National Leadership Grants for Museums

Sample Application MG-245427-OMS-20
Project Category: Collections Care and Public Access

Rochester Institute of Technology

Amount awarded by IMLS:	$429,409
Amount of cost share:	$0

The project description can be viewed in the IMLS Awarded Grants Search:
https://www.imls.gov/grants/awarded/mg-245427-oms-20

Attached are the following components excerpted from the original application.

- Narrative
- Schedule of Completion

Please note that the instructions for preparing applications for the FY2021 National Leadership Grants - Museums grant program differ from those that guided the preparation of FY2020 applications. Be sure to use the instructions in the Notice of Funding Opportunity for the grant program and project category to which you are applying.

Cost-Efficient and Environmentally Responsible Preservation Methods for Preparing Paper-Based Objects for Transit and Display

Image Permanence Institute, Rochester Institute of Technology

PROJECT NARRATIVE

The Image Permanence Institute (IPI), a preservation research laboratory in the College of Art and Design at Rochester Institute of Technology in Rochester, NY is applying for a National Leadership Grant for Museums in the categories of *Collections Care and Public Access* and *Data, Analysis, and Assessment* to support a three-year research project. The proposed research project will answer the question: What are the most cost-efficient and environmentally responsible methods of preparing paper-based collection objects for transit and display while maintaining preservation standards? To adequately address this question, this project will include both field and laboratory research, and will be the first research project to collect environmental data from multiple museums' shipping crates simultaneously. Data will be collected from a variety of shipping crate and packing configurations traveling through a range of regional climates. Laboratory experimentation will include testing the safety and relative humidity buffering capacity of crate packing materials and methods, as well as different microenvironment sealed frame package designs used to protect objects during transit and display. Results will be used to determine which methods are most effective and cost-efficient while producing the least amount of disposable waste. The combined field and laboratory research components will provide IPI with the information necessary to create data-driven guidelines for museums to make research-based, informed, sustainable, and cost-efficient decisions for maintaining preservation standards when traveling and displaying framed paper-based collection objects. IPI has a long history of creating research-driven guidelines that have proven critical to the field. Guidelines from this project will be useful to all museums with exhibition and loan programs, and have the potential to reduce the cost and material waste associated with thousands of museum objects prepared annually for transit and display. Reduced costs associated with exhibition and loan preparation will allow museums to make more objects accessible, while reduced waste will facilitate environmentally responsible collections care and access.

PROJECT JUSTIFICATION

Collecting institutions have a mandate to both preserve and create access to collections. Public display of museum collections is the dominant form of access experienced by the general public either in an institution's own spaces or via loans to other institutions. As such, exhibition is an essential activity for many museums to achieve their missions and to ensure current and future generations learn from and appreciate our shared cultural heritage. Display often involves travel, and both exhibition and travel introduce challenges for preservation as this is when objects can be most vulnerable and susceptible to irreparable damage. While vast numbers of museum objects travel annually for exhibition or other purposes, objects that are sensitive to changes in relative humidity, such as manuscripts, documents, works of art on paper, and photographic prints – referred to collectively as paper-based objects in this proposal – are of particular concern as environmental fluctuations experienced during transit or display can lead to irreversible damage, such as cockling, warping, or cracking.

Currently there is limited data documenting what environmental conditions objects actually experience in museum shipping crates while traveling. Due to concerns over potential damage, significant thought, care, and costs go into preparing museum shipping crates for transit to safeguard collection materials during travel. In order to mitigate the potential effects of short-term relative humidity (RH) changes during transit, many museums create microenvironments called sealed frame packages for each object in preparation for travel. While some materials used to make sealed frame packages can be reused, many are not reusable or recyclable, producing a significant amount of non-biodegradable waste. There is concern that institutions are over packing collections and as a result significantly overspending on travel preparation and unnecessarily producing excessive plastic waste associated with exhibitions and loans.

Cost-Efficient and Environmentally Responsible Preservation Methods for Preparing Paper-Based Objects for Transit and Display

Image Permanence Institute, Rochester Institute of Technology

During the development of this proposal IPI contacted several museums to pursue partnerships on this project. All museums contacted expressed a strong interest in having more concrete information about travel environments to help them evaluate and mitigate risks associated with travel. None of the museums contacted monitor temperature and relative humidity in their shipping crates, and all but one are using sealed frame packages when shipping paper-based objects. As demonstrated in the letters of support accompanying this proposal, museum professionals involved in preparing exhibitions including curators, conservators, registrars, and administrators, are interested in guidelines informing cost effective packing approaches and material selection for preparing framed paper-based objects for transit and display.

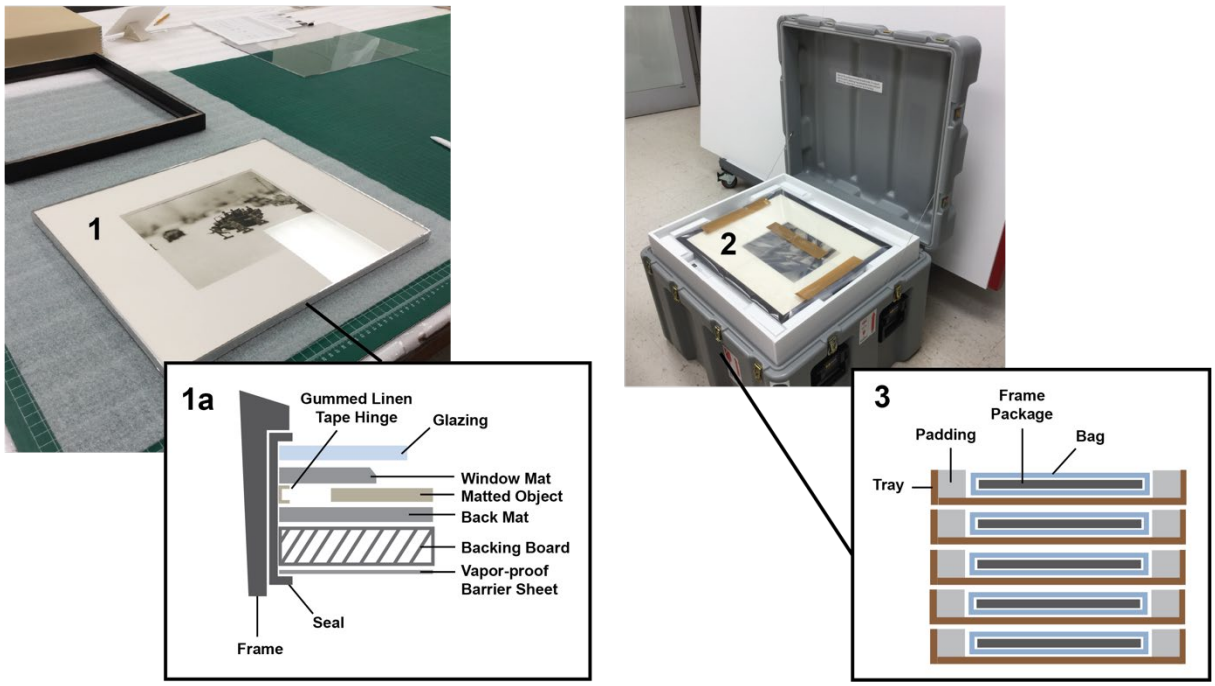

Figure 1. In many museums paper-based objects are given multiple "layers" of protection for transit. A typical approach includes the following process: 1. Each object is placed in a sealed frame package which is then inserted into a frame (1a illustrates the cross section of materials used to create a sealed frame package); 2. The frame package is then wrapped in a plastic bag (the bag in the image above is taped closed with brown packaging tape); and then 3. Packages are placed into closely packed trays organized vertically or horizontally with multiple objects in a single shipping crate, leaving limited air space.

Most of the published research devoted to understanding the risks associated with short-term travel environments explored custom approaches to traveling unique objects, therefore the data reported relates only to a unique situation and is difficult for most museums to apply to typical travel circumstances, different climate regions, and different types of collection objects. That research also focused largely on fine-art paintings and three-dimensional objects, with very little data related to paper-based objects (see Supporting Document 1 – *Bibliography*). Additionally, that research was published in the 1990s and early 2000s, and since then technology and techniques for collecting, analyzing, and interpreting preservation-related environmental data have advanced significantly. Packaging materials and travel methods, such as the use of climate controlled trucks, have also changed significantly in the last two to three decades, all warranting a reexamination of previous research as well.

Cost-Efficient and Environmentally Responsible Preservation Methods for Preparing Paper-Based Objects for Transit and Display

Image Permanence Institute, Rochester Institute of Technology

While research on crate travel environments has been limited, an empirical awareness and development of approaches to reduce risks associated with traveling paper-based collections has existed for decades. In fact, some museums limit or restrict the travel of collection materials given concern over the risks associated with travel, thus limiting access to broad audiences. In the late 1980s, an increased awareness of condition changes associated with exhibition travel and display led to the practice of creating sealed frame packages (see Figure 1a), to mitigate risks associated with changing relative humidity conditions during transit. Sealed frame packages are also frequently used for in-house exhibitions to mitigate potential changes in a museum's own display environment. There are a wide variety of sealed frame package designs used for paper-based objects; some designs are unique and some are variations on published designs (see Supporting Document 1 – *Bibliography)*. In each design the matted object is between acrylic glazing, a backing board, and a vapor proof backing material which is sealed around the perimeter with a vapor proof sealing tape encapsulating the object. The basic principles of each package are the same, they are designed so that little or no outside air or moisture can enter. However, there are numerous types and quantities of materials used in the various designs. The intent is to keep the moisture content of the collection object stable so that it does not expand or contract and lead to mechanical damage, like cockling, seen as disfiguring wrinkles, puckers or ripples in the paper-based material. These packages are very expensive and time consuming to create. The vapor proof materials are primarily plastics and cannot be reused thus producing a significant amount of plastic waste when the objects are unframed after exhibition or loan. For example, many designs using a plastic and aluminum foil laminate as a vapor barrier across the back of a frame package result in plastic waste equal to one-and-a-half single-use plastic water bottles for every 11 x 14 inch print.

There have been limited studies comparing the effectiveness of sealed frame package designs. One study tested two designs to determine how well each maintained its internal microenvironment under very high RH conditions at a constant temperature. Another tested two designs during complete submersion in water. The largest study, conducted by the Museum of Modern Art, looked at sixteen variations of design and materials but in display scenarios only (see Supporting Document 1 – *Bibliography*). When it comes to ideal design and material selection, museum staff are dealing with many unknowns and their efforts to use designs that are effective at maintaining preservation conditions are limited by existing research. This will be the first comprehensive study to compare the effectiveness, cost, *and* environmental impact of several sealed frame package designs under various and changing temperature and RH conditions. The results have the potential to improve how museums, and other collecting institutions like libraries and archives, of all sizes prepare paper-based objects for transit and display.

The primary research question for this project is: What are the most cost-efficient and environmentally responsible methods of preparing paper-based collection objects for transit and display while maintaining preservation standards? To address this overarching question, it is important to answer several questions regarding current practices in preparing objects for transit and display: 1) What are the temperature and RH conditions inside crates during transit? 2) What crate materials and packing configurations provide the best preservation conditions inside crates at the least cost and waste? 3) When do paper-based objects require sealed frame packages to mitigate risks associated with changes in RH? 4) What sealed frame package designs are most efficient at buffering against environmental changes, while also being the most cost effective, and produce the least amount of plastic waste?

Previous moisture equilibration research projects at IPI that focused on the ways in which hygroscopic materials respond to intentional changes in temperature and relative humidity in storage configurations inform the

proposed project. Controlled experiments confirmed that the movement of moisture through an archival storage box filled with paper-based collection materials, such as documents, prints, or matted photographs, is slow and that short-term changes in RH have little to no effect on stacks of paper-based objects in common storage configurations. Results demonstrated that it can take as long as one month for an entire box of objects to equilibrate to a new RH level in the ambient (or storage space) environment. It is expected that objects in most shipping crates will behave similarly to the storage configurations tested. Moisture diffusion through a crate, and all the packing materials within, should be as slow, if not slower, than that of the archival storage boxes previously tested. To assess actual environmental conditions within museum shipping crates in transit, IPI will partner with ten museums placing digital temperature and humidity dataloggers inside museum shipping crates containing paper-based objects traveling for exhibition or loan. This is the first research project to collect environmental data from multiple museums' crates simultaneously and to evaluate crate materials and packing configurations in controlled laboratory experiments (see Project Work Plan). In doing so, this project will provide valuable data to analyze and interpret the effectiveness of different types of crate materials and packing configurations at buffering against external environmental conditions, and potential differences in the impact of ground versus air travel from various regions of the country.

This research project addresses goals for two of IMLS's National Leadership Grants for Museums categories, *Collections Care and Public Access* and *Data, Analysis, and Assessment*. The results of this research will be used to write guidelines for best practices in preparing paper-based objects for transit and display. These guidelines will help museum professionals make research-informed decisions when preparing objects for transit to ensure collection objects are properly safeguarded during travel, while also reducing the costs associated with preparing exhibitions and loans, and reducing material waste. Implementation of these guidelines will benefit museum programs across the United States through improved preservation and access, as well as the sustainability of essential museum resources. Cost reductions associated with preparing exhibitions and loans will increase access to collections by alleviating the financial impact of traveling exhibitions and loans. Increasing access with a focus on environmental responsibility will make the critical activities of our national's museums sustainable for many future generations.

PROJECT WORK PLAN

Project Team- IPI's project team includes professionals with experience in laboratory and field-based research activities, environmental management, collections care, materials testing, and exhibitions work (see Personnel section for more details). The IPI project team will collaborate with conservation, registration, and exhibition preparation staff in ten museums to meet project goals. Letters of commitment from five museums are included in the *Supporting Document 2* section of this proposal: Art Institute of Chicago; George Eastman Museum; The Nelson-Atkins Museum of Art; San Francisco Museum of Modern Art; and Smithsonian's Museum Conservation Institute. Each partner will assemble a team of two to three staff members responsible for exhibitions and loans within their institution to work directly with IPI in assessing materials used in crating and transport. Additional museums will be selected at the start of the project, and from this pool of potential partners ten will be selected based on their geographic climate location within the United States, 2021-2022 traveling exhibition and loan schedules, and methods of transport expected for those exhibitions and loans, to ensure data collected represents a wide variety of transit scenarios.

Equipment and Materials - Digital temperature and humidity dataloggers will be provided for partner museums to place inside museum shipping crates containing paper-based objects traveling for exhibition or loan. Forty-five TRH–1000 two channel temperature and relative humidity dataloggers from ACR Systems, Inc. will be

purchased for the project and are included in the project budget. Forty will be deployed to partner institutions, and five will be used for crate performance testing in the laboratory. IPI has previous experience with the ACR dataloggers and their size, accuracy, reliability, and functionality will be very effective for this project.

Fifteen sealed frame package designs will be laboratory tested in triplicate using IPI's existing walk-in and incubation chambers. Sixty EL-CC-2 EasyLog two channel temperature and humidity dataloggers will be ordered for the project and are included in the project budget. These will be placed inside sealed frame packages during laboratory experiments to monitor the buffering capacity of each design. The EasyLog dataloggers were selected for this aspect of the project because they are similar in size to a credit card making them ideal for insertion into standard size mat packages.

The project work plan integrates safeguards to monitor for and mitigate risks associated with research data collection. IPI project staff have years of experience programming and deploying dataloggers and therefore risks associated with deploying this equipment are limited. Potential electronic failure of dataloggers is possible, although this is not expected to be an issue with the selected dataloggers. IPI's walk-in and incubation chambers are serviced annually, and six chambers are required for this project. IPI has additional chambers in its incubation laboratory, therefore in the unforeseen event of equipment failure, the additional chambers could be utilized for continued experimentation. The data from both datalogger types will be exported and uploaded into *eClimateNotebook*, an environment analysis web application launched by IPI in 2011, which will be used to analyze data from both the field and laboratory research components. The application allows for easy comparison between datasets and its built-in preservation metrics help to determine when collection objects are at risk for mechanical, chemical, and biological deterioration. Additional project supplies in the budget include crate and sealed frame package materials for materials testing and laboratory experiments. Project expenses associated with these materials will be evaluated to make cost comparisons for different packing configurations.

A detailed work plan for the project is provided below. Activities are divided into field research components, laboratory components, and results and dissemination. The activities are organized in the sequence that they will be performed over the three-year project period. Additional information about the project timeline is provided in the Schedule for Completion.

Field Research Components: Documenting and Analyzing Crate Environmental Conditions
The goal of the field research is to document and analyze real-world temperature and relative humidity conditions in museum shipping crates transporting framed paper-based objects. Given the nature of this project, collaboration with museums that actively travel paper-based collection objects is a necessity, as is a willingness of partner museums to place project dataloggers in shipping crates with their treasured collection objects. Currently committed partner museums are located in four of the nine US climate regions, and additional partners in the remaining regions will be selected to provide the opportunity for a diverse set of data representing both transcontinental and intercontinental travel as well as different modes of transit such as road and air travel.

Field Research Phase One: Planning – IPI project staff will work closely with each partner museum's team through a series of remotely conducted meetings. Travel to partner locations is not required. Planning meetings will identify optimal exhibitions and loans to monitor to meet project goals. Each museum team will also contribute valuable expertise to inform the practical aspects of datalogger placement within crates. With the information gathered during these meetings, IPI will develop a plan for datalogger placement on the interior of

crates and a second method for securing dataloggers to the exterior surface of crates. IPI will share the datalogger placement plan as a webinar presented to project partners. This format will allow partners to engage in dialog with IPI during the initial presentation of information, and the webinar will be recorded so participants can access and review the information again, if desired, before placing dataloggers. Individual planning meetings with each partner team will be one hour and the webinar for all partner institutions will be an additional hour. The intent is to facilitate project planning in a way that will ensure accurate and consistent field data collection with minimal impact on partners' workflow and time.

Two electronic questionnaires will be created to collect information from museums about current practices in preparing paper-based objects for transit and display. The *Crate Questionnaire* will gather information about shipping crates, packing configurations, and materials used to pack crates. The *Sealed Frame Package Questionnaire* will collect detailed information on sealed frame package materials and designs.

Field Research Phase Two: Data Collection – IPI will send four digital dataloggers that record temperature and relative humidity to each partner museum. The partners will place a datalogger inside three separate crates traveling together with framed paper-based collection objects. This will provide three overlapping data sets for each travel itinerary on the actual environmental conditions experienced by objects inside crates while in transit. Overlapping replicates are an essential aspect of scientific experimental design as they show patterns and trends verifying experimental results. Also, in the unlikely event of logger failure, triplicate data collection will ensure data is collected from each museum. One datalogger will also be placed on the exterior of a crate containing an interior datalogger. This will provide data for evaluating the impact of different crate types and packing materials at buffering different external environmental conditions. Each datalogger will be programmed before leaving IPI to begin collecting data on a specific day and time based on each partner museum's schedule. Crate temperature and relative humidity conditions will be monitored during outgoing and return travel, and travel itineraries will be selected during the planning phase to ensure data for different seasons is recorded. Museum crates are typically in transit for one to four days before and after a four to six month display period. Each partner institution will keep a detailed travel itinerary for crates monitored, which will be shared with IPI.

The *Sealed Frame Package Questionnaire* and *Crate Questionnaire* will be distributed to partner institutions. They will also be broadly distributed through direct emails, posting in IPI's quarterly newsletter with more than 2,900 subscribers, and through professional distribution lists to collect data from a wide variety of museums and other collecting institutions. Information collected will be detailed enough that each sealed frame package design and crate packing methods can be considered for inclusion in the project, and replicated by IPI staff in preparation for laboratory experiments. A comprehensive list of sealed frame package and crate packing components will be created and evaluated based on the *Questionnaires*.

Field Research Phase Three: Data Analysis - Once the monitored crates return to the partner institutions, partners will return dataloggers to IPI for data retrieval and analysis. Each data set will be documented and compared to its corresponding travel itinerary to determine how both external environmental conditions and modes of travel effected the internal crate environments. Data sets will also be compared to one another to identify trends and variances between modes of transit, crate styles, and packing materials used. Once that analysis is complete, the field data will be compared to the laboratory experiments as well as previous moisture and temperature equilibrium research results to predict the potential for condition changes in paper-based materials in response to crate environmental changes.

Laboratory Research Components: Testing Crate and Sealed Frame Package Designs and Materials
The goals of the laboratory research are to gather crate packing and sealed frame package materials identified in the project questionnaires and test the effectiveness of various crate materials and packing configurations at buffering against external changes in RH, the effectiveness of sealed frame package designs at buffering against external changes in RH, and to ensure all materials evaluated during experimentation are chemically inert.

Laboratory Research Phase One: Sealed Frame Package and Crate Testing – Fifteen sealed frame package designs described in the project questionnaires will be selected for testing based on the most common designs and variation in materials reported with respect to cost and associated waste. IPI will purchase materials and construct each package design in triplicate. Small dataloggers will be placed within each sample package, and the packages will be placed in IPI's temperature and humidity-controlled incubation chambers and exposed to a range of environmental testing profiles. Research data from IPI and other cultural heritage research centers agree that changes between 30-55% RH are safe for paper-based materials. The RH ranges in the testing profiles will represent extreme fluctuations outside of what is typically considered "safe" for paper-based materials, exceeding 55% RH and dropping below 30% RH to ensure the packages' efficiency at mitigating risks associated with dangerous RH levels are tested. Each RH profile will be tested at different temperature set points because temperature plays a role in the rate of moisture diffusion; diffusion is slower at low temperatures and faster at high temperatures. Both short-term fluctuations and extended changes in temperature and RH will be tested (see *Experimental Testing Profiles* in Supporting Document 3).

From the comprehensive list of sealed frame package and crate packing materials collected in phase two of the field research, IPI will identify and test any materials that have not been previously tested under the international testing standard, ISO 18902 *Imaging materials—Processed imaging materials—Albums, framing and storage materials*, (see Supporting Document 4 – *Photo Storage, Display and Labeling Materials - a guide to ISO 18902 "photo-safe" testing*). While this standard pertains specifically to photographs, framing and packing materials that are not safe for photographs will likewise be unsafe for other paper-based materials and will not be recommended in guidelines produced at the conclusion of the project. It is possible that there are alternate materials unknown to the museum community, such as bioplastics, that may be effective at creating sealed frame packages while being more environmentally responsible than materials currently in use. IPI will reach out to colleagues across campus in the Rochester Institute of Technology (RIT) Packaging Science program for alternate material recommendations. Packaging Science frequently creates moisture barrier packaging for food, pharmaceuticals, and electronics with an eye on RIT's sustainability initiatives. IPI will test these new materials under ISO 18902 as well to ensure they are chemically inert prior to testing their effectiveness at providing a moisture barrier in sealed frame packages. This aspect of the project has the potential to introduce new environmentally responsible materials for museums to consider when preparing paper-based objects for travel.

Drawing from the data collected with the *Crate Questionnaire*, IPI will identify the two most common types of crates currently used in the field. One of each crate type will be purchased by IPI. The interior of each empty crate will be monitored as the crates are exposed to a range of environmental testing profiles in IPI's walk-in temperature and humidity-controlled testing chamber. This will provide data on the buffering capacity of the crate construction alone. The chamber's full RH range between 10% and 80% RH will be used, which exceeds the upper and lower "safe" limits for paper-based objects, and represents potential outdoor RH conditions experienced by crates during transit. Each RH profile will be tested at different temperature set points as temperature plays a role in the rate of moisture diffusion. Both short-term fluctuations and extended changes in

temperature and RH will be tested. Tests will be conducted three times to ensure repeatability and to verify test results (see Supporting Document 3 – *Experimental Testing Profiles*). After monitoring and testing the empty crates, the crates will be packed following the most common packing configurations reported in the project questionnaire and exposed to the same testing profiles. The data collected will be used to evaluate how different packing materials and packing configurations influence the interior crate environment and contribute to RH buffering.

Laboratory Research Phase Two: Data Analysis - Sealed frame package data will be analyzed to determine the effectiveness of each sealed frame package design at maintaining a microenvironment over time. Each package will also be evaluated based on material cost, labor, and quantity of non-reusable materials. New materials recommended by RIT Packaging Science that meet ISO photo-safe standards will also be evaluated based on cost and environmental impact. Crate data will be analyzed to determine the effectiveness of the crate itself at buffering against changes in RH. This data will be compared to data collected from the different packing configurations to determine how the quantity, type, and configuration of packing material helps to buffer against external environmental changes. Each packing configuration will also be evaluated based on material cost and quantity of non-reusable materials. In addition, laboratory crate data sets will be compared to field data sets to correlate real-world conditions to laboratory experimental conditions.

Reporting and Dissemination - The final aspect of the project will be reporting and dissemination of results. Data disseminated will include: field crate and transit data; lab crate and packing configuration buffering data with a comparison of effectiveness, cost, and environmental responsibility; lab sealed frame package designs and materials data with a comparison of effectiveness, cost, and environmental responsibility; and ISO 18902 test results for materials tested during the project. There are many museum professionals involved in decision making and preparation of collection objects for exhibition and transit. Curators, directors, conservators, and registrars are primarily involved in deciding if objects can or should travel and they collaborate with exhibition preparators to determine the options for crating objects and estimate the labor and material costs associated with preparing objects for transit. These professionals are the target audience for dissemination of data and information collected during this project.

Reporting and Dissemination Phase One: Communication with Partners - IPI will conduct remote meetings with the ten partnering museums to discuss and disseminate data as well as receive feedback on their understanding of the data, how they plan to implement changes in preparing objects for exhibitions and loans, and on the project as a whole. This partner feedback will inform the dissemination products created by IPI (see Phase Two), which will be presented to a wider audience.

Reporting and Dissemination Phase Two: Publishing and Presenting Results - IPI will publish guidelines for best practices in preparing and packing paper-based objects for transit and display based on the results of this project (see upcoming Project Results section for a detailed description). The guidelines and data from the field and laboratory research will be available for free on IPI's website and will be advertised on professional listservs as well as in each of the speaking and publishing opportunities listed below. This information will inform best practices in the field and assist others in future research on this topic. Crate and transit data and sealed frame package data will not bear identifying information of participating institutions; data will be provided in a generalized format.

IPI will look to publish in professional publications that relate to the field and to present at conferences that reach the target audience such as: present at a Preparation, Art Handling, and Collections Care Information Network (PACCIN) conference or workshop; present a free webinar with Connecting to Collections Care Online Community (C2CC); present at the American Alliance of Museums (AAM) annual meeting; present at the American Institute for Conservation (AIC) annual meeting; publish in the Journal for the American Institute for Conservation (JAIC); present at the Association of Registrars and Collections Specialists (ARCS) annual meeting. Estimated travel costs associated with one dissemination trip to the AAM annual meeting are included in the project budget. AAM was chosen because membership represents the full cross section of allied museum professionals. Travel expenses for other conference presentations will be covered by IPI.

Project Personnel – IPI's project team has the necessary field- and laboratory-based research experience, as well as the technical, organizational, administrative, and design skills necessary to complete the plan of work outlined above. The team also excels at collaborative work and looks forward to partnering with experienced museum professionals including conservators, registrars, and exhibition preparators to meet project goals. IPI staff will meet quarterly throughout the project to track progress.

Al Carver-Kubik, Research Scientist and Principal Investigator (PI), will oversee project activities and devote 40% of a full-time schedule to the project over the entire three years. Carver-Kubik has previous experience as a multi-year research project PI investigating the physical response of paper-based objects and other materials to changes in RH. With that experience comes in-depth project management and data analysis skills as well as a deep understanding of the moisture equilibration research previously referenced and operation of the laboratory equipment required for this project. Carver-Kubik will lead all the laboratory experiments, and serve as the primary contact for the partner institutions, and project reporting.

Christopher Cameron, Sustainable Preservation Specialist, will commit an average of 10% of a full-time schedule to the project over the course of three years, with particular emphasis on datalogger preparation and analysis of environmental data. Cameron brings a wealth of preservation environmental management experience to the project team, including consulting with collecting institutions, establishing environmental monitoring programs, and environmental data analysis. Cameron's expertise will be essential to the field research planning, data collection, and analysis phases of the project.

Jennifer Jae Gutierrez, Executive Director, will spend an average of 20% of a full-time schedule on project activities over the course of three years. Gutierrez will play a key role in collaborating to define project conclusions and in writing guidelines for the field. Having previously served as senior photograph conservator and head of the conservation department for a prestigious photography collection, Gutierrez is well versed in the processes and materials associated with preparing paper-based collection objects for transit and display. Gutierrez will play an important role in preparing sealed frame packages for laboratory experiments, and evaluating sealed frame package designs for cost and associated waste comparisons.

TBD, Research Scientist - IPI is actively conducting a search for a new research scientist with expertise in research and testing methodologies applied to materials used for the storage, transport, and display of library, archive, museum, and private collections. Upon submission of this proposal, IPI has received multiple promising applications and the interview process is scheduled to begin December 2019. The successful candidate will have at least six years of experimental research experience and will be responsible for developing new or improved techniques for testing materials, and leading IPI's materials testing services. This staff

member will spend an average of 15% of a full-time schedule on project activities over three years, leading the ISO testing of materials being used for crate packing and sealed frame packages, and participating in laboratory experiments on sealed frame packages and data analysis.

PROJECT RESULTS

The goals of this research project align with IMLS's *Collections Care and Public Access* and *Data, Analysis, and Assessment* project categories in that this project aims to increase access to collections and analyze and compare existing approaches to define new guidelines for best practices in achieving cost-efficient and environmentally responsible preservation methods for preparing paper-based objects for transit and display. The results of this project have the potential to completely revolutionize how paper-based objects are prepared for transit by providing information that will allow museums to make informed, cost efficient, and environmentally responsible decisions for maintaining preservation standards and mitigating damage and risk when traveling paper-based objects.

Currently, very little is known about environmental conditions experienced by collection objects in transit. As a result, museums are currently taking a very conservative approach to preparing objects for transit that involves extensive labor to prepare, high cost of materials, and significant material waste. When objects return from exhibition or loan, most of the crate packing and sealed frame package materials are discarded because they are not reusable and many of these materials are also non-recyclable plastics. It is likely museums are overpacking collections for transit which in turn significantly increases exhibition and loan costs and increases the carbon footprint of each exhibition and loan. This research project will collect and analyze data pertaining to crate environments in transit, the buffering capacity of shipping crates and crate packing configurations, and materials and designs of sealed frame packages. Sealed frame packages are not only used for objects in transit, but also frequently used for in-house exhibitions to mitigate potential changes in a museum's own display environment. Therefore, the sealed frame package data from this project also has the potential to greatly influence how objects are prepared for display in non-traveling exhibitions.

Results of this research will be used to write guidelines for best practices in preparing paper-based objects for transit and display. These guidelines will help museum professionals make research-informed decisions when preparing objects for transit to ensure collection objects are properly safeguarded, while also reducing the costs associated with preparing exhibitions and loans, and reducing material waste. Information will include crate and sealed package material cost comparisons, crate and sealed frame package performance comparisons, and material waste comparisons. An understanding of interior crate environments in transit will inform decisions on what collection objects can safely travel, if and when sealed frame packages are needed, the optimal sealed frame package design and materials, and optimal packing configurations based on climate regions and seasons.

Implementation of reduced material costs and waste associated with exhibitions and loans in museum programs across the United States will benefit preservation and access, as well as the sustainability of essential museum resources. Reduced costs associated with preparing exhibitions and loans will alleviate the financial impact of traveling exhibitions and loans and thus increase access to collections. Optimally, lower costs associated with preparing exhibitions and loans will also enable lending museums to charge lower fees to borrowing institutions, making traveling exhibitions affordable for more collecting institutions and allowing exhibitions to reach broader audiences. Finally, increasing access with a focus on environmental responsibility will help to ensure the critical preservation and access activities of our nation's museums are sustainable for many future generations.

Schedule of Completion

	Year One				Year Two				Year Three			
Activity	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Field Research Phase One: Planning												
Procurement of dataloggers												
Meet with partners, coordinate travel schedules												
Prepare questionnaires												
Prepare datalogger packages for transit and ship loggers to partner institutions												
Conduct webinar on datalogger placement												
Field Research Phase Two: Data Collection												
Place dataloggers in partner institutions' shipping crates												
Collect crate environmental field data												
Distribute *Sealed Frame Package and Crate Questionnaires*												
Compile list of testing materials, crates, and sealed frame package designs												
Field Research Phase Three: Data Analysis												
Partners return dataloggers and Questionnaires to IPI												
Data retrieval and analysis												
Laboratory Research Phase One: Sealed Frame Package and Crate Testing												
Purchase testing materials and crates												
Prepare sealed frame package test samples												
Test sealed frame package design buffering capacity												
Test crates and packing configuration buffering capacity												
Consult with Packaging Science experts at RIT												
ISO 18902 testing of materials												
Laboratory Research Phase Two: Data Analysis												
Analyze sealed frame package data												
Analyze laboratory crate data												
Compare laboratory crate data to field crate data												
Reporting and Dissemination Phase One: Communication with Partners												
Communicate project results with partners; discuss implementation of results												
Reporting and Dissemination Phase Two: Publishing and Presenting Results												
Write and publish guidelines for preparing paper-based objects for transit and display												
Make data electronically available through IPI website												
Present and publish results at conferences, webinars, and submit to journals												