

ART AS A WAY OF KNOWING

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CONFERENCE
REPORT

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EXECUTIVE SUMMARY

Introduction

In 2011, the Exploratorium hosted a conference called Art as a Way of Knowing. The purpose of the conference was to gather a broad range of artists, scientists, and educators to explore the history, practice, and value of the arts as a means of inquiring into the natural world. The conference brought together some 125 leading international thinkers—representing work in education, art and science museums, contemporary art, and interdisciplinary research. Participants gathered at the City Club, a venue in downtown San Francisco, and at an evening After Dark program at the Exploratorium, to participate in two days of presentations, discussions, performances, and roundtable conversations about art as a method of inquiry and way of knowing. In particular, we were interested in art practice in relation to the field of public engagement with science, including programs for children and youth in community-based organizations, schools, museums, and other types of learning environments.

The conference was structured into three main strands designed to facilitate dialogue about the role of art in learning, and in particular, its role in science learning:

- exploring art as a form of inquiry
- understanding lesser known histories of art, education, and science that converged to shape the post–World War II science museum and the institutional learning cultures that emerged from this legacy
- surveying the contemporary landscape, focusing on compelling ways in which artists are working in science and interdisciplinary contexts today, including in informal public learning environments



Still from the film *Frames of Reference*.

We opened the conference by showing a clip from an educational film produced in 1960 by the Educational Science Study called *Frames of Reference* to acknowledge the complexity of bringing together people with widely varying professional viewpoints. Conference participants—throughout the two days—referred to the benefits and challenges of bridging experiences and discourses.

The conference emerged out of an interest across many overlapping professional fields to better frame both theoretical and practical questions related to the role of art in science learning. These questions are of special interest to the Exploratorium. The museum was established in the late 1960s—a time when artists, scientists, and educators around the world were crossing disciplinary boundaries to develop radically new forms of engagement with science. From the first days, artists were integral to the vision, design, and work of the museum. In light of our imminent relocation and the reshaping of our institutional culture at Piers 15/17 in San Francisco, the Exploratorium was compelled to question and clarify how the work, insights, and interests of artists have shaped our work and the experiences of learners in the museum. Moreover, we wanted to situate this work in the larger cultural history that surrounded the museum’s founding. The Exploratorium’s rich history in the arts—its philosophy and working methodologies—provided an important context for the conference. Yet, in giving shape to Art as a Way of Knowing, we drew upon wide academic, artistic, and curatorial expertise, which we hoped would contribute to an international conversation concerning art and learning.

Art and Inquiry

A starting point for the conference was to move beyond the discussion about similarities, differences, or complementarities between art and science. Instead, we wanted to know how the arts expand our engagement and understanding of the natural and social worlds.

Over the centuries, the power and efficacy of art as a way of knowing has been proven by a vast array of models and exemplars drawn from different cultures and historical contexts. One could point to the prevalence of the arts in cultures throughout the world, the integration of arts in well-known school systems such as Waldorf or Reggio Emilia, the value placed upon the arts by educational philosophers such as John Dewey, and the work in both art and science by practitioners from Leonardo da Vinci to Ernst Haeckel. Yet despite this large body of evidence, art continues to be marginalized in discussions of education. Despite its epistemological potency—for identifying, penetrating, synthesizing, and representing both natural and cultural phenomena—art has been conceptually relegated within educational discourse largely to a domain of technique and production. Thus, it is rarely part of discussions of teaching and learning, except when those discussions involve artistic disciplines. The debate about the inclusion of arts within the curriculum is a vitally important one, but in designing the Art as a Way of Knowing conference we were concerned with a different question. We sought to understand and to articulate how art as a cultural tool to advance human insight and understanding operates to support learning, particularly in the curricular domain of science.

The premise of Art as a Way of Knowing was that art is a fundamental part of being human, and that learning in and through the arts is a serious form of interacting with the world by engaging with its questions, formulating ideas, and deepening knowledge. By *learning* we refer, broadly, to the complex processes of being, doing, knowing, and becoming. We understand that learning is a journey across a range of settings and timeframes and involves

a diverse combination of symbolic, visual, auditory, and embodied experiences. We see learning as deeply personal as well as a profoundly social and cultural process.

When we link the making and appreciation of art to philosophies of learning based upon developmental growth through curiosity and inquiry, we realize that art is of equal importance in the development of a child, to the vitality of a culture, and to the evolving work of a professional artist whose investigations are pursued over a lifetime. This emphasis on art and inquiry also aligns the practice of art in dynamic relationship to scientific inquiry and other disciplinary approaches of perceiving, apprehending, imagining, and remaking the world around us.

A rich plenary session, *Art and Becoming* (see summaries of this session on pages 12–14 of this report), explored art as a method of inquiry and as a way of knowing. The presentations addressed the varied ways in which art is central to learning. In common was a focus on art as an essential tool. This particular tool, it was noted, had been all but removed from the learner’s toolkit in the context of K–12 education, thus compromising children’s learning potential. The key ideas that the presenters described and demonstrated are the following:

- Art is effective at engaging and distilling complex and dynamic problems.
- Art challenges habits and certitude.
- Art frames familiar problems in new ways.
- Art enchants and invites participation.
- Art engages all of the senses and sense-making capacities of the learner.
- Art provides opportunities for synthesis and personal meaning-making.
- Artists and scientists pursue the big questions of their times.

Cultural History

To ground the discussions at the *Art and a Way of Knowing* conference, we wanted to examine how both historical context and recent cultural developments have shaped interdisciplinary approaches to learning in public education venues. Our thesis was that the confluence of interest for art and science collaboration that began in the 1960s has direct bearing on the potential for art and artists supporting science education efforts today. Therefore, there were plenary presentations about the history of science museums, the relationship between art and science in the 1960s, and the intertwined art and educational histories at the advent of the post–World War II science museum. Our intent was to show the rich cultural history out of which the postwar science museum emerged in order to better appreciate where we stand today. To this end, we explored institutional learning cultures that emerged from this legacy.

For decades, and perhaps especially in the post-*Sputnik* era, a broad range of thinkers, designers, educators, and inquirers have been developing a provocative body of work that uses artistic practices to expand engagement and understanding about natural and cultural phenomena. In the 1960s, the art world embraced developments in science and

technology, leading to boundary-crossing exhibitions and the productive blurring of categories. This work—in such seminal projects as Experiments in Art and Technology (E.A.T.), Cybernetic Serendipity, and the Los Angeles County Museum of Art’s Art and Technology program in 1971—not only appropriated the tools of science for use in artistic production, it also addressed the meaning of science and technology in society. Artists and scientists developed new methods of collaborative inquiry, which led to the establishment of artist-in-residency programs in unexpected settings such as industrial research labs, museums, and university-based science and engineering departments.

Key ideas that emerged from the conference’s plenary sessions, Cultural Context: A Nonlinear History, and Learning Cultures, include the following:

- Artists after *Sputnik* increasingly engaged directly with processes of nature and systems of the natural world.
- Artists in this post-*Sputnik* era experimented with the inherent qualities of materials, participating in the new and expanding field of materials science.
- Artists in the late 1950s and early 1960s moved their work outside of the art world’s gallery system to everyday locations, public spaces, and public lands to foster new perceptions of the world.
- The Exploratorium, which opened in 1969, incorporated artistic investigations of the natural world to create unique and transformative experiences.
- The questions, tools, materials, and inquiries of artists from the 1960s have influenced the practices of artists and cultural institutions today.
- Institutions established in our current time, such as the Science Gallery in Dublin, reflect cultural and artistic values that have further evolved to engage visitors as participants, content creators, and members of a knowledge-producing community.

(See pages 15–19 [Cultural Context] and pages 19–21 [Learning Cultures] of this report to read further details about these presentations.)

Program Design

The conference surveyed the contemporary landscape of artists working in scientific and interdisciplinary contexts to better understand current trends—particularly for formal and informal learning environments. The Program Design conversations were organized to explore emerging practices through presentations about some two dozen projects in a diverse range of community settings across the country and internationally.

These conversations reflected a historical shift. While some continue to look to a 1960s paradigm that aims to bridge the cultures of art and science, another generation, which has come of age with information technologies and “interdisciplinarity” built into academic programs, has developed practices and methodologies based upon a different set of cultural assumptions. In recent decades, smaller-scale projects and storefront experiments, led by artists or interdisciplinary teams, take into consideration and respond

to where and how knowledge is produced and contribute to more distributed networks of knowledge. In addition, ever-expanding boundaries of art as a field of activity encompass experiments where aesthetics reshape learning situations and power dynamics and look to more integrated approaches to address complex systems.

Several broad themes emerged from these sessions:

- Opportunities for artists to move out of the studio and into the lab continue to proliferate, providing rich contexts for artistic research and investigation.
- The arts are positioned as central to the development of maker and hacker cultures, blending low- and high-tech means of production.
- Artists are engaging the public in explorations focused on the dynamic relationship among local physical, cultural, and natural landscapes.
- The arts are being integrated as both a process and as a means of authentic assessment for students and teachers.

The broad range of programs that were presented at the conference reflect the ways in which the arts permeate intellectual and cultural life and serve to generate new art/science forums for questioning, redefining, and offering new visions of the relationship between science and society. In today's heterogeneous art and education communities, rethinking the role of art as process—as a form of inquiry—has great potential for artists, scientists, and institutions as they navigate these complex fields and advance the essential role of art in interdisciplinary learning across generations and in a wide range of contexts. (More details from conference discussions and presentations about program design can be found on pages 21–32 of this report.)

Conclusions and Future Work

Many ideas emerged at the conference to further art/science integration. From these ideas, we have identified four key future strands of work.

PRACTICE

There is a need to engage the public in science as a cultural tool that can address the compelling questions of our time. Art, as a way of knowing and a means of inquiry, may be critical to supporting this engagement. How can educational institutions, both formal and informal, restore the arts to a culturally evolved position as a tool of interpretation and understanding?

DOCUMENTATION

There is a need for greater documentation of learning and meaning-making in interdisciplinary contexts. Further documentation that describes the working processes of artists will help to build additional descriptive language and understanding of art as a form of inquiry in its many variations. As part of this project, further longitudinal case studies are needed.

RESEARCH

There is a need to better capture and understand the ways in which learning through the arts enriches understanding and meaning-making. This work can be carried out in both formal and informal contexts, through ethnographic and other kinds of studies that create rich cases of people, including children, coming to know, care, pursue, and demonstrate developing interest, awareness, and commitment to ideas related to science and the natural world. Historical research is needed to trace the evolution of art/science collaborations from the 1960s to our current time.

POLICY

There is a need, at a policy level, to foster more interdisciplinary collaborations and syntheses of knowledge, including the creation of networks that link educators, artists, scientists, and others committed to furthering the role of art as inquiry in interdisciplinary learning environments. Collaborations between the NEA and the NSF and other similar agencies would help to bridge the worlds of art and science professionals.

SUMMARIES OF THE SESSIONS

The conference plenary sessions focused on art and cognition and cultural history, while the breakout sessions looked at contemporary approaches to program design. The summaries that follow contain highlights of the sessions. Videos of the complete plenary talks, a selection of papers based on the talks, transcripts of the breakout sessions, and further documentation of the arts performances that surrounded the conference can be found on the Art as a Way of Knowing website (<http://www.exploratorium.edu/knowning>). Biographies of the conference presenters are also provided.

PLENARY SESSIONS

Opening Presentations

In the opening plenary session, writer Lawrence Weschler, Director of the New York Institute for the Humanities at New York University, reasserted the deep connections between art and science, drawing upon their intertwined histories to describe the overlapping spheres of art and science as inquiry. A former staff writer for the *New Yorker*, Weschler is the author of more than a dozen books, including two rare longitudinal studies¹ of artists' working lives. Both books trace the evolution of an artist's ideas, exploring what it means to seriously pursue questions through the arts over the course of a lifetime—to speculate, hypothesize, research, test, and experiment as an artist.

LAWRENCE WESCHLER ON ART AND SCIENCE AS PARALLEL AND DIVERGENT WAYS OF KNOWING

The world occludes the distinction between artists and scientists as both become absorbed in its vast questions.

Weschler's remarks focused on "absorption" and "concentration." He described how artists and scientists, when most deeply engaged in their work, "lavish attention" on their subjects, losing a sense of their own subjectivity. Weschler observed that insight and understanding are linked to "receptivity." We exclaim "I see!" when we as perceivers suddenly

¹ Weschler, Lawrence. *True to Life: Twenty-Five Years of Conversations with David Hockney*. Berkeley: University of California Press, 2009; and *Seeing Is Forgetting the Name of the Thing One Sees: Expanded Edition, Over Thirty Years of Conversation with Robert Irwin*. Berkeley: University of California Press, 2009.

gain clarity. We have perceived form where before we saw none and simultaneously are reformed by what we have seen.

Weschler observed that Michelangelo and Leonardo would never have drawn a distinction between their artistic and their scientific practices. He reminded us that the division between the arts and the sciences began in the mid-seventeenth century, around the time of Descartes' *Discourse on Method* and *Meditations on First Philosophy*.

He quoted artist Robert Irwin, who sees many differences between the practices of art and science and yet finds a common thread of inquiry, with the practitioners seeking answers to the questions of their times:

Although we may use different methods to come at them, even different thought forms in terms of how we deal with them—and we will eventually use a different methodology in terms of how we innovate them—still, really those questions are happening at the same moment in time. So that when we find these so-called accidental interrelationships between art and science, I don't think they're accidental at all.

Art and Becoming

The rich plenary presentations made by four thinkers from the fields of philosophy, cognitive psychology, science, and art addressed the varied ways in which art is fundamental to learning. In common was a focus on art as an essential tool for inquiry. It was noted that art has been all but removed from K-12 education, thus compromising children's learning potential. Summarized below are the plenary session's key ideas.

SIMON PENNY ON ARTFUL COGNITION

Art is a culturally evolved strategy for human cognition related to complex problems.

Contemporary work in cognition, psychology, and biology reveals the ways in which knowledge is embodied, distributed, and materially based. Knowledge is not limited to abstract thought or representations residing within a person's brain. Yet, despite a growing body of evidence refuting Cartesian mind-body dualities, mainstream discussions about teaching and learning continue to privilege symbolic and textual modalities over embodied or performance-based ones. Such impoverished views of learning are incomplete, contended Simon Penny, media artist and theorist from the University of California, Irvine. He noted that some of our most important insights and understandings are not transmissible through text or symbol. Penny asserted that art is humankind's evolved cultural tool for grappling with ideas and understandings. As such, he argued, art and artistic ways of knowing are essential tools for learning about the world, and therefore indispensable in any form of education.

ALVA NOË ON HOW ART ENGAGES THE INTELLECT

Art frames problems and demands engagement.

Building on the concept of art as a cultural tool for knowing and understanding, philosopher Alva Noë of the University of California, Berkeley, suggested that art functions in social and cultural life to help to frame problems and to provoke thought. But art does more than invite a form of noticing, he argued, art demands it. Noë projected several different perceptual illusions to remind us that perception is something that we “achieve” through filtering and noticing and making meaning of the images that are projected on our retinas. Our expectations and assumptions about what matters deeply frame what we notice in a given setting. Much research on perception and cross-cultural anthropology and psychology has shown that the process of noticing is context-dependent and culturally based. Like the discipline of philosophy, Noë argued, art is a sociocultural device that helps people attend to and consider concepts or ideas that might otherwise be invisible to them. Works of art say to us, “See me if you can. Bring me into your life.” In this sense, art engages our intellect in ways that other strategies used in teaching and learning may not. Art is consequently more than an invitation to participate—it is revelation as to why one should participate.

MARGARET WERTHEIM ON FIGURING IN THE LANDSCAPE OF IDEAS

Art allows new ways in and through scientific material and thought.

Art is a resource for learning science and mathematics, claimed science writer and co-founder of the Institute For Figuring Margaret Wertheim. Art enchants us, she said, and draws us in. She recalled how as a science journalist she was continually delighted by the ideas and imagery of science. Her work today involves experiments with the creation of embodied representations of mathematical ideas that are normally only encountered in symbolic form. Circulating an eight-inch woolen crocheted object among conference participants, she described it as a mathematically perfect representation of a hyperbolic plane. Hyperbolic geometry launched the field of non-Euclidian geometry

that underlies the theory of general relativity. Before the crocheted object had been created (by a mathematician), it had been thought impossible to represent hyperbolic geometry in three-dimensional form. The object, she argued, provides new avenues into thinking about mathematics through its enchanting textural and chromatic qualities, and its attention grabbing in the unexpected confluence of a familiar cultural form and an esoteric symbolic one.



Institute For Figuring's crocheted hyperbolic form.

EDITH ACKERMANN ON MINDFUL LEARNING

Art challenges habits and certitude.

The unexpected takes us off guard and challenges us to rethink our situation. This, said Edith Ackermann, Visiting Scholar at MIT, is critical to learning. Children are good learners because they are largely unshackled by experience and expertise. Ackermann presented three archetypal personae that are each essential to learning: the craftsman, the trickster, and the poet. Expertise (represented in the meticulous care and method of the craftsman) works well in unchanged conditions. But when conditions change, learning depends on the ingenuity of the trickster and the imagination of the poet.

Ackermann, citing German philosopher Ernst Cassirer and others, noted that the power of Wertheim's crocheted hyperbolic planes was their power to enchant (as the poet enchants and makes us notice, consider, and dream) and to subvert (as the trickster subverts, by uniting crochet and advanced mathematics).

The canny defiance of categories, the deliberate crossing of boundaries is the terrain of the trickster. The trickster confuses distinctions in order to question assumptions. The poet, she remarked, is equally implicated in forcing us to view things afresh, through imbuing objects with symbolic meanings that enchant and provoke. Through the work of the poet and the trickster, learning becomes mindful (attentive, deliberate) rather than mindless (dogmatic, habituated). Art as a way of knowing therefore expands our insights in complex and changing conditions.

GEORGE HEIN, DISCUSSANT

Art provides opportunities for synthesis and meaning-making.

In his invited response to the four presentations, George Hein of Lesley University remarked on the continuity of ideas between the presentations and the writing of John Dewey. Dewey, he noted, rejected dualisms of all sorts, and argued that art was perhaps the most important way of engaging with the world.

Breakthroughs in science occur, said Hein, when the trickster and poet come into the lab. He also noted the ways in which art allows for synthetic and not just analytical ways of thinking. Chemists have for centuries used analytical ways of breaking down compounds to determine their constituent parts and the relationships among them, but it was only through nonlinear processes of synthesis—"by throwing things into a pot"—that they began to make breakthroughs in the creation of organic molecules. Synthesis is an often-overlooked aspect of learning and of science education, he remarked. Consequently, the role that art plays in allowing learners to make meaning and find relevance is critical.

Cultural Context: A Nonlinear History

From the Blaschka glass flowers at Harvard to the anatomical wax models of La Specola at the Natural History Museum of Florence, art/science fusions have animated public learning environments for centuries. Yet, the zeitgeist of the 1960s produced new forms of art/science collaboration that fundamentally shaped the post–World War II science museum and other cultural projects of the day. As art moved beyond the decorative and illustrative, it came to be understood as a legitimate form of inquiry in and of itself, and artists began to be honored equally with scientists as explorers and guides to the natural world.

The confluence of art, education, and science that began in the 1960s opened new potential for art and artists to work in the realm of science and influenced many of the paradigms that still affect work in this arena today. This plenary session explored some of the largely undocumented histories of art, education, and science of the late sixties from a wide range of perspectives.

ROBERT SEMPER ON THE HYBRIDIZATION OF “LAB AND MUSEUM”

Art and artists open new doors to science education.

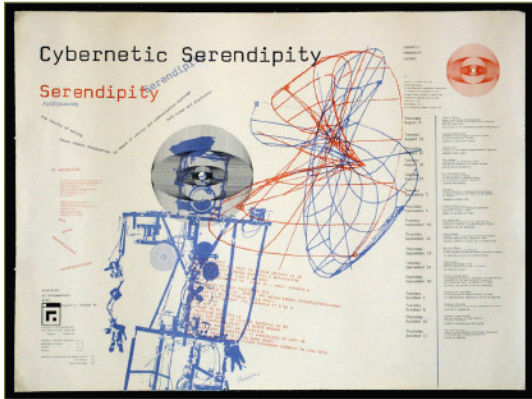
Rob Semper, the Exploratorium’s Executive Associate Director and Director of Program, discussed the beginnings of the Exploratorium, which early in its history incorporated art into its programming in meaningful ways. Started in 1969 by Dr. Frank Oppenheimer, the Exploratorium was designed to be an environment where visitors could learn about the natural and built worlds through their own investigations. In its fusion of “lab and museum,” the Exploratorium modeled a new public space that fostered scientific inquiry through personal exploration.



The Exploratorium in the 1970s.

The Exploratorium’s foundational exhibits were derived from the elementary and high school science curricula developed in the post-war science education movement. But the early success of a traveling exhibition of electronic, cybernetic, and computer art, *Cybernetic Serendipity*,² demonstrated the value of art in shaping the Exploratorium’s science learning experiences. Not

² Originally displayed at the Institute of Contemporary Arts in London in 1968.



Poster from the exhibition Cybernetic Serendipity.

only were the artist-produced exhibits engaging and aesthetic, they provided access to explorations of nature in new and compelling ways.

The accomplishments of Cybernetic Serendipity led to the establishment of an artist-in-residence program and the strong, continuing commitment to arts in exhibits, media, programs, and teacher education at the Exploratorium. As Semper contended, the

example of the Exploratorium clearly demonstrates that the inquiry-driven investigations of the world by artists can help support science education learning goals for students, teachers, and the public.

CASEY REAS ON ART, SCIENCE, AND TECHNOLOGY EXPERIMENTS

Art embraced the developing science and technology of the late 1960s, leading to boundary-crossing exhibitions and a blurring of categories.



John Cage performance "Variations V" with Merce Cunningham, Billy Kluver, and David Tudor in 1965 as part of Experiments in Art and Technology.

In a highly visual presentation, artist Casey Reas reviewed the period between 1965 and 1971, which saw an explosion of art and technology experimentation. Starting with the Retrospective Eye show at MoMA in New York and the 9 Evenings: Theatre & Engineering at the New York 69th Regiment Armory, a series of exhibitions and events involving artists working with scientists and scientists making art occurred at different locations around the world. In some cases these projects such

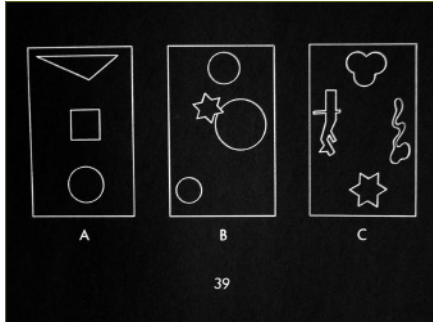
as Experiments in Art and Technology (E.A.T.) involved artists and scientists working collaboratively. This art/technology movement culminated with the Los Angeles County Museum of Art's Art and Technology program in 1971.

But as Reas pointed out, in other cases, such as Cybernetic Serendipity investigative work by artists was displayed side by side with that of scientists, with no distinction made. In a few cases, such as at the Exploratorium and at the Center for Advanced Visual Studies (founded by Gyorgy Kepes as a laboratory for interdisciplinary art practice at MIT), artists were able to investigate the world in a manner akin to scientists in a laboratory setting, leading to work that advanced human understanding.

JEANNETTE REDENSEK ON ART AND PEDAGOGY

Though we may perceive art as an autonomous sphere of endeavor, it is bound to moral and ethical claims.

In a humorous and provocative presentation, *Art Is Good for Nothing*, art historian Jeannette Redensek revealed an ongoing tension surrounding claims for the “use value” of art. Redensek pointed to three very different art histories in the context of art as a way of knowing: philosopher Immanuel Kant’s *Critique of Judgment* in 1790; Friedrich Froebel’s kindergarten “gifts” (pedagogical toys), circa 1840; and a series of aesthetic judgment tests developed in the early twentieth century by Edward Thorndike. Redensek rhetorically asked, “Why shouldn’t art be subject to the same rules of assessment and value that govern any other field of human knowledge?” During the last two centuries artists have at times retorted, “Art is only good if it is good for nothing.” Redensek reminded us that ethical and moral claims for the



From Maitland Graves, *Design Judgment Test*. New York: The Psychological Corporation, 1948.

value of art continue “to haunt the worlds of art today, in institutions that give art its cultural presence . . . in criticism and theory, in everything from magazine reviews to the rationales for museum acquisitions and exhibitions, classroom curricula and educational policy.”

DOMINIC WILLSDON ON CONCEPTUAL ART AND ART EDUCATION OF THE 1960S

In the conceptual art of the 1960s, we find the roots of contemporary art concerned with knowledge production.

SFMOMA Curator of Education and Public Programs Dominic Willson addressed “art as a way of knowing” through two lesser-known, intertwined histories from the early 1970s. The first dealt with the context of conceptual art in the 1970s as a nascent root for a strain of art that since that time has been concerned with the “production of knowledge” and the “institutional apparatus surrounding knowledge.” *Index 01*, by the conceptual art group Art & Language, was presented at the art show Documenta 5 in 1972 and consisted of a set of metal filing cabinets in a room.³ Willson explained how *Index 01*,⁴ for him, was exemplary of an early instance of art as a system dealing with knowledge conditions—the “social conditions of knowing” that since then have become an important concern of contemporary art.

³ The filing cabinets contained textual materials from the collection of the Art & Language group. On the wall of the room was an index, a system for connecting the materials in the cabinets to one another. Symbols indicated whether the materials were “compatible,” “incompatible,” and did or did not belong to the same “ethical” or “logical” space.

⁴ In introducing this project, Willson pointed to the anti-aesthetic tendency in this kind of work and suggested that within contemporary art, conceptual art “most programmatically deals with knowing.”

The second history that Willsdon shared dealt with ideas surrounding the formation of artists and the pedagogy of art school. Here Willsdon described an article by Charles Harrison, a member of the Art & Language group that was published in the magazine *Studio International* in the same year. Willsdon explained how the article appeared at the moment when independent art schools were becoming incorporated into polytechnic universities as art departments in the UK. Willsdon described that, for many, this threatened the autonomy of art schools as a free space of creativity, self-expression, and visual learning.

Harrison, however, saw grounds for optimism, thinking that the contextualization of art into the polytechnic might help to bring an end to the “isolation of art,” and put art practice into relationships with “more securely founded disciplines of knowledge.” Harrison saw the potential for art practice to begin to know itself through the development of a body of theory based upon protocols borrowed from other disciplines that would help it to gain some sense of order and priority. Harrison called for a research-based art that would serve as a means to “explicate rather than decorate the world.” Willsdon described how he, too, looked to this as an ongoing potentiality, pointing to a kind of “hermeneutic art” that could meet “knowledge-based disciplines halfway.”

JEFF KELLEY ON DOING AS KNOWING

Experimental art of the 1960s explored art as a means of illuminating the everyday.

Art historian Jeff Kelley discussed the influence of educational philosopher John Dewey upon artist Allan Kaprow. Kelley explained how Kaprow coined the term “happenings” to describe his vanguard performances in which various art media became disguised as normal occurrences blurred and “collaged into quasi-theatrical events.” Kelley explained Kaprow’s interest in the “aesthetic illumination of the commonplace,” and how art could find significance in our “habits, assumptions, exchanges, and daily routines.”

Kaprow was inspired by John Dewey’s 1934 work *Art as Experience*, which called upon artists (who he felt had become disconnected from common experience) to restore continuity with the flow of daily living. In his writings, Kaprow echoed Dewey’s ethos. If in the past the task was “to make good art,” Kaprow asserted, now artists must “not make art of any kind at all, so that they might discover all around them forgotten sources of art,” such as “the vapor trail of a jet,” or the “lint gathering on the floor.” In place of the “heroics” of an “overdetermining style,” Kaprow suggested that artists commit to an experimental method of “unforeseen outcomes.”

Kelley aligned Kaprow’s search for the integration of art into everyday living as part of a line of American pragmatic thought where “action ripened philosophy into forms of living.” Kelley cited Ralph Waldo Emerson who, in his 1837 speech “The American Scholar” described “thought as a partial act” and “living as a total act.” A century later Dewey would

proclaim, “Doing is a form of knowing.” And in an 1897 article, “My Pedagogic Creed,” Dewey maintained that “education . . . is a process of living and not a preparation for future living. I believe that the school must represent life—as real and vital to the child as that which he carries on in the home, in the neighborhood, or in the playground.”

ADI SHAMIR ON MODERNIST CONUNDRUMS

Remaking the world in contemporary times is burdened by history.

Architect, design historian, and educator Adi Shamir brought together the threads of the various presentations in the plenary session dedicated to history by referencing Gertrude Stein’s statement that “a museum can either be modern or a museum, but it cannot be both.” Stein’s words resonate when we think of the conundrum facing museums of modern art today as they evolve and attempt to embrace the contemporary moment. The challenge they face is how the modern remains modern after modernism. Evoking the work of Alexander Dorner, Maholy Nagy, and the cubist artists, Shamir showed how 1960s attempts to remake the museum, to invent a new form of “man/machine” art, to link art with everyday life, and to integrate art education in universities, were all projects first taken up by the avant-garde of the 1920s. In linking these histories, Shamir pointed to the conundrum that art education, post-war science museums, and other cultural projects face today as one of reinvention—the challenge of existing within history and at the same time remaking the world.

Learning Cultures

The plenary session summarized below preceded breakout conversations on program design that explored how artistic approaches have shaped the methodologies and public appeal of museums and other learning environments. In order to understand what kinds of possibilities exist for cross-pollination for both preexisting institutions and new initiatives, the session was a reminder of how individual institutions are formed by historical conditions and local cultures. Michael John Gorman of the Science Gallery in Dublin and Peter Richards of the Exploratorium discussed the social values that shaped their institutions. Though the Exploratorium and the Science Gallery were founded at different moments, both responded to historical, political, and cultural contexts to generate rich seedbeds for the arts.

PETER RICHARDS ON THE CULTURAL ATMOSPHERE SURROUNDING THE ADVENT OF THE EXPLORATORIUM

The extraordinary social change of the 1960s shaped an experimental learning culture in the United States.

The 1950s and ’60s were a time of great enthusiasm for science and technology—along with tremendous fear surrounding the cold war. Exploratorium Senior Artist Emeritus Peter Richards reflected on the impact of the times through that heady period between the

October 1957 launch of *Sputnik* through the moon landing in August 1969. The *Sputnik* launch stimulated an enormous investment in science and technology in the United States, leading to major changes in science education and public policy. At the same time, the rise of electronic media and popular music fostered a culture of individualism that challenged established forms of government and norms of behavior.



The earth as seen from the moon, 1969.

This stew of ideas led to the development of artists interested in the processes of nature, the inherent qualities of materials, and the systems of the natural world. Artists moved beyond the gallery to create land art, reshaping the landscape to foster new perceptions of the world. Others blurred the boundaries between science and art, creating unprecedented experiences that were truly transdisciplinary. These times were about the

ability to create new knowledge in transformative ways, to experiment, and to develop creative and more accessible ways to share widely the process of learning. The Exploratorium was born out of this ethos.

MICHAEL JOHN GORMAN ON THE CULTURAL FORMATION OF THE SCIENCE GALLERY

The new century brings new institutions focused on art/science explorations that suggest new possibilities for public learning.

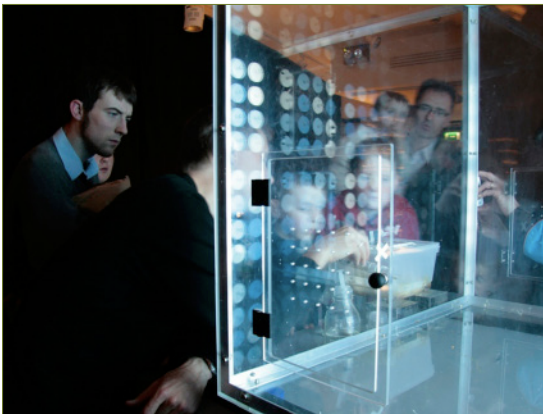


Exhibit at the Science Gallery.

At the turn of this new century, art is concerning itself with ethically charged subject matter. Director of the Science Gallery in Dublin Michael John Gorman claimed that artists are a kind of “advance warning system” for the effects of technology on our lives. As such, they provide avenues for learning about systems and interactions at a profound level. New forms of art/science have shaped institutions such as the Science

The Science Gallery exterior.



Gallery, which Gorman described as a “creative platform” and “a magnet or flypaper for the modern-day Leonardos.” An initiative of Trinity College Dublin, the Science Gallery uses open calls, “fuzzy boundaries,” and interdisciplinary themes to develop programming for an audience fifteen years old and up. In Gorman’s eyes, learning institutions such as the Science Gallery exemplify the changing cultural and institutional

shift from stable to agile, interactive to participatory, content provider to creative platform, visitor experience to meeting place, and stand-alone to networked.

PROGRAM DESIGN BREAKOUT SESSIONS

Making as Thinking

Making builds somatic knowledge. When we “think with our hands” we deepen our understanding.

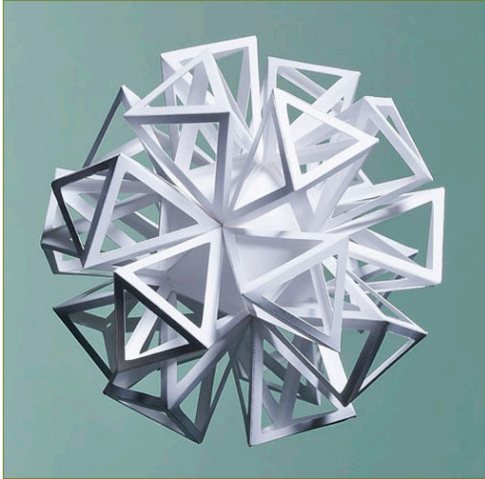
We remake the world.

Margaret Wertheim moderated this breakout session, which focused on how understanding, imagination, and leaps of insight occur in relation to working with tools and materials.

Cartoonist, engineer, and tinkerer Tim Hunkin described his work in creating a homemade arcade of coin-operated automata and video games at Southwold Pier in Suffolk, England. He spoke of how after many years of creating didactic museum exhibits he found that he preferred delighting people to “educating” them. Hunkin described how he surrounds himself with “junk” in a materials-rich environment where he thinks with his hands. Hunkin described how he enjoys when things go wrong since it introduces the “exciting element of the unknown.”

Reflecting upon theories of evolutionary biology, Hunkin referred to a paper by Francis Evans that connected the development of an enlarged brain to bipedalism. (Evans suggests that walking on two legs freed our arms and created the opportunity for hand-eye coordination). Hunkin spoke of how working with one’s hands today is not seen as glamorous, but for him Evans’s theory elevates his work and contributes to his zeal for helping children to use tools. He bemoaned the fact that schools have been eliminating workshops from their curricula. Hunkin contends that “technology and tool use is innate in all of us.”

Paper folded
form by
Matthew
Shlian.



Paper engineer Matthew Shlian, a visiting research scholar in the University of Michigan’s Materials Science and Engineering Department, also showed images of his “messy” working environments and made the distinction between art as “representational” versus “exploratory.” He spoke of the difference in understanding that occurs when one holds something in one’s hands versus beholding it as an image at a remove and understanding it intellectually. Quoting physicist Victor Weisskopf,⁵ Shlian spoke of how as an artist he intentionally puts himself into a

state of willful ignorance in order to explore possibilities and make new discoveries. While showing images of his astounding folded-paper works, he explained how paper folding has lately led to great advances in research science by modeling protein folding and DNA knots inside cells. Shlian showed images of scale models of emergency shelters and microscopic scale models of stents as examples of how origami has led to technical innovation.

Gever Tulley, cofounder of the Tinkering School, furthered the discussion of Making as Thinking by asserting that through tactile processes such as cutting, welding, and tying that we find “truth” in the real constraints of materials that in turn leads to discovery: “There is something in the materials that comes to us.” Tulley explained his interest in how children become competent with tools and processes of making, and how they develop problem-solving skills through materials-based learning. Like Hunkin, he referred to the decline in tool usage, citing the number of households that no longer have simple tool sets. In describing his work with children at the Tinkering School, Tulley shared how he orchestrates processes of open-ended inquiry and exploration. The aesthetic quality of his own notebook sketches informs the feasibility of the projects that he takes on with children. Aesthetics also permeate a pedagogy where experts share what they love and children explore and develop projects.

In the discussion that followed, Wertheim described how Hunkin, Shlian, and Tulley all share an interest in getting people engaged almost as an ethical commitment to sharing the pleasure and power of working with one’s hands. She spoke of processes of making as processes of becoming and of how in grappling with materials-based problems we encounter the unexpected and constantly need to redirect our path of inquiry. Wertheim spoke of the value and validity of things “going awry.”

⁵ MIT professor Victor Weisskopf wrote in an essay entitled “Teaching Science” that “in science we must always begin by asking questions, not giving answers. In this way we contribute to the joy of insight. For science is the opposite of knowledge. Science is curiosity.”

Further discussion included dialogue surrounding gender biases in relation to making. Also considered was whether the recent enthusiasm for making is a reaction to screen-based culture: Does the current information age privilege particular human capacities over others? If so, what is being left behind?

In the Field: Nondisciplinary Research in Landscape and Culture

Art is a vehicle for transforming our perceptions of place.

Moderated by Andrea Grover, research fellow at the Studio for Creative Inquiry at Carnegie Mellon University, this session explored the work of artists engaged in public education projects related to physical and cultural landscapes.

Rosten Woo shared the methodology behind the youth programs at the Center for Urban Pedagogy in New York. The program, which aims to engage public participation in land-use decisions, employs an investigatory approach initiated by a simple yet complex question such as, “Where does our water come from?” The program encourages direct observation through site visits, while interviews help students to create a “social portrait of the infrastructure that people inhabit.” Woo explained how making projects—maps and physical models—help the students and instructors to discover knowledge gaps. The program turns young people into “teaching artists,” and new “knowledge networks” are created as educators, artists, designers, and advocates collaborate to help create new ways of seeing.

Exploratorium Senior Artist Susan Schwartzberg presented the work of a new initiative at the Exploratorium, called Learning about the Landscape, that takes the Exploratorium out of the lab and into the field to develop new learning tools related to observation and perception of place. Schwartzberg described how the project has involved developing a new methodology based upon the observing sciences and reading the cultural and natural history of the landscape. Through this initiative, the Exploratorium has engaged a new set of practitioners and developed a new vocabulary for exploring the city as an organism. The intent is to return the visitor back out into the world with a new perceptual tool kit.



Center for Land Use Interpretation bus tour.

Matthew Coolidge presented the work of the organization he founded, the Center for Land Use Interpretation. Coolidge described how the Center conceives landscape as “a machine to support life, our economy, and culture.” He explained the Center’s view that humans are part of nature, a “geotransformative agent.” Coolidge described how the Center’s work (which takes the

form of publications, exhibitions, and bus tours) arises from a land-use database (both a physical archive and a searchable web-based archive) where sites from across the United States are categorized according to cultural, industrial, and military rubrics. Coolidge spoke of looking and perceiving as “acts of transformation” and the importance of interpretation to the Center’s work.

Geoff Manaugh, writer of the BLDGBLOG blog, presented his work as a “spatial anthropologist”—a writer and editor who expands definitions of architecture and landscape to encompass “conjecture,” “speculation,” and “futures.” Manaugh showed documentation of architectural ideas (such as bioluminescent billboards and artificial glaciers) that reveal important relationships between the real and the imagined. Manaugh spoke of bridging fields and industries through his research, which manifests in creative design studios and public exhibitions.

In the discussion that followed, participants spoke about methodology and how the projects presented spanned documentary objective truth with poetics. There was also conversation surrounding expectations in regard to educational outcome. Woo described how deepened community engagement was seen as a measure of success, while Schwartzberg emphasized the Exploratorium’s view of learning as qualitative “process” in contrast with quantitative “product.” There was also discussion of the political nature of the work and how some positioned themselves as overtly political while others aimed for a more open-ended approach where participants will draw their own conclusions.

Art as a Way of Knowing in School Settings

When art is integrated into curricula, students develop crucial learning capacities and find personal meaning in schoolwork.

This session highlighted the work of four projects that integrate the arts into science curricula in K-12 schools. These projects were the Lincoln Center Institute (presented by Madeleine Holzer) the Oxbow School (presented by Stephen Thomas), Project Zero (presented by Steve Seidel), and the Exploratorium Institute for Inquiry (presented by Lynn Rankin and Mildred Howard). Nick Michelli of the Graduate Center at the City University of New York responded.

The projects described in the four presentations focused on the ways in which the integration of the arts in the school curriculum, including the science curriculum, provide a context for students to tap into personal meaning-making and connect with larger social constructs. The presenters argued that this helps to support students’ development of interest, capacities, and commitment to the subject matter.

Steve Seidel presented ideas that underpin the work at Project Zero, the forty-five-year-old research organization at the Harvard Graduate School of Education. Among these ideas is the work of philosopher Nelson Goodman, especially his 1968 book *Languages of Art*. Goodman believed that the capacity to use symbols to communicate, represent, and make sense of the world is also the capacity to make art. This has inspired Project Zero to explore what it means to become literate in an art form. “What does it mean to develop the vocabulary, syntax, and various means of expression within a language?” Seidel asked. Project Zero has aimed to understand how artistic processes are learning processes, and to show how art is a legitimate and vital way of knowing.

Madeleine Holzer described how aesthetic education, the honing of students’ skills of perception through processes of reflection and inquiry in relation to works of art, is the focus of Lincoln Center Institute. Holzer emphasized the importance of articulating what students learn through the arts in order to counter the marginalization of the arts in American education. Holzer discussed how the Institute’s “Capacities for Imaginative Learning,” which details the important skills that students learn by studying works of art, has been important in helping to advocate for the integration of art education in more formal school settings and will serve as the organizing framework for twelve new charter schools in NYC. Holzer explained how aesthetic education goes beyond the arts to develop methods of inquiry and to cultivate imagination in other disciplines such as science, math, history, and language arts.

Stephen Thomas described the curricular design of the Oxbow School, a one-semester program for high school students where cross-disciplinary learning is experienced through the lens of art. Thomas explained how at Oxbow studio-based art-making and academic topics are interwoven, so that students cannot separate English, math, science, history, and art, but experience how “depth in any area will lead to valid connections in other disciplines.” Oxbow instills personal growth by emphasizing the “importance of having a question, and learning how to solve it.” Thomas explained how at Oxbow “artistic inquiry is a variation on the scientific method,” and that making art is a way of making sense of the world.

Lynn Rankin and Mildred Howard described their experience collaborating with artists-in-residence at the Exploratorium Institute for Inquiry, a program in which professional developers, educators, and scientists learn about the theory and practice of inquiry-based teaching and learning in science. Rankin quoted Exploratorium founder Frank Oppenheimer, who said that “art is included, not just to make things look pretty, but because artists make different kinds of discoveries about nature than do physicists or biologists. Both artists and scientists help us notice and appreciate things that we have learned to ignore or have never been taught to see.” Rankin explained how working with artists taught IFI “different ways of seeing the world and a different way of thinking about teaching and learning.” Howard gave examples of how artists, students, and teachers collaborated on the creation

of public installations that grew out of the Institute’s explorations of light, color, and optics. Howard observed that what was most profound for him was not knowing whether what they created was art or science or both.

In his response, Michelli noted that a concern that came up repeatedly in the session’s small group discussions was how to engage stakeholders and policymakers in the power of arts-integrated instruction. Art, he noted, provides a more inclusive way for students to engage with the curriculum than a sole focus on a symbolic/textual method can provide. For cities like New York, with dropout rates hovering near 50 percent, expanding means of participation is essential. Michelli quoted former American Federation of Teachers President Albert Shanker—“what matters is what we measure”—and concluded that measurement strategies were fundamental stumbling blocks for augmenting art as an important way of knowing in school contexts.

Knowing and Showing: Evidence and Method

Art makes powerful learning evident.

In science education, art is often positioned as an entry point to engagement. For example, artworks in informal science-learning environments are often designed to attract, puzzle, or surprise, with the aim of triggering the learner’s attention, curiosity, and desire to make sense of the phenomenon addressed by the artwork. As such, art serves as an invitation to engage with science. While invitation is essential, the conference wanted to explore how art can be more than that in designed learning environments.

This session reviewed video data of children’s learning from three projects to explore how we know and show learning in and through the arts. These projects were preschoolers at a Reggio Emilio school (presented by George Forman), the case of an eight-year-old boy’s imaginative work with cardboard (presented by Dennie Palmer Wolf), and youth learning in the Exploratorium’s Tinkering Studio environment (presented by Karen Wilkinson). Steve Seidel of Project Zero at Harvard University responded.

Forman’s images of children in Reggio Emilia schools captured the great care and precision that children used in constructing their work with glue and paper. He noted moments of hesitation, consideration, and choice, all providing evidence of intentionality and thought. In one video, a collapsing tower of blocks visibly forced a child to reconsider the tension between symmetry and balance. After some thought, he chose to adjust his design, creating a wider base, and turning blocks on their sides instead of their ends to increase the tower’s stability. The video clearly captured evidence of the child’s processes of intentionality, experimentation, assessment, and revision, as well as his developing fluencies with issues of size, scale, balance, and symmetry.

As Forman noted, the aesthetics involved in the construction of the tower gave a purpose to his process of working through the physics of the construction. Forman told the audience that a careful viewing of this video led the boy's teachers, who had been planning to require the boy to repeat a year, to advance him along with his schoolmates.

Karen Wilkinson of the Exploratorium Tinkering Studio described how her team collaborates with artists to develop a public environment that encourages people to think with their hands. The questions, materials, aesthetic, and unexpected juxtapositions that artists bring to *making* activities operate to surprise, delight, and continually engage learners in processes of making. Describing how constructivist and constructionist theories of education underlie the project, Wilkinson spoke of the importance of providing evidence of the work's educational value in order to counter the response, "It looks like fun, but what are they learning?" Wilkinson explained how video documentation is an essential means for the group to reflect upon their work and to capture complex individual learning experiences that can later be carefully studied and discussed. The team is focusing in particular on points of transition and redirection as indicators of growing intentionality, understanding, and innovation.

Dennie Palmer Wolf discussed the pressure on public institutions to prove their value in an "accountability driven age." She urged that we turn research and evaluation "inside out" and invent "new, powerful, and beautiful ways to exhibit understanding" (rather than thinking simply of evaluation as a means of extracting information). Referring to how research and evaluation is based upon "capability theory," Palmer Wolf cited Amartya Sen's work on equality and advocated that innovation be an educational goal for all children as part of a twenty-first-century agenda.

Using the example of the imaginary world that an eight-year-old boy had created with cardboard over multiple years, Palmer Wolf emphasized the depth of documentation required to capture creativity. She also suggested that research and documentation be appreciated as a gift that can be given back to participants to help them appreciate their own creativity. Palmer Wolf also suggested that science museums encourage young people to document their own learning.

Small-group discussions explored the multiple ways that learning was evident in the presentations, the ways in which art was involved in supporting such learning, and the struggles the programs had in making the powerful learning evident and convincing in a context where learning is commonly represented through abbreviated symbolic forms such as a letter grade or numerical score.

In his invited response, Steve Seidel reminded the group that the work of making learning visible was, as Noë had described earlier, to come to notice what is right in front of us. We

also need to think about what forms of visible learning are important for different audiences, including at different moments. For example, a superintendent may need to see some types of evidence of learning for her district but would be interested in other types for her grandson. Seidel commented on the importance of starting these conversations.

He highlighted the ways in which the video documentation used methods including speeding up, slowing down, multiple perspectives/angles, and how important it was to accompany them with other artifacts and materials (interviews, narratives, objects). He noted that the video data showed clearly that children were capable of complex and wonderful work, but that subjective perspectives actually framed what was there.

The group agreed that there was a need for an ongoing working discussion about how to best capture (both technically and conceptually) the ways in which art advances learning within designed activities, and in ways that could relate to school-based discussions (and investments) in learning experiences for children and youth.

In the Lab: Cross-Pollinations

The lab as a site for exchange and cross-pollination between art and science continues to thrive as a programmatic paradigm.

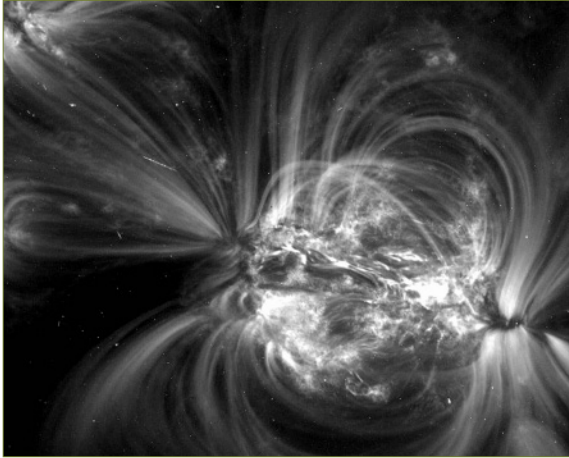
Astrophysicist and editor Leonardo Roger Malina moderated this session, which explored the contemporary landscape of art/science collaborations in research contexts.

Amanda McDonald Crowley, director of the art and technology center Eyebeam, presented a taxonomy of the different kinds of spaces and contexts within which art and science collaborations have been seeded. These include government research labs, academic interdisciplinary research programs, corporate research labs, art and technology centers, artist studios that function as research labs, and emerging hacker spaces and bio labs. Crowley's presentation suggested that spaces that bridge and foster collaboration between artists and scientists remain an important paradigm with a wide range of potential outcomes.

The UK artist duo Semiconductor (Ruth Jarman and Joe Gerhardt) presented their first experience "going in cold" as artists-in-residence at a research laboratory.⁶ They discussed the cultural divide that they initially discovered, but how through interviews they were able to enter into the questions and research that animated the scientists in the lab. They spoke about the challenges of the public reception of their resulting work, *Magnetic Movie*, as scientific "truth," when their interest lay instead in the experiential and fictive space of scientific imagination.

⁶ Semiconductor was in residence at the UC Berkeley Space Science Laboratory in 2005 where they created their computer-generated work *Magnetic Movie*.

Still from
Semiconductor's
film installation
Brilliant Noise.



Rob La Frenais of the Arts Catalyst in the UK presented a mix of “laboratory” projects that he has helped to seed related to space travel, interspecies relations, and biology. These ranged from artists building rockets to experimenting with DNA tattooing.

In his presentation, San Francisco-based artist Philip Ross described how his experience of knowledge exchange in different domains⁷ had prepared

him to build a home clean room for artistic experimentation with fungus. Ross presented his sculpture, which exists at the intersection of art and biology. He also described the public programs he’s developed in the playful public forum, Critter Salon, an experiment in public pedagogy where biology is made accessible through engaging events such as kimchi contests, insect tastings, and microscope fairs.

Ariane Koek, who leads International Arts Development at CERN, began by sharing her perspective that art and science “together form culture.” In developing the Collide Arts Residency at CERN, her intent has been to give “equal weight, equal value, equal exchange, and an equal platform” to art and science. By establishing a Cultural Board that helps to direct CERN’s art effort, Koek has hoped to put an emphasis on excellence in the selection of artists. The residency is designed to be experimental and research-based with no expectation of a final product. Koek’s hope is that the arts can serve as a springboard to inspire and deepen the public’s imagination regarding particle physics.

Stephen Nowlin, director of the Williamson Gallery at the Art Center College of Design in Pasadena, described his work in seeding research-based collaborations between artists and scientists. Nowlin articulated his aim as the “nondidactic integration of science into the practice of contemporary art.” As a curator, Nowlin’s skill is in matchmaking and helping to manage the relationships in these “highly entangled” collaborations. Nowlin showed works from the exhibition *Neuro*, which suggested the ways in which artists and scientists had expanded their vocabularies and jointly produced new works that deepen public insight.

Michael Naimark, visiting researcher at MIT’s Media Lab, presented a panoramic view and contemporary read of recent paradigms that surround art/science collaboration in both academic and start-up contexts. He spoke of how the terms *art* and *research* signaled very

⁷ Ross referred to underground health networks and culinary training. Later, Ross said he learned that scientific protocols resembled recipes.

different ideas. Citing international examples, Naimark also discussed how cultural contexts and economics inform artists' decisions and the terms in which they work in research contexts.

While moderating the discussions between presentations, Roger Malina asserted that both art and science are part of the humanities and proclaimed that collaboration between the two cultures is crucial to addressing the urgent issues of the day. Malina described how hybrid spaces that began in the 1960s, and again flourished in the '90s as a result of the Internet, are now in a new phase. Today they take the form of the "small and scrappy." Malina, La Frenais, and Naimark pointed to projects in China, India, and Brazil, where a new generation is developing spaces that bridge discourses and practices.

Malina observed that collaborative spaces today are mostly artist-driven and wondered why there are no programs for "scientists in residence" in artist studios. Malina praised a recent series of NEA/NSF collaborations that explored the potential for productive collaboration between art and science and wondered how something more systemic might develop from these conversations. Director of the Carnegie Museum of Natural History Sam Taylor asked how science and art museums might work together to develop collaborative projects given their disciplinary entrenchment. There was also discussion about how curators respond to the ethical questions that arise in relation to bio art.

Learning without Knowing

Artist experiments in public learning show how aesthetics can reshape the discursive spaces that surround and form the participants' experience.



Forest installation at Machine Project.

Mark Allen, founder of the storefront Machine Project, led a discussion based on the work of three artist-driven experiments in participatory public learning. He began by describing his work at Machine Project, a collaborative, community-based storefront with a whimsical approach to informal learning. He described how storefront spaces have a porosity where "the barrier . . . between public and private is very thin." Allen explained how Machine Project's programs employ technology, which he broadly defines as "anything that constructs the built environment."

Allen shared several examples of playful and provocative programs (such as a children's workshop on hot-wiring cars) to explain how Machine uses outlandish hooks to teach science and technology. He explained his interest in creating situations that allow different communities to interact (where crochet hobbyists engage with mathematicians, for example.) He also spoke of "museums as engines for attention" and how through collaborations with well established institutions (such as the Armand Hammer and the Los Angeles County Museum of Art) Machine has experimented with the potential of museums to function as civic spaces for exploratory learning.

Sean Dockray, director of the Telic Arts Exchange in Los Angeles, a nonprofit dedicated to providing critical engagement with new media and culture, shared his project Public School:⁸ a school with no curriculum where people propose classes that they want to take or teach. In his presentation, he gave examples of different ways in which "not knowing" generated intriguing possibilities and drove interest and enthusiasm among participants. Dockray shared a series of situations such as a course where a teacher did not have mastery of the subject that he was teaching. Dockray also gave the example of a course on "speculative realism" where there was no teacher and the participants groped their way through readings to develop an understanding of the subject matter on their own. Dockray explained how the undefined aspects of a class and more open-ended learning situations attracted and catalyzed interest and participation.

Adam Lerner, director and chief animator of the Museum of Contemporary Art Denver, described Mixed Taste, a public platform where two experts present lectures on radically different subjects that bridge "high brow" and "low brow" culture and juxtapose diverse spheres of knowledge. The topics (such as Prairie Dogs and Gertrude Stein or Earth Arts and Goat Cheese) are paired arbitrarily, which destabilizes the usual structures of authority and forces the audience to make new connections.

In the discussion that followed, Allen spoke of his interest in "knowing" as "experiential" and talked about the potential of aesthetics to frame whole learning processes—the "discursive spaces" that surround and form the participants' experience. Allen expressed his interest in disassociating art from approaches that aim to convey a particular knowledge set. He discussed how as audience members of public programs we learn how to empathize with "someone else's subjectivity," to inhabit different perspectives, and share in other people's passions and enthusiasms.

Much of the conversation revolved around power relationships related to knowledge expertise and how by removing the usual validating contexts of institutions, these experiments have the potential to empower audiences and participants. This discussion responded in

⁸ Based out of a small storefront in Los Angeles's Chinatown, Public School now exists in nine cities internationally.

part to Margaret Wertheim’s provocative questions related to the sphere of authority that can surround knowledge: “Whose ideas count? Whose ideas matter? Whose ideas do we take seriously?”

Allen asserted that authorship and participation are not necessarily on the same axis, and it was suggested that accessing expertise was different than being subjected to expertise. Others spoke of the appeal of old-fashioned pedagogical exhibitions in museums and how anxiety can result from too much freedom. It was suggested that the recreational access to information on the Internet had changed hierarchies and helped to fuel enthusiasm for these storefront projects.

CLOSING DISCUSSION

As the group gathered for the closing plenary session, artist Mel Chin gave a performance that was based on his Fundred Dollar Bill project. The project uses symbolic elements to catalyze public awareness and give voice to disempowered communities living with lead toxins in urban environments. Chin’s work exemplifies an important form of interdisciplinary community-based art practice that addresses the complex interplay among social, political, and natural systems.

Following Chin’s performance, Dennis Bartels, Roger Malina, and Margaret Wertheim led a final discussion that synthesized the main themes of the conference. Malina spoke of the new knowledge networks of our times—citizen science, DIY communities, and hacker groups appropriating tools and knowledge for self-empowerment. Bartels spoke of a conviction to advocate for the “empowered learner.” Sharing a story related to melting Arctic ice and native knowledge, he asserted the importance of embracing multiple ways of knowing in the universal search for meaning and our own humanity.

Referring to introductory comments made by Dennis Bartels on the first day of the conference, when Bartels discussed learning as a form of “radical participation,” Malina asserted the ethical importance and urgency of art as a way of knowing reaching diverse populations as we shape new knowledge networks. Like Mel Chin, the Exploratorium’s inquiry-based approach to art and science learning empowers society to engage in the big questions of our day. Malina spoke of exciting developments in China and India and the value of learning from contributions from around the globe. He discussed the need for “safe places” such as the Exploratorium in which to build cultural value for art and science integration.

Wertheim echoed Malina’s concern for ethical responsibility and pointed to how children, women, and racially diverse communities are the populations most often excluded from access to new knowledge.

Conference participants spoke of how the discussions of the last two days pointed to a gap between the current understanding of the nature of learning as participatory and inquiry-based, and the way in which science is commonly presented and experienced in systems

of education, including informal education. As seen in many powerful examples shared at the conference, arts-infused engagements with the natural and social worlds have flourished in public intellectual life, but such approaches are rarely found in conventional representations of teaching and learning science.

For the field of informal science education, the discussions and experiences of this conference suggest a need for growth and transformation. Work shared at the conference confirmed the epistemological potency, the liberatory expansiveness, and the cultural inclusiveness that could result through the integration of the arts as a way of exploring and coming to know, care about, and pursue engagements with science and the natural world. It may be especially critical now, in a radically transforming world, to equip our public audiences, including school-aged children, with the full set of cultural tools—and especially with art as a way of knowing and a means of inquiry—to grapple with the profound and compelling questions of our times.