

Advancing Heritage Preservation through Artificial Intelligence, 3D Scanning, and the Co-production of Knowledge Framework

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Introduction

This paper was originally presented as a keynote at the *Technology as a Bridge to the Museum* conference at the Institute for the Study of Ancient Cultures at the University of Chicago. We intended to reflect on the broader field by discussing lessons learned through our collaborative work using emerging technologies in the context of Indigenous Data Stewardship. Our aim is to engage the heritage sector in the broadest sense by drawing on the knowledge co-produced with Alaska Native community partners.

We would like to acknowledge that the conference took place on the traditional homelands of the Council of the Three Fires: the Ojibwe, Odawa, and Potawatomi Nations and the land of the Peoria, Kaskaskia, Miami, Mascouten, Sac and Fox, Kickapoo, Ho-Chunk, and Menominee.

It is a privilege to give this talk and contribute to the discussion on the use of technology in heritage preservation and perpetuation, as well as to have the opportunity for a focused discussion on the use of emerging technologies in the heritage sector.

The work we share here emerged from our ongoing collaboration with Kawerak Inc., the consortium of twenty federally recognized Alaska Native Tribes in the Bering Strait region. The region covers the majority of the Seward Peninsula, including the communities along Norton Sound all the way down south to Saint Michael and Stebbins, as well as the islands of Little Diomedé, King Island, and St. Lawrence Island (Figure 1).

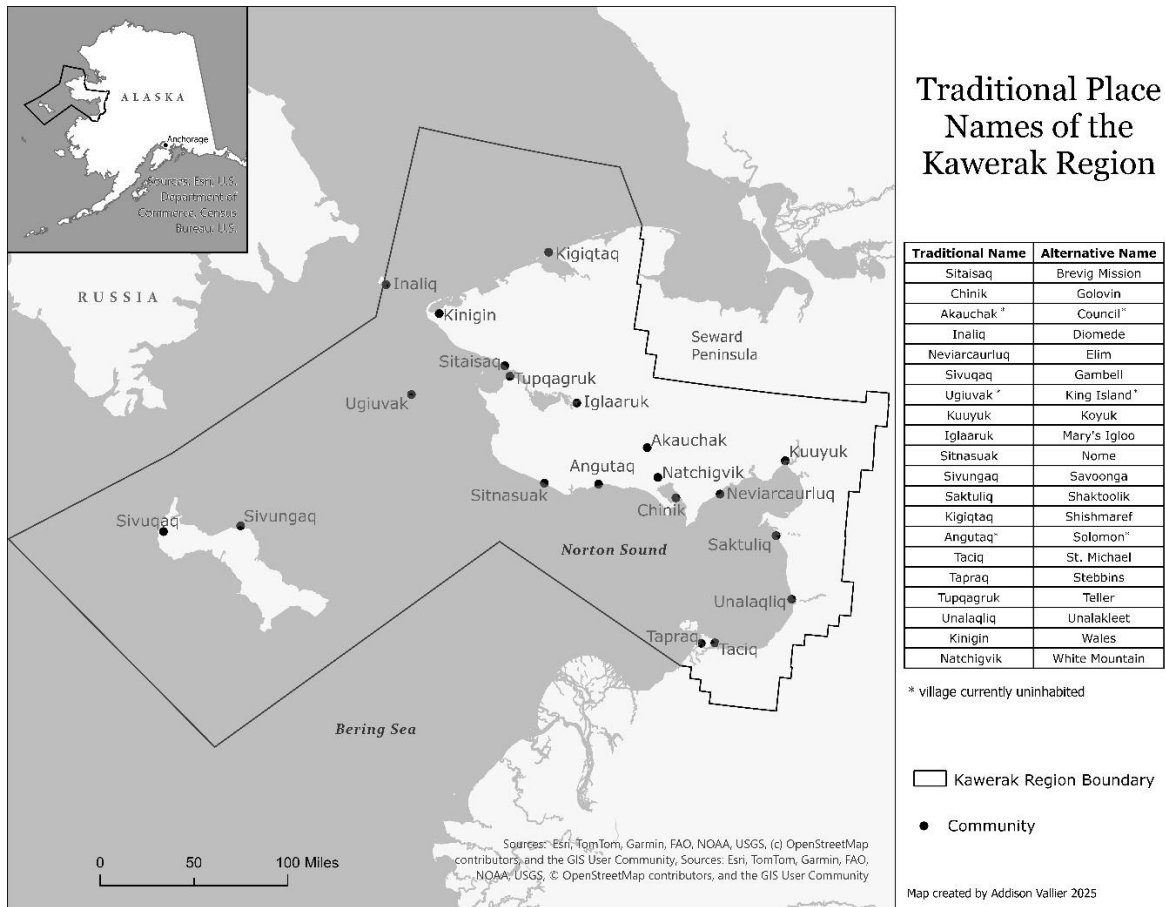


Figure 1. Map of Kawerak region with traditional and English placenames. Map by Addison Vallier, 2025.

We would like to take this opportunity to acknowledge that we work with Yup'ik, Inupiaq, and St. Lawrence Island Yupik Alaska Native heritage that is shared with us by collaborators and Knowledge Holders who provide guidance for us in our work. We included 3D models of heritage pieces as well as 2D photos of our collaboration with permission to share these visualizations in this paper. Our work examines Alaska Native use and perceptions of digital 3D models of heritage pieces through the process of digitally reuniting museum collections with their origin communities. The project undertakes an innovative approach that merges community-engaged research methods with collaborative 3D modeling through the co-production of knowledge framework (Ellam Yua et al. 2022) and centering Indigenous Data Governance (Carroll et al. 2020).

We invite you to consider the larger societal impacts of our collective work and go beyond the capabilities of emerging technologies. Digitization and emerging technologies can produce innovative and never before seen visualizations and data that are easy to marvel at and revel in. Who is not thrilled when a 3D model finally all comes together after hours of meticulous documentation and even longer and painstaking editing?



Figure 2. This ornately carved walrus ivory pipe is originally from Western Alaska, and it is currently in the collection of the Hood Museum of Art at Dartmouth College (181-2-26114, 3 ¼ x 1 ¼ x 12 ½ inches). The photogrammetry model was created by Peyton Smith, one of the undergraduate RAs in the 3D Heritage Informatics Lab at the University of Missouri. [Link to the video of the 3D model.](#)

Recently Truman Kava, one of our collaborating Knowledge Holders, reviewed this model during a zoom interview and he noted that he has seen similar circles as decoration on other pieces from St. Lawrence Island (Kava 2025) (Figure 2). Truman also shared with us that while the main animal face is clearly a walrus, the two other faces on the lid and at the joint, as well as the animals carved into the side of the stem are not like any animals he has seen before. He remarked that pipes from the region are usually made of metal and wood and he also noted that this was an unusual piece that was exceptionally well carved. This was a difficult piece to 3D model and Peyton Smith spent countless hours carefully editing the photogrammetry data to make sure the face on the lid aligned and all the details were visible.

While seeing the output from emerging technologies is impactful, mapping the capabilities of new technologies is just the first step in their effective use to further project goals. Co-creating comprehensive knowledge connected to a piece that represents both tangible and intangible heritage is inalienable from knowing and acknowledging where that knowledge is coming from. In our case, we work with Alaska Native Knowledge Holders, whose heritage we visualize. They share their knowledge about the pieces with us during this process and they also provide guidance on what they believe to be an appropriate use of emerging technologies in relation to their heritage.

All technologies change rapidly and often unpredictably—in truth, this can be said about the World; we live in interesting times. We are all affected by recent changes that have unforeseeably impacted our work and lives. These changes also continue to challenge us to communicate the significance, the societal impact, and value of our research outcomes and output. At the same time, we struggle to evaluate the impacts of these changes on our research teams and collaborations. While we all try to assess the new research landscape that is unfolding, we also try to respond and pivot so that we can continue our work. We all process and respond to idiosyncratic challenges based on our priorities and information available to us at the time. Our challenges are not your challenges, and our circumstances may be very different from your work environment. We are aware of, and deeply empathetic to, the fact that we, as heritage informatics professionals, are all doing our best to navigate a unique set of circumstances. What we would

like to offer in this discussion is one way of approaching these uncertain times through wisdom and guidance we received from our collaborators.

All technologies change rapidly and often unpredictably –these are both their drawbacks and their advantages. It is in our power to create a strategy for responding to challenges and finding ways to create advantages. In our work, we chose to continue focusing on co-creating and maintaining a positive collaborative environment, and supporting team members' well-being. We are realistic and practical about recognizing ongoing changes, while also acknowledging their immediate and potential long-term impacts on our team as a whole and as individual members. For this reason, we chose to prioritize supporting ongoing collaborations, and in particular, early career scholars: undergraduate and graduate research assistants. As teachers, scholars, and practitioners, we are committed to mentoring the next generation of scientists, who are entering a field at a tumultuous time when previous opportunities and career paths have been upended. Early-career scholars contribute immense value to our work through their capacity for innovation, their boundless ideas on the use of emerging technologies, and their continued curiosity that helps us see our work anew and reframe it for new audiences. They trust us to share our knowledge with them and to guide them in developing new skills. Similarly, our collaborators, whose heritage we digitize, entrusted information and ancestral knowledge to us. They intentionally invested time and energy into getting to know us so that we can co-create a community that is built on trust and respect – a reciprocal relationship that transcends individual projects. This relationship and the responsibilities of stewarding the Knowledges that have been entrusted to us continue regardless of funding disruptions or changes in the scientific research landscape. Maintaining good working relationships, whether in a laboratory or in a remote Arctic community, requires flexibility and the capacity to react to continually changing environments. Defining what flexibility looks like to our teams on a day-to-day basis in order to support our long-term goals is a process that requires us to review and re-prioritize our work. For example, many of us find ourselves asking whether creating direct and multiple points of access to our work can help in reaching a broader audience to explain why our work benefits and is relevant to all segments of society. Reflecting on what we can do helps us recognize it is our responsibility to change our existing science communication strategies to meaningfully engage this broader audience.

Contextualizing Co-Production of Knowledge

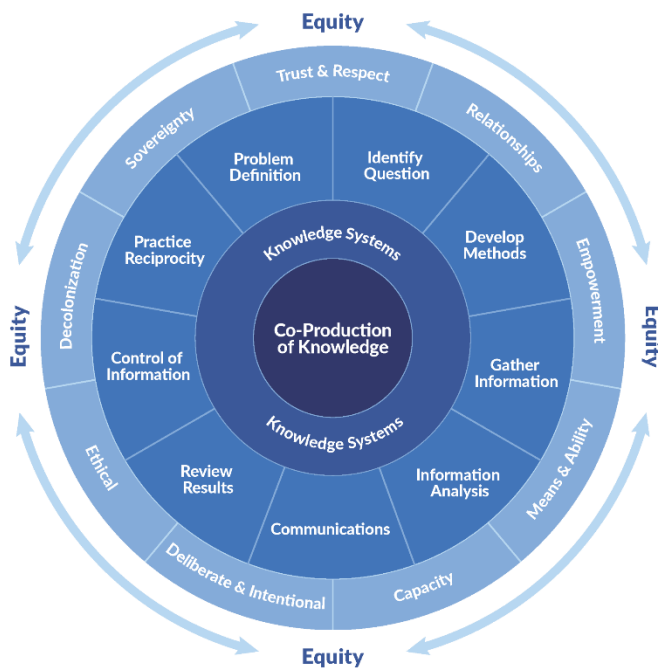
Engaging with new and emerging technologies does not happen in isolation. It is important to recognize the significance of the work produced by a team of collaborators in creating new Knowledges that lead to innovations. It is equally important to intentionally and thoughtfully incorporate processes into shaping collaboration, as this will greatly enhance the process of knowledge creation (Csoba DeHass et al. 2025; Hollinger 2025). Science happens through people and cannot be separated from human innovation. Technology provides us with tools, including AI-based and enhanced tools, and we have the capacity to use these tools responsibly by aligning that use with proven, ethical working strategies that have already produced innovative results. Our understanding of how humans choose to engage with emerging technologies always lags behind, especially if we prioritize capability testing over understanding

societal effects (Magnani et al. 2020). Not fully understanding the impacts of our work can hinder the overarching goal of exploring how emerging technologies can move us collectively forward in creating more comprehensive approaches to complex issues. This is also true in heritage preservation and perpetuation.

In our work we apply the co-production of knowledge (CPK) framework to help us as co-creators and responsible partners to fully understand potential and actual impacts, and to realize the synergy of our collaboration. Our goal is to co-produce strategies that inform comprehensive outcomes with the potential for a broad societal impact while producing research outcomes that address locally relevant expectations. We specifically use 3D and related emerging technologies to preserve and perpetuate Alaska Native heritage, and our collaborating partners are federally recognized Alaska Native Tribes in the Bering Strait region.

The co-production of knowledge (CPK) framework is an increasingly prominent model for structuring collaborative, equitable research that integrates diverse knowledge systems, particularly in contexts involving Indigenous communities (Ellam Yua et al. 2022; Kawerak, Inc. 2025). It is a paradigm shift in research as it creates meaningful collaborations through a

convergent science approach across multiple epistemological traditions. Often this means the integration of Indigenous knowledge systems with non-Indigenous science paradigms. We specifically use this approach to understand Alaska Native perspectives on the use of 3D technologies when working with Alaska Native heritage. A key aspect of the CPK framework is its flexibility. It is designed to accommodate all intentional collaborations and it lends itself to use with projects employing emerging technologies in a community-engaged context.



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Figure 3. The Co-Production of Knowledge Framework (Ellam Yua et al. 2022).

Drawing on the work of Ellam Yua et al. (2022), we use the CPK wheel to demonstrate the key concepts of the framework and their integrations to create a complete process that is built on equity in both praxis and intellectual labor (Figure 3). While all elements of the wheel are equally important, we particularly emphasize the conceptual tools arranged on the outer ring. These conceptual tools are essential for assembling a well-functioning team, which can progress to the inner action circle of the framework to carry out a specific research project.

Equity in Research (Ellam Yua et al. 2022, 7) is a key concept that weaves through the entire CPK framework. The focus extends beyond the inclusion of all participants to encompass a commitment to establishing team processes that clearly delineate roles, responsibilities, contributions, and decision-making strategies. In our case, centering equity recognizes Indigenous Knowledge Holders as leaders in the project as they provide ongoing guidance. This includes prioritizing community-defined goals, establishing ethical protocols in alignment with Indigenous values, and ensuring that knowledge production serves the interests of origin communities while also advancing science. This approach is also in alignment with the Tribal Research Protocols developed by Kawerak and the 20 Tribes of the region (Kawerak, Inc. et al. 2024). In CPK, equity is foundational as it recognizes Indigenous community partners and Knowledge Holders as co-researchers who actively shape the project from design to the dissemination of the results. Implementing equity in research is challenging as it requires collaborators to give up sole control over their projects and fully trust their team members (Kovach 2021; Smith 2021). This is antithetical to the traditional, academic-led research process. Equity is woven into the fabric of our collaboration. We co-developed the project with Kawerak Inc., and we follow the lead of Knowledge Holders from the Kawerak region in selecting materials for 3D modeling. We also intentionally modify the research process in response to ideas that emerge through collaboration. For example, at the request of Knowledge Holders, we are creating a short film documenting the stages of the project, specifically for communities in the Kawerak region. While a film was not initially planned as a project output, its integration became essential in light of how Knowledge Holders understand the film's potential to share information about the project with the communities they represent.

We also highlight *means and ability* as well as *capacity* from the collection of conceptual tools (Ellam Yua et al. 2022, 8-9). Both tools, though distinct, emphasize the equitable sharing of resources to support all collaborators during the co-creation process. Means and ability focus on directly addressing the needs of community partners and creating opportunities for their participation, while capacity building emphasizes the need for training academic researchers to engage in ethical and effective partnerships with communities. Effective and ethical co-production requires that all partners have support to fully contribute to the shared project. Both means and ability and capacity building are reciprocal; researchers develop cultural competence before they engage in work with communities, and Indigenous communities gain access to technological and methodological, infrastructural, and training resources that create a long-term investment in local expertise. Through CPK, projects are co-designed to support Indigenous Data Governance so that communities can make their own decisions regarding their own sustainability goals. In our case, this translated to developing sub-awards to Kawerak Inc that were based on the same budgetary rationale as the academic budgets. This ensured that we supported all collaborators to successfully participate in the project based on their needs - including changes and re-budgeting to reflect these changing needs.

Intentionality within the CPK framework refers to the deliberate and reflective structuring of research partnerships (Ellam Yua et al. 2022, 7). In a project partnership, all participants consciously make the decision to participate in the specific research activity while also making the commitment to continue their participation in a meaningful way. Intentionality is an integral

part of ethical relationship-building, as is transparency in decision-making processes. In order to foster the commitment to long-term relationships, partnership development usually begins with early and iterative consultation. These early partnership-building activities provide a forum for understanding community priorities, mapping out how a project can best align with those priorities, discussing mutual expectations, and aligning project outcomes to community priorities and expectations. Discussing levels of involvement and articulating the resources needed to successfully contribute to the project are critical to the project's success. Taking the time to collaboratively develop team processes, responsibilities, and shared outcomes supports the formation of agreements that honor both academic goals to advance science and community-defined priorities, ensuring that research contributions are locally-meaningful and benefit partnering communities. This approach also includes developing shared governance structures, outlining data access protocols, and the collective definition of success in both procedural and relationally meaningful terms. This is particularly crucial when working with emerging technologies that may require periodic review of project goals and agreements in light of the rapid development of new technological capabilities that can pose both potential benefits and risks.

Artificial Intelligence and Cultural Heritage

The integration of Artificial Intelligence and 3D technologies offers opportunities to move beyond one-dimensional methods of knowledge production when strategically deployed within the CPK framework. Through the blending of multiple knowledge systems, collaborative teams can leverage emerging technology tools to create a multifaceted and integrated understanding of complex phenomena. To fully explore how these technologies can help us do better science through the synergy of multiple knowledge systems, we need more collaborations that center strategic, intentional, and ethical engagement with emerging technologies and that are guided by the needs and priorities of society. Our understanding emerges from use, praxis, and reflective, periodical review of project goals and processes. As AI and other emerging technologies continue to evolve, there is an increasing need for ethical and intentional engagement through strategic and active collaborations.

AI is now one of the most widely discussed technologies in nearly all sectors of life. Broadly, AI is any technology that enables computers and machines to mimic human intelligence and learning. It is a computer system that can perform complex tasks that traditionally only humans could do, such as language processing, problem solving, or decision making. As these technologies benefit from large-scale, crowd-sourced human training through end-user agreements prioritizing the use of human-AI interaction data for development, AI is becoming increasingly more sophisticated and creative. AI is expected to continue expansion, promising more efficiency in the workplace and groundbreaking discoveries. The rapid advancement and proliferation of AI have given rise to a range of ethical concerns, including issues related to data privacy. New concerns surface with every new update, current challenges include perpetuating biases and stereotypes (Derda and Predescu 2025; Terentia 2024), mining culturally sensitive data (Atkinson 2023; Terentia 2024), and infringements on Tribal sovereignty (Starr et al. 2025). Although the future trajectory of AI is still rapidly evolving, it is important for industries,

especially the cultural heritage sector, to critically engage with how AI can be leveraged as a tool for enhancing ongoing work already being done in this space.

Museums and cultural institutions are already embracing AI as a tool to increase productivity, visitor engagement, and preservation efforts with promising results. One significant application of AI is enhancing visitor experience through personalization and accessibility (Atkinson 2023; Derda and Predescu 2025; Styx 2024). For example, AI-powered chatbots can interact with visitors, providing real-time responses to questions and tailoring content based on visitor preferences. These tools enrich the educational experience and bridge the gap between physical and digital engagements thereby deepening the connection between audiences and collections.

AI is also playing an increasingly critical role in collection management and conservation. Computer vision algorithms can identify artworks, generate descriptive metadata, and recognize artistic styles across vast digitized archives supporting a more efficient cataloging process (Terentia 2024). Similarly, AI's optical character recognition capability is used to scan through handwritten documents in archives (American Alliance of Museums 2024; Derda and Predescu 2025). Machine learning techniques contribute to conservation through monitoring and analyzing artworks and can detect signs of deterioration invisible to the human eye (Derda and Predescu 2025; Styx 2024). Integrating AI into museum operations can improve efficiency and redefine the boundaries of accessibility, education, and preservation in the heritage sector.

Indigenous communities are also experimenting with the possibilities of AI as a tool for language revitalization and the stewardship of their heritage. With language loss being a pressing issue for many Indigenous communities worldwide, AI technologies are being harnessed to combat this decline through digital archives and language models (Heidt 2025; Wat 2025). The Cherokee Nation has collaborated with AI researchers to develop a language-learning application powered by natural language processing (NLP) algorithms (Hackett 2025; Starr et al. 2025). The Maori Language Commission partnered with AI companies to create AI-driven speech recognition systems that can transcribe and translate the Maori language (Lee 2024; Lee-Morgan et al. 2019, 56). Inuit organizations in the Canadian Arctic employed AI technologies to track and predict environmental changes, such as shifts in sea ice patterns and wildlife migration to make more informed decisions about traditional hunting practices (Alza 2024). Furthermore, AI is being leveraged in Indigenous-led mapping projects, where community knowledge is integrated with geospatial technologies to document sacred sites, natural resources, and areas of cultural significance (Canavera 2023, Maloney 2024).

The breadth of Indigenous-led projects already underway using AI technologies demonstrates the potential for ways for researchers to engage with Indigenous communities through the co-production of knowledge framework. As with any emerging technology, there is a learning curve with AI that needs to be incorporated into team science processes, especially through strategic and intentional collaboration. The application of artificial intelligence is not a uniform solution, rather, its strength is in its adaptability that can align it with the scope of project goals and outcomes as defined by project team partners.

Indigenous Data Governance and the CARE Principles

In the heritage sector, where we work with a great variety of all humanities' tangible and intangible heritage, it is crucial to center ethical considerations in technological innovation. Prioritizing societal interests over purely technological advancement is an important step in recognizing that digital representations need to be both accurate and also culturally respectful. Actively cultivating, maintaining, and prioritizing a respectful and reciprocal relationship that is built on trust are also key tenets of Indigenous methodologies.

In our work, respecting and adhering to Indigenous Data Governance principles while approaching community engagement through the Co-Production of Knowledge framework has provided a foundation for ethical management of data, meaningful community engagement, and successful research outcomes as defined by all partners. We build on previous work such as the CARE principles (Collective Benefit, Authority to Control, Responsibility, Ethics) that were developed by the Global Indigenous Data Alliance [GIDA] (2019) to complement the FAIR principles (data that is Findable, Accessible, Interoperable, Reusable)(Wilkinson 2016), we also produce potential new directions from what we learn while exploring 3D and related technologies with our Tribal partners.

IDG principles emphasize the importance of sovereignty, strategic stewardship, and the protection of cultural knowledge, so that Indigenous communities retain control over their data and the narratives it supports. When these principles are integrated into collaborative research practices, they foster mutual respect between researchers and Indigenous communities, co-creating space for meaningful, culturally sensitive engagement. Through the Co-Production of Knowledge framework, all partners—whether Indigenous or non-Indigenous—participate in shaping the research process, from data collection to analysis and dissemination, ensuring that outcomes align with the priorities and values of the community. This inclusive approach safeguards Indigenous Knowledges and leads to more relevant and impactful research outcomes. It reflects the needs and goals of the community, rather than imposing external agendas. Ethically working with Indigenous communities requires trust, reciprocity, and respect. Taking time to develop a relationship that is built on trust is essential to long-term partnerships. IDG provides guidance on creating these partnerships that co-produce projects with a focus on centering Indigenous research agendas, expectations, and priorities for using the data for the benefit of their communities. Through centering these principles in the research process, data becomes a tool of empowerment rather than exploitation as Native Nations define and communicate their terms of data collection, usage, and dissemination to their research partners. While this approach places data stewardship fully into the hands of the origin communities and reinforces trust and accountability throughout the research lifecycle, it also underscores the need for leveraging collaborations to support the enhancement of means and ability. Our role as researchers and collaborators is to contribute our collective knowledge and not to make decisions for communities.

For example, open-access has been cited as completely incompatible with Indigenous data. Through our 3D heritage informatics work, some communities are interested in making 3D models of their heritage open-access, or partially open-access for specific purposes (Csoba

DeHass et al. 2025). Other communities are very concerned about how open-access would expose their data. As researchers, we provide information to communities on the potential risks and benefits of open-access according to the state of knowledge at the time, but our role is to consult and not to make decisions. One of the lessons learned from this experience is to re-define open-access as a spectrum of options that Native Nations can consider in re-defining and strategically using to advance their own data governance agendas.

When integrated with the Co-Production of Knowledge framework, the application of Indigenous Data Governance principles facilitates a collaborative approach where all collaborators, including Indigenous communities, co-design research agendas, methodologies, and interpretations of findings. This model promotes reciprocal learning, and values diverse epistemologies, acknowledging that knowledge is not the sole domain of academic institutions but it is also deeply embedded in community contexts and lived experiences. As a result, community engagement becomes more meaningful, leading to research outcomes that are not only scientifically robust but also culturally relevant and benefit all parties involved.

Applying the Co-Production of Knowledge Framework

We would like to share a few examples from our work to help contextualize our larger framework. In addition to using the CPK framework, the CARE principles, and IDG as core tenets of our collaboration, we also created a Memorandum of Understanding (MOU) between Kawerak Inc. and the Curators of the University of Missouri. This MOU clearly states Kawerak's sole ownership, and outlines data transfers, re-use request procedures, and public dissemination permissions and protocols. No data from the project is to be released without prior consultation with Kawerak, even including social media posts. Often, IDG is misunderstood as Tribes refusing to share information or participate in research. This is largely incorrect - Tribes and Native Nations are often very interested in participating in research projects, but they also want to have procedures in place that guarantee their control over their data. For Native Nations this may mean investing time into finding the right partners, developing their own research ethics guidelines, or instituting research consultation requirements and policies.

As researchers, we were aware of some of these challenges and we invested intentional time into team building. All Knowledge Holders are recognized for their contributions and referenced accordingly. Anonymization of data sets is often portrayed as best academic practice to protect participants' privacy but working with Alaska Native Knowledges, this would mean alienating Knowledges from Knowledge Holders and communities who entrust them to us. We also make time and space for exploring new and unexpected results, outcomes, and ideas, as well as for considering the needs of all participants. For example, we may misunderstand each other and have to make a conscious effort to understand diverging perspectives. During the past year, we have been working on multiple publications and we often described Alaska Native communities as Indigenous origin and descendant communities. From an etic perspective, a museum collection piece may have come from a community whose descendants are now claiming it. Yet, from an Alaska Native perspective, there are no descendant communities, only origin communities. From the perspective of the Alaska Native communities we work with there is only one community. All members of that one community, whether they were born 2,000 years ago or

10 years from now, belong to the same community, which is the origin community of the heritage piece. Recognizing this nuanced difference also helped us better understand the significance of the 3D models for community members. Although Alaska Native belongings have been once removed from their origin communities and placed into collections, they never cease being part of their communities as they carry relationships and intangible knowledges within themselves.

In the past four years, we worked with close to 2,000 pieces at three museums, the Milwaukee Public Museum, the Hood Museum of Art, and the University of Missouri Museum of Anthropology. We 2D documented all three collections using a culturally responsive 2D photography method that highlights information relevant to origin communities (Vallier et al. 2025; Wachowich 2018). We also 3D documented over 250 pieces using photogrammetry, structured light scanning or a combination of both technologies. In May of 2025, we completed one-on-one ethnographic zoom interviews with our collaborating Knowledge Holders. We asked them to review the 3D models and share information about collection pieces. We also asked them to reflect on the 3D technologies we use based on their experiences with them in the past three years. A couple of key concepts emerged from these discussions through the synergy of our work that reflect Alaska Native perspectives on 3D and related technologies.

Leora MaNaq TunGowchuk Kennick from the Nome Eskimo Community noted the importance of sharing 3D models with communities both with and without texture views (Kennick 2025). Looking at just the structure without the texture helps recognize carving marks, weaving techniques, stitching, and other nuanced information about how that specific piece was made. Oftentimes, these nuances would not be visible while looking at the piece in real life or through 2D photos. As Leora pointed out, 3D technology helps people develop a more complete understanding of the heritage pieces. For example, 3D models of baskets shown both with and without texture can be used in teaching a class on basket weaving as master weavers can analyze the weaving techniques through the model. Similarly, the stitching used on a kickball is easier to see on a model without the texture, and it helps understanding the nuances of the sewing techniques used such as finishing of a seam or the differences between functional and decorative stitching.

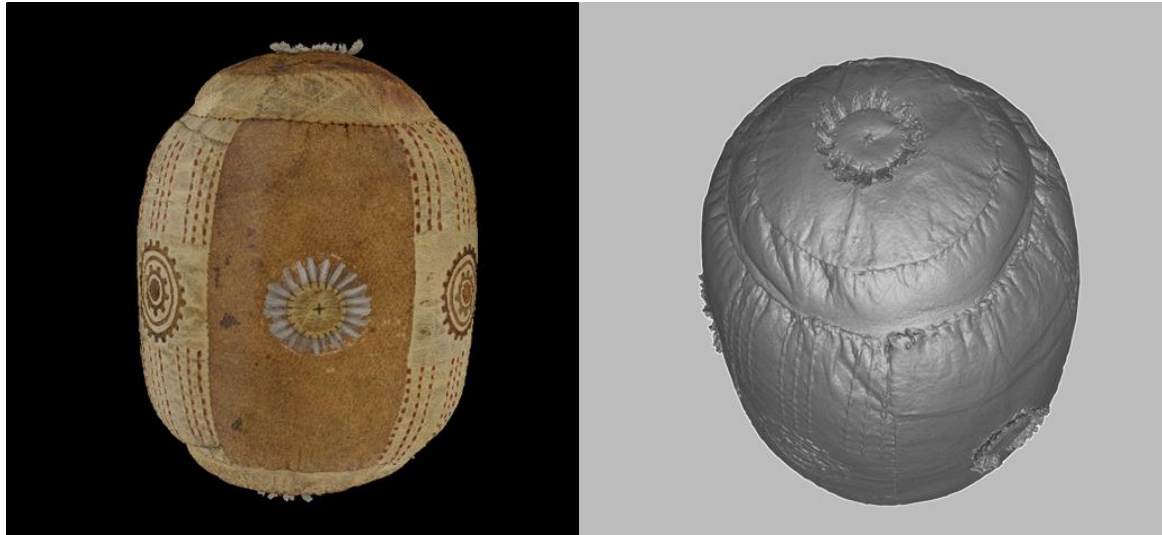


Figure 4. This women's kick ball, originally from St. Lawrence Island, currently resides at the Hood Museum of Art (46.17.9670, 6 ½ inches). It is made of leather and fur with stitching details. Photogrammetry model by Peyton Smith. [Link to the video of the 3D model.](#)

Rose Fosdick from the Nome Eskimo Community pointed out the importance of feeling the grain of the wood when learning about a large wooden bowl or a platter (Fosdick 2025). These platters and bowls were used by ladies to serve the extended family pieces of boiled seal and walrus meat. They were highly prized and passed down from mothers to daughters and female relatives. Rose added: "We have a platter from Dad's mother's family that was in Mom's use as well as used by Uncle Buster after Dad and Mom moved to Nome. The platter got returned to Mom and Dad's family, and later to me via a neighbor in Wales who wanted to make sure it stayed in our family before the old house was torn down" (Fosdick 2026). In the Kawerak region, all wooden pieces are made from driftwood, and the skill needed to select the right piece of driftwood and to carve these large platters and bowls were highly valued. Male relatives usually made the bowls for their beloved female relatives. As Rose discussed, physically engaging with these pieces is integral to fully experiencing them, and while this is not possible with digital 3D models, Rose appreciated the opportunities 3D technologies provide. She suggested that we work with a carver to 3D model all stages of carving a wooden bowl to collect information complementary to the digital 3D data. Expert carvers can glean information from 3D models that help them replicate the carving techniques used in the original piece. Touching original pieces of carved wood is often not possible due to geographical distance between origin communities and museum collections, contamination due to the preservation process, or the fragility of the piece. Touching a recently carved piece that is subsequently 3D modeled, however, can give an insight into the correlation between textures seen on the digital 3D model and their tactile, real-life physical feel. This information can be used to extrapolate information about the physical feel of various textures present on original heritage pieces. From Rose's perspective, fully documenting a piece means that if we 3D model the piece of driftwood before carving begins, and then again, periodically re-model it as the bowl emerges, we can compare the grain of the wood with the platters and bowls we 3D documented in museums.

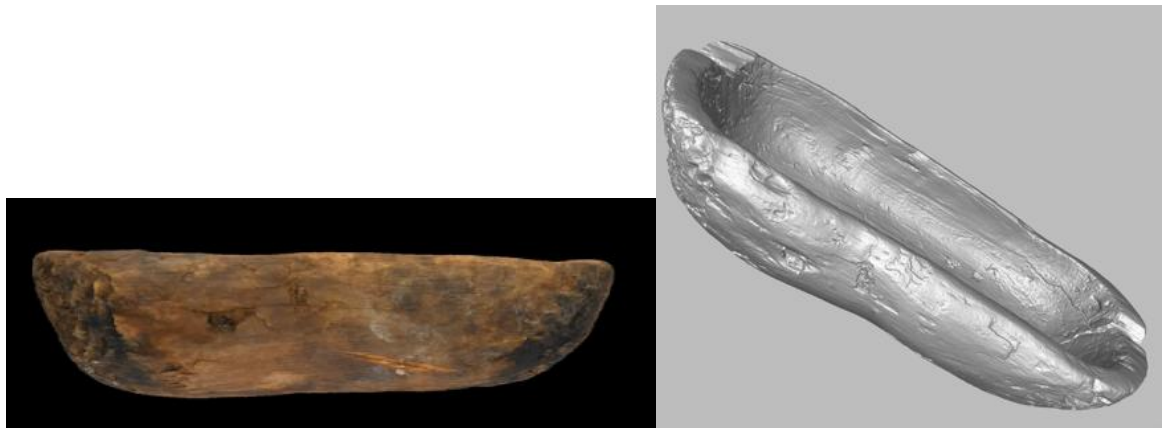


Figure 5. Wooden bowl from St. Lawrence Island, Thule period. Collected by Charles McAlpine sometime between the late 1950s and 1965. Currently in the collection of the Milwaukee Public Museum (E58999, 13 x 5 inches). Structured light model by Brennan Meyerhoff. [Link to the video of the 3D model.](#)

Charla Koozata from the Native Village of Gambell on St. Lawrence Island asked us to find a way to bring the technology to the Island so that young community members can learn how to document pieces locally (Koozata 2025). She also shared that learning 3D technologies would be a good entry point for younger generations to interact with their ancestors' past and learn about the rich history of the Island. Currently, there are two inhabited communities on the Island, Gambell and Savoonga, however, in the 1850s, before famine and waves of epidemics, there were 40 communities. Due to the Island's location between Siberia and the Alaska mainland, many of the communities actively engaged in trade, and so it is not surprising that about half of the museum collection pieces we have worked with through our current and past projects are from St. Lawrence Island.

Truman Kava, also from St. Lawrence Island, shared his interest in creating a specific digital collection of the 3D models so that community members can access them even from remote locations (Kava 2025). While most of the repatriated collection pieces find a permanent home in Nome, the regional hub, other communities such as those on the Island, or Diomedes, or even communities on the northern shores of Seward Peninsula such as Shishmaref, may have a difficult time accessing these collections in Nome. Truman shared that it would be good to place the digital data into the care of Kawerak as it is more feasible than local data management by each Tribe, but creating online digital 3D model collections for each community would mean people can more readily engage with the heritage.



Figure 6. This richly decorated bone needle case with seal and bear hunters is originally from the vicinity of Nome and currently resides at the Milwaukee Public Museum (E65476, 3 x ½ inches). Needle cases are often thought of as women’s items, but men also regularly carried similar cases to make repairs on their hunting gear while on the go. Photogrammetry model by Peyton Smith. [Link to the video of the 3D model.](#)

These insights demonstrate the type of innovations that can only happen through active and intentional work with community partners. Some of our outcomes translate to technology-based innovations, while others inform digital-data stewardship challenges and, hopefully, at some point, solutions.

Concluding Notes

While we work specifically with Alaska Native communities, we recognize that many of the issues of using digital technologies in heritage preservation and perpetuation are not unique to us. Data deterioration and sustainability, data access and ownership, and digital data stewardship are questions all of us are working towards to address as they affect all of our work. Opportunities such as the *Technology as a Bridge to the Museum* bring together practitioners to share, learn, and contribute to the unfolding discussion. From our work, the key questions emerging in heritage informatics focus on long-term societal impacts, translational science, and long-term data management. Technological development will continue to enhance and expand opportunities; however, understanding how people interact with these emerging technologies and their products in the heritage sector is key in innovation.

The heritage sector continues to produce massive amounts of digitized and born-digital data, but struggles to future-proof data integrity and access. Early digitized data, including 3D data, is often lost and cannot be salvaged even with more sophisticated technologies. Most collaborations default to cold storage options as there are few sustainable data management practices, workflows, and repositories with secure, long-term support. We are good at producing data, and we will have to become good at managing it in a way that balances cultural contexts and advancing science. In part, this prompts us to consider questions of ownership, stewardship, and access. All data, including Indigenous data, benefits from culture-specific data reuse

considerations. Assessing ways to steward open and sovereign data leads us to consider how the Co-production of Knowledge approach can inform non-Indigenous praxis. While we live in a data-centered world, data still needs to be interpreted in a cultural context through a meaning-making process. Developing comprehensive science communication and translational science approaches that go beyond capability testing for emerging technologies will help us actively engage with, or even meet, our current and future challenges.

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