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Research, part of a Special Feature on Convergent Science for Sustainable Regional Systems

Shared.Futures: fostering convergence and envisioning possible futures through ArtScience

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ABSTRACT. Amid uncertain and complex environmental and climate futures, both science and society need an agent for active hope and shared perspectives to address these existential challenges. ArtScience, created through transdisciplinary collaboration between artists and scientists in which artistic inquiry can impact scientific inquiry, and vice versa, is one means to this end. We describe the Shared.Futures Workshop and Exhibit, based in Albuquerque, New Mexico, USA, as an example of ArtScience as convergence research and community engagement with current scientific findings. The inaugural Shared.Futures program was a five-month workshop (April-August 2022) that brought together five professional artists and five academic scientists to collaborate across disciplines and sector lines. Five workshop organizers established the goals and timeline as well as facilitated meetings to support the cohort of ArtScience teams. The workshop culminated in a month-long exhibition of the resulting artwork from the five artist-scientist pairs along with one additional project led by the workshop organizers at the Explora Science Center and Children's Museum, Albuquerque. Inspired by principles of transition design, the Shared.Futures program nurtured a locally rooted yet globally informed dialogue, empowering collaborations between artists and scientists to explore complex wicked problems. This approach leveraged the synthesis of art and science to promote equity and co-create shared realities, exemplifying the potential of convergence research.

Key Words: *ArtScience; convergence; possibility studies; sustainable futures; transition design*

INTRODUCTION

Whether generated by anthropological or natural sources, environmental challenges impact broad regions of the Earth's interconnected ecosystems. Assessing these challenges often requires complex methods, analysis, and solutions. A major barrier to addressing environmental challenges through scientific solutions is the slow policy response to both new and longstanding issues (Weitz et al. 2017, Mahony and Hulme 2018). Due to the broad reaching nature of environmental challenges, large-scale actions in the form of societal shifts and policy changes are necessary to adequately address these issues (Smajgl et al. 2016). These challenges are often referred to as "wicked problems," in which problems and potential solutions are complex and non-linear, and where no single optimum solution can be tested with full confidence in advance (Rittel and Webber 1973, Ross et al. 2022). Unlike more traditional linear problems, these wicked problems require groups of individuals with diverse perspectives to come together and view the problem from a wide range of lenses. To add to the challenge, individuals in the general public, including those who are impacted by wicked problems (such as climate change), may be receiving biased, potentially incorrect information due to the current era of media punditry and rhetoric that is not based on scientific realities (Cook et al. 2017, Pennycook and Rand 2021, Roozenbeek et al. 2022). Environmental issues can be remediated, prepared for, or even avoided, if an informed society, which engages with both scientific findings and lived experiences, can hold equitable discourse to inform policy (Kliskey et al. 2021, Rabonza et al. 2022). Given the intricacies of wicked problems, approaches like convergence research, which emphasize collaborative and interdisciplinary strategies, become essential.

Convergence research is defined by the National Science Foundation (NSF) as having two key characteristics: research that is driven by a specific and compelling problem, and research that is deeply integrative across disciplines (https://www.nsf.gov/pubs/2018/nsf18058/nsf18058.jsp). Convergence research seeks to address the wicked problems by incorporating multiple ways of knowing, transdisciplinary collaboration, and the interconnectedness of actions (Sundstrom et al. 2023). The field of convergence research and education is currently in a dynamic phase of growth and exploration (Fleerackers et al. 2022). Despite its progressive approach, gaps exist that hinder its full potential. Such gaps include (1) the inadequate representation of diverse disciplines, cultures, and worldviews; (2) the inadequate pedagogical strategies that foster cross-disciplinary integration and collaboration beyond merely co-existing in parallel; and (3) under-utilization of social sciences and humanities in convergence efforts (National Research Council 2014). These gaps inhibit the comprehensive and meaningful fusion of different perspectives, limiting the depth and breadth of convergence (Sundstrom et al. 2023). In addition, conventional scientific methods might not suffice to foster genuine interdisciplinary thinking, which forms the bedrock of convergence research and education (Bowman and Arnold 2019). One example of a significant convergence research effort is the Intermountain West Transformation Network, which aims to build resilient communities and ecosystems throughout the Intermountain Western United States and has been working to further define convergence and create new frameworks and models to support convergence research (Morgan et al., in press). Shared.Futures is part of the broader Intermountain West Transformation Network.

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To realize its potential in addressing wicked problems, a shift to a more equitable and inclusive convergence model is essential, one that embraces the fusion of disciplines and perspectives. This is where the role of ArtScience becomes pivotal. Science and art are key methods for both envisioning possible futures (Glăveanu 2023) and designing toward sustainable futures (Irwin 2015). ArtScience interplays meaningfully with the intersection of equity and convergence. ArtScience refers to art that has been developed through a deeply collaborative process between scientists and artists (Root-Bernstein et al. 2011, Jung et al. 2022). The main distinction between ArtScience and other forms of art and science such as "science communication" is the process and purpose under which the art is created. Science communication tends to be a more linear, unidirectional process, whereby the science has been completed and is handed off to a creative team/person to communicate the findings more broadly beyond an academic audience. There often is limited feedback between the final output and the scientist's future research. In contrast, deeply interdisciplinary and collaborative modes of ArtScience are intended to be a process in which the scientific and artistic development are co-developed, in which the scientific process informs the artistic process, and the artistic inquiry can also have an impact on the scientific inquiry. ArtScience is a means to explore uncertainty, not through the examination of probability but through the lens of possibility (Clark et al. 2020). ArtScience melds the analytical with the creative, unlocking diverse perspectives essential to convergence and to the promotion of inclusivity (Jonsson and Grafström 2021). By exploring scientific concepts through various forms of art and by positioning art as an epistemology (e.g., Hawkin 2020, Gibbs 2014, Magrane and Johnson 2017), ArtScience allows individuals from different backgrounds, cultures, and education levels to understand and engage with these concepts in a more personalized and meaningful way. Thus, the integration of ArtScience within convergence research promotes not just intellectual diversity, but also cultural and social equity, reinforcing the importance of diverse ways of knowing and inclusivity in our pursuit of knowledge and understanding.

We identify the transition design framework as a key framework to connect the methodology of ArtScience with the broader goals of moving toward sustainable futures and addressing wicked problems. The transition design framework is defined by four co-evolving areas of knowledge, action, and self-reflection: vision for transition, theories of change, mindset and posture, and new ways of design (Irwin 2015; Fig. 1). Transition design was first proposed as a concept in 2011 by Gideon Kossoff (2011), developed as a framework by Terry Irwin (2015), and is in part inspired by the grassroots Transition Town Movement (Hopkins 2008) that seeks to build resilient local communities in the midst of global climate change, reliance on oil, and economic instability. Transition design as a design framework stands in contrast to more mature design approaches (e.g., design for service or for social innovation approaches) for its emphasis on long-term thinking, as opposed to designing for short- or mid-term solutions, and for its explicit emphasis on social and environmental concerns (Irwin 2015). Transition design has since prompted a growing field of research in design (e.g., Sangiorgi 2011, Odabasi et al. 2023, Irwin et al. 2022), including the establishment of a PhD program focused specifically on this framework (Irwin 2015).

The Shared.Futures Workshop and Exhibit, guided by the transition design framework (Irwin 2015), serves as an exemplar of how ArtScience can drive convergence research toward sustainable and inclusive solutions for wicked problems (summarized in Fig. 1). While ArtScience provides an epistemological approach for Shared.Futures, informed in part through a greater body of geohumanities literature (e.g., Hawkins 2020), and convergence research provides the theoretical foundation for greater connection between the academia and broader society and between disciplines (e.g., Morgan et al., in press), transition design brings into focus the specific goals of designing toward sustainable futures and provides a framework for how we can adaptively stitch together a variety of evolving tools, theories, and methods. Embracing place-based visioning and cosmopolitan localism, which is defined as small, local, diverse, and place-based communities that are also connected globally through exchange of information, technology, and awareness (Irwin 2015), Shared.Futures' diverse collective of artists and scientists demonstrated the power of collaborative innovation across disciplines. This case study, detailed through reflexive research and documented in this paper, underscores the potential of integrating ArtScience and transition design principles (Irwin 2015) to enrich education and practice in convergence.

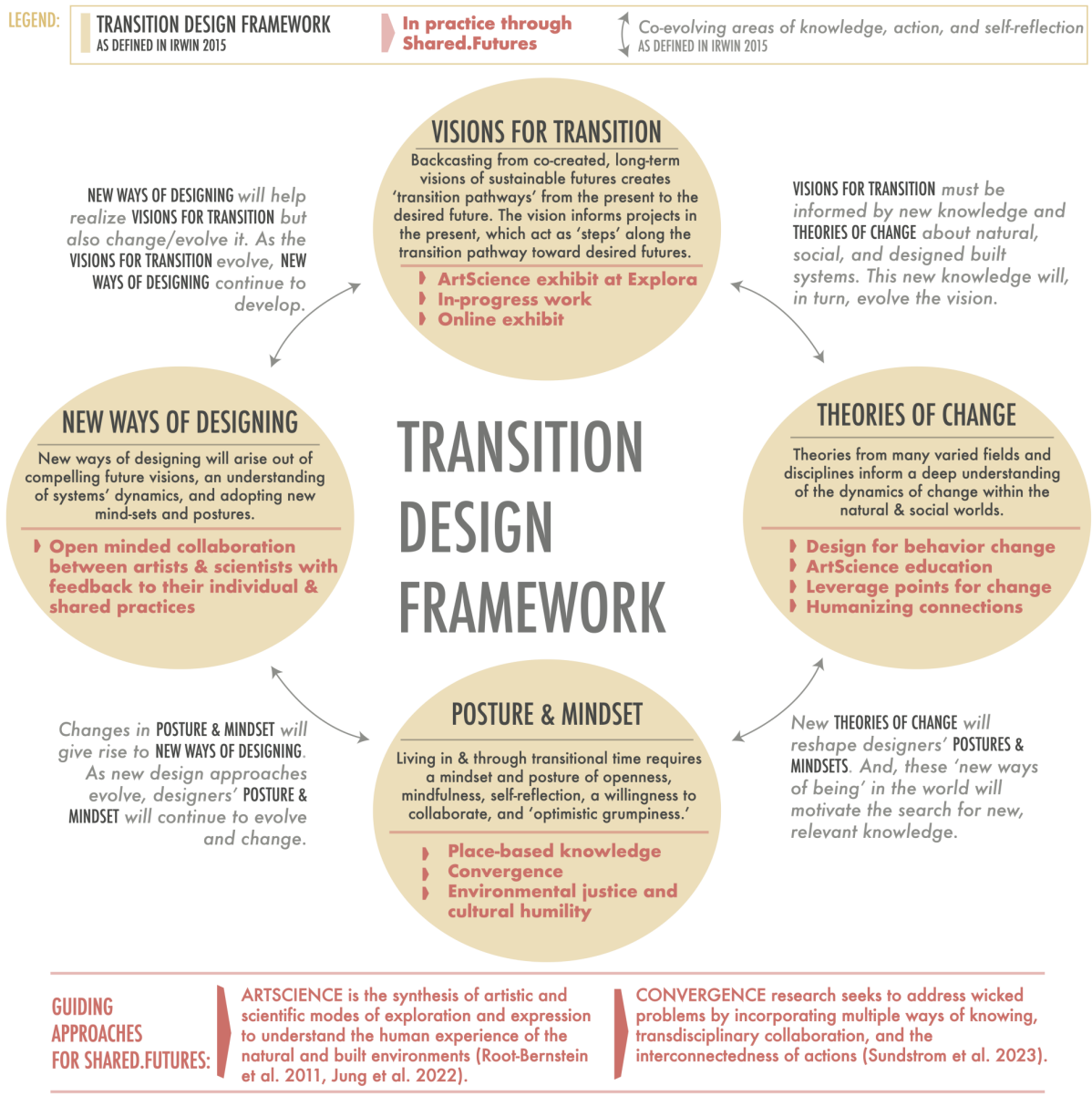
WORKSHOP DESIGN

Shared.Futures is well positioned to cultivate a transition design framework by acting as a "visioning space" (see Fig. 1) that can promote the idea of cosmopolitan localism. The five-month long workshop structure, consisting of five meetings, was designed by Lin, Casuse-Driovínto, Meyer-Driovínto, A. Stone, and M. Stone. The five began to meet regularly starting in the fall of 2021 on a semi-monthly basis, approximately five months before the start of what would be the initial program meeting and envisioned the development of this ArtScience program. This included co-creating the name Shared.Futures and identifying its founding principles of ArtScience convergence visualized in the Shared. Futures logo, shown in Figure 2. The logo is intentionally designed to be read in multiple orders, such as "Artists empowering scientists; scientists inspiring artists," or "Artists inspiring scientists; scientists empowering artists." We present the process of finding the Shared.Futures identity, goals, and philosophy throughout the first year of implementing the transdisciplinary workshop structure and reflecting on the ArtScience generated and outcomes.

One key goal of Shared.Futures is to grow and develop both organizational and participant capacity to converge with other fields to promote interdisciplinary relationships that can develop and share solutions and narratives of possible futures. Shared. Futures intentionally allocates time and funding to host a visioning space for the convergence of science and art. Through annual programming, adaptation and evaluation processes, Shared.Futures acts as a "co-evolving body of knowledge" (see Fig. 1) with the intention of growing and adapting annually and expanding in a way that supports and maintains a placed-based approach.

In these early stages, we identified three core values for the program.

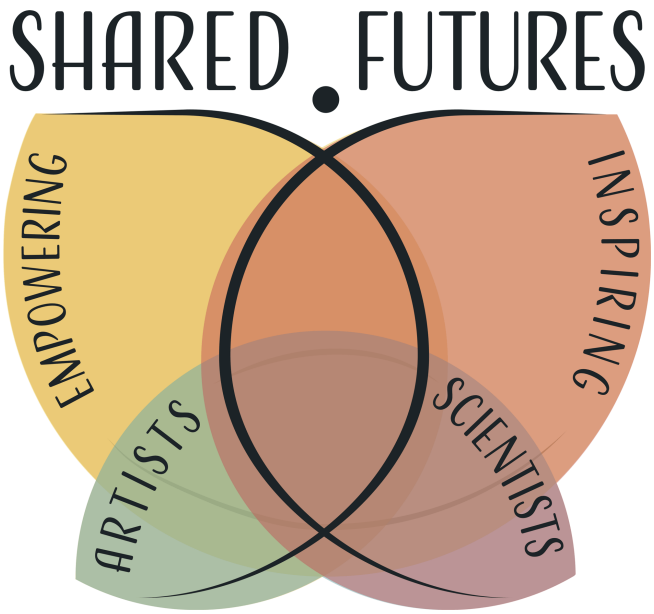
Fig. 1. Overview of the transition design framework and application (Irwin 2015) through the Shared.Futures ArtScience Collaborative.



Relationality and relationship building

As an example of how deeply integrated relationship building is incorporated into the Shared.Futures structure, the founding organizers met over meals and have built genuine relationships with one another both in a professional and interpersonal manner. Building strong relationships within the organizing team is seen as a foundation for developing relationships within and external to Shared.Futures. In particular, we strive to build non-hierarchical relationships, while acknowledging the need for specialized responsibilities. As another form of relationality and relationship building, Shared.Futures is also built as a place-based practice. As a place-based program, we emphasize connection with the local landscape, culture, and people in and around Albuquerque, New Mexico. These relationships that Shared.Futures seeks to foster exist within the academic spheres (e.g., between disciplines), between academia and the general publics, and between academia and other relevant sectors (e.g., non-profits). As such, our program is also designed for in-person interactions and participation is limited to the greater Albuquerque metropolitan area. By engaging local science researchers and working artists in the community who are focused on global wicked problems, this emphasis on relationality within our local community and care for the global community embodies principles of cosmopolitan localism (see Fig. 1).

Fig. 2. The Shared.Futures logo. The logo is designed intentionally to be read in multiple orders, such as "Artists empowering scientists; scientists inspiring artists," or "Artists inspiring scientists; scientists empowering artists," to visualize and embody the principle of reciprocity within the relationships cultivated through Shared.Futures.



Catalyzing active hope for sustainable futures

Rather than focusing on the more dominant "doom and gloom" conversations that flood our news outlets and other mainstream conversations (Knowlton 2017, Rabonza et al. 2022, Rozado et al. 2022), we wanted to create a space that could catalyze active hope to uplift our community. Active hope is hope that is accompanied by action to move toward a more positive, sustainable future (Macy and Johnstone 2012, Wiek and Iwaniec 2014). Being overridden by fear can lead to learned helplessness and inaction (Schmid 2019). Instead, active hope provides a powerful antidote to combat fear, and action can act as a hope-making strategy. Creative activities serve as a powerful medium for processing emotions about complex issues like the climate crisis. Such activities facilitate visualization of a hopeful future, which in turn becomes a strategy for instilling hope when combined with shared expressions (Marks et al. 2023).

Excellence through diversity, equity, inclusion

Diversity, equity, and inclusion (DEI) extend beyond mere aspirational values; they're essential for addressing the grand challenges of our resilience and well-being. To solve complex wicked problems, convergent approaches are essential. Diversity brings different viewpoints, equity makes sure every voice is heard, and inclusion means everyone gets engaged. A convergence approach is optimal when DEI principles are practiced. The Shared.Futures program, built on these DEI principles, focuses on local design while considering worldwide insights to address environmental issues and seek environmental justice. By merging ArtScience with DEI, Shared.Futures creates an environment in which science and art work together toward a resilient future.

These principles guided decisions around the application process, ArtScientist recruitment, program design, and partner organization collaborations.

Application, recruitment, and selection

Cultivating "posture and mindset" (Fig. 1) within the cohort of artists and scientists started with the design of the application, recruitment, and selection process. The application included questions meant to match teams based on their shared artistic and scientific interests and skills, as well as work and communication preferences and styles. To affirm our commitment to diversity and inclusion, the application also collected demographic information on racial/ethnic identity, pronouns, and education. In addition, the application asked about the applicant's interest in participating, previous experience with ArtScience collaborations, their commitment to diversity, equity, and inclusion, and gave the applicant the opportunity to share any previous work. Selected questions are included in Table 1. We also wanted Shared.Futures to welcome and represent a wide range of science, from engineering through natural and social sciences. The application questions were developed to promote willingness to collaborate and converge, and to foster a mindset of cultural humility, environmental justice, and optimism.

Table 1. Selection of questions from the Shared.Futures application. For the questions shown below, all responses were set up as a long text responses, with a suggested length of 1–2 paragraphs per question.

Select questions from the Shared.Futures application	
1	Please tell us why you're interested in participating in Shared.Futures.
2	Please describe artistic mediums you are interested in. For artists, which mediums do you primarily work in; for scientists, which mediums do you enjoy or are you familiar with.
3	Please describe resilience topics or systems (e.g., food, water, transportation) that you are interested in. For artists, which topics are you interested in, motivated by, or want to learn more about; for scientists/researchers, which topics do you research or have you worked on in the past. Based on your work, what message do you want to share with the world through art?
4	Please describe how you are committed to supporting diversity, equity, and inclusion (for example, in New Mexico, the southwest, your professional field, etc.).

Recruitment efforts for artists and scientists for the workshop were locally based because the workshop was planned as an in-person workshop over the course of five months. We also wanted to facilitate connection between the workshop art-scientists as a cohort, and between the art-scientists and target outreach audience; as such, maintaining the scope of the greater Albuquerque area helped build additional points of connection between individuals. Recruitment for the scientist role was mainly through e-mail advertisement and word of mouth with relevant departments, centers, and projects at the University of New Mexico. For the artist role, organizers again used word of mouth and actively recruited potential individuals at the First Fridays Art Walk in Albuquerque. When seeking artists at the art walks, we sought art that had elements of storytelling. If the artist liked science and was interested in collaborating with scientists, we told them about Shared.Futures and invited them to apply.

In March 2022, the organizers held a meet and greet session to answer potential participants' questions. The purpose of the

March meeting was to explain what the commitment to Shared.Futures would look like in terms of time and end-product, answer any questions they might have, and provide the opportunity for them to identify a preferred artist/scientist partner. To facilitate finding possible connections between pairs, we engaged in a dominos activity in which everyone filled out a sheet with prompts on each edge (e.g., favorite artistic mediums, scientific topics of interest, hobbies). Gathered around a large table, we introduced ourselves within this framework and set our responses on the table. As commonalities emerged, we arranged the response tiles with matching responses. In the end, we had a visual depiction of how we were interconnected as a whole. The rest of the time was unstructured and open for each individual to make connections with others in the room. The application was due a couple weeks later.

Once applications closed (end of March 2022), the organizers matched pairs of artists (five artists) and scientists (five scientists) based on the application responses. In this case, there was an even number of artists and scientists, so the matching process was relatively straightforward; in the case of an imbalance of applicants on either side, the organizers considered forming larger teams (greater than two partners per team), participating themselves as artists or scientists in the workshop, or extending the deadline to purposefully recruit additional participants. This may be a necessary condition for future Shared.Futures workshops.

In their applications, the participants self-identified their races/ethnicities as follows: white (2), anglo (1), caucasian (1), hispanic (1), latina (1), chicana (1), Asian Indian (2), Black (1), and Native American (1). One participant identified as multi-racial. We refrained from using the conventional categorizing method to properly honor their identities. The application chose to inquire about the participants' pronouns instead of their gender identities because they were more relevant to our communications and partnerships. Nine of the participants used she/her pronouns, and one participant used he/him pronouns. The participants' interest areas were evenly spread with five interested in the artist role, four interested in the scientist role, and one interested in either. Those who expressed interest in the scientist role had a diverse background including biology, geography, earth and planetary science, environmental engineering, and law. Artists' primary mediums included photography, abstract art, illustration and printmaking, film, and oil painting.

Workshop scientists represented a wide range of career stages. On the academic scientist end, our group included one scientist who had just completed their undergraduate degree; one master's-level graduate student; one PhD-level graduate student; one assistant professor; and one full professor. Similarly, workshop artists ranged from newly emerging artists to more established artists.

Financial agreements

One key partner of Shared.Futures is Explora Science Center and Children's Museum (hereafter, shortened as Explora). Before beginning the program, we had several meetings with Explora to determine the alignment and feasibility of our partnership. After identifying several key shared goals, we solidified our partnership through a memorandum of agreement. The agreement articulated our shared values in increasing awareness and participation of students and school-aged children in STEM + art and outlined our participation in Explora's events, including the New Mexico Science Fiesta and Meet a Scientist. In addition, Explora committed space for our event and exhibit, and also agreed to administer payments to our ArtScience fellows (a stipend of $US500 per individual ArtScience fellow and up to $US200 per team for materials related to their ArtScience piece). These payments were budgeted for and provided by our grant funding, and by administering these payments through Explora, we were able to guarantee timely payments to all participants regardless of their university affiliation. To support Explora's operations, we budgeted for a room rental to host a lunch reception on our opening exhibit day and agreed to an administrative fee, which was applied to stipend payments and materials reimbursements. The MOU also outlined other roles and responsibilities, intellectual property, the duration of the agreement, indemnity, liability, and also stated the principal contacts for each party.

Workshop meeting descriptions

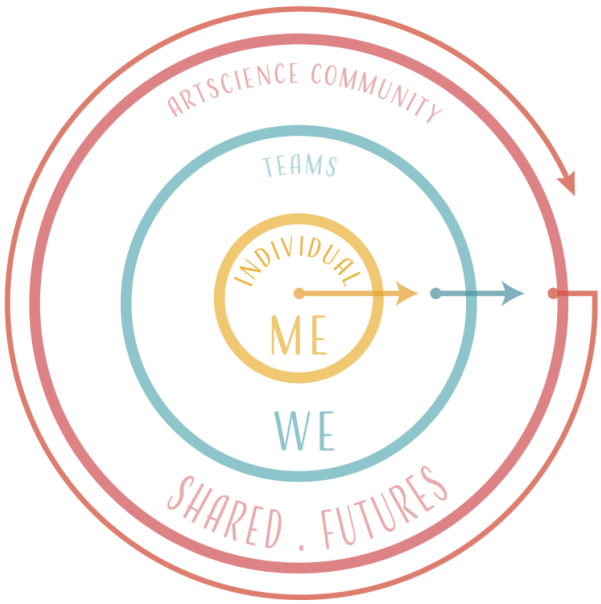
Monthly meetings were hosted to check in with the ArtScience teams, to act as a resource, track team progress, and build community within the cohort. The target design is a series of concentric circles (Fig. 3), intended to depict a process of transformation and outward growth that acknowledges first the individual (ME), then the ArtScience team (WE), and finally the broader ArtScience Community (Shared.Futures). As we completed meetings in the program, participants were asked to move outwardly through each phase of the circle. The first phase was to identify and communicate participants' individual identity (ME) by writing short biographies and then sharing them in the meeting. In the second phase, ArtScience pairs were asked to create a shared identity (WE) that encompassed positionalities from each participant in the ArtScience pair. The third phase (Shared.Futures ArtScience Community) encouraged participants to reflect on the collective identity of the Shared.Futures program cohort. The community phase communicated our overarching theme to the participants in such a way that allowed them to encompass it in their collective work and communicate stories of possible futures to the broader community. This workshop series of concentric circles starting with the self and moving outward was designed as a way to establish a firm foundation to deepen mutual communication and collaboration. This series is also designed to build capacity for behavior change, which allows for better communication and understanding of the dynamics of change between intertwined social, ecological, and technological worlds. The concentric circle design is also meant to symbolize the inherent interconnection between each individual ArtScientist and the whole of the Shared.Futures ArtScience community. Each meeting is described in detail in Figure 3. Through this process and cohort meeting progression, we co-created our mission and vision statement:

> *Shared.Futures is an ArtScience collaborative where we bring together local scientists and artists. Together, we aim to showcase what our shared futures can look like.*

This mission and vision statement has since been used on our website and in advertising subsequent Shared.Futures events and future workshops.

Teams were expected to organize meetings with both the scientist and the artist of their team to cogenerate the concept and physical manifestation of the final ArtScience piece. Some teams met regularly and spent a large amount of time together, whereas

Fig. 3. Shared.Futures program phases and workshop description. The workshop starts first with understanding the individual (ME), then works its way to developing the team (WE), and finally ends with building community among the whole Shared.Futures ArtScience community.



Who am I?

Meeting 1: April 2022

We focused on establishing identity at the individual level by asking individuals to craft a short biography to share with the group. This also helped the cohort learn more about each other. Between the first and second meeting, individuals were asked to prepare a short bio of themselves to share on social media and the Shared.Futures website in preparation of the final "who am I?" activity, which was an on-camera interview intended for inclusion in the short documentary of the event. They were also tasked with meeting together once outside of the context of the scheduled workshop meetings. Where they met, and whether they met virtually or in person, was up to each team to decide.

Who are we?

Meeting 2: May 2022

We focused on establishing a joint identity between the artist and scientist pairs, building on the individual activities of the previous month. This meeting took place at Explora Science Center and Children's Museum in Albuquerque, NM, the location of the final art exhibit. This gave teams the opportunity to deepen their relationship by exploring the space together. The setting was also fitting to draw inspiration from the many interactive STEAM (Science, Technology, Engineering, Art, and Math) exhibits available at Explora. This also served as the opportunity to envision their own eventual art work in the space. After this meeting, teams provided their ideas for how they would like to install their work, and this was the start of our conversation with Explora to identify what constraints and opportunities existed for our Shared.Futures installation.

What is Shared.Futures?

Meeting 3: June 2022

As the inaugural workshop and cohort, we asked ourselves: what is Shared.Futures? Is it a workshop? Is it a community? Is it just a broader impacts activity for the associated research project under which it receives funding (the Intermountain West Transformation Network), or is it something more? Will it persist beyond the year, or beyond the research grant? How do we explain what Shared.Futures is to others? Is this research, practice, or something in-between? We discussed how Shared.Futures was at the intersection of many of these: both a workshop and a community, and both part of a larger research project while also maintaining a new emerging identity. There was strong consensus that this should - and could - live beyond its inaugural year. These conversations helped to shape our narrative for participating in the New Mexico Science Fiesta on June 18, 2022 (see Fig. 4).

Meeting 4: July 2022

Because the main event was approaching and the group wanted to promote their participation in Shared.Futures, the meeting turned to a conversation on how all of the participants were explaining Shared.Futures to their friends and strangers. Through the conversation we collectively converged on the following statement: Shared.Futures is an ArtScience collaborative where we bring together local scientists and artists. Together, we aim to showcase what our shared futures can look like. This co-created mission and vision statement has since been used in advertising subsequent Shared.Futures events, future workshops, and on our website.

Meeting 5: August 2022

The week before the exhibit opening, we met to install ArtScience pieces at Explora. The final exhibit is described in detail in the **Art outcomes and Exhibit Description** section of this paper. Additionally, after the official exhibit opening during Meet a Scientist and Artist, we hosted a lunch reception for the ArtScientists and their friends and family to celebrate the accomplishments of the ArtScience fellows. We also invited other members of the Intermountain West Transformation Network.

Fig. 4. The New Mexico Science Fiesta took place on June 18, 2022, from 10 a.m. to 4 p.m. At any given time during the day, we had 2–3 activity stations active. Each team was responsible for an activity station for two hours, and a new activity station started each hour (ie., activity slots were 10 a.m.–12 p.m., 11 a.m.–1 p.m., 12–2 p.m., 1–3 p.m., 2–4 p.m.). The organizing team also had an activity station that spanned the entire event (10 a.m.–4 p.m.). Pictured here are various activities to engage with people of all ages, all designed and created by Shared.Futures ArtScience teams. Top row, from left to right: collaborative mixed-media collage making (see Fig. 6 for related project); an interactive photo display; and a coloring book. Bottom row, from left to right: finger painting with prompts related to the future and place; fungi viewing; and water quality testing. At this event, we also featured in-progress work, including a partially completed oil painting, draft illustration, and test photographs. Sharing the collaborative ArtScience process was identified as a common goal between both the Shared.Futures organizing team and Explora early in the planning stages. Rather than focus exclusively on final products, this emphasis on process was identified as one way to make art, science, and ArtScience more relatable, engaging, and imaginative for audiences. Additionally, the organizers created a loom weaving station (described in Fig. 11). Activities were developed as part of Cohort Meeting 3 in June. The Science Fiesta was identified as a mid-point check-in for teams. This provided an opportunity to both ensure that teams were taking steps forward toward their final product, and that they could share part of that collaborative ArtScience process with a broader audience.

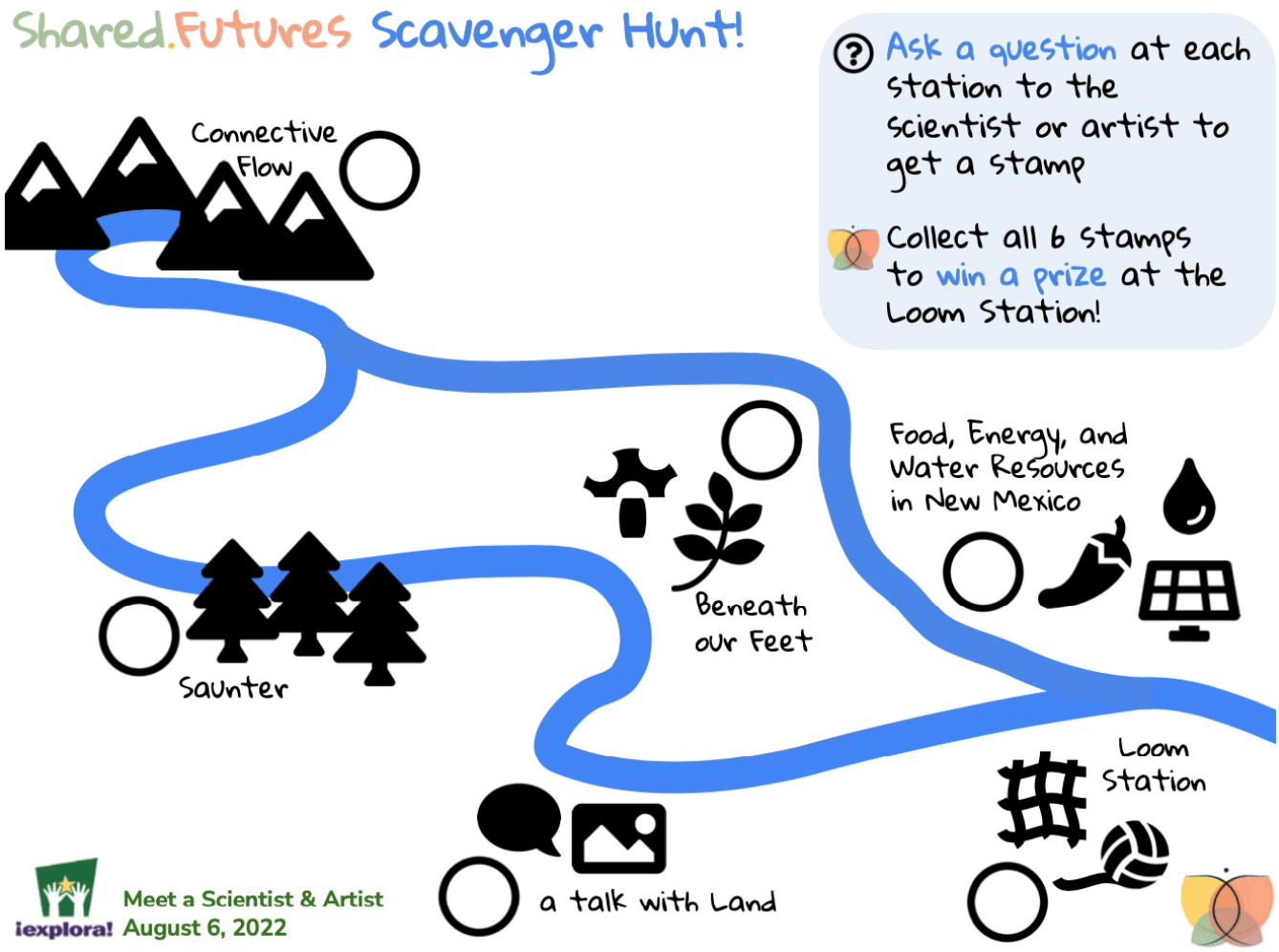
others met minimally. This aspect was not regulated by the organizers due to the acknowledgement of variable life circumstances and availability for the teams to meet.

In addition, there were two public events as part of the workshop program: an in-progress exhibit at the New Mexico Science Fiesta (see Fig. 4) and a final exhibit at Explora.

ART OUTCOMES AND EXHIBIT DESCRIPTION

On the opening day of the exhibit, the ArtScience teams and Shared.Futures organizers were featured as part of Explora's Meet a Scientist and Artist event (10 a.m.– 1 p.m., August 6, 2022). The Meet a Scientist event is a regular, recurring event that Explora organizes for children to meet local STEM professionals. For this event, Explora modified the event title to Meet a Scientist and Artist to reflect the nature of our group. Each team, plus the organizers, had a station set up near their art piece. Over 500 people attended the opening of the Shared.Futures exhibit on August 6, 2022. Upon entering the museum, the first station visitors encountered was the organizer's station. This was designed to be the first and last station that visitors interacted with. Upon arrival, visitors received a Scavenger Hunt activity (Fig. 5) to guide children and people of all ages through each of the exhibits and encourage them to visit all the ArtScience team stations (original ArtScience work and descriptions shown in Figs. 6–11).

Fig. 5. Scavenger hunt created for children and people of all ages to explore all the ArtScience on display and to encourage visitors to interact with all the Shared.Futures teams at the final exhibit. Each station had unique stamp shapes and colors. Eighty scavenger hunt maps were distributed, and 45 returned with their completed scavenger hunt map for a prize. The prize was a modular eraser toy provided by Explora. The majority of the scavenger hunt participants who completed the challenge (33 scavenger hunt participants) wanted to take their map home.



This was especially helpful given that two of the ArtScience stations were integrated into unconventional spaces that were not obviously on the main exhibit floor (e.g., in an elevator, in the case of "a talk with Land," see Fig. 9, and in a theater for "Food, Energy, and Water Resources in New Mexico," see Fig. 10). It also was intended to create an atmosphere of discovery and adventure for the exhibit visitors. Each station had unique stamp shapes and colors as part of the scavenger hunt. To receive a stamp at each station, the scavenger hunter had to interact with the ArtScience team and/or participate in their station's activity when applicable.

Following the scavenger hunt distribution station, visitors were free to visit any booth in any order. On the first floor of the museum, visitors were able to view "Connective Flow" (Fig. 6), "Saunter" (see Fig. 7), and "Beneath Our Feet" (Fig. 8). "Connective Flow," a mixed-media piece by Arelis Haskamp and Melinda Morgan, was installed near an existing water section on the first floor of the museum. "Saunter," an oil painting collaboratively created by Noami DeLay and Sonia Luévano, was installed near the same water section behind an interactive water exhibit. "Beneath Our Feet," a screenprint on wood by Malcolm King and Abigail Granath, was installed on the wall beneath the central staircase, such that visitors could view it from the first floor, and the piece would indeed be beneath their feet as they walked up the stairs to see the rest of the Shared.Futures exhibit.

Another way to get to the second floor is by taking Explora's room-sized elevator, complete with a couch, coffee table, and piano, where visitors would find yet another Shared.Futures ArtScience team. The installation from M. J. Rain Song and Ria Mukerji, "a talk with Land" (see Fig. 9) was an immersive and interactive experience. The video was projected on one wall of the elevator. After watching the video, viewers were encouraged to write on paper leaves about what they viewed as important about

Fig. 6. Resulting ArtScience work and artist-scientist team statement from the 2022 Shared.Futures exhibit: Connective Flow (mixed media collage, 2022) by Arelis Haskamp and Melinda Morgan.

Connective Flow

Mixed media collage, 2022

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Artist: Arelis Haskamp, Person of Interest Arts
Scientist: Melinda Morgan, Geography and Environmental Studies, University of New Mexico

Team's ArtScience Statement: The Intermountain West faces many challenges, including catastrophic wildfires, dwindling water supplies, and rapid urban population growth. In response, the Transformation Network (TN) was formed–connecting scholars and community partners across the Intermountain West. Our goal is to help build resilient communities and ecosystems. The TN represents a partnership between eight Western U.S. universities, including the University of New Mexico, with over 50 partner organizations representing Tribal partners, public utilities, local governments, nongovernmental organizations, and others.

This mixed-media piece captures the beauty, complexity, and diversity of our Transformation Network. Fluid and ever evolving, the connectivity and evolution of the engagements within the Transformation Network are made visible. Like a river, the research taking place is dynamic and ever changing. It reflects the conditions present at any given moment and the social and ecological contexts involved. The work is funded by the National Science Foundation (NSF Grant# 2115169) and takes a convergent research approach. We involve experts from different disciplines to pursue common research challenges, and their knowledge, theories, methods and data become increasingly intermingled and integrated. For us, convergent research also means commitment to community engagement and working with these partners in both designing and conducting research.

Recognition of different kinds of knowledge, particularly local knowledges and Indigenous knowledges, is a key element of our research design. We place an emphasis on the co-design of research questions and methodologies and honoring Indigenous and local knowledges and ontologies. The Shared.Futures project is part of this effort. It brings together researchers and artists and is a part of the Transformation Network's efforts to build community and foster communication. You can find out more information about the Transformation Network and its activities at https://resilience.unm.edu

Fig. 7. Resulting ArtScience work and artist-scientist team statement from the 2022 Shared.Futures exhibit: Saunter (oil on canvas, 2022) by Sonia Luévano and Naomi DeLay.

SHARED . FUTURES

Saunter

Painting in oils, 2022

Artist: Sonia Luévano, Sonia Luévano Fine Art & Design
Scientist: Naomi DeLay, Earth & Planetary Sciences, University of New Mexico

Team's ArtScience Statement: My name is Naomi Delay, and I am the scientist involved in this work. In my pursuit of science, I started graduate school at UNM in August of 2019. My mindset has gone through quite a shift from the start of my degree to now as the world also experienced a very dramatic shift in March of 2020. My research in graduate school is mainly focused on aqueous geochemistry. It is a fancy word for how hydrology and geology coincide. I am fascinated with the interaction of water and how solutes are released based on different chemical reactions within the water system. My focus area is in the Manzano Mountains in Cibola National Forest. I study springs in this region to understand the flow pathways and the sources of these spring-systems. These spring-systems affect the quality of the water sources that many communities rely on in the region. Additionally, these systems are affected by processes that go on around them. Forest fire plays a big part in this system when considering the most recent forest fire, the Doghead Fire in 2016.

In collaborating with the artist, Sonia Luévano, we both wanted to show the importance of these interactions with all the elements (fire, water, earth, and air) and how they manifest on a New Mexico landscape. I knew I wanted to draw from my current research, so this work is about the interplay of these many elements within my research. Working in science, the one aspect that can be missing is the emotional and mental connection to the work. I believe that art can bridge that gap. It allows a space for self-expression, and it allows yourself to be vulnerable with the creative process. I wanted to draw inspiration from past artists who thought of science and art together. Leonardo da Vinci is one such artist that Sonia and I connected with. Sonia really understood the importance of conveying the mood of the piece, with the burnt tree forms, fogginess (sfumato) and the earthiness of the landscape. I think it is important to show the value of creativity and using your imagination when it comes to doing anything in life, especially in science. What better way than collaborating with an artist to demonstrate the emotion and the process behind the hard work.

Fig. 8. Resulting ArtScience work and artist-scientist team statement from the 2022 Shared.Futures exhibit: Beneath Our Feet (screenprint on wood, 2022) by Malcolm King and Abigail Granath.

SHARED . FUTURES

Beneath Our Feet

Screenprint, 2022

Artist: Malcolm King, Screenprint and illustration
Scientist: Abigail Granath, Biology, University of New Mexico

Endophytic fungi are a type of fungi that live inside plants and can help them get nutrients and water when they're in need. Most land plants form a symbiotic relationship with these fungi, especially plants in hot and dry environments. Like humans, fungi eat carbon-based food. In exchange for the energy-full carbon that the plants make via photosynthesis, the fungi provide nutrients like nitrogen and phosphorus that help plants thrive. As ecosystems are continuing to become more stressful with climate change, the relationships between these fungi and their plant hosts are likely to change also. Understanding how these fungi respond to things like increasing temperatures and increasing drought can help us better understand how plants will also respond with their fungal partners. These beneficial fungi can be introduced to plants sensitive to climate change, such as crops and essential native plants.

Our piece utilizes microscopic imaging and illustration processed through screen print to create a visual representation of fungi's importance and omnipresence in the world beneath our feet. The fungal species were cultured from the roots of plants and grown on individual agar plates. To highlight the textural aspects of mycelium, the inter-connected cellular web that fungi form, we gathered a series of images of these endophytic fungi through a Scanning Electron Microscope (SEM). Contrast and organic repetition determined which image was used in the final composition. The illustration component represents endophytic fungi's symbiotic relationship with plants, providing essential nutrients to their root systems. By utilizing multiple mediums, we hope to engage viewers regardless of their prior knowledge or pedagogical preference. Mycology, illustration, and screen print are our tools for creating inclusive gateways for learning.

Fig. 9. Resulting ArtScience work and team's ArtScience statement from the 2022 Shared.Futures exhibit: a talk with Land (videography, 2022) by Mandolin J. Rain Song and Ria Mukerji.

a talk with Land: an elevator speech about place attachment and the power of care

SHARED . FUTURES

Videography, 2022

Artist: M. J. Rain Song, Filmmaker
Scientist: Ria Mukerji, Geography and Environmental Studies, University of New Mexico

Team's ArtScience Statement: What is place? What does place mean to you? When you think of your favorite place, what goes through your mind? Do you miss it? Do you feel at home? Safe? Energized? Sad? What would you like to say if the land could hear you? And If the land could speak to you, what would it say?

Place attachment is an emotional bond between people and place and plays an important role in protecting the places we love most. Care and our own memories also play an important role in actively protecting place. How people interact with the environment helps shape their views of the world and how the environment interacts with us. In the times we are living in, we often think about our environment as something that happens to us, but we are as much a part of our environment as the grass below our feet, and the birds singing in the trees. When people grow up connected to the environment, they view it as a part of themselves and approach it with a deep sense of respect, responsibility, and love. If we love our spaces and treat them well, all life thrives! Not just ours but those who cross paths with the love we have given to the land - people, animals, plants, and bugs: all living things.

We hope that while you go through this exhibit and listen to how people connect to place, as well as how place connects to people, you think about your own connection to the landscape, and how you can take that care, that love, and turn it into action. The places shown in this short video are here in New Mexico, where people feel a deep (some might say spiritual) connection between themselves and their surroundings. As you ride the elevator, we hope you are prompted to think about how you feel about the state of our climate, then your own connection to places you and your loved ones share, thinking of the mountains, the deserts, the waters, the forests, these beautiful places, how can you show them that you care?

Fig. 10. Resulting ArtScience work and artist-scientist team statement from the 2022 Shared.Futures exhibit: Food, Energy, and Water Resources in New Mexico: Past, Present, and Future (photography and videography, 2022) by Lisa Hurst and Anjali Mulchandani.

Food, Energy, and Water Resources in New Mexico: Past, Present, and Future

SHARED . FUTURES

Photography and videography, 2022

Artist: Lisa Hurst, Photographer, In Search of Solid Ground
Scientist: Dr. Anjali Mulchandani, Environmental Engineering professor at the University of New Mexico

Team's ArtScience Statement: How have humans survived and thrived in New Mexico for hundreds of years? Three essential resources have made this possible: water, energy, and food. The systems that produce these three resources are deeply interrelated.

Both food and energy resources rely heavily upon our limited water resources. Agriculture requires water for irrigation – over 80% of New Mexico's water usage is for growing crops such as onions, potatoes, corn, beans, and alfalfa. The energy sector requires water for steam turbines, hydropower, thermoelectric cooling, and fracking. Meanwhile, the water sector requires energy for pumping, water treatment, and wastewater treatment. Agriculture also requires energy for multiple purposes – for pumping water for irrigation, and for food distribution from producer to consumer.

Over our past, present, and future, humans continually make choices about how to use and maintain these water, energy, and food resources. Some of these choices, such as planting crops that have low water needs and using drip irrigation instead of flood irrigation, have been positive. They have both helped human growth and conserved limited resources. However, some choices, like drilling for non-renewable resources such as oil and gas, have led to negative impacts on the health of our environment.

The grand challenges that New Mexico and our planet face today, such as climate change and population growth, threaten the availability and security of our resources. How can we preserve Earth's natural resources to continue to provide water, energy, and food for a shared future? By understanding the linkages between these three resources, we can work to preserve and protect them all simultaneously.

Fig. 11. Resulting ArtScience work and team statement from the 2022 Shared.Futures exhibit: Shared.Futures Weavings I and II (collaborative community textile, 2022) by Marisol Meyer Driovínto, Tybur Casuse Drivínto, Asa Stone, Mark Stone, and Yolanda Lin.

Shared.Futures Weavings I and II

Collaborative community textile, 2022

SHARED . FUTURES

Facilitated by the Shared.Futures Organizing Team:
Marisol Meyer Driovínto, Community and Regional Planning, University of New Mexico
Tybur Casuse Drivínto, Civil, Construction, and Environmental Engineering, University of New Mexico
Dr. Asa Stone, Geography and Environmental Studies, University of New Mexico
Dr. Mark Stone, Civil, Construction, and Environmental Engineering, University of New Mexico
Dr. Yolanda Lin, Geography and Environmental Studies, University of New Mexico

Shared.Futures Weavings I

Shared.Futures Weavings II

Team's ArtScience Statement: The Shared.Futures weavings are physical symbols representing the collaborative process of bringing the desires and goals of a community from a conscious and communicated space into a physical reality. As we navigate the path from thoughts to physical manifestation, we can influence the resulting shared reality with constructive or destructive perspectives. We asked attendees at New Mexico Science Fiesta (June 18, 2022) to contribute a constructive and inclusive message to inform our journey towards a shared future written on a piece of fabric. This fabric was then woven into the collective weave (Shared.Futures Weavings I). This activity was repeated at Explora's Meet a Scientist event on August 6, 2022 (Shared.Futures Weavings II).

At times, as individuals, we can feel alone in our thoughts and fantasize that our perspectives can only be seen and understood by ourselves or those who are closest to us. The messages written into these weavings act as beacons to the next generation of community members and show that we are not alone in our hopes for a better world. Building a shared reality and a shared future is going to be more fulfilling by using constructive and loving communication with ourselves and others so that we may grow, listen, and create together. Collaboratively constructed by people of all ages, this weaving helps us to consider our ancestors and our descendants as we create our hopes and desires, and in turn, our physical experience.

Throughout Explora from August 6 to August 31, 2022, you will find five ArtScience pieces that communicate a scientific perspective through an artistic medium to showcase what a shared future can look like. As you engage with the art and read about the research and process behind the art, we hope you reflect on what a shared future looks like to you.

the land. This activity was a demonstration of harmony and reciprocity: viewers wrote down what they love about the land on a leaf and hung it up on the reciprocity trees located on the second floor outside of the elevator; in return, they were given a flower to symbolize that the land loves them back.

On the second floor, in Explora's theater room, the "Food, Energy, and Water Resources in New Mexico: Past, Present and Future" piece featured videography playing on a projector and custom-made photo stands with six photographs and accompanying essays by the ArtScience team, Lisa Hurst and Anjali Mulchandani. One of the photographs is shown in Figure 10, and the whole exhibit is available for digital viewing; the link is available through the Shared.Futures online gallery (https://www.sharedfutures.gallery/gallery). Outside the theater, the team set up a board to invite attendees to share visions and actions for future food, energy, and water resources. Some example responses include "compost more!" and "plant seeds."

After visiting these five stations, visitors had one more stamp to gather back at the organizer's table. After experiencing the five ArtScience pieces, we asked viewers to reflect on what they would like to see in their shared future, write (or draw) their vision on a strip of fabric, and then weave the fabric into the collective weaving (Fig. 11). Responses in the weaving ranged from serious reflections on our shared futures, such as "the world to respect each other a little more," "sharing resources," "peace," and a "socialist revolution," to playful responses including one young child wishing to see a world "made of candy," and another who dreamed of "unicorn kitties."

OPPORTUNITIES AND CHALLENGES OF CONVERGENCE THROUGH ARTSCIENCE AND TRANSITION DESIGN

A major goal of the coauthor team for this paper, inclusive of all artists, scientists, and organizers that collaborated in Shared. Futures 2022, is to share the process and work that goes into a cross-disciplinary, convergent collaboration across traditional academic, professional, and community boundaries. We identified key practices, opportunities, and challenges in organizing and participating in this type of convergent art and science collaboration within a transition design framework. These key opportunities and practices are informed through two sources. First, through qualitative content analysis of written and oral reflections, the coauthor group discerned themes that consistently emerged as a common thread during ongoing dialogues (see Table 2 for questions included in the post-workshop reflection discussion). These identified themes were also consistently observed and validated through the analysis process. Second, the organizers engaged in a reflexive evaluation through a qualitative research method of a collective visioning process to determine short-term, mid-term, and long-term goals, as well as identify strengths and areas of improvement of the inaugural program. This three-part process, which included collecting responses through sticky notes, guided conversation, and group diagramming, is detailed in Table 2.

Table 2. Coauthor discussion questions and organizers' collective visioning process that informed the opportunities and challenges identified in this study.

Coauthor group written and oral discussion questions	
Post-workshop reflection questions:	What was your favorite part of Shared.Futures? What was your least favorite part of Shared.Futures? What do you wish you knew before beginning your team's project? What did you gain from participating in Shared. Futures?
Organizers' three-part collective visioning process	
PART I	Initial visioning board Key words and phrases written individually on sticky notes
Guiding questions:	How would you define the Shared.Futures organizational structure? What are the most successful aspects of the current Shared.Futures organizational structure? What aspects of the Shared.Futures organizational structure do you think needs improvement?
PART II	Guided conversation Responses shared in real time, out loud with the group
Guiding questions:	Can you give a brief background to where you're coming from and what led you to becoming an organizer for Shared.Futures? Generally speaking, how has this experience been for you?
PART III	Concluding visioning exercise Collaboratively created a visioning board organized by short, mid, and long-term goals. No other limitations or structure was required.
Process:	Create draft visioning board together. Once complete, each person reflects on one aspect of the board that excites them most and why. After sharing individually, discuss the following as a group: what do the organizers identify as the top three priorities on the visioning board?

Breaking down barriers between academia and the broader public

Shared.Futures is designed to foster relationships between artists and scientists. By emphasizing understanding and trust, the program aims for convergence through personal bonds. We believe that with mutual respect, communication about expertise becomes simpler. A major success indicator for the program was the genuine friendships that emerged. When asked what the ArtScience Fellows gained from participating in Shared.Futures, every person's response mentioned connections and new friendships. One example of this: "I loved getting to know the amazing people involved. The connections I gained were the best part." Several teams continued collaborations beyond professional mandates. However, holding cohort meetings at UNM sometimes made them feel lecture-like, highlighting the importance of choosing inclusive, conversational settings. This was an important finding because the program aspires to bridge the general public and academic spheres through genuine partnership in decision making and creativity. Shared.Futures seeks to advance an environmentally just future by genuinely including community members in knowledge generation and communication to advance community self-determination. Although academia offers technologies and insights for a better future, barriers like technical jargon, paywalls, and accessibility limit public access. ArtScience combines art's narrative power with scientific insights, presenting research in an inclusive manner. Shared.Futures harnesses ArtScience to address environmental issues, aiming for a sustainable future for all. It provides a platform for meaningful dialogues and a space to share visions for transition (Fig. 1), letting community and academia discuss shared experiences and knowledge, which can lead to new ways of designing.

Embracing different ways of knowing

Embracing diverse ways of knowing in ArtScience is essential for equity in convergence (Morales 2022). Ensuring both scientists and artists are equitably compensated acknowledges the value of each of their contributions, fostering mutual respect. Moving beyond task-based collaboration to a partnership model in which scientists and artists share insights enhances interdisciplinary understanding. This facilitates the fusion of perspectives, promoting co-creation of the knowledge central to convergence. In addition, a key challenge in environmental justice is including marginalized community voices in creating policies that protect against environmental hazards and ensues fair distribution of benefits (Shilling et al. 2009). To make the process more equitable and fair, communities need to understand the systems and science shaping environmental risks. Using ArtScience can help make these complex topics more accessible to diverse audiences. Thus, ArtScience that intentionally integrates DEI goals and approaches can powerfully enhance equity in convergence, welcoming diverse perspectives in shaping our future with a focus on new ways of designing and on emphasizing posture and mindset within the transition design framework (Fig. 1). Honoring and advancing diverse goals within the group

Honoring diverse goals is vital in ArtScience projects. Participants have varied aspirations, from learning, community building, and income generation, to experimenting with mediums, forming friendships, and gaining publicity. It is essential to recognize these goals for a thriving ArtScience community (Fleerackers et al. 2022). ArtScience, with its interdisciplinary nature, promotes DEI by integrating diverse perspectives, hence fostering inclusivity. In education, it introduces pedagogical strategies for varied learning styles, emphasizing diverse ways of knowing. Adequate funding, particularly in stipends and organizer support, values participants' contributions and promotes equity across socioeconomic backgrounds. For ArtScience to elevate equity and convergence, it is vital to create spaces for meaningful dialogue, seeking and integrating diverse views. Ensuring fair representation and compensation is essential for fostering the posture and mindset for transition design (Fig. 1), as is developing methods to regularly assess and enhance the integration of DEI principles within ArtScience, ensuring continuous progress in equity and convergence that contribute to theories of change.

Building local partnerships to support ArtScience in communities

We focused on building two types of local partnerships: developing relationships with the existing artist communities in Albuquerque and with local organizations also interested in ArtScience. Our primary artist recruitment occurred at the ABQ Artwalk. Benefits of recruiting at this venue include accessibility, relationship building, and inherently community-orientated artists due to the nature of the artwalk. Explora Science Museum was our primary partner organization due to our shared values in increasing the accessibility and engagement of the public with science. Initial conversations with Explora began in December 2021, and we solidified our partnership through a memorandum of understanding that articulated our shared values, outlined our participation in Explora's events, defined our financial commitments to contribute to our shared activities, and also outlined other roles and responsibilities. Clearly defining roles and timelines well in advance, as well as providing transparency in defining financial commitments and abilities, was a key foundation for the success of this inaugural event. The inaugural year is seen, by both parties, as just the first step in many potential opportunities for mutual mentorship and collaboration in the future. This embodies the interaction between all four elements of transition design, in which a collaborative and equitable posture and mindset through local partnerships leads to new ways of designing and visions for transition that can lead to new theories of change (Fig. 1).

Pulling back the veil of ArtScience collaborations

The final ArtScience pieces, although illustrative examples, only tell part of the story: another narrative lies in their creators and their creative journeys. To showcase the interdisciplinary collaboration journey as part of showing new ways of designing, the organizers documented through digital video and audio, crafting a short series from individual interviews, group discussions, and events such as the NM Science Fiesta (Fig. 4). Early in the planning process, as a mutual goal, both the Shared. Futures organizing team and Explora partners identified sharing the ArtScience collaborative process as a means to make art, science, and ArtScience more conceptually accessible to more people. Although a finished product can be intimidating or feel unrelatable, an in-progress and process-oriented showcase can show that everyone and every project starts somewhere, with the hope that others feel empowered to start their own ArtScience journey. Participants delved into their backgrounds, experience with transdisciplinary workshops, and thoughts on effective ArtScience collaborations. This series (available at https://www.sharedfutures.gallery/watch) aims to highlight participants and serves as a lasting digital gallery to host visions for transition (Fig. 1). As the series expands, it will offer insights on ArtScience collaboration methods, potentially guiding other groups in creating similar programs. Creating the series was not without challenges. Finalizing videos demanded significant time, financial, and human resources. Coordinating and filming, particularly dynamic interview sessions, were logistically complex. Obtaining consent, especially with children present at some events, required diligence. We recommend a predetermined filming schedule and clear event signage about ongoing recording.

Fluidity of roles: organizers vs. participants; artists vs. scientists

This workshop aimed to de-emphasize traditional boundaries for instance between organizers and participants or scientists and artists to foster new ways of designing. We endeavored to reduce barriers among ArtScientists to foster egalitarian interdisciplinarity, inclusion, and creativity-key elements in interdisciplinary collaborations (Lallemant et al. 2022). We adopted several strategies. First, an ArtScientist led a meeting on ArtScience project presentations, encouraging fellows to actively lead and share. Second, continuous feedback from fellows pinpointed concerns and facilitated prompt action. For instance, after confusion arose regarding Shared.Futures' identity post-June Science Fiesta event, the July meeting addressed it, leading to a jointly crafted mission and vision statement. Third, Shared. Futures organizers actively participated in public events and even produced an ArtScience piece (Fig. 11), offering firsthand experience of program demands. Furthermore, an ArtScientist from the first-year cohort later became an organizer, providing invaluable insights for subsequent programs. We emphasized an integrated ArtScientist approach over isolated scientist or artist roles, urging mutual contribution to all deliverables. Qualitative analysis showed that such role fluidity bolstered feelings of inclusion within the group.

The challenge and opportunity of time

Transitioning through new ways of designing, creating visions for transition, fostering a willing posture and mindset, and ultimately creating new theories of change demands time and energy. The 2022 program ran from April to August, presenting unique challenges, opportunities, and insights for the time needed to engage in transition design. Availability of participants and organizers varied, with some on academic and others on individual work schedules. Differences in academic semesters led to participants feeling meeting frequencies were either too many or insufficient. The me-we-community design, while fostering lasting relationships for some ArtScience pairs, led others to desire more structured later meetings. A crucial feedback point was the need for clarity about the time investment right from the program's application phase, underscoring the importance of setting clear expectations for commitment.

The organizers, through a reflective evaluation, saw the need for capacity-building to ensure sustainability and scalability of similar future initiatives. Individual feedback and group discussions revealed the value of informal meetings in building trust and enthusiasm. The organizers' practice of weekly meal sharing before detailed program discussions significantly contributed to the program's success. Because of this weekly practice, one organizer shared, it "feels like I know the other organizers as whole people and not just co-workers." As discussions about capacity-building proceeded, emphasis was placed on allocating time for relationship building within the organizer structure and the ArtScience teams. Consistent meetings among organizers allowed prompt addressing of challenges, while still recognizing the inevitability of imperfections and the need to admit shortcomings. One organizer described: "I think that Shared.Futures is a side-gig for most of us which can limit our ability to produce at the rate which we are hoping for."

CONCLUSION

The Shared.Futures ArtScience collaborative was designed to bolster shared realities and build connections between academics, artists, and the broader public. ArtScience is a key method for engaging in convergence research and for communicating convergence research to the public. ArtScience can draw on the shared reality and knowledge-seeking strengths of science and merge them with the storytelling and empathetic strengths of art. The inaugural 2022 Shared.Futures program was seen overall as a success from the perspectives of the organizers, ArtScience participants, partner organizations, and those who we interacted with during each of the two public-facing events. At the time of writing, we have concluded the program's second year and are preparing for a third year. Feedback continues to be positive (even demanding) for more ArtScience in the communities we serve.

We described the Shared.Futures program's key components and provided a summary of reflections on our lessons learned that may benefit others as they move forward in their own convergent ArtScience efforts. One major takeaway is that resources, both human and financial, for ArtScience programs must be built in from the start and cannot be treated as an afterthought. Creating and organizing Shared.Futures takes significant people-hours. Creating ArtScience in a meaningful, collaborative framework also requires true time and effort. These efforts cannot be taken advantage of as volunteered hours or enrichment for enrichment's sake. This requires sufficient financial resources allocated through means such as external grant funding, institutional support, or other alternatives.

Funding alone, however, will not sustain ArtScience programming. Ensuring that there are individuals who are interested and available in organizing and/or participating in such programs is also key. For both organizers and participants, transparency in time commitment and financial support were repeatedly identified as key requirements to enable engagement in the program. Financial support is critical for supporting diversity, equity, and inclusion in the program.

Shared.Futures is an application of transition design in praxis to help move our communities toward possible, positive futures. Shared.Futures is a co-evolving visioning program for identifying possible futures by building capacity for convergent collaboration between the disciplines of art and science, and in the emerging approach of ArtScience. The program is process-oriented and prioritizes building lasting relationships between differing fields that can extend beyond the five-month program. Multiple artist and science pairs have shown lasting partnerships with enthusiasm to continue collaborating beyond the program timeline. This is a rewarding development that shows value in intentional ArtScience capacity-building.

One limitation of our discussion here is the primary focus on the organizers and participants of the Shared.Futures program. Over 600 people from the greater Albuquerque, New Mexico community interacted with Shared.Futures in the same year through the two public-facing outreach events. Additional work is warranted on studying impacts on attendees of these types of events, but we consider this as separate and future research.

Shared.Futures is a program built on interconnections: between disciplines, organizations, ideas, and ultimately between individuals. The program is built on the principle that transdisciplinary and convergent work cannot flourish without understanding each other's lived experiences and lived realities. We hope that these interconnections enhance individual perspectives and enable co-creation through transitional times in a convergent space, in which we see artists empowering scientists and scientists inspiring artists, as well as scientists empowering artists and artists inspiring scientists.

Author Contributions:

YCL, MMD, TQCD, and ABS led the development, conceptualization, design, and analysis of the study; YCL wrote the original draft of the manuscript and led the revision process. MMD, TQCD, and ABS also contributed to the original draft of the manuscript. MMD led visualizations (outside of the artwork photos). Author names are listed according to the degree of significant contribution (first four authors), then listed alphabetically to indicate equal contribution in this paper, including the co-creation of artwork and accompanying statements included in this paper (Boxes 1–6). All authors also participated in revising and editing the manuscript, and all authors approved the final manuscript.

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Data Availability:

Data/code sharing is not applicable to this article.

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