Acknowledgments
The Exploratorium wishes to thank the National Science Foundation for its support of this conference. Special thanks go to Al DeSena, program officer in the Informal Science Education Program of NSF, Jeannette Redensek, writer and art historian at the Albers Foundation, and Peter Richards, senior artist emeritus at the Exploratorium. These three interdisciplinary thinkers were instrumental in setting the vision for this conference and for making it possible.

This material is based on work supported by the National Science Foundation under Grant No. NSF DRL-0905069. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.
CONTENTS

EXECUTIVE SUMMARY

Introduction 5
Art and Inquiry 6
Cultural History 7
Program Design 8
Conclusions and Future Work 9

SUMMARIES OF THE SESSIONS

PLENARY SESSIONS 11
  Opening Presentation 11
  Art and Becoming 12
  Cultural Context: A Nonlinear History 15
  Learning Cultures 19

PROGRAM DESIGN BREAKOUT SESSIONS 21
  Making as Thinking 21
  In the Field: Nondisciplinary Research in Landscape and Culture 23
  Art as a Way of Knowing in School Settings 25
  Knowing and Showing: Evidence and Method 26
  In the Lab: Cross-Pollinations 28
  Learning without Knowing 30

CLOSING DISCUSSION 32
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

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 enchant 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