the Museum, make creative projects inspired by their experiences, have gallery discussions, meet Museum staff and artists, and experiment with new ideas and media. Students applied for the program and received program awards for their participation. Teen Lab is run in partnership with After School Matters, a nonprofit organization focused on out-of-school-time opportunities.

The goal of the semester was for teens to critically investigate, through discussion and studio activities, the meaning and value of making objects today. 3D production, introduced a few weeks after program launch, was only one component of the Teen Lab curriculum. Teens experimented with scanning, designing, printing, and had the option to utilize 3D production in their final projects.

Two museum educators ran the program, with assistance from a program assistant, SAIC co-op and work study interns and a teen who doubled as a participant and an intern.

Program 4: Objects: Remixed, Reconfigured (Tweens)
The Tween Art Camp, titled Objects: Remixed, Reconfigured, ran from June 23-27, 2014 at the Museum. Participants, ages 8-12 from Chicago and the suburbs, came to the Museum each day from 11:00AM-3:00PM. Participants applied to the program and received free tuition upon acceptance. A total of 12 students enrolled in the program.

The content of Tween Camp focused on the concept of remixing/reconfiguring. Tweens spent time in the galleries looking at mixed/remixed/mashed-up objects, in the studio making their own remixed work, and designing and printing original work on the 3D printer.

An educator from the Museum ran Tween Camp, with help from a digital teaching artist from the local maker community, a DEA staff member, a current graduate student from the School of the Art Institute of Chicago, a recent graduate from the School of the Art Institute of Chicago, and a teen intern (a different teen each day). A total of 12 tweens—eight female and four male—enrolled in the program. One tween, a female, dropped out after the first day without citing a reason.

Program 5: Teacher Workshop—An Introduction to 3D Printing (Educators)
This introductory workshop was offered as part of ongoing professional development opportunities available to educators year-round at the museum. The program took place July 9-11, 2014 and ran each day from 8:30AM-2:30PM with one hour for lunch. A total of 15 teachers—12 female and 3 male, a mix of elementary, middle school and high school teachers across disciplines—enrolled in the program. One student, a male, dropped out after the first day citing reasons of dissatisfaction regarding content and pedagogy.The program was fee-based.

The main goal of the educator workshop was to give participants a well-rounded introduction to the entire spectrum of 3D printing production, from ideation to creating a finished product. The pedagogical model emphasized peer-to-peer instruction and flipped teaching—participants were encouraged to consult online tutorials on their own time and bring specific problems to the class. Teachers spent time in the galleries exploring original works of art and in the studio learning to use SketchUp, designing work, and producing work on the 3D printer. The thrust was disruption—taking a personal/memorable/significant object from home, intervening with that object's design and purpose, and printing a new version of the object.

A faculty member in Art and Design at Columbia College co-taught the program with an educator from the Museum, with help from a DEA staff member, and two graduate student interns from the School of the Art Institute of Chicago.

Program 6: Capstone Event Project Showcase (Public)
Wrapping up the grant, the Museum3D team held an event September 18, 2014 to showcase the program and project results. The evening included work accomplished in the public programs, a panel discussion from program leads and an overall evaluation outcome report.

Framing the Investigation
The project evaluator worked closely with the Museum3D advisory team to refine the grant's core questions intended to guide the evaluation process. Individual evaluation instruments were designed for each program looking to capture data addressing these three overarching guiding questions across all five Museum3D public programs.

Guiding Questions:
In what ways (or to what degree) is engagement evident as audiences participate in 3D production programs?
For this question the investigation honed in on two high-level engagement indicators that were measurable/relevant across the five programs: Focused Action and Connection.

In what way(s) does exposure to 3D production activities impact audience understanding and perception of the AIC collection, art objects, and art-making?
Although the question uses the term "understanding," the team determined that "discernment" more accurately represented our intended investigation. This investigation, therefore, focused on the impact of 3D production programming on participant discernment and perception of the Museum, art objects, and art-making.

What are the identifiable factors that influence/impact program efficacy?
The quantitative data in the investigation only tell one part of the story. To get at the next level of information, we conducted debriefs with leads for each program to explore the weight of four variables on program efficacy—the ability for the program to achieve its intended outcomes. The four factors we explored included: audience characteristics, program design, differentiation, and object selection.

IV. Project Results

Significant Findings

1. **Getting through the glass is powerful. And possible.**
   Multi-sensory experiences facilitate connection with the collection.

   "Touching awakens my imagination. I could see it better, but in a different way. Touching made up for lack of vision; it was a very emotional experience."
   --Adult Sight-Impaired tour participant

   "When something is described, you're taking someone else's impression/perspective. But if you give me the delicious pastry, then I can make my own decision about what it is."
   —Adult Sight-Impaired tour participant

The strongest evidence of 1:1 relationship development came from adults on the guided tours. This response is likely attributed to the self-described emotional experience—the awakening—created by the multi-sensory inputs. The teen, tween, and educator programs yielded the same data levels (also high) for this indicator.

We learned that the replica objects, despite being different sizes, weights, and materials from the original objects—and despite being copies of the original—were fully welcomed by participants. A museum educator observed that, "[participants] asked questions about the original object's material, suggesting recognition that the plastic 3D model was of a different material and knowing the original material was important. Not that the plastic material was inherently inferior! The difference in material became a vehicle for engagement."

2. **Encounters with 3D-printed objects provoke critical thinking about art.**
Both making and viewing generate discussion about art, art-making, and artistry.

"This [3D printing] gives everybody chance to be artist."
—Teen Lab participant

Both the teen and educator groups engaged in intellectual discussions about their perceptions of art, art-making, and artistry. Neither conversation offered a definitive conclusion; as participants pointed out, perception is subjective. The tweens reported the act of art-making and remixing as the primary reason for their new/renewed relationship with the Museum.

One Teen Lab student made the observation: "Donatello's David—how he used strictly marble, didn't use other media. Marble is really really hard. How he sculpted it; it looked smooth and polished. It was much harder for him to do that. It's much easier today to print. Anybody can be an artist. If you have idea and materials you can just print it; versus education, going to classes, spending time sculpting." For his final project, this teen made a work titled *Old Art vs. New Art,* which included 3D printed objects and an alabaster carving.

3. **Living fully in the 3D production ecosystem is healthy.**
Participating in all components on the production spectrum leads to greater connection and discernment.

The 3D production ecosystem can be broadly divided into six functional categories— scanning, designing, manipulating, printing, the designed output and sharing. Each of these categories allows for different types of engagement with a museum's collection. While programs can be designed to use as much or as little of this ecosystem, investigation revealed that programs using more aspects, such those with the teens, tweens and educator, indicated a deeper effect of the connection and discernment indicators. Incorporating more of the ecosystem into a program is also time consuming, therefore this longer program design may also be a correlating factor.

The Hands On! Adult Accessibility tours engaged in only the output portion of the 3D ecosystem, and yet was very high-impact. The reason for this perhaps unexpected finding is most likely due to the unique audience characteristics and strong program design.

4. **Experimental programming requires specific infrastructure.**
Collaboration and flexibility are essential.

Public programs intending to use unfamiliar technologies need to have a highly collaborative and communicative exchange amongst departments with different expertise. Museum3D had resourcing and communication challenges even with the structure of the grant and the advisory team. For example, the Teen Program was designed within a loose framework to promote opportunities for learner-directed experiences. This type of responsive planning had challenges because it did not give much lead time for scheduling human resources, equipment, software needs, training, etc.

Having the flexibility to adjust the program on-the-fly also served these experimental programs well. Crowd-flow and activities were redeveloped during the first hour of the Diwali Family event when confusion and wait times were evident. It was agreed that these quick changes improved the offering for the remainder of the program.

5. **The strong presence of facilitators significantly impacts program efficacy.**
Other key factors are program setting and structure.

The most significant sub-factor within program design was facilitation—the presence and strength of Museum staff, teaching artists, and technical assistance. This group, responsible for program content and pedagogy, tailored programming to meet the needs of distinct audiences, interpreted the Museum collection and helped make connections between visitors and Museum content, and inspired the act of art-making. At the tween, teen, and educators programs, the ratio of facilitator: student was 3:1.

One participant cited "Lucas's [the educator/tour guide] calm, engaging manner of asking questions and listening" as a key factor, and another said the facilitated tour brought the objects to life; on her own she "would have just walked right by."

V. Recommendations

Design multi-sensory experiences to facilitate greater connection between visitors and the collection. 3D printing offers a relatively easy, inexpensive way to create replicas for use in programming. Work to integrate other senses as well—sound, taste, smell—into program experiences.

When possible, design 3D production experiences that cut across the full production ecosystem. Feasibility of this idea depends on program goals, audience, duration, and other constraints.

Focus on facilitation, program setting, and program structure when designing new experiences. Conduct additional research to unpack the other factors that may impact program efficacy.

Invite participants to explore what art, art-making, and artistry mean to them. Use the 3D objects to spark investigation of the Museum collection, and vice-versa. Include audiences of all ages in this conversation.

VI. Roadmap for Future 3D Programs

Museums3D was an experimental endeavor for the Art Institute. The internal team committed to taking note of significant lessons throughout design and implementation, with the goal of remediating programming in subsequent years. Lessons learned are also documented for use by other museums and libraries interested in 3D production programming.

Planning

Do your research.
There are a lot of options when it comes to 3D production software and hardware. What you choose will depend on your budget, program design, audience skill level, staff capabilities, room capabilities, and more. Spend proper time researching the right direction for your programming to set yourself up for success.

Create a project/program infrastructure.
Upon kick-off, the project leads created an infrastructure that they utilized for all programs. Several components of this infrastructure—particularly collaboration with internal and external experts—were adhered to closely and turned out to be key factors of program success.

Pilot, practice, document.
Leave ample time prior to program kick-off to 3D print the objects needed during the program, pilot the activities using the dedicated software/hardware, and create any necessary technical documentation to ease the visitor experience.

Remember your audience.
Can an eight-year-old sit still long enough to produce a successful self-scan? Will a teen stay on task after being at school all day? The programs at the Art Institute were successful partly because the (very experienced) educators carefully mapped the programs to the anticipated needs and interests of the different audiences.

Assess your program space.
Plan your space based on your desired learning environment and audience activities you plan for your program. Do you want the more formal feel of a computing lab or pods of work stations that enable small group collaboration like a makerspace. Space layout can impact how audiences engage and interact with each other, the technology, and project making. The educator, teen,tween programs carefully planned their learning environments to optimize target audience engagement and technology access.

Staffing
Bring in the expertise you need.
Debriefs with staff repeatedly revealed the important role collaboration played in program success. In particular, museum educators pointed to the significance of collaborating with the Department of Digital Experience and Access (DEA), which improved pedagogy (in terms of integrating new media in thoughtful ways) and and reduced technical complications.

Be realistic about staff constraints.
Be realistic about what's feasible to implement, given audience prior knowledge, the unique setting that a museum provides, and the complexity of working with 3D production software and hardware. Be ambitious and experimental, but set yourself—and therefore your audience—up for success by setting realistic expectations about what your staff can handle in a given day.

Build capacity.
See each program as an opportunity to develop new competencies and experts. Ensure that all staff participating receive adequate training on software and equipment. For collaborative programs schedule the opportunity to learn from each other and build new relationships that could lead to future brainstorming and collaboration. Include external advisors and student interns not only as extra help and expertise, but in ways that the team can build new knowledge.

Facilitation
Strong facilitation is key to program success.
As outlined above, the most significant aspect of program design—impacting program efficacy—was the presence of strong facilitators. Included in this umbrella term are internal educators, external teaching artists, and interns (from graduate schools, high schools, and other). Gather and train the necessary troops to implement a successful program.

Technical assistance is also key to success.
When designing the program, factor in the right level (per program complexity, audience size, internal expertise, and more) of technical experts needed for implementation. These experts play a crucial role in assisting with pre-production of 3D objects, handling the 3D production software and hardware, and assisting with fabrication and post-production cleanup.

Teaching artist: must-have or nice-to-have?
The presence of a teaching artist enables participants unique access to an expert in the field. Carefully outline the role of the teaching artist, and ensure that his/her presence and expertise are evident during programming. Depending on the context of programming—art museum, science center, etc.—a teaching artist may be a nice-to-have. At the Art Institute, given the questions under investigation (related to new ideas about art), and

given the newness of 3D production in museum settings (at the time of the grant), a teaching artist was a must-have.

Setting Expectations

Product vs. process.

Some 3D production programs are about product, or process, or both. Set expectations ahead of time so participants know whether or not they will be walking away with finished work (in hand or online). Be sure that expectation-setting includes the estimated amount of time required to make new work (i.e., it's possible to walk away with finished work, but you'll need to spend x minutes/hours waiting, etc.).

"Glitch is Good."

Be clear (with yourself and your audience) about the complexity level of the task, and the inherently messy nature of technology-based (especially 3D printed-based) programming. If frustration and failing are tenets of the program, be clear about that. This quote from the Educator PD program stands out: "I'm so confused and don't know what I'm doing and don't know where to begin." Ultimately, this teacher powered through and felt accomplished, but the context of the workshop supported that level of frustration.

Prepare for the known barriers.

Make a list of known barriers—based on previous programs of a particular type (family, teen, etc.) at your institution, and on previous tech-based (and/or specifically 3D printer-based) programs (at your institution or elsewhere). The known barriers to 3D printing are: complexity of software programs, time required to wait for scans and prints, inexperience with hardware, foreignness of 3D printing and 3D design process, and more.

Equipment

Determine how much equipment you'll need.

How long will it take participants to complete the activity? How many participants will you have? Based on that (and other information, like how long devices will stay charged, etc.), determine the quantity of equipment.

Determine how you will be servicing equipment.

What is the process—and who is responsible—for refreshing supplies and recharging or fixing equipment?

Safety

Safeguard equipment.

Devices—especially small ones—have a way of disappearing, especially in public spaces. Create a way to organize and track all equipment that is used for programs.

Safeguard participants.

The mechanical movement of a 3D printer is mesmerizing to watch. Choose equipment with safeguards, so curious hands and fingers are not in contact with moving parts or hot filament.

Prepare the room properly.

Be sure electrical cords are routed safely around tables and taped to the floor to eliminate tripping hazards.

VII. Resources

Full documentation for this project can be found on the Museum3D blog, http://museum3d.artic.edu