

Constructive Friction Creates a Third Space for Art/Science Collaborations

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ABSTRACT

Successful interdisciplinary collaboration between artists and scientists is not about discovering “common ground,” but about deliberately creating new spaces for collaboration. These spaces include physical, virtual and intellectual elements brought together through constructive friction and creation and honest use of a shared language. Communication shapes the collaboration, leads to the creation of joint work and engenders new ways of working together and new levels of understanding. The authors interrogate their collaborations to identify essential general principles for synergistic communication and productive collaborations between artists and scientists.

Artists and scientists explore ideas and hypotheses beyond our current understanding, but collaborations between them can be burdened by what British scientist and novelist C.P. Snow described as “two cultures” [1]. However, rather than sharing common knowledge or an epistemological stance about how the world “works,” artists and scientists share a common mode of work: using “slow looking” [2] or “slow ecology” [3] to identify patterns and processes and envision novel ecosystems [4]. Neither artists nor scientists explore and formulate these novel ecosystems only for themselves. Rather, both share their visions and engage others in imagining new ways of doing, collaborating and being in our rapidly changing world. A central component of this work is accessibly communicating complex ideas to ourselves, our colleagues and very broad audiences with a diversity of media.

In this article, we reflect on our interdisciplinary collaboration, which has involved science, art and design, and in which we use communication as a creative force and value-generating process for a given community [5]. We identify general principles for successful art/science collaborations—those leading to completed, exhibited creative work, publications and media coverage—by interpreting the origin and

dynamics of our own collaboration, as well as challenges arising in this working relationship and their solutions [6].

THE COLLABORATIVE MAELSTROM

The traditional conception of art/science collaborations reflects a unidirectional, hierarchical relationship [7] in which scientific data provide the conceptual foundation for creativity (Fig. 1). In this view—often expressed in “broader impact” statements in scientific research grants—scientists hand off their data to artists. The resulting artistic creations are meant to communicate important messages to “broader” audiences. Occasionally, “design thinking” addresses project constraints, mission, goals and final deliverable(s) [8–10].

In contrast, our collaboration revolves around a shared mission, builds on disciplinary strengths and includes iterative testing and productive feedback that modulate and amplify the desired goals (Fig. 2). We see this “third space” of successful art/science collaborations as including all participants and content in shared frictional spaces. Within this broader context, there are three parts of this paper: an introduction to the authors, the origin of our collaboration and our shared mission; a discussion of the importance of shared spaces for fostering collaborative work; and analysis

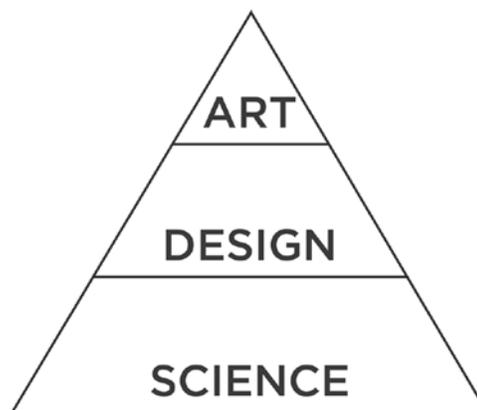


Fig. 1. A parti diagram illustrating the traditional unidirectional relationship from science to art. (© David Buckley Borden)

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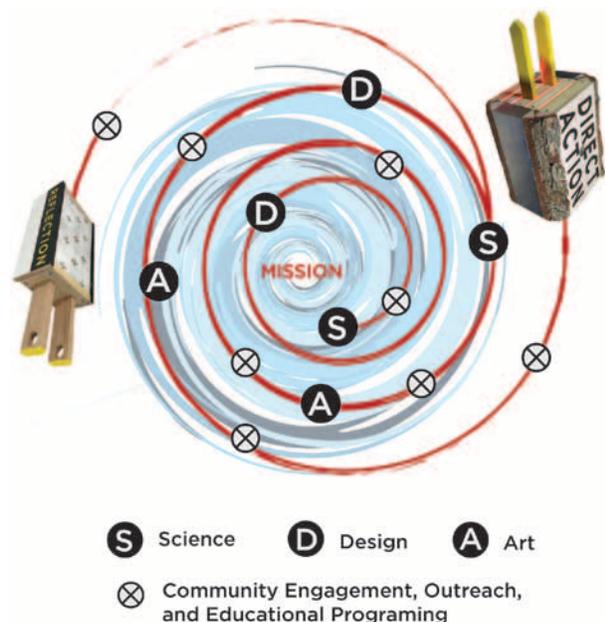


Fig. 2. Our interdisciplinary practice model sparks critical thought or encourages direct action by combining feedbacks between science, design and art with iterative testing through educational programs and public engagement. No disciplinary precedence or directionality of feedbacks are implied by the locations in the illustration of each discipline. (© David Buckley Borden and Aaron M. Ellison)

and evaluation of the creative stances and attitudes we have brought to it. The lessons we have learned in building our collaboration can be applied by others exploring similar collaborations or enhancing existing ones.

Origin of Our Collaboration

We met at David's 2015 *Hibernaculum* exhibition, where Aaron was chuckling at the playful and accessible artwork depicting woodland ecology issues through the cultural lens of summer camping in New York's Adirondack Mountains (Fig. 3). David warily asked Aaron what he was laughing about, and friction gave way to discovery of our compatible interests in art, design, ecology, science communication and environmental activism [11]. Aaron observed that David's work mirrored many topics and ideas studied by Harvard Forest researchers and could be used for education and outreach. A subsequent meeting at the Harvard Forest, a long walk through the woods, emails and digital concept drawings initiated our collaboration, which was supported further when David was awarded a Bullard Fellowship by Harvard University [12].

THE IMPORTANCE OF A PLACE-BASED CREATIVE INCUBATOR

The Value of a Collaboratory

A dedicated physical location or virtual space where a collaborative team can think, ideate and produce work together [13] is recognized as a critical element of successful collaborations [14,15]. We were fortunate to work together at the Harvard Forest, a research institute of Harvard University that has a year-round staff and 4,000-acre land base dedicated to long-term study and experiential learning about the biological, physical and human systems of the New England landscape



Fig. 3. Artwork from the *Hibernaculum* exhibition at the Innovation and Design Building, Boston, MA. Top: David Buckley Borden et al., *Snack Stand*, silkscreened wood and assorted hardware, 16 × 18 × 18 in, 2015. Bottom left: David Buckley Borden, Morgan Grenier and Helen Popinchalk, *Nurse Log*, silkscreen print on paper, 8 × 10 in, 2015. Bottom right: David Buckley Borden, John Cronan and Myles O'Brien, *Firewood Quarantine*, paint on wood, 2015. (Photos © David Buckley Borden)

[16]. The Harvard Forest is a shared socio-emotional-cognitive platform [17] that is a unique incubator for creative research and practice. It is colocated with the Fisher Museum, which has world-renowned forest dioramas [18]. It also has an extensive network of Internet-accessible research and technological infrastructure [19] and forest trails open to and heavily used by the public. In addition, the Harvard Forest has a targeted science communication program and an engaged, participatory community. The trails provided us with numerous opportunities to embed ourselves in the physical space that our joint work eventually would represent while tossing concepts and ideas around and easing friction from fear of overstepping intellectual boundaries (“What happens in the forest stays in the forest”). The dioramas provided a window into an artful and effective communication of science that led to David's collaboration with another research group [20].

The Importance of Friction

We use friction and disagreements as prompts to explore different perspectives that lead dialectically to new ideas and directions. To help smooth rough edges, we consciously support our working process while avoiding misunderstandings. For example, we first identify the scientific question or issue, then design a framework and creative direction for new pieces. If we cannot find common ground, we abandon the idea for something else. When we do find common ground, the resulting artwork is “coauthored”—both we and the fabricators involved in producing the works get full credit in

all signage and publications (see all figure captions herein). Most successful artists and scientists have strong egos, but neither of us insist on having it our way every time; we make conscious efforts not to pressure each other into making uncomfortable decisions, and we talk openly rather than suppress feelings of ambivalence [21]. Dedication to an open process and creating successful work has maintained and strengthened our long-term collaborative partnership.

COLLABORATIVE ATTITUDES AND A COMMON LANGUAGE

Collaborative teams without an explicit shared mission and a common language often fail to make progress, or they disintegrate [22–25]. Our shared mission is to create work that communicates scientific ideas accurately to nonspecialists while meeting professional standards in science, art and design. Creating a common language took time and encouraged us to take advantage of constructive friction.

Developing a Common Language

Disciplinary specialists use jargon-laden technical languages to share ideas and concepts quickly. When scientists and artists (*sensu lato*) come together, their different underlying assumptions and modes of communication can be cacophonous. During David's first six months at Harvard Forest, we simply walked, talked and listened as we intentionally learned each other's languages of practice and developed a common mode of communication to facilitate our work together—a linguistic “third space.” Commonalities emerged from Aaron's long-standing interest in the arts and David's interest in ecology, allowing us to evolve a deeper, more nuanced language of practice that included concept drawings, diagrams, study models and sculptures. These in turn generated the new, shared meanings [26] now evident in our physical creative projects, co-delivered public lectures, and coauthored publications (Table 1).

Collaborative Process

We use design thinking [27] throughout the creation, development and production of our artistic work to present and communicate scientific concepts aesthetically and accessibly. Like the language of creativity shared by artists and scientists [28], design thinking shares practices of inquiry, testing, knowledge creation and communication with the classical “scientific method” (Table 1). It also is undergirded by creative empathy and characterized by community collaboration, iteration, testing and feedback. For example, the *Exchange Tree* in our *Hemlock Hospice* exhibition started with a shared interest in designing a low-tech interactive sculpture to reflect the decline of eastern hemlock trees and elicit responses from visitors to the exhibition and the forest in which it was embedded. The form of *Exchange Tree* was inspired by the shape and position of fallen hemlock trunks and iteratively tested with drawings and models (Fig. 4). Similar iterative processes were used for the other pieces of *Hemlock Hospice* and all our subsequent collaborative projects.

Collaboration also entails shared responsibility for all aspects of the process, including intellectual effort, creative development, physical production, and administrative, lo-

TABLE 1. Points of intersection in languages, methods and practices of science, design and creative arts (here exemplified by painting) that ground our collaborative language and practice.

Science	Design	Art
Define problem space	Empathize	Discover personal interest
Create hypotheses	Define problem statement	Determine interest with community/society
Design experiment	Ideate	
Execute experiment	Create prototype(s)	Study drawing
Collect and analyze data	Test prototype(s) with users	
Iterate testing hypotheses with data	Iterate until design problem is solved	Iterate study paintings
Write up findings	Market test	Final painting
Peer review	Critical review	Peer review
Publication	Fabrication	Critical review
Outreach	Marketing	Exhibition

gistical and financial details. We embrace our individual strengths while sharing the workload. For example, David often identifies and develops new opportunities; *Warning Warning* (Fig. 5) was initially conceived for a garden design competition before being redeveloped as a public art installation at Harvard. In its depiction of global warming since



Fig. 4. Top and bottom right: David Buckley Borden and Aaron M. Ellison, *Exchange Tree*, installation at Harvard Forest, Petersham, MA; wood, paint and flagging tape, 9 × 10.5 × 12 ft, 2017. Fabrication by David Buckley Borden, Salvador Jiménez-Flores and Salua Rivero. Bottom left: Study model for *Exchange Tree*. (© David Buckley Borden and Aaron M. Ellison)

the 1880s and inclusion of possible scenarios for reductions in carbon dioxide emissions, *Warming Warning* responded to the critique of *Hemlock Hospice*: it inspired critical thinking but did not suggest any direct action (Fig. 2) [29]. The opening of *Warming Warning* was accompanied by workshops promoting positive actions and teacher-led curriculum development to bring climate change into K-12 classrooms. Beyond developing concepts with David, Aaron assists in fabrication and carpentry. Examples include the study model for *Warming Warning* (Fig. 5, bottom left) and the model and final construction of *Novel Ecosystem Generator* (Fig. 6).

Supporting a Collaboration

Equitable financial support can be a major challenge for art/science collaborations. Most practicing scientists are employed in academic institutions, governmental agencies or the private sector and are paid a salary for the “process” of doing science. In contrast, most practicing artists and many designers are self-employed and paid only when “products” are completed. We feel strongly that all participants in art/science collaborations should be compensated equitably for the creative process and the collaborative products. Clear communication and decisions about financial support and the costs of production should be articulated *before* the project gets underway.

In our case, David’s Bullard Fellowship allowed him to work full-time with Aaron. Harvard Forest’s Summer Research Program in Ecology [30] supported three students to work on *Hemlock Hospice* during two successive summers. Outreach and additional fabrication costs were supported by



Fig. 5. Top and bottom right: David Buckley Borden and Aaron M. Ellison, *Warming Warning*, installation on the Science Center Plaza, Harvard University, Cambridge, MA; wood, paint assorted hardware, 9 × 10.5 × 28', 2018. Fabrication by Christian Delano Borden et al. Bottom left: Study model for *Warming Warning*. (© David Buckley Borden and Aaron M. Ellison)

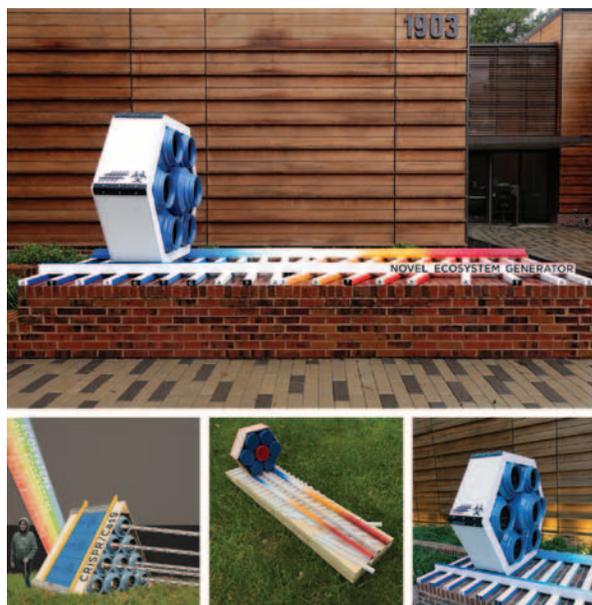


Fig. 6. Top and bottom right: David Buckley Borden and Aaron M. Ellison, *Novel Ecosystem Generator*, installation at Art’s Work in the Age of Biotechnology, North Carolina State University, Raleigh, NC; wood, paint, vinyl decals, nylon mesh, recycled fans and assorted hardware, 5 × 5 × 15 ft, 2019. Bottom left: Original study drawing (digital image). Bottom center: Study model. (© David Buckley Borden and Aaron M. Ellison)

compensation for guided tours and public lectures and the sale of related and derived artwork.

CONCLUSION

No two art/science collaborations are alike. Although there are no fixed rules for creating successful collaborations, we offer a few suggestions and foreground the essential factors that have been critical to our successful work together. Trust, open communication and shared interests are the essential foundation of creative partnerships. Interdisciplinary collaborations flourish when they are guided by a clear mission and an explicit understanding of agreed-upon goals, processes and final products. Goals are more fruitful and products are more interesting if they range well beyond those of each individual and their immediate professional agenda. This is especially true when these explorations create friction. Collaborations require time to build trust and understanding, but we do not suggest that goals, processes and outcomes need to be fully set before any collaborative work gets underway. Rather, a critical part of the creative process is the creation and use of a collaborative space (physical, intellectual, temporal) that supports a process characterized by mutual understanding, generosity and open-mindedness. Working with the constructive friction encountered beyond the comfort of one’s professional silo is essential to building a shared creative trust. Successful collaborations make room for new creative opportunities when the individuals involved are open to unknown possibilities and curb their pride of place (in ownership, authorship, etc.). Indeed, an emergent collective output of a science-arts collaboration is the cocreation of new ways of communicating and amplifying our collective voice(s).

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- Following Catarina Patoilo Teixeira and Cláudia Oliveira Fernandes, "Novel Ecosystems: A Review of the Concept in Non-urban and Urban Contexts," *Landscape Ecology* 35, No. 1, 23–39 (2020), novel ecosystems are unprecedented combinations of species emerging because of anthropogenic alterations of climate, land, water and movement of species across boundaries. By extension, art/science collaborations lead to original and unconventional creations. See also Diana Rhoten, Erin O'Connor and Edward J. Hackett, "The Act of Collaborative Creation and the Art of Integrative Creativity: Originality, Disciplinarity and Interdisciplinarity," *Thesis Eleven* No. 96 (February 2009) pp. 83–108.
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- Des Fitzgerald et al., "Ambivalence, Equivocation, and the Politics of Experimental Knowledge: A Transdisciplinary Neuroscience Encounter," *Social Studies of Science* 44, No. 5, 701–721 (2014) p. 713; note that the politics and expression of the well-known "hierarchy of intellectual prestige" among the social, natural and humanistic sciences is "strangely absent from . . . instrumental descriptions of cross-disciplinary collaborations." This absence is reflected in the traditional approach of scientists using artists as creators of broader impacts.
- Chris Reed and Nina-Marie Lister, *Projective Ecologies* (Cambridge, MA: Harvard GSD, 2014).
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- Hannah Star Rogers et al., eds., *The Routledge Handbook of Art, Science, and Technology Studies* (London: Routledge, 2021).
- Aaron is an ecologist who studies the assembly, disassembly and reassembly of ecosystems following natural and anthropogenic disturbances and uses visual arts to augment his scientific research. David has a degree in landscape architecture and worked in corporate design before pivoting into a self-directed practice integrating visual arts and ecology. For further discussion of our overlapping interests, see Aaron M. Ellison and David Buckley Borden, "Learning from Art: *Hemlock Hospice* Inspires New Ways of Doing Science," *SciArt Magazine* 33 (October 2018): www.sciartmagazine.com/learning-from-art-hemlock-hospice-inspires-new-ways-of-doing-science.html (accessed 11 November 2020).
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- A "collaboratory", originally "an open space where action learning and action research join forces, and students, educators, and researchers work with members of all facets of society to address current dilemmas," Katrin Muff, *The Collaboratory: A Co-Creative Stakeholder Engagement Process for Solving Complex Problems* (Abingdon, U.K.: Routledge, 2014), has been generalized to denote spaces and processes where collaborative groups work together on complex problems. Among scientists, collaboratories often are virtual spaces with shared instrumentation, data, computational resources and platforms for simultaneous writing, editing and coding; Nathan Bos et al., "From Shared Databases to Communities of Practice: A Taxonomy of Collaboratories," *Journal of Computer-Mediated Communication* 12, No. 2, 652–672 (2007).
- Muff [13] p. 12.
- Bos et al. [13].
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- A shared socio-emotional-cognitive platform is a "collectively constructed space in which individuals interact socially, emotionally, and cognitively to study a relatively common question and advance productive insights through interdisciplinary exchange." See Veronica Boix Mansilla et al., "Building Socio-Emotional-Cognitive Platforms for Interdisciplinary Research Collaborations," Canadian Institute of Advanced Research (June 2010): www.researchgate.net/publication/46016459_Building_Socio-Emotional-Cognitive_Platforms_for_Interdisciplinary_Research_Collaborations (accessed 9 December 2020).
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- See Rhoten et al. [4] p. 86.
- See Boix Mansilla et al. [17] p. 25.
- See Craig [5] p. 125.
- David Kelley and Jonathan Littman, *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm* (New York: Currency/Random House, 2001).
- Hans Ulrich Obrist quoted Heinz von Foerster saying "a scientist is in some respect also an artist. Because when they invent something new and describe it, they have to work artistically to communicate

their research findings.” Lilia Ziamou, “Hans Ulrich Obrist on how technology is impacting the art world,” *Thrive Global* (23 April 2020): thriveglobal.com/stories/hans-ulrich-obrist-on-how-technology-is-impacting-the-art-world/ (accessed 2 November 2020).

29 We discuss in detail the tension between communication and direct action in Aaron M. Ellison and David Buckley Borden, “Ecological Art: Art with a Purpose,” *The Goose* 17, No. 2, article 3 (2019).

30 See harvardforest.fas.harvard.edu/other-tags/reu (accessed 13 November 2020).

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