Sparks! Ignition Grants for Museums

Sample Application LG-45-14-0012-14

Indianapolis Museum of Art

Amount awarded by IMLS: $18,643

Attached are the following components excerpted from the original application.

- Abstract
- Narrative
- Schedule of Completion

Please note that the Sparks! Ignition Grants for Museums program no longer exists as a standalone funding opportunity. However, IMLS welcomes proposals for similar work through its National Leadership Grants for Museums / Rapid Prototyping funding level. Instructions for preparing narratives for FY2017 applications differ from those that guided the preparation of previous applications. Be sure to use the narrative instructions in the FY2017 Notice of Funding Opportunity for the grant program to which you are applying.

ABSTRACT

Lead Applicant: Indianapolis Museum of Art (IMA)

Project Duration: August 1, 2014–July 31, 2015

Project Need: The current method of visitor behavior tracking through staff observation is time-consuming and expensive. Providing visitors with context-aware, online content, accessible via smartphone device, is also a challenge in the confines of a museum, as many museums lack strong cellular data signals. With more museums embracing Wi-Fi connectivity, users are now able to use their own devices to access museum content. However, providing users relevant data based on their location has proven to be difficult. Locating a visitor using current industry practices is often expensive and unreliable. The current marketplace offers solutions to track visitors using Wi-Fi, however, the high cost of these solutions is out of reach for most museums.

With the majority of visitors carrying smartphone devices, the IMA is interested in investigating two technologies contained in these devices—Wi-Fi and Bluetooth—developing low-cost tools and open-source applications to make these technologies accessible to the museum community. These technologies have the potential to help museums understand visitors' interactions with their exhibitions and facilities, as well as to provide contextual content to users as they move throughout a museum.

Target Audiences: This project would benefit the larger museum community, providing museums a low-cost approach to tracking visitor flow and traffic patterns, visitor totals, and visitor frequency. With such data, museums of all types would have the ability to not only more accurately track and count visitors, but also better understand the needs and interests of their visitors. This project would also provide museums access to technology to deliver location-specific content to visitors as they move through gallery spaces. Museum visitors would ultimately benefit from the more tailored experiences provided by the institutions utilizing this technology, which would ideally lead to improved visitor satisfaction and increased attendance.

Project Activities: The IMA proposes to test Wi-Fi technology in visitor tracking, processing the data in order to show traffic patterns, visitor totals, and visitor frequency. This project would also test Bluetooth technology in delivering location-based content to visitors as they move through gallery spaces.

Tangible Products: The IMA will test and develop low cost, open-source tools and applications that museums can utilize to better understand visitors' movements through gallery spaces and to deliver location-based content to gallery visitors. The software to be developed includes the tools for collecting and analyzing the visitor data. Additionally, enhancements will be made to the TAP mobile tour platform, an open source tool for building mobile tours created by the IMA (http://tapintomuseums.org), for providing location-based content.

Potential Impact and Benefit to the Museum Community: The use of indoor location technology has the potential to transform many areas of the museum, as information about visitor flow can inform exhibition development, wayfinding, and education and interpretation. The location technology can also offer the visitor unique experiences that provide greater context to the things around them. Bringing location-based technology to a lower price point will allow more museums to take advantage of the benefits. The IMA will use an open-source model to aid in the adoption by others in the greater museum community. With proper documentation, each of the activities will be made in a reproducible manner so that any museum, regardless of technical ability, can implement these technologies and get them up and running. All of the software and documentation will be made open-source so that other institutions can learn from the IMA's experience and develop their own plan for indoor location technology.

Demonstration of Broad Impact and Significant Innovation: Developing open-source tools and applications that can leverage Wi-Fi and Bluetooth technologies, along with keeping the costs low, can open the doors for industry-wide adoption, allowing museums to better understand their visitors and offer improved visitor experiences.

1. PROJECT JUSTIFICATION

The Indianapolis Museum of Art (IMA) proposes to implement the project *Visitor Flow: Observing and Providing Location-Based Content* to test the effectiveness of Wi-Fi technology in tracking visitors as they move throughout the Museum to determine traffic patterns, attendance, and visitor frequency. The project will also test the use of Bluetooth technology in providing visitors with location-based collection content, accessible via smartphone, based on their location within the galleries. By developing low-cost tools and open-source applications, this project has the potential to open the doors for industry-wide adoption, allowing museums to better understand their visitors and provide more personalized and engaging experiences for their audiences.

Statement of Need

One of the most prevalent issues facing museums today is how to establish and maintain relevance with their audiences. Every day thousands of visitors cross the thresholds of museums around the world. Understanding their motivations and how they use museum spaces can aid cultural institutions in the planning and development of exhibitions, programs, and gallery experiences. While traditional evaluation techniques, such as visitor observation by museum staff to determine traffic patterns and duration of stay, have proven successful, this methodology is extremely time-consuming and expensive to administer. Coupled with the additional hours needed to compile data and generate usable statistics, this type of visitor research is not a sustainable model for evaluating visitor patterns on a large scale. The proposed project attempts to use simple technologies to develop a more efficient model of visitor research so cultural institutions can more effectively serve the needs of changing 21st-century audiences.

In addition to tracking user behavior, another challenge that museums grapple with is how to provide visitors with location-aware, online content accessible via smartphone devices. The thick walls and complex floor plans of many museums prohibit strong cellular data signals that are essential to transmitting this content. Without proper Wi-Fi coverage, museums are relegated to offering temporary technology solutions for delivering information that are rented or stationary. With more museums embracing Wi-Fi connectivity, users are now able to use their own devices to access museum content in the galleries. However, providing users relevant data based on their location has proven to be difficult. Locating a visitor using current industry practices is often expensive and unreliable.

Visitor-intercept surveys conducted by the IMA in September 2012 indicated that 73.3% of visitors to the Museum were carrying a smartphone during their visit. The number of visitors to museums with smartphones will continue to increase as the use of these devices continues to grow in the general population. As technology advances, the costs tend to decrease over time—providing museums the opportunity to take advantage of technology that previously would not have been accessible. As phone capabilities continue to increase, museums have a prime opportunity to leverage these everyday devices to better understand how visitors interact with their facilities and collections, as well as to provide location-based content to users as they navigate a museum, in order to enhance accessibility and overall experience.

Knowing that the majority of its visitors will be carrying smartphones into the Museum, the IMA plans to leverage this technology to assist in visitor tracking and providing location-aware content and apps. Modern smartphones contain two technologies that the IMA is interested in investigating through the proposed project: Wi-Fi and Bluetooth. Smartphones, like laptops, have the ability to connect to Wi-Fi hotspots, which allows them to access data from the Internet at speeds typically faster than cellular providers. In order to connect to Wi-Fi hotspots, smartphones broadcast Wi-Fi signals that can be captured for tracking purposes. Bluetooth technology allows smartphones to connect to other devices for streaming audio, sharing data, and other applications over short distances.

The current marketplace offers solutions to track visitors using Wi-Fi, and such solutions are used heavily in retail outlets. However, the high cost of these solutions is out of reach for most museums. The IMA has developed plans to build its own tracking device using off-the-shelf components and open source software. This

approach will help keep the cost low to make the technology accessible to a wider audience within the museum field. The IMA currently has three of these Wi-Fi tracking devices collecting data in its galleries. Initial testing of the devices has proven successful at data collection, and the Museum is interested in expanding the testing and data analysis of this technology.

Bluetooth is the latest technology to be used in retail and sporting venues to track visitors and provide them with location-based content. Using smart sensors that emit a Bluetooth signal (beacon), a smartphone can determine its location and trigger content or tracking data based on the beacons with which it is in contact. This technology is advantageous to Wi-Fi because it uses very low energy, and companies are already developing low-cost beacons for use. Additionally, Bluetooth has a much shorter range, so it is easier to determine how close a user is to a specific beacon. The user must initiate this form of tracking by downloading an app, thus opting in to the experience. Having a user download the app can alleviate privacy concerns because the user is explicitly giving permission to use their location. The IMA is interested in exploring the use of Bluetooth technology to provide location-based content because of the low cost, shorter range for increased accuracy, and ease of integration with existing tools.

Target Audiences

While the initial research would benefit the IMA, the tools and applications developed through this project would benefit the larger museum community by providing a new, low-cost approach to tracking attendance, visitor flow and traffic patterns, and visitor frequency. With such data, museums of all types would have the ability to not only more accurately track and count visitors, but also better understand the needs and interests of their visitors. Such information would be invaluable as museums plan exhibitions, gallery rotations, object selection, interpretation strategy, and accessibility. This project would also provide museums access to technology to deliver location-specific content to visitors as they move through gallery spaces. By creating open-source tools and keeping the costs of the technology low, the IMA would make these tools accessible to a larger audience within the museum community. Museum visitors would ultimately benefit from the more tailored experiences provided by the institutions utilizing this technology, which would ideally lead to improved visitor satisfaction and increased attendance.

Intended Results

The intended results of this project align with the Sparks! Ignition Grant program's pursuit of advancing practice within the museum profession. The primary goal of *Visitor Flow: Observing and Providing Location-Based Content* is improve visitor experience by testing new research methodologies and content delivery. The IMA will test and develop open-source, low-cost tools that museums can utilize to better understand visitor behavior and to deliver location-based content as visitors move through gallery spaces. Developing open-source tools and applications that can leverage Wi-Fi and Bluetooth technologies, along with keeping the costs low, can open the doors for industry-wide adoption, allowing museums to better understand their visitors and offer improved visitor experiences.

2. PROJECT WORK PLAN

Project Activities

Split into three phases, the project will be executed over a 12-month period beginning August 1, 2014 and ending July 31, 2015. The first phase will be devoted to tracking visitors using Wi-Fi (August 2014–December 2014). The second phase will be dedicated to using Bluetooth to provide indoor location data for contextual tours (December 2014–July 2015). The third phase will be used to author the whitepaper and disseminate grant project findings (June–July 2015). Please see *Schedule of Completion* for a more detailed timeline of when project activities will occur.

Phase I: Tracking Visitors Using Wi-Fi (August 2014–December 2014)

The goal of Phase I will be to determine if Wi-Fi probe requests are sufficient for tracking users as they move through the galleries. The first step will be to purchase and deploy Wi-Fi sensors in the galleries to locate

visitors in the Museum as they move throughout the building. The devices will be placed where both power and network access are available to reduce the installation cost. As visitors navigate the galleries, their Wi-Fi capable devices, such as a smartphone, output signals called probe requests that can be captured by Wi-Fi sensors. These probe requests are the visitors' devices searching for a Wi-Fi network that it has connected to in the past. For each probe request, a device identifier called a MAC address is transmitted. These probe requests are unencrypted, and other than the MAC address, do not contain any personally identifiable information. Capturing these requests, and their relative signal strength, is what allows for additional analysis of visitor traffic. This data can allow museum staff to know where a person is located in the gallery and how often they return to the museum. Utilizing multiple sensors to capture the probe requests will allow for useful analysis of the data including visitor frequency, location hotspots, and visitor flow. All data will be captured and sent to a centralized server where it is anonymized. This data can then be further processed to show traffic patterns, attendance, and visitor frequency.

In order to keep the cost of each Wi-Fi sensor device low, the IMA will utilize off-the-shelf parts. Each device will be built using a Raspberry Pi Model B, a small computer approximately the size of a credit card. Each of these computers contains a 700MHz ARM11 CPU and ports for connecting USB devices and networking. These computers run the Linux operating system and can be purchased for $35 each. In addition to the Raspberry Pi, several other components are necessary to build out the device, including a USB Wi-Fi adapter and an SD card for storage. Adding these components brings the total cost of each Wi-Fi sensor device to approximately $70. Each device will require a power source and a wired Ethernet connection. A micro-USB adapter rated at 1 amp or greater is sufficient to power the device. Having the Ethernet connection allows for the data to be transmitted back to the server with no interruption to the data gathering. The IMA currently has three of these devices collecting data in the galleries. The purchase of three additional devices for each of the Museum's four floors, for a total of 12 devices, will provide further coverage of the building and allow the IMA to better understand how this data can be used for tracking purposes (please see *Supportingdoc1* for a map of the Museum building). This coverage will allow data collection primarily in the galleries, but will also provide coverage in the IMA Museum Store and Café.

In addition to using low-cost hardware, all of the software used for this activity will be open-source. The IMA currently has a GitHub repository (https://github.com/IMAmuseum/visitorflow) that contains the code used in capturing the data. This software is free for anyone to download and use in building a visitor tracking device.

The majority of the work for this activity will involve the continued development of the existing software platform created and utilized by the IMA. Due to the amount of data that is received from these devices, using the data in its raw form is nearly impossible. The IMA plans to develop new algorithms for turning this data into a usable dataset. IMA staff will condense the records into a smaller dataset, eliminating repeating records. Additionally, the IMA will develop an algorithm to remove staff from the dataset so that only visitors are tracked. With the dataset at a more manageable size, mapping the device and signal-strength readings to the building floor plan will allow developers to determine flow-based data.

Phase II: Using Bluetooth to Provide Indoor Location Data for Tours (December 2014–July 2015)

The goal of Phase II will be to test whether Bluetooth LE (low energy) technology provides visitors with timely and accurate information based on location as they navigate the galleries. This goal will be accomplished by providing users of existing mobile tours with internal location data. Building on top of the mobile tour platform TAP, an open source tool for building mobile tours created by the IMA (http://tapintomuseums.org), tour content can be contextualized based on the location of a user in the galleries.

All modern smartphones come equipped with Bluetooth technology, which offers the smartphones the ability to communicate with other Bluetooth enabled devices, such as beacons—small Bluetooth emitters. Beacons broadcast an identifier and have a range of approximately 70 feet. Placing these beacons in a room allows a smartphone to receive a signal that can tell how far from a beacon it is located. Having multiple beacons in the

same room then allows for triangulation of the user's current position. With this information, it should be possible to load location-based tour information onto a user's phone. For example, if a visitor downloads the tour app and proceeds to walk through the Museum galleries, the app can listen for the signal from beacons placed on the walls or ceilings. As the user enters a new gallery space, the tour app can display a list of objects in that gallery and related information. Instead of requiring the user to enter a code or scan a code on a label, the visitor will be automatically provided with the information relevant to their location.

To test the functionality of Bluetooth LE devices, the IMA will acquire 15 total beacons to place strategically across the second level of the Museum—the first and largest floor of gallery spaces, including the IMA's permanent collections of European and American art; the Allen Whitehill Clowes Special Exhibition Gallery, a 10,000 square foot gallery space devoted to the presentation of traveling exhibitions; the Davis Lab, a gallery space utilized for hosting exhibitions and installations that use technology as a primary means of experiencing, interacting with, and interpreting art; and the Indianapolis Star Family Studio, a free, interactive, drop-in space that offers hands-on activities designed for families with children ages 0–12. Selected to reach the maximum number of visitors, this coverage area would provide multiple galleries and configurations to test the best possible placement and configuration.

Currently, Estimote makes the most capable devices for this purpose (http://estimote.com/). Each package of three beacons costs $120, or $40 per beacon. These beacons can be mounted to any surface and run a small battery that can last up to two years, making a good testing platform. The development kit included with the beacons provides proximity and geo-fencing functionality, which allows for the triggering of notifications or actions on a smartphone when a user crosses into a region determined by location data. Testing of the application will be done initially by staff at the IMA. A small group of three to four staff will use the test application within the galleries, with project staff observing their use. If the software proves successful, the app will be placed on current IMA iPod touch devices for extended visitor testing.

The result of this activity will be the updated TAP software that takes advantage of Bluetooth sensing for internal location, including the Drupal web application for authoring content and an updated iOS app that can take advantage of the location data. This updated software will allow other museums already using the TAP software to take advantage of the work done as a part of this grant (please see http://tapintomuseums.org/case-studies for examples of museums offering TAP-based tours).

Project Resources

The IMA respectfully requests $25,000 to support the *Visitor Flow: Observing and Providing Location-Based Content* project. Grant funds would directly underwrite salaries and benefits for IMA project staff and device hardware costs. The IMA will demonstrate its commitment to the project by providing cost share of $4,000 to fund the attendance of two project staff at the Museum Computer Network conference in 2015. Please see *Budget* and *Budget Justification* for a complete description of expenditures.

IMA Staff and Expertise

The Museum is committed to visitor research and advancing the field of museum technology and is currently focused on a larger institutional initiative to better serve its visitors. Research Leadership is a pillar of the IMA's 2011–2015 Strategic Plan, with primary objectives including establishing the Museum as a research leader in the areas of information science and visitor studies, as well as the production and sharing of open-content and scholarship (please see *Supportingdoc2* for full Strategic Plan). Since the arrival of Dr. Charles L. Venable as the IMA's Melvin & Bren Simon Director and CEO in October 2012, there has been a renewed emphasis placed on the museum visitor experience. Innovative research that will provide the museum community with a better approach to understanding visitors aligns with this institutional goal.

The IMA Lab, the technology development arm of the IMA, is a dynamic group of designers, developers, and digital strategists that creates and shares technology solutions for the cultural sector, serving the IMA and cultural institutions in the U.S. and abroad by offering technical solutions and consulting services. The award-

winning team represents a wide range of expertise and background, including digital strategy, information architecture, branding, web design and development, custom software development, mobile and iPhone applications, and deployment/systems integration. The IMA Lab is dedicated to the creation of open-source software and aims, through its work, to continually benefit the entire cultural technology community (http://imamuseum.org/imalab).

As a recognized leader in the application of technology for museums, the IMA Lab has demonstrated success in advancing the field of museum technology and promoting the production and sharing of open-content and scholarship. Through a 2011 grant from The Getty Foundation, the IMA Lab created an open-source online publishing toolkit that museums can utilize to create and publish scholarly catalogues online. This *Online Scholarly Catalogue Initiative (OSCI) Toolkit* allows museums to reach users on new platforms, including e-reader tablets, as well as provide innovative ways to interact with online catalogues (http://oscitoolkit.org/). With support from an IMLS National Leadership Grant awarded in fall 2011, the IMA launched the project *TourML and TAP: A Toolkit Supporting Mobile Museum Experiences.* Through this project, the IMA Lab has developed open-source tools and a specification for building, sharing, and preserving mobile tours that can be used by museums of all types and sizes to create and deploy their own mobile experiences (http://tapintomuseums.org).

The IMA will contribute the expertise of three IMA Lab staff members to complete this project. Kyle Jaebker, Director IMA Lab, will serve as project director. In this role, Jaebker will oversee project management, authoring, budgetary oversight, and supervision of overall project goals and deliverables. Jaebker will be supported by IMA Lead Software Architect Gray Bowman and IMA Web/Application Developer David D'Amico. Bowman will be responsible for technical oversight of project implementation. Both Bowman and D'Amico will be responsible for software development and authoring of reports. Jaebker and Bowman will be responsible for data collection, analysis, and dissemination of results. Jaebker will monitor the development of the project and ensure all milestones are being met, and all project staff will check-in on the project at weekly IMA Lab meetings. Qualifications of these staff members are summarized below; please see *Resumes* for further explanation of credentials.

- **Kyle Jaebker, Director IMA Lab.** As Director, Jaebker leads the strategic vision of IMA Lab and oversees day-to-day operations of the team. Jaebker has used his background in software development to build technology solutions for a variety of museum projects, including the IMA website, special exhibition tours for iPad and iPod devices, and the in-gallery kiosk Launch Pad for the Art Institute of Chicago. His passion for using open-source tools and the latest technologies to solve complex problems for both the IMA and the museum community-at-large have been crucial on such projects as the mobile tour platform TAP and the online publishing platform OSCI Toolkit. Jaebker received a B.S. in Computer Information Systems from the Kelley School of Business, Indiana University, and has worked in the field for 10 years.
- **Gray Bowman, Lead Software Architect.** Bowman develops software and websites for the IMA Lab, and has immense experience in creating web experiences that utilize open-source software and tools. He came to the IMA in October 2010 from *NUVO,* a weekly local news publication, where he was the IT Manager. Bowman has held a wide range of IT related positions, from interface design to military network management.
- **David D'Amico, Web/Application Developer.** D'Amico extends and develops existing and new web and iOS applications for use within the museum/cultural sector and contributes to the IMA Lab's ongoing open-source projects, such as TourML and TAP and the OSCI Toolkit. Prior to joining the IMA Lab team in 2013, D'Amico held a variety of web and application development positions. He holds a BFA in Image Arts from Ryerson University, Toronto, Canada.

Dissemination of Results

The IMA is uniquely positioned among museums to be effective in exploring the ways that visitor tracking technology can be applied in museums, and to make recommendations regarding the potential applications and

challenges inherent in using these techniques with visitors. The IMA has a proven track record of sharing project results with the field, as demonstrated in technical collaborations pursued in the past several years, including leading the technical efforts of both the *TourML and TAP* software development project and the *Online Scholarly Catalogue Initiative Toolkit*. Each of these grant projects feature a broad collaboration of important cultural partners and is dedicated to sharing both tools and research openly with the community.

The Museum has a consistent commitment to producing and sharing the results of its efforts through the development and release of open-source software tools. Efforts such as the IMA Dashboard (http://dashboard.imamuseum.org/), *TAP and TourML*, and the tools released by the *OSCI Toolkit* project demonstrate the IMA's ability to execute and deliver results that benefit the larger community of museums. This practice and history help ensure that the work of this project will be well disseminated throughout the field of museums and able to be put into practice by a large segment of the community. The IMA plans to submit a presentation to discuss project findings at the Museum Computer Network conference in 2015. In addition, the IMA will provide written documentation of the software on the GitHub project pages. The IMA will post all of the report documents and results on its website or the IMA Blog (http://www.imamuseum.org/blog/).

The Museum will convene a cross-departmental team to evaluate the results for internal use. This team will consist of staff from Audience Engagement, Curatorial, Design, and Education departments to determine how the IMA can better accommodate visitor movement in the galleries. Project results will inform future placement of sensors throughout the Museum and the IMA's overall audience evaluation efforts.

3. PROJECT RESULTS

Project Results and Benefit to the Museum Field

The use of indoor location technology has the potential to transform many areas of the museum, as information about visitor flow can inform exhibition development, wayfinding, and education and interpretation. In addition to providing vital information to museum staff, the location technology can offer the visitor unique experiences that provide greater context to artworks around them.

Bringing location-based technology to a lower price point will allow more museums to take advantage of the benefits. The more information museums can learn from and about visitors, the better these institutions can meet visitor needs and expectations in developing experiences to which visitors will return time and time again.

How Project Success Will Be Measured

Each of the activities outlined in the project plan has measurable outcomes. For Phase I, tracking visitors using Wi-Fi, the IMA will determine if Wi-Fi probe requests are sufficient for tracking users as they move through the galleries. The data must prove to be accurate and measurable; thus, software will be developed to analyze the data and validate its accuracy and effectiveness.

For Phase II, using Bluetooth to provide indoor location data for mobile tours, success will be measured in a broader sense. This phase will use IMA staff to test the functionality of the application developed and the accuracy and the speed of the location data using Bluetooth. Accurately determining when a person enters a room or a physical location to trigger location-based content will prove a successful experiment.

An Open-Source Model for the Greater Museum Community

The IMA will use an open-source model to aid in the adoption by others in the greater museum community. Due to the technical nature of this project, adoption in the field might be somewhat limited. However, with proper documentation, each of the activities will be made in a reproducible manner so that any museum, regardless of technical ability, can implement these technologies and get them up and running. The IMA often provides assistance to other museums to ensure the tools created are functional by all. All of the software and documentation will be made open-source so that other institutions can learn from the IMA's experience and develop their own plan for indoor location technology.

Visitor Flow: Observing and Providing Location-Based Content **SCHEDULE OF COMPLETION**													
	2014					**2015**							**Aug. 2015 and beyond**
	AUG.	**SEPT.**	**OCT.**	**NOV.**	**DEC.**	**JAN.**	**FEB.**	**MAR.**	**APR.**	**MAY**	**JUN.**	**JUL.**	**Post Grant Period**
Phase I													
- Purchase Raspberry Pi-Based Hardware													
- Develop Collection Software													
- Collect Data													
- Install Devices in Building													
- Develop Analysis Software													
- Develop Visitor Reports													
Phase II													
- Purchase Estimotes													
- Integrate Estimote API with TAP Mobile App													
- Install Estimotes in the Building													
- Add Location Information to Tour Content													
- Test Content Delivery in the Galleries													
- Deliver Location-Based Data													
Phase III													
Write White Paper on Findings													
Develop Documentation for Tools Built													