



National Leadership Grants - Museums

Sample Application MG-255920-OMS-24
Project Category: Collections Stewardship

Foundation for Advancement in Conservation

Amount awarded by IMLS:	\$691,965
Amount of cost share:	\$0

The Foundation for Advancement in Conservation (FAIC) will conduct research and develop tools enabling cultural heritage professionals to make institution-specific decisions to lower environmental impacts. FAIC will partner with researchers to understand the carbon impact of six activities central to museum collections work: treatment; environmental control; emergency preparedness; time-based media and digitization; pest control; and object loans. For each topic, the project will create an environmental modeling tool to calculate energy use and environmental impacts; a case study demonstrating the model; a user guide to help generate results; and a sustainability action guide to provide information and advice based on site-specific results. By providing tools and information needed for professionals to make more sustainable daily choices, this project will address increasing concerns about energy use within the field.

Attached are the following components excerpted from the original application.

- Narrative
- Schedule of Completion
- Digital Product Plan
- Performance Measurement Plan
- Data Management Plan

When preparing an application for the next deadline, be sure to follow the instructions in the most recent Notice of Funding Opportunity for the grant program to which you are applying.

New Threads: Expanding Sustainability Tools in Cultural Heritage

Project Justification

Which program goal and associated objective(s) of National Leadership Grants for Museums will your project address?

The Foundation for Advancement in Conservation (FAIC) seeks a \$691,965 research grant to develop an integrated suite of environmental assessment models and life cycle assessment (LCA) tools through [Sustainability Tools in Cultural Heritage \(STiCH\)](#). These new tools will enable cultural heritage professionals to make data-driven, institution-specific decisions to lower their environmental impacts in six topics that are central to museum collections work: treatment; environmental control; emergency preparedness; time-based media and digitization; pest control; and object loans. For each topic, the project will create (1) an environmental modeling tool (**Heritage LCA Tool**) to calculate energy use and environmental impacts, (2) a **Case Study Report** to demonstrate the model, (3) a **User Guide** to help heritage professionals use the model to generate their own results, and (4) a **Sustainability Action Guide** to provide information and advice on what actions to take, based on their site-specific results.

Launched in 2021, STiCH is hosted by the Foundation for Advancement in Conservation (FAIC) and houses a free online Carbon Calculator, a Library of Case Studies, Information Sheets, and educational materials specific to custodians of cultural heritage. STiCH has been accessed more than 60,000 times, a testament to the need within the museum community for guidance on sustainable practices.

This project will address Goal 3, Objective 3.3. New Tools that help museums make more sustainable decisions will **advance the museum field's ability to identify new solutions that address high priority and widespread collections care or conservation issues (Goal 3) by supporting research** on the carbon impact of six common carbon-producing activities related to **managing, conserving, and preserving collections (Objective 3.3)**.

It will also address a central outcome of FAIC's recent *Held in Trust* project, which examined how cultural heritage conservation and preservation must evolve to confront pressing issues the United States faces today.

While awareness and understanding of human's impact on the climate is growing and more efforts to reduce that impact are emerging, unprecedented damage to cultural heritage resources has already occurred, and data portends worse to come...To fulfill its responsibilities to cultural heritage resources and the cultures that value and learn from them, the sector must broaden and accelerate its climate work.¹

STiCH is based on energy and environmental assessment methods for determining the most effective actions for improving environmental performance. One such method is Life Cycle Assessment (LCA), an internationally standardized tool commonly used to quantify environmental and health impacts of a product or process². LCA considers the whole life cycle of a product, including emissions and impacts that occur both directly from use as well as indirectly from extracting materials, manufacturing the product, transportation, and, eventually, its end-of-life waste management. LCA provides quantitative evaluations of materials and processes, allowing informed and effective lower impact choices for industry and individuals. But performing a full LCA requires extensive experience and data access that is out of reach of most people, which is why STiCH makes LCA available to cultural heritage professionals by providing open access to LCA-based tools with easy-to-use formats. Effective LCAs are individualized according to the nuances of each scenario, especially for

¹ Foundation for Advancement in Conservation, "Held in Trust: Transforming Cultural Heritage Conservation for a More Resilient Future," 17. See Bibliography in Supporting Documents.

² ISO 14044: 2006, 2022.

the detail oriented cultural heritage sector. This grant project will provide tools that allow for such detailed, individualized studies.

What field-wide need, problem, or challenge will your project address, and how was it identified?

From 2020-2023, FAIC led [Held in Trust \(HIT\)](#) in collaboration with the National Endowment for the Humanities to evaluate the state of preservation and conservation in the United States. Early on, it became clear that without addressing the effects of climate change on cultural heritage, other project recommendations become irrelevant.

Leading cultural organizations such as FAIC and FAIC’s member-based partner organization the American Institute for Conservation (AIC) are beginning to prioritize sustainability.³ The July/August 2022 issue of the American Alliance of Museums (AAM)’s *Museum* magazine was on climate change⁴. The United Nations has also raised awareness regarding the role cultural heritage plays in sustainable development with its 17 [Sustainable Development Goals](#) (SDGs). In addition, cultural heritage funders are showing a deep investment in climate empowerment through initiatives like the National Endowment for the Humanities \$6 million investment for [Climate Smart Humanities Organizations](#).

STiCH is already part of the international conversation on climate impacts in cultural heritage. The Society of Fellows at the American Academy of Rome awarded a 2022 Rome Prize Fellowship to PI Sarah Nunberg, supporting her work to disseminate STiCH internationally. Only 3.6% of applicants are accepted – clear evidence of STiCH’s high profile. The International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) established [Our Collections Matter](#), which features STiCH in its international database of toolkits that support sustainable development. Likewise, STiCH is cited as a resource in the joint publication between Curating Tomorrow and CO₂ Action titled [“Measuring and Reporting Greenhouse Gas Emissions: An Introduction for Museums and Cultural Institutions.”](#) A more complete list of talks and presentations is included in the Supporting Documents.

The STiCH team chose topics for each LCA modeling tool and Case Study based on high impact preservation activities and topics of greatest interest to preservation professionals as identified in previous STiCH work:

- **Environmental Controls:** Building off a [2016 LCA examining one gallery](#)⁵ research will create building energy simulation models to compare the energy required to maintain an exhibition gallery, storage facility, or a microchamber, at different relative humidity ranges and temperatures. This study will also include new research on museum energy use by climate zone, building and enclosure type, and gallery/storage facility conditions such as lighting and visitor flow.
- **Loans:** This tool will provide a method for institutions to evaluate the impact of actions and materials required for exhibition loans. It will evaluate and compare impacts from art transport (crate type, mode of transportation), gallery preparation (wall construction, paint, case construction, lighting) and exhibition. The tool will build off the two existing STiCH Crates and Loans Case Studies⁶. The tool interface will allow users to enter any arbitrary loan scenario including parameters such as exhibition duration (as many months or years as they choose), size, location, type of space, material choices, visitor numbers, and material disposal types.

³ Sustainability was named as one of six core values and one of five strategic priorities in the 2023-2025 AIC Strategic Plan, as well as a top priority in FAIC’s 2023-2025 Strategic Plan. AIC Strategic Plan, 2023-2025, 2-3. FAIC Strategic Plan, 2023-2025, 2-3.

⁴ *Museum*, July/August 2022.

⁵ Nunberg, Eckelman, and Hatchfield, *Life Cycle Assessments of Loans and Exhibitions*, 2-11.

⁶ Nunberg, Eckelman, and Hatchfield, *Life Cycle Assessments of Loans and Exhibitions*, 2-11.

- **Disaster Recovery:** During an emergency, a need for quick recovery supplants sustainability concerns. But during the preparation process, emergency kits can be stocked with lower climate impact materials. The accompanying Action Guide will help users select these environmentally preferred materials by connecting to the existing [carbon calculator](#) for material selection..
- **Time Based Media/Collection Digitization:** The growing digital preservation sector requires extensive energy use. Recent research estimates that 1-1.5% of global electricity generation is used for data centers.⁷ The Heritage LCA tool for this topic will enable users to calculate individualized energy use modeling according to data storage and will evaluate environmental impacts from hardware preservation. The Wadsworth Atheneum in Hartford, CT, and the Henry Ford in Dearborn, MI, will provide data on their electronic media and digital preservation activities to parameterize the model and create initial cases.
- **Insect eradication and low-oxygen long-term storage:** The existing STiCH Anoxia Case Study⁸ examines low oxygen environments using nitrogen or argon gas or ageless oxygen scavenger along with the materials and equipment to build a one-size chamber. This project will expand prior work to include additional options such as freezer use and will allow users to input materials, size requirements, and duration to calculate a full custom LCA model.
- **Cleaning treatments:** A model covering a range of cleaning options relevant to multiple conservation specialties will evaluate environmental and occupational health impacts of each treatment option, such as laser cleaning, gels, or solvents. Many of the chemicals and materials in this study will link to the [STiCH carbon calculator](#), and may be important inputs for the other relevant Heritage LCA tools created in this grant. The accompanying Action Guide will help treatment professionals choose materials that are best for the planet.

Who is the target group for your project and how have they been involved in the planning?

The collection of proposed STiCH Heritage LCA Tools will target any cultural heritage professional involved in decision making, including collections managers, curators, exhibition designers, registrars, facilities managers, administrators, conservators, art handlers, and transporters. Development of existing STiCH resources involved input from a large group of cultural heritage professionals (see the STiCH [Acknowledgements](#))⁹, combined with inquiries from existing users. A learning group of twelve heritage professionals representing different specialties, institutions, and geographic locations will provide critical end-user feedback on the new tools during the development process. Guided by LeeAnn Gordon, Associate Conservator at the Museums of Fine Arts, Boston (MFA), learning group members will explore each new Case Study, corresponding User and Action guides (with video tutorials), and the Heritage LCA tool itself, using their institution or private practice as a test case. Their feedback will inform the PIs during development and revision.

Who are the ultimate beneficiaries for this project?

Beneficiaries to this project include all museum professionals who are engaged in any of the six activities evaluated by the STiCH Heritage LCA Tools. Without scientific analysis, attempts to lower impacts can be non-productive or even counterproductive. For example, replacing glue made from endangered fish with glue made from over-farmed seaweed may worsen overall environmental quality, but such trade-offs are very difficult for the average person to evaluate without quantitative decision-support framework like that provided by STiCH.

How will the museum field benefit from your project?

The museum field will receive free, unlimited access to cultural heritage-focused and data-driven LCA research and custom-built tools. No other cultural association provides this range of resources for free in the US or globally. One LCA

⁷ International Energy Agency, *Data Centers & Networks*.

⁸ Sanchez, et. al. *Life Cycle Assessment of Anoxic Treatments for Cultural Heritage Preservation*.

⁹ <https://stich.culturalheritage.org/about>

typically costs \$30,000 to \$70,000. Few organizations can afford to undertake these independently. By the end of the IMLS grant period, STiCH will have produced energy analyses, footprint reports, and LCA Case Studies to address a range of preservation actions and materials and developed user-friendly modeling tools designed for streamlined assessment by preservation professionals. A new feature will allow users to complete the new Case Study templates with their own data and share their resulting Studies back to the Library of Case Studies, establishing a foundation for common environmental literacy and action, backed up by cutting-edge environmental research methods. This will provide more examples that support sustainable choices for storing, packing, treating, shipping, and display collections. The Learning Groups will help ensure the tools can benefit all heritage institutions regardless of size or specialty.

Through applying the new tools, museums will reduce their energy use and environmental impact. As heritage institutions adopt energy efficient methods, they will save money on energy bills, and reduce waste.

How does this proposed project differ from, or build upon existing theory, scholarship, and practice?

This proposed project will utilize the international standards (ISO 14044 and 14044) that govern LCA for building the models behind the Heritage LCA Tools for the six topics. However, the STiCH project differs fundamentally from prior published LCAs that address cultural heritage practices, such as Settembre Blundo *et al.*¹⁰, Franzoni *et al.*¹¹, and Pranjić *et al.*¹² in that its models will be published open-source and designed to be adaptable for each user's circumstances. In addition, a critical feature of the STiCH project is that all research will be designed by preservationists themselves, which should ensure that the options and scenarios that become part of each model will be relevant for the profession.

This project will make all materials available in one location (the STiCH website) at no cost to the user, complementing (but not duplicating) the existing STiCH resources. The current STiCH Carbon Calculator provides only the carbon dioxide equivalent (CO₂eq) of greenhouse gas emissions from producing a material or product. It functions best when comparing one item or group of items to another, but it is a simple material list and cannot be used to model the complex scenarios for each of the topics proposed here. This project will support more complex individualized studies and will provide full LCAs that examine other environmental impacts categories (beyond carbon footprinting). The existing STiCH [Crates Case Study](#) examined emissions related to packing and shipping cultural heritage for a specific crate type and scenario. After reading the Crates study, museum and industry professionals such as the Los Angeles County Museum of Art (LACMA), several crate manufacturing companies, and the International Convention of Exhibition and Fine Art Transporters (ICEFAT) contacted PIs Nunberg and Eckelman with requests to create customizable models to evaluate crate performance and sustainable options, demonstrating the desire for the proposed open-access modeling tools that can be used directly by museum professionals to answer questions in their own institutions.

Project Work Plan

What activities will you carry out and in what sequence?

Two institutions will serve as on-site Case Study hosts; MFA Boston and Wadsworth Atheneum (Hartford, CT) based on the information they offer and their easy access for most members of the core team, limiting travel costs and carbon footprint of the project. To provide geographic and building-type diversity the STiCH team will partner with three virtual Case Study hosts: The Henry Ford (THF); a historic house museum in Minnesota (identified with assistance from the Outreach Conservator of the Minnesota Historical Society); and San Francisco Museum of Modern Art (SFMOMA).

¹⁰ Settembre Blundo, et. al, *Improving sustainable cultural heritage restoration work through life cycle assessment based model.*

¹¹ Frononi, Volpi, and Bonoli, *Applicability of life cycle assessment methodology to conservation works in historical building.*

¹² Pranjić, et. al., *Life cycle assessment of novel consolidants and a photocatalytic suspension for the conservation of the immovable cultural heritage.*

Project Foundations September - December 2024

- FAIC contracts with all project consultants
- PA plans logistics for Boston/Hartford site visits, establishes work platforms
- All-team virtual meeting to introduce team and project goals, share project materials: December 2024

Research and Data Collection, Outreach/Education1: January - April 2025

MFA: Environmental Controls, Loans; **Wadsworth Atheneum:** Environmental Controls, TBM/Collection Digitization

- **Onsite: January 2025**
Three-Day In-Person Site visits with PIs, Engineering Students, PA, SME Sutton
 - Day 1 (MFA Boston): Team meets liaison and other staff (facilities, conservators, exhibition design)
 - Day 2: (Wadsworth Atheneum): Team meets with the museum liaison, registrar, curator, facilities manager. Team presents the project for all-staff.
 - Day 3 (NEU): Project wrap up, presentations at NEU and MFA Boston
- **Virtual Site Visits:** THF, MN Historic House *March 2025*
- Follow up virtual meetings (2) liaisons, PIs, SMEs Sutton and Frohnhart

Research and Data Collection 2: April 2025 - November 2025

- Virtual: SFMoMA, Emergency Kits, Treatments Studies, virtual meetings; liaisons provide data; PIs oversee

Research Results: Model Case Studies, Write Case Study Reports February 2025 - March 2026

- Case Studies Modeled *February - December 2025*
- Cast Study Reports written and rolled out *May 2025 - March 2026*

Resource Development/Resource Testing: March 2025 - May 2026

- Learning Groups Identified *March 2025*
- Complete: Heritage LCA Tool, Website to accept new Tools, Tutorial *March 2025 - May 2026*
- Write Guides, Design Templates: *July 2025 - May 2026*
- Learning Groups Test Tools, Website Function, Tutorial, Guides *April 2025 - February 2026*
- Revise: LCA Tool, Tutorial, Guides *September 2025 - May 2026*

Dissemination: January 2025 - August 2026

- Updates and milestones posted on social media *January 2025 - August 2026*
- Webinars, Presentations at Association for Preservation Technology (APT), Association of Registrars and Collections Specialists (ARCS) conferences, AAM Annual Meeting *October - November 2025, May 2026*
- PA posts video tutorial *April 2026*
- **Heritage LCA Tool, User Guide, Sustainability Action Guides Published on STiCH website *May - July 2026***

What are the risks to the project and how will you mitigate them?

The greatest risk is the potential for creating tools that are too complex for the heritage professional. Response to the STiCH website and calculator by users has been overwhelmingly positive, with international usage. Users have commented on the easy navigation through the site, the simple user-friendly Carbon Calculator, and the helpful information sheets that provide background to LCA. This proposed project will follow a similar design for the models, User Guides (including video tutorials), and Sustainability Action Guides will continue the user-friendly approach.

Who will plan, implement, and manage your project?

The STiCH team, with heritage professionals fluent in LCA and engineers familiar with heritage preservation needs, constitutes the ideal group to carry out this work. FAIC will contract with PI Eckelman (the engineering expert) from research partner Northeastern University, PI Nunberg (the conservation expert), and Lead Content Expert Sarah Sutton (the museum expert) to lead this project. They have collaborated for ten years developing, planning, and implementing FAIC's STiCH projects supported by three National Endowment for the Humanities grants in 2017, 2020, and 2023.

PI Matthew Eckelman will supervise **three Northeastern University engineering graduate students** with expertise in LCA as they model each Case Study. He is Associate Professor in Civil and Environmental Engineering, with secondary appointments in Chemical Engineering, Marine & Environmental Science, and Public Policy. His deep knowledge of LCA research and ten years' experience working with the cultural heritage sector place him as the leader for engineers to design and model Case Studies relevant to the field.

PI Sarah Nunberg will guide SMEs in Case Study designs; design the loans Case Study; co-build the Decision Support Guides co-write Results Interpretation Guides. Nunberg is principal of The Objects Conservation Studio, LLC, a PhD candidate at the National Heritage Science Program at University di Sapienza, Rome Italy, and Adjunct Professor at Pratt Institute. Her knowledge of museum practices, conservation methods, and LCA allows her to facilitate collaboration between the engineering and cultural heritage sectors and usher her colleagues through the LCA process.

Lead Subject Matter Expert (SME) Sarah Sutton will co-design the Decision Support Guides and Result Interpretation Guide and assist in the Environmental Management Case Study. Sutton is CEO of Environment and Culture Partners (ECP), a nonprofit accelerating climate action in the cultural sector through research, consulting, and project management. She has nearly twenty years' experience supporting the cultural sector's work in mitigation, adaptation, and resilience to climate change.

Four Subject Matter Experts will provide expertise for specific studies, as needed beyond that of the PIs and Lead SME. The SMEs will be Pam Hatchfield (Treatment Case Study), Melissa Amundson (Disaster Kit), Christine Frohnhart (TBM), Sarah Sanchez (Insect Eradication/Long Term Storage).

Demonstration Case Study Liaisons from each Case Study museum (MFA Boston, Wadsworth Atheneum, SFMOMA, The Henry Ford, and a MN historic house museum) will attend the all-team introductory meeting, arrange the site visits where applicable, collaborate with the PIs to design the Case Study, and provide institutional data.

Project Assistant (PA) Shiori Oki will usher the team members efficiently through the project goals and milestones. She will schedule team meetings, take minutes, and assign action items, manage the program schedule, facilitate communication among the project team, create the video tutorial, and work with the Software Developer on adding content to the STiCH website.

Learning Group Coordinator LeeAnn Gordon will identify and lead **12 Learning Group Members** representing a wide range of museums through a comprehensive end-user review to refine the Tools and ensure they resonate with the broad target audience defined above. Gordon has worked with FAIC and Sutton to lead Learning Groups to evaluate tools and decision matrices for the [Climate Resilience Resources for Cultural Heritage](#) project.

Editor Denise Mix will edit the Case Studies to ensure consistent language is used throughout. She has worked with SME Sutton to edit past projects related to sustainability in the museum field.

Tiffani Emig, FAIC's Deputy Director, will serve as Grants Project Director. She will manage the budget, contracts, and payments; provide access to FAIC communication and collaborative work resources; assist with dissemination; and ensure that reports are submitted.

Katelin Lee, FAIC Outreach Manager, will assist with dissemination via online communities and social media.

A Software Developer (to be identified) with PI Eckelman will build each Case Study Tool and with PIs Nunberg and Sutton will establish the decision guides, linking each decision step to the appropriate tool. A **Visual Designer** (to be identified) will ensure that Case Studies, User Guides, and Action Guides are visually approachable for a wide audience. With PIs, they will design all templates, tables, and graphs and will design graphics and pdfs for the website and dissemination materials.

Advisor Antonella Poce from Sapienza di Roma, specializing in Museum Education and digital tools, will provide pro bono insight for the design and flow of the decision guides.

What time, financial, personnel, and other resources will you need to carry out the activities?

This project will run 24 months. The proposed activities will require \$691,965 that will fund the research partner subaward, consultant fees, and all expenses related to the Boston/Hartford three-day work event. Boston was selected as the work site so PI Eckelman and the engineering students can attend free of travel cost, the two initial museums will be easily accessible, and only one participant must fly to the event. The personnel needed has been outlined above, and a Chart of Case Study Participants (see Supporting Documents) summaries liaisons and subject matter experts needed to gather data for each study. In addition to the data provided by the Case Study sites and liaisons, the required resources include LCA software openLCA 2.0.1 and the commercial database ecoinvent 3.9, all provided by Northeastern University as the research partner on this project.

How will you track your progress toward achieving your intended results?

The Program Assistant will establish milestones and track progress based on the work plan. PA will require all PIs to monthly update processes on a data collection platform with the work plan in place.

PI Nunberg will interface with the SMEs to guide them in designing their Case Study and ensure they progress according to the project timeline. During the modeling period Eckelman will track the graduate students' progress and report to Program Manager and Nunberg during weekly meetings. The engineering students will meet with PI Nunberg every other week (if necessary) to review progress and questions.

Feedback from the Learning Group will ensure that the data derived from the research is turned into useful resources for the field. Their input will support adjustments in the Case Studies, Heritage LCA Tools, Decision Guides, and instructional video to ensure the final versions are user-friendly for the broad audience we aim to reach.

What are your research questions, methods, and theoretical framing?

This study will conduct research and build LCA-based models to help heritage institution staff make informed sustainable decisions in six common topics of heritage preservation activity. While each topic has specific considerations, there will be a common set of research questions that each model will aim to address, including:

- What museum materials or practices contribute most to environmental impacts?
- What is the role of location in determining how sustainable or low emissions a museum can be?
- How much of a museum's environmental impact is under its direct control?
- What are the most influential actions that museum professionals can take to reduce impacts?

All the Heritage LCA Tools and corresponding Case Studies will be based on internationally standardized methods for life cycle assessment and ecological footprinting. Specifically, ISO 14040 and 14044 (2006) standards govern the application of life cycle assessment, the creation of performance-based benchmarks and reference flows for making fair comparisons across options, data quality, documentation and review procedures, and appropriate scoping of studies to ensure that recommended actions do not have deleterious unintended consequences.

The common theoretical framing of all Case Studies is a life cycle approach, as instituted across many engineering design and policy-making domains around the world, including and especially assessment of carbon emissions. Environmental impacts may arise from direct actions by museums but also from indirect effects, which tend to be poorly understood and rarely quantified. A 2009 study found that for the entertainment sector (defined by the U.S. Dept. of Commerce as

including museums), more than half of its carbon emissions arise from these indirect sources¹³. Other common environmental management tools such as energy efficiency programs are a useful first step for museums to undertake in their sustainability programs but are not sufficient for meeting the aggressive decarbonization and net-zero goals that many museums have set for themselves, and that the U.S. government has set for the country.¹⁴

According to the LCA ISO standards, all Case Studies will include four phases: (1) Goal and Scope definition; (2) Life Cycle Inventory where material, energy, water, and emissions data are collected; (3) Life Cycle Impact Assessment where the physical flows in the inventory are translated into their environmental impacts; and (4) Interpretation of results, including recommendations, uncertainty, scenarios.¹⁵ A comprehensive LCA study not only looks at the carbon emitted during production, use, and disposal of a material, but it incorporates other “impact categories” such as ozone depletion potential, smog potential, or acidification potential of water bodies.

Each Case Study will then be parametrically structured to allow users to change the quantities or technical characteristics of each modeling parameter so they may adjust the Case Study results to their own institution setting or situation while taking advantage of a consistent life cycle modeling approach. For example, the Heritage LCA Tool for Exhibitions and Loans will allow users to vary the number and size of objects, crating needs, distances traveled, duration of loan, location of exhibition, climate zone, and energy system type. For each Tool, the corresponding SME will provide guidance on which parameters will need to be open to user customization. Methods for parametric LCA modeling are well-established¹⁶ and PI Eckelman has extensive experience building them for corporate and non-profit institutions.

The goal of the project is to provide heritage professionals with tools for quantitative decision support so they can depend on data, rather than assumptions or instinct, for sustainable decisions. For example, a museum might assume that relaxing their thermostat settings by one degree will help them save energy, but the building energy simulation used in the Tool will provide actual quantitative results for their location and HVAC settings, which can be used to better balance energy savings with protection of the collection.

What is the relevance of your proposed research for current practice?

While there has been notable climate action in the museum sector by early movers (Phipps Conservatory, California Academy of Science, Science Museum of Minnesota, Museum of Fine Arts Boston, and Madison Children’s Museum), the bulk of museums and heritage professionals require external information support and guidance to make progress. There are far too few tools and not enough science-based, accessible research to support the appetite for change in all aspects of heritage operations, and especially in collections care; we know of no other LCA research in the cultural heritage field with the depth and scale of STICH. Key to this project is the development of information resources that support a data-driven change in behavior. It is not enough to simply be aware of the carbon impact of current practices, especially when awareness is often based on assumptions, and is not data driven. Through providing individualized impact data, the Heritage LCA Tools and Sustainability Action Guides will empower museums and other heritage institutions to measurably reduce their carbon emissions and impacts.

What type of data will you gather for your research? How will you collect, analyze, and use the data?

The data gathered for this research project includes quantitative analysis that reflects the goal and scope of each Case Study scenario, inventory lists of all the materials, actions, impacts involved in the Case Study scenarios. PIs and

¹³ UN Environment Programme, “The Life Cycle Initiative.”

¹⁴ <https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf>

¹⁵ Huang, et. al, “Categorization of Scope 3 Emissions for Streamlined Enterprise Carbon Footprinting,” 8509-8515.

¹⁶ Miller, et. al, “Parametric Modeling of Life Cycle Greenhouse Gas Emissions from Photovoltaic Power,” 760-774.

institutional liaisons will define the goal and scope of each study, collect necessary data by referencing safety data sheets, relevant publications, product websites, energy bills, regional energy maps, manufacturer data, and related publications. Engineers will guide the data collection process based on their knowledge of materials, resources, and energy use. PI Nunberg along with the institutional liaisons and SMEs will guide the data collection to keep the project on course and relevant to the heritage sector. The PA with the Visual Designer will establish online work platforms where institutional liaisons will deposit all data for the engineers to model. PI Nunberg will shepherd these actions by working closely with the liaisons and SMEs. Analyses will reflect LCA environmental impact data that will include full environmental relevant data including climate change potential, acidification potential, eutrophication potential, ozone depletion potential, photochemical fog potential, human health particulate matter, human health cancer and non-cancer potential, ecotoxicity, and resource depletion ([LCA Information Sheet, STiCH](#)).

The engineering students will model the LCAs based on the scenario inventory lists. LCA modeling will be completed using the free, open-source software OpenLCA (2.0.1) with material-specific data from the ecoinvent database (v3.7, APOS) (Ecoinvent 2023; GreenDelta 2020). Global warming potential (or carbon footprint, measured in carbon dioxide equivalents, kg CO₂ eq) and nine other categories of environmental and human health impacts for each scenario will be calculated using the Tool for the Reduction and Assessment of Chemical and other environmental Impacts (TRACI v2.1) impact assessment method developed by the U.S. Environmental Protection Agency (EPA 2012). Further information concerning tools and methods can be found in the STiCH [Introduction to LCA](#) Information Sheet.

Does your study require Institutional Review Board (IRB) approval? If so, what steps have you taken to secure IRB approval? IRB approval not required.

How will you report and disseminate your findings?

Early dissemination will occur at the MFA Boston, the Wadsworth Atheneum, and Northeastern University when the entire team presents the Case Study process to staff and students at the hosting institution. Each time a study is published, and after each work event, FAIC will post an announcement on social media and in its online communities, which include the Global Conservation Forum with over 11,000 subscribers. PIs will post links on professional distribution lists, Northeastern University social media, Environment & Culture Partners' social media and website, and will hold a launch webinar at the end of the project to "unveil" the new products. Additionally, PIs will present the project results at three major conferences of museum professionals: Association for Preservation Technology Conference (Fall 2025, location TBD), Association of Registrars and Collections Specialists conference (November 2025, location TBD), and American Alliance of Museums Annual Meeting (location TBD) in May 2026. Further, FAIC staff typically attend 4-8 additional conferences each year. Rack cards will be printed and distributed at each of these events to direct people to the STiCH website.

Project Results

What are your project's intended results, and how will they address the need, problem, or challenge you have identified? Be sure to address this question from the dual perspectives of advancing knowledge and understanding and ensuring that the federal investment made through this grant generates benefits to society.

This project will result in a more strategically organized, farther reaching, more effective Library of LCA Case Studies and Heritage LCA Tools. As professionals use the tools to individualize Case Studies, they will simultaneously grow the new body of LCA research concerning impacts of the profession. The existing STiCH Crates Case Study has already set off this domino effect. It has prompted development of tools to individualize analyses of packing materials and established the need for new explorations of vibration absorption methods to replace foams, which the Case Study identified as the highest impact part of a museum crate. These professionals have been empowered by the STiCH results, as they work

towards effective, lower impact art transport, and higher functioning services. The results and actions from the Crates Case Study exemplify how STiCH research can motivate sustainable actions and lower carbon emissions, prompt new sustainability questions, and lead to lower carbon emissions for the museum sector. Given the number of museums, libraries, and archives across the country, reducing their climate impacts could have a substantial effect and help the US meet its carbon emissions reductions goals.

How will the knowledge, skills, behaviors, and/or attitudes of the target group change as a result of your project?

Through referencing the Case Studies and Results Interpretation Guidelines, the target group will extend their knowledge about what comprises a sustainable decision-making process, strengthen their ability to make more sustainable decisions, and support the adoption of new behaviors and attitudes towards sustainability. Importantly, heritage professionals will gain insight into effects from long term preservation and reconsider goals. For example, Case Studies examining energy from storing and preserving digital art and from collection digitization will support energy consideration when acquiring digital artwork, photographing collections, or digitizing archives. In general, the expanded collection of STiCH tools and information resources will demonstrate the value in comparing impacts from one material or action to another and how impacts accumulate over time. STiCH provides a framework for cultural heritage custodians to look at their working procedures and collections with different eyes. It does not provide ready-made recipes but shows the available choices.

What models, tools, research findings, and/or services will result from your project? How will you ensure that they are broadly adaptable and usable by other institutions and are widely disseminated to the field?

The collaborative efforts and detailed results presented in the Case Studies will not only provide LCA models for continued studies in cultural heritage, but they will serve as a blueprint for collaborations across other sectors. PIs will produce step-by step instructions for engineer/preservationist collaboration, and for reference by other sectors. Templates for new Case Studies will be refined and will be free and accessible to all users. Users will be encouraged to upload their individualized Case Study, promoting, and supporting field-wide sharing and growth of sustainable choices. The Case Studies will follow ISO standards for complete accessible results, and posts will present research findings in graphs, tables, visuals, and written explanations.

The STiCH website will remain hosted by AIC and will be free and accessible. Social media sites will present data and research findings as they unfold. PIs will present findings at the AIC annual meeting and at the launch webinar, which will be recorded and posted alongside the relevant Case Studies, allowing for downloadable teaching material. Engineers will present their findings to LCA focused audiences.

How will you sustain the benefit(s) of your project beyond the conclusion of the period of performance?

The expanded STiCH tools developed during this research project will benefit collections care professionals for years to come through FAIC's free and publicly available website. FAIC is committed to STiCH as a key project that supports its overall commitment to addressing the relationship between the climate crisis and cultural heritage, as identified in its [Core Value and Strategic Priorities](#).¹⁷ STiCH benefits will extend beyond the project to maintain relevance of LCAs as new methods, products, and energy sources development. The Case Study Library will continue to grow as users upload their new, individualized Case Studies, and eventually a robust library will develop.

¹⁷ FAIC, *FAIC Strategic Plan 2023-2025*, 2-3.

Digital Products Plan

New Threads: Expanding Sustainability Tools in Cultural Heritage

Foundation for Advancement in Conservation

Type

The digital products to be created in this project are new calculator tools, webpages, and pdfs for each of six topical areas of study. The new webpages will be built as subpages of the existing STiCH website at <https://stich.culturalheritage.org>, and all tools and pdfs will also be hosted on the website. In addition, we will create PowerPoint presentations and a video tutorial for dissemination.

Availability

The STiCH website is and will continue to be open-access, freely available to all with no registration or log in required. This project aims to provide easily accessible information to encourage utilization of the data in decision-making. The website is a Wordpress site that allows for easy editing and updating as needed.

Access

There are no privacy concerns or culturally sensitive aspects. STiCH webpages contain a copyright notice to help prevent editing that might distort the information presented.

Sustainability

Cost for webhosting is nominal at \$100/month. FAIC has been supporting the web hosting fees to date and will continue to do so after the completion of the project. Availability of new products or future changes in standards for museum practice may require re-analysis in the future, but the website is easily editable to add temporary caveats or edits as needed.

Applicant Name: Foundation for Advancement in Conservation
Project Title: New Threads for STiCH: LCA Tools for Research

Performance Measure	Data We Will Collect (e.g., counts, costs, weights, volumes, temperatures, percentages, hours, observations, opinions, feelings)	Source of Our Data (e.g., members of the target group, project staff, stakeholders, internal/external documents, recording devices, databases)	Method We Will Use (e.g., survey, questionnaire, interview, focus group, informal discussion, observation, assessment, document analysis)	Schedule (e.g., daily, weekly, monthly, quarterly, annually, beginning/end)
Effectiveness: The extent to which activities contribute to achieving the intended results	<p>Example: At the end of each month, using a report prepared by the registrar, we will compare the cumulative count of rehoused objects against the total number proposed for the project.</p> <p>Example: At the end of each project year, our external consultant will present results of the ongoing observation-based evaluation and compare them against our intended project results.</p>			
Efficiency: How well resources (e.g., funds, expertise, time) are used and costs are minimized while generating maximum value for the target group	<p>PI Eckelman will evaluate the effectiveness of the LCA modeling performed by graduate students to ensure that the scenario structure and modeling are conducted according to ISO 14040. Nunberg will review the LCA modeling and reports to ensure relevance to the cultural heritage field.</p> <p>Feedback from the Learning Group will provide opportunity for qualitative feedback through the development process.</p> <p>FAIC will record page visit analytics to ensure effective dissemination and discoverability. Actual use of the tools built will be the best indicator of success.</p> <p>Example: Twice per year, we will assess our expenditures for program supplies on a per-person-served basis.</p> <p>Example: Each quarter, we will calculate the dollar value of volunteer hours contributed to the project as recorded in our online volunteer management system.</p> <p>The Project Director will monitor expenditures to ensure they are in line with the project budget.</p> <p>PI Eckelman will review the progress of MA students weekly to ensure they have the information and methods needed to work efficiently.</p>			
Quality: How well the activities meet the requirements and expectations of the target group	<p>Example: At the beginning, the mid-point, and end of the project, we will administer a satisfaction survey to staff who have participated in the training.</p> <p>Example: We will gather opinions about our online services through questionnaires provided to every 20th user.</p> <p>The Learning Group will be critical to ensuring the targeted end users find the tools easy to use, informative, and engaging. Their feedback throughout the project will allow the team to make adjustments for improvement as needed.</p>			

Timeliness: The extent to which each task/activity is completed within the proposed timeframe	<i>Example: Every six months, our Project Director will assess the fit between our proposed Schedule of Completion and actual activity completion dates.</i> <i>Example: Each quarter, each project partner will submit to our Project Director a templated report showing their progress on meeting project milestones.</i>
	The Project Assistant will be responsible for tracking progress according to the Schedule of Completion. Every three months, the Project Assistant will submit a progress snapshot to the Project Director to show which tasks have been completed (green), which are on schedule (yellow), and any that are behind schedule (red). The Project Assistant will gather justifications and updated timelines from project team members for any red items.

New Threads for STiCH Data Management Plan

Data Management Best Practices

It is the intent of the PIs to make as much useful information as possible about the STiCH project data and case studies accessible to stakeholders and the public. We will work actively with all the appropriate institutional bodies to ensure that our activities and the resulting data are appropriate in regards to privacy, confidentiality, security, intellectual property, or any other rights or requirements that may arise.

Any publication or report utilizing the resources provided by the IMLS award will place an acknowledgment of IMLS grant support and a disclaimer, as appropriate, on any publication written or published with such support and on any publication reporting the results of, or describing, a grant-supported activity.

PI Eckelman at Northeastern University will hold overall responsibility for data management as described below.

I. Data Types to be Managed

Data gathered by the research team will include supply lists, environmental (rH and temperature) readings from multiple museums, and electronic storage size data for the time-based media/digitization study. All data will be gathered and submitted by Case Study Site Liaisons, Subject Matter Experts, or the PIs with full permission from the owners of the data (see letters of commitment). Most of the data collection will occur in Year 1 of the project.

The project will generate the following data types:

- Qualitative descriptions of case study processes and materials
- Quantitative information of case study energy, material, and waste flows
- Product descriptors including vendors, price, unit quantities, and images
- Life cycle inventory data
- Life cycle assessment results
- Written case studies
- Web-versions of case studies, maintained on the FAIC website with a permanent URL (<https://stich.culturalheritage.org/>)

Data generation will occur throughout the full two years of the project.

II. Sensitive Data

This project does not include collection of data of a sensitive nature.

III. Technical Requirements

LCA data generated by this project will populate the LCA Heritage Tools on the STiCH website, which are publicly and freely available to anyone with internet access. The Tutorials (written and video), Case Studies, User Guides, and Sustainability Action Guides are all designed to help users interpret and make use of the data generated.

IV. Documentation and Metadata

Qualitative descriptors are expected to be stored as plaintext in .docx or Google Doc formats or embedded in spreadsheets. Images will be stored in standard image file formats (.png, .jpeg)

Quantitative descriptors will be stored in .xlsx or google sheet spreadsheet format.

Life cycle inventory data will be stored as JSON or .zolca format.

Life cycle assessment results and visualizations will be stored in openLCA database formats, with results exported to .xlsx or google sheet spreadsheet format.

Written case studies will be stored as formatted text in .docx or google doc formats.

Web-versions will be stored as posted .pdf files and/or HTML

During the project, all data and working documents will be available to project participants in a shared Google Drive folder already established and managed by the project team. Access to the folder is by unique invitation only and will be managed by the Project Assistant.

IV. Data Management and Dissemination

All completed Tools, Case Studies, User Guides, and Sustainability Action Guides will be made available on the project website and available on the website for at least three years following the completion of the project.

All data will be archived on FAIC's existing cloud-based server.

VII. Review of the Data Management Plan

FAIC will review the Data Management Plan upon completion of the project, and thereafter in coordination with the organization's broader data management activities.