

A photograph of a woman with glasses and a ponytail, wearing a blue long-sleeved shirt and light-colored pants, standing on a stage and speaking into a microphone. She is facing left. In the background, a large, diverse audience is seated, looking towards the speaker. The setting appears to be a large hall or auditorium with blue and red stage lighting. The image is partially covered by a semi-transparent green overlay.

The Evolving Culture of Science Engagement

An exploratory initiative of MIT & Culture Kettle

Report of Findings | September 2013 Workshop



Massachusetts
Institute of
Technology

culturekettle

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Report of Findings: September 2013 Workshop

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Cover photo: Emily Graslie at The Story Collider, Cambridge, Mass. on September 23, 2013. Photo by Lisa Abitbol.

This report is dedicated with admiration and affection
to the memory of **Alan J. Friedman** (1942–2014) and
Duncan Dallas (1940–2014).



We are grateful to the following institutions, which generously supported the initial phase of the Evolving Culture of Science Engagement: the September, 2013 workshop at MIT.

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executive summary

This report presents the findings of a two-day invitational workshop held at MIT on September 23–24, 2013 as part of the Evolving Culture of Science Engagement Initiative, an ongoing collaboration between a new nonprofit organization, Culture Kettle, and several MIT departments led by the Program in Science, Technology & Society and the MIT Museum. The initiative explores a new wave of public science engagement activity that appears to be dissolving the once-bright line between science and popular culture. Its goals are to:

- Generate greater understanding of how science engagement is changing in contemporary society;
- Analyze and compare the operating assumptions, strategies, and sensibilities of some of the most innovative science engagement programs across settings and media;
- On the basis of that new understanding and analysis, explore what the science engagement field can do to extend and diversify the public connection with science;
- Identify gaps in our knowledge about the landscape of public science experiences and develop a research and experimentation agenda aimed at generating useful insights and advancing science engagement in contemporary culture;
- Create a new, multidisciplinary network of science engagement practitioners and researchers from professional communities that do not usually collaborate;
- Inform the work of specific science engagement and research initiatives underway in the US and elsewhere.

An important first step toward those goals, the workshop brought together a diverse group of 74 scientists, science communicators and educators, researchers, funders, and policymakers—mainly from the United States but including several participants from the UK and Ireland—to explore how the forms, settings, and cultural sensibilities of science engagement are changing. The participants were selected for what the organizers viewed as their culturally innovative approaches to public science engagement in a range of areas, from blogging and filmmaking to online comics and citizen science.

Participants were impressed and a bit surprised by the profusion of styles and approaches to science engagement represented at the meeting. Most people knew only a handful of others in the room and were delighted at the chance to meet and work with people outside their own practice areas. There was a strong sense of a nascent community of interest with a common commitment to the idea of mainstreaming science in the wider culture. But beyond that shared interest, there was a remarkable

divergence of opinion about the aims of science engagement, with some practitioners disavowing instrumental aims altogether and focusing instead on artistry and self-expression.

Among other topics, the workshop explored eight dimensions of change—six chosen in advance by the organizers and two nominated by the participants:

1. **Story(telling):** A resurgence of personal storytelling in contemporary culture has helped science communicators humanize what might otherwise be bloodless scientific ideas; telling stories also shifts some of the focus from the *objects* of science (phenomena, facts, etc.) to the *subjects*, the people doing science and their personalities, drives, doubts, etc.
2. **Humor:** Although it carries risks (e.g., of trivialization or exclusion), humor can help make science welcome and relevant in other contexts; it can link relatively obscure material to familiar ideas, help put scientists and non-scientists on a level playing field, and foster a sense of community and connection.
3. **Mystery and the unknown:** Focusing on what we can't yet grasp taps into a basic human attraction to the unknown, makes certain subjects “grabby” to non-experts, and conveys the idea that science isn't finished yet—that it's a living enterprise with room for others to participate.
4. **Informality/science as part of everyday life:** A sense of casualness, playfulness, and spontaneity are evident in many of today's science engagement programs, helping audiences feel more comfortable when encountering science and lowering the barriers between science and other areas of contemporary life.
5. **Artistic expression:** The interest of visual and performing artists in exploring science as both subject-matter and method seems to be increasing, as does the range of collaborations between artists and scientists in diverse settings; both can help foster perceptions that science is a creative, human way of exploring the world.
6. **Participatory engagement:** The rising popularity of dialogue events, citizen science projects, and other forms of public participation in scientific research and policy-making is one of the most noteworthy shifts in the culture of science engagement; it alters the definition of authority and lets non-experts identify with science.
7. **Emotion:** An emotional connection can be a powerful “way in” to a science experience for non-experts, capturing initial attention and increasing feelings of bonding with the communicator or educator as well as the subject; but it can include negative emotions as well as positive ones, and requires a vulnerability that may be difficult for some practitioners.
8. **Power, barriers, and belonging:** Participants pointed out that the community of science engagement practitioners is not sufficiently diverse, nor are its audiences; to move past this longstanding problem, the field may need to focus less on science literacy and learning goals and more on engaging communities on their own terms, for their own purposes.

Participants also discussed several themes that emerged from those initial discussions, including learning; civic engagement; affiliation and community; the difference between a desire to inspire or otherwise affect audiences and a desire to express or create something on the part of the science communicator; and how the shared goal of mainstreaming science can be accomplished without losing the “edge” of creativity and cultural innovation that marks so much of today's practice.

The conversation highlighted **new research opportunities** that are emerging in this period of rapid change. At a general or ecosystem level, research could help determine how far these changes represent a historic shift in cultural sensibilities and reveal overall patterns and trends in public engagement with science across settings and media. At a more specific level, research could illuminate the effects of various cultural strategies on engagement and identify what works, for whom, and why. Both levels of knowledge would help the field build on its successes and remain adaptive in a fast-changing environment.

Participants suggested that, while a great deal of potentially relevant research has been done on the cultural issues we discussed, much of it has been conducted in distant disciplines and published in literatures that the science engagement community may be unaware of; there's a need for greater interdisciplinary collaboration. They also emphasized that the ways in which citizens respond to science are intimately bound up with their own identities and cultures, so it's urgent that we better understand not only those cultures but more broadly *how* culture matters in science engagement.

The workshop confirmed the organizers' sense that these are interesting times in science engagement, with new forms of practice proliferating and new "rules of engagement" being explored and embraced by both producers and participants. However, that embrace is also accompanied by some ambivalence and debate; there are risks as well as rewards associated with the emerging practices. Our dialogue was a snapshot of the current moment of experimentation in science engagement—or rather, a snapshot of the views of a carefully curated group of innovators. The authors invite responses, including suggestions for the next stages in what we hope will be a widening conversation about practice and research in this field. Colleagues are invited to post comments on the initiative blog at cultureofscienceengagement.net or email the authors directly at team@cultureofscienceengagement.net.



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introduction

Our cover photo shows science communicator Emily Graslie onstage at a Story Collider event in Cambridge, Massachusetts in September, 2013. Less than a year earlier, Graslie—whose undergraduate training had been in art, not science—was a volunteer at the University of Montana Zoological Museum, where she appeared in a video by Hank Green, himself a biochemist and musician who was producing offbeat YouTube videos on science and other subjects with his brother, which earned them a large following of “Nerdfighters” around the US and abroad. Graslie began creating her own videos to share her love of the sometimes messy backstage work of a natural history museum; the name of her YouTube channel, The Brain Scoop, puns on both taxidermy and journalism. Goofily funny, personal, and low-tech, the videos drew several hundred thousand viewers and led to a job offer from Chicago’s Field Museum, where Graslie now serves as the venerable institution’s first Chief Curiosity Correspondent. That night in Cambridge, she told that story—her coming-of-age as a science communicator—as one of four storytellers curated and coached in part by Ben Lillie, a physicist who returned to his roots in theater to co-found The Story Collider, a live event series and podcast in which both scientists and nonscientists tell personal stories connected to science to an audience of mostly young adults drinking beer.

You get the picture: this is not your grandparents’ science scene. The work of independent, creative, entrepreneurial communicators like Graslie, Green, and Lillie is part of a new wave of public science engagement that operates on very different principles than the lectures, documentaries, and exhibits of decades past. Those new experiences—and the enthusiastic audiences they attract—illustrate the complex and changing roles that personality, informality, humor, story, emotion, and social participation play in contemporary public science experiences, and they hint that a profound shift in values and assumptions may be underway. Scientists and other science communicators are increasingly stepping out from behind the white-coated authority long associated with the discipline, acknowledging their own place in the drama of discovery and putting their own drives, doubts, wonder, and frustration on the table along with what they know—and, increasingly, what they don’t yet know. Science is being revealed and celebrated as a social enterprise: a messy, human process that all of us can relate to, and which can be enjoyed for its intrinsic, mind-blowing fascination and fun. The once-bright line between science and popular culture appears to be dissolving.

Goals of the initiative

Sensing that these shifts may be important for the fields of science communication, informal and formal science education, and science policy and funding, among others, and observing that such cultural dimensions of science engagement have received little attention at conferences and in the literature in those fields, the authors began collaborating in 2012 on the Evolving Culture of Science Engagement initiative. The work is an attempt to frame and discuss questions about public science engagement in unusually holistic and outcome-agnostic terms. Instead of starting within a given practice domain focused on a particular delivery vehicle (science museums, say, or science journalism, public media, or the online world), we wanted to look across those categories at the full landscape of activities in which citizens connect with science. Instead of starting from the goals of science communication and education (such as a more informed and rational electorate, more people interested in and capable of pursuing STEM careers, etc.), we decided to start with the forms, settings, and sensibilities of engagement and explore how these may be changing. And instead of looking at science engagement through the lens of learning or understanding, we wanted to place it in the broader context of contemporary cultural activity and view it as a cultural phenomenon.

Within that broader framing, we believe, there may be an opportunity to reconsider some long-standing assumptions that continue to undergird policy, funding, and evaluation frameworks in the field. Like many observers, we are excited about the pace, creativity, and public embrace of innovation in science engagement today. But we are concerned that our collective understanding of how people experience science—the rules of engagement, and possibly also the outcomes and impact of that engagement—has not fully kept pace with the action on the ground. In some ways we may still be working with a picture of success that is based on the very assumptions that these new modes and sensibilities of science engagement have begun to challenge. It is time for a fresh, clear-eyed look at how science engagement works in the 21st century.

Broadly speaking, what we hope to achieve in the initiative is a new understanding, one with not just theoretical but immediate practical value. The emerging wave of public science experiences seems to work by very different means than those of past generations. Unless we understand those means we can't hope to understand why non-experts choose to engage with science or how they—and their families, communities and society at large—are affected as a result. Nor can we hope to leverage and 'scale' those new experiences to foster broader and more diverse audiences for, and public connection to, science. We aim to contribute to those and other desirable ends by sparking a new conversation and sketching out a rigorous, creative investigation into the "new rules" of science engagement.

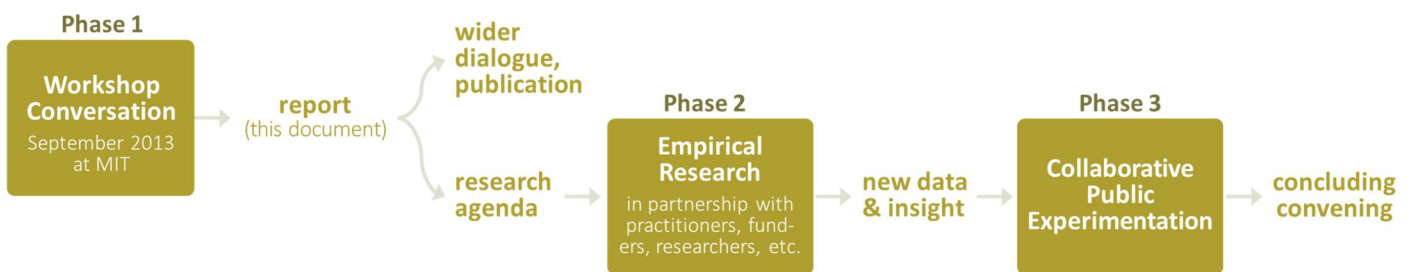
A possible structure

To that end, we imagined a three-phased inquiry that could span several years. The first phase centers on the invitational **workshop conversation** among innovative practitioners, researchers, and funders that we hosted at MIT on September 22–24, 2013. This report presents findings from

that phase and begins to identify some of the open questions about contemporary science engagement that may be worth further exploration (see “About this report,” below). We hope it will be followed by the development of a research agenda that codifies and prioritizes those questions for possible investigation in a second phase, **empirical research**, in which research partnerships could be formed to fill the most important gaps in our collective knowledge about how public science engagement works in contemporary culture and how to further it (see “Toward a research agenda,” below). That research could involve a wide range of methods, from sociological surveys of the population and ethnographic studies of specific science engagement experiences or audiences, to historical analysis, social psychology experiments, or “big data” analysis of attention and sharing patterns in science engagement; the right methods will depend on what the most pressing questions are. The findings from such studies will be valuable in their own right, but we hope they will also inform a number of new programming experiments in a third phase of the initiative, **collaborative public experimentation**, designed to tie the dialogue and research back to practice and shed new light on how science engagement professionals and organizations can leverage emerging cultural strategies to broaden and deepen the public connection to science. Ideally, the whole initiative would conclude with another dialogue or convening, this time larger and more representative, to share and discuss what has been learned with the broader field—or rather, fields. That potential process is illustrated in the diagram below (Fig. 1).

Fig. 1. **Potential initiative structure**

Evolving Culture of Science Engagement



Leadership and advisors

The Evolving Culture of Science Engagement initiative is a collaboration between Culture Kettle, a new nonprofit organization whose mission is to explore big-picture questions about public engagement with culture, broadly defined, and several departments and units at the Massachusetts Institute of Technology, led by the Program in Science, Technology & Society and the MIT Museum. The principal investigators (and authors of this report) are:

- **David Kaiser**, MIT: Germeshausen Professor of the History of Science; Director, Program in Science, Technology & Society; Senior Lecturer, Department of Physics

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- **John Robert Durant**, MIT: Director, MIT Museum; Adjunct Professor of Science, Technology, and Society
 - **Peter Linett**, Founder, Culture Kettle; Chairman & Chief Idea Officer, Slover Linett Audience Research; Associate, Cultural Policy Center at the University of Chicago
 - **Thomas Levenson**, MIT: Professor of Science Writing and Director, Graduate Program in Science Writing
 - **Ben Wiehe**, MIT: Manager, Science Festival Alliance (MIT Museum)

In addition, we are fortunate to have had the support and input of a number of partners and advisors, including **Tiffany Lohwater**, Director of Meetings and Public Engagement at the American Association for the Advancement of Science, which co-convened the 2013 workshop with MIT. The following practitioners and researchers served on the advisory committee:

- **Brian Greene**, Columbia University
- **Ben Lillie**, The Story Collider
- **Bruce Lewenstein**, Cornell University
- **Tom Rockwell**, Exploratorium
- **Meena Selvakumar**, Pacific Science Center
- **Bruce Sherin**, Northwestern University
- **Martin Storksdieck**, National Academy of Sciences
- **Kathy Sykes**, University of Bristol (UK)
- **Peter Ward**, University of Washington
- **Carl Zimmer**, New York Times and Yale University
- **Bora Zivkovic**, Scientific American and Science Online¹

Our advisory committee also included the late **Alan J. Friedman**, science museum consultant and former director of the New York Hall of Science, who was an early and influential supporter of the initiative and an eloquent participant in the workshop.

The authors are indebted to all the advisors for their input in advance of—and during—the 2013 workshop, but all responsibility for this report, including any errors or omissions, is our own.

Our purview—and what we mean by “science engagement”

As noted above, we wanted to consider the full range of ways in which adults encounter the ideas, people, processes, stories, and objects of science. Many different terms have been used to refer to that broad field of engagement. In the not-so-distant past, public lectures and demonstrations, science magazines and newspaper journalism, and public radio or TV programs about science were

¹ No longer involved in the initiative.

often characterized as “popular science” or “science outreach”—both terms which sound dated now and faintly condescending (nicely captured by the corresponding French phrase in use for much of the 20th century, *vulgarisation scientifique*). Starting in the 1980s, those terms began to give way to “public understanding of science,” but that notion came to be associated with a “deficit model,” in which information was thought to flow unidirectionally from those presumed to know (scientists, communicators, educators) to those presumed to be ignorant and lacking (non-scientists, students). In the last few years, “public understanding” has lost ground to “public engagement with science,” which emphasizes two-way dialogue between science and the public rather than monologue. Meanwhile, there is still a boundary between “informal science learning” (mostly science centers, natural history museums, planetariums, zoos, etc.) and “science communication” (the worlds of media, publishing, and online science experiences), although a new dialogue has been developing between the two in recent years.

In this initiative, we aren’t interested in adjudicating among those models of the relationship between science and the public. We simply want to be as inclusive as possible about the ways adult non-scientists “consume” and participate in science in contemporary society for reasons other than work or school, without privileging any particular medium, context, or desired outcome—indeed, without ignoring public experiences that are science-related but operate in other domains or under other names. That landscape is dizzyingly varied: online science comics like xkcd and Sci-ence; performances by science comedians, or general comedians working with scientists or incorporating science into their acts; songs about biology or cosmology by pop and rap performers like GZA and Bjork; radio shows and podcasts like Radiolab and Science Friday; books for the general reader by scientists like Brian Greene and Richard Dawkins or science journalists like Carl Zimmer and Ben Goldacre; television specials on PBS and Discovery; citizen science programs run by Zooniverse and the Cornell Lab of Ornithology; advocacy and empowerment programs for girls such as Science Cheerleader; innumerable blogs and Twitter feeds by scientists and other science communicators and educators, not to mention the extraordinarily popular Facebook page, “I Fucking Love Science”; citywide science festivals; science cafes and Nerd Nite; science centers and planetariums, natural history museums, zoos and aquariums, national park visitor centers, and other exhibits; science-themed theater or dance performances and art exhibitions; community dialogues; and much else. We chose “science engagement” as the most general way to refer to that varied landscape of public encounters with science. We acknowledge the overlap of that phrase with the specific practice of facilitating mutually informative dialogue between scientists and the public on science and related policy matters, but we don’t mean to emphasize that idea over any other.

About this report

This report summarizes the first phase of the Evolving Culture of Science Engagement initiative, the two-day workshop held at MIT in September, 2013. In it, we have attempted to identify the most important themes that emerged in those discussions and frame some of the still-open questions that could be investigated in the next phases of work. We emphasize that this is just a start: it may be a ‘final report’ with respect to the generous grants that funded the workshop itself, but it is just a

next step in what we hope will be a fruitful, field-spanning collective inquiry into how culture is changing both around and within science engagement. We welcome comments, challenges, and questions via email (team@cultureofscienceengagement.net), and we invite anyone interested in being involved in subsequent phases of the initiative to get in touch with us at the same address.

In the “Findings” section below, readers will notice that we’ve included a number of direct quotes from workshop participants without attribution. We wanted this conversation to begin where previous public gatherings on the subject had left off, to get past the received wisdom and familiar, occasionally self-justifying arguments about science communication and public education. We knew we needed to create a “safe space” for attendees to engage in a full and frank exchange of views, including any doubts or disinclinations they might have with respect to current orthodoxies of policy or practice. (This would be challenging enough with a few funders in the room, we imagined). So we asked participants to abide by what the British call the “Chatham House Rule,” which stipulates that what is said in the meeting may be disseminated as long as no quotes are attributed to individual speakers. We have played by the same rule in this report.



the workshop

In this section, we describe the objectives, invitees, discussion topics, funders, and agenda of the workshop, including the six dimensions of change that we particularly wanted participants to discuss.

Objectives

As noted above, the September 2013 workshop is the first phase of what we hope will be a broader initiative aimed at shedding new light on how science engagement works—and could work even better, for a more diverse public—in contemporary culture. The goal of the workshop was to convene a high-level, creative dialogue about the most interesting emerging strategies and sensibilities on the science engagement scene, both to improve and update our collective understanding in an immediate way and to help set an agenda for future dialogue, research, and experimentation.

More specifically, we had five objectives in mind as we began planning the workshop:

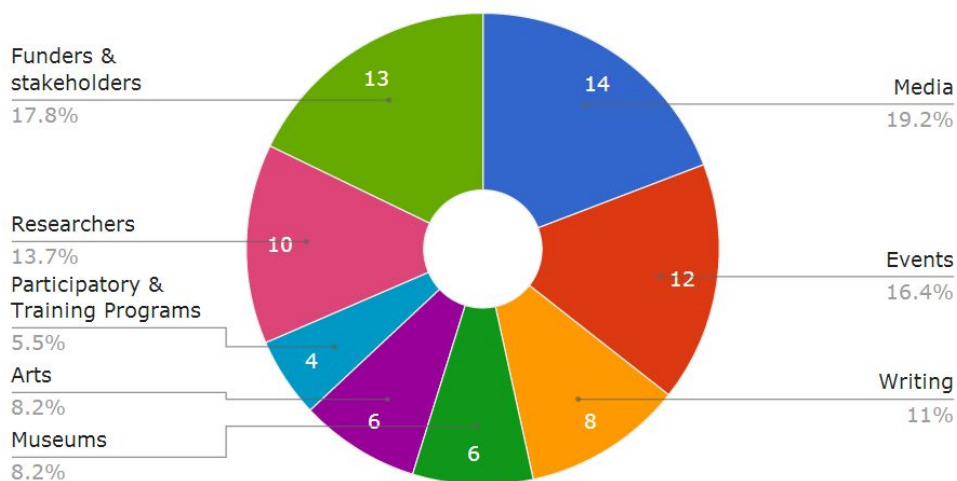
1. Generate greater understanding of how the assumptions, priorities, and practices of public science engagement are changing and how greater relevance and wider participation might be achieved;
2. Scrutinize public science engagement as a cultural phenomenon, paying special attention to dimensions on which change seems to be occurring not only in science but in the wider culture, as well;
3. Create a new, multidisciplinary network of practitioners, researchers, theorists, and funders who seldom have opportunities to interact or collaborate, despite their mutual interest in public engagement;
4. Identify a range of empirical questions about the causes, experiences, and effects of public engagement for possible inclusion in a research-and-experimentation agenda (Phases 2 and 3 of the initiative);
5. Inform the work of other initiatives and programs underway around the US, UK, and elsewhere.

Gathering the innovators

We decided to make attendance at the workshop invitation-only because we wanted to keep it small enough for in-depth conversation, genuine debate, and relaxed social interaction. We also wanted to ensure that innovative practitioners from across the landscape of contemporary engagement would be at the table, and we knew that some of the people we had in mind attended few if any conferences on this subject, while others regularly attended conferences only within their own community of practice. So we wanted to cover their travel expenses if at all possible, to eliminate cost as a possible reason for declining. Thanks to generous support from our funder-stakeholders (see next section), we were able to offer each participant an adequate travel stipend.

We created an initial “long list” of more than 100 practitioners responsible for what we viewed as culturally contemporary, sometimes groundbreaking forms of science engagement. Our own ideas were supplemented with referrals from our advisors and other colleagues. Then we added a handful of academic social scientists and learning scientists working in science communication and one or two professional evaluators of science programs. The hard part was winnowing the list down to the 65–70 people we could accommodate. The process was admittedly subjective: we chose people whose work excited us, who were using not just 21st-century technologies but 21st-century sensibilities, who were blurring old boundaries and creating new categories, and who we hoped might be interested in a reflective conversation about that work. Within that category of innovators, we strove for diversity by practice area (see chart, Fig. 2), gender, geography (to include UK- and Ireland-based practitioners), and career stage (a balance of emerging and well-known communicators). Ethnic diversity was also very much on our minds but turned out to be harder to achieve; **we acknowledge that the gathering was not sufficiently diverse, and in retrospect we should have worked even harder and more creatively on that score.** The underrepresentation of people of color at the meeting may say more about the composition of our own networks than about the composition of the profession of science engagement, but both points were made—passionately and unprompted—by participants at the workshop: that there wasn’t enough ethnic diversity in the

Participants’ practice areas (Fig. 2)



room, and that there's not enough ethnic diversity in the profession (see "Power, barriers, and belonging" section, pages 29–31).

As our circle of funders grew, we also invited a number of representatives from those foundations and elsewhere in the policy community, making a point to ask them to help us create a receptive, non-judgmental atmosphere that would encourage candor among the practitioners.

Naturally, not every invitee was able to attend, but we gathered 74 participants working in many corners of science engagement and ranging from influential "insiders" to relative newcomers and figures from related fields. A full list of participants is included in the Appendix. Most who attended knew only a handful of the others in the room, which indicated that we had successfully drawn from multiple professional communities. We were deeply excited to have such a talented group of "unusual suspects" on hand for the conversation, and we are grateful for their time, energy, and insights.

Circle of funder-stakeholders

While we were inviting participants, we were also in conversations with a number of leading science education and science communication funders in the US and UK. In the space of a few months, the **Noyce Foundation**, **Alfred P. Sloan Foundation**, and **John D. & Catherine T. MacArthur Foundation** committed to supporting the workshop through generous grants. Equally importantly, each foundation provided valuable insights and collegial suggestions as we planned the convening, becoming stakeholders in, as well as funders of, the project. All three foundations sent senior personnel to the workshop, and those individuals were key participants in the dialogue.

Crucially, several departments at the **Massachusetts Institute of Technology** also provided generous support, including the Program in Science, Technology, and Society; the Dean of Humanities, Arts, and Social Sciences; the Dean of Science; the Department of Physics; the MIT Knight Science Journalism Fellows Program; and the MIT Museum. The **Wellcome Trust** contributed in the form of travel assistance for a number of participants from the UK, each of whom brought unique and valuable perspectives to the gathering. In addition, the **Intel Corporation** generously sponsored two social events associated with the workshop, including the Story Collider performance described at the start of this report. We're also grateful to **Microsoft**, which donated its New England Research and Development (NERD) Center as the venue for the first day of the workshop.

Setting the table: six dimensions of change

What are the most interesting cultural shifts underway in science engagement? Why do certain public encounters with science feel so different from the tone and expectations of previous decades? We structured the first day of the workshop around a half-dozen dimensions of change that we felt were at the heart of the emerging ecosystem of engagement. (Our summary of what we learned about each of these themes begins on page 16.)

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1. **Story(telling).** Even traditional science narratives often have a beginning, middle, and end. But a narrative is not the same as a story, as the revival of oral storytelling in live events, radio, and podcasts suggests. Stories presume a storyteller, and their success hinges on the communicator's personality, language, and emotional engagement — precisely the kinds of subjective factors that the practice of science itself seeks to strip away in service to objectivity. **How do story and storytelling work in science engagement** today? Does the new crop of **story-based science experiences change where we draw the line between “core” science content and “extraneous” information about the lived experience of science?** What kinds of relationships are today's science stories forging between scientists or other communicators and the public?
 2. **Humor.** Science has long been viewed by much of the public as a serious, stereotypically “heavy” subject. While some 20th-century science communicators used a lighthearted tone and offered family-friendly witticisms, recently we've seen the rise of science experiences for adults in which humor plays a more central role: online science comic strips, some YouTube science videos, and live performances in which standup comedy and science content are intertwined (**Infinite Monkey Cage, Star Talk Radio**). Is laughter the “great leveler” in science communication, creating a sense of community and receptivity despite the unfamiliar content? What's the role of humor in repositioning science as relevant and enjoyable to non-experts?
 3. **Mystery/the unknown.** Science communication and especially informal science education have traditionally focused on some domain of knowledge, helping the public understand what is known and sometimes how it came to be known and who did the discovering. The edges of our understanding were acknowledged but rarely focused on. Today, those edges seem to be moving to the center. The mysteries of science play prominent roles in the work of several successful science authors, radio hosts, and other communicators, who openly explore not just what we don't yet know, but also what we may never be able to know. In such a context, what becomes of the traditional function of *explaining*? Does focusing on mysteries make science more compelling to non-experts? Does it help humanize science and scientists? How does it affect values like clarity and authority?
 4. **Artistic expression.** Poets and other artists have been expressing science artistically since Lucretius. But the emerging landscape of science engagement is marked by new overlaps between the subjective, intuitive realm of the arts and the objective, rational world of science. Recent attempts to turn STEM into STEAM with the infusion of the arts have focused on a shared interest in creative problem-solving and innovation. Meanwhile, musicians, novelists, playwrights, poets, screenwriters and directors, visual artists, and choreographers have taken an interest in science and expressed it in new musical, theatrical, fictional forms. Does artistic expression of scientific ideas or stories make them more culturally or socially relevant, and if so, to whom? Does it also reshape the information itself, and in what ways?
 5. **Participatory engagement.** Much has been written about the shift toward active, participatory engagement by non-experts in a wide range of domains that had long been highly professionalized and presented to outsiders as passive experiences, from the arts to journalism and politics. In science, that shift includes citizen science projects such as those at SciStarter and Zooniverse; the maker movement; and community dialogues to inform policymaking on

scientific and technological issues. Do participatory programs reframe science in the public mind as an ongoing, “relatable” human process? How do we think about expertise, authority, and communication in a participatory era?

6. **Informality/science as part of everyday life.** Science is sometimes viewed as a rarefied realm set apart from everyday life and meaningful only to specialists. But in recent years a sense of informality, spontaneity, and playfulness has emerged in many science engagement programs, some of which explicitly aim to reposition science as part of everyday life and accessible to everyone. On Facebook, the title and tone of Elise Andrew’s “I Fucking Love Science” page tell us how far we’ve come. On PBS, non-scientist David Pogue has become a popular NOVA host by treating science and technology with irreverent enthusiasm and connecting them to popular movies, music, and literature. How is the new informality shaping public perceptions of science, and what might be gained or lost as a result?

We also asked the workshop participants to nominate additional dimensions of change for discussion (see below and page 18).

Agenda in action

After a convivial gathering at a Cambridge restaurant on the eve of the workshop, the meeting got underway on Monday, September 23, 2013 with a series of rapid plenary discussions focused on the six dimensions listed above. Some of these were “quick colloquies” in which three practitioners (invited by the organizers in advance) came to the front of the room for a brief, facilitated discussion. Others were “lightning pairs” in which two participants interviewed each other about the given dimension in the context of their work. After each colloquy or pair, the rest of the participants generated questions and comments, some of which were voiced and all of which were posted for later perusal.

After lunch, participants brainstormed additional dimensions of change in science communication, then selected two of the new dimensions for further discussion: **emotion** and **power, boundaries, and belonging** (the latter a complex topic relating to the ethnic diversity of science audiences, barriers to participation, and the need for a sense of connectedness to science as a community). Participants were then divided into eight small groups, each of which was assigned one of the dimensions to discuss and analyze; a worksheet of questions was provided. Reporting back to the full workshop took place in three “roll-up” panels, each featuring a representative from two or three of the breakout groups. The first day of the workshop concluded with a full-room discussion of possible outputs and outcomes of the workshop.

That evening, all participants were invited **to a Story Collider event at** a famed music club in Cambridge’s Central Square. Hosted by Story Collider’s producer Erin Barker and co-founder Ben Lillie (the latter an advisor to our initiative), the event played to a boisterous, standing-room crowd of mostly young Cambridge and Boston residents and featured live, personal stories told by four of our workshop participants: science writer Deborah Blum, video maker Emily Graslie, science festival organizer Kishore Hari, and physicist and author Alan Lightman. (Recordings of these stories can be heard at <http://storycollider.org/shows/2013-09-23>.) Afterward, by pre-arrangement, our work-



A few of the 74 workshop

participants on Day 1 at the Microsoft NERD Center in Cambridge, Mass.

Top row: left, Kathy Sykes; right, Nico Yunes (left) and John Beck-Hoffmann.

Second row: left, Heather Berlin and Neil deGrasse Tyson; right, Ashley Braun.

Third row: left, Carl Zimmer; right, Robert Krulwich (left) and Alan Lightman.

Fourth row: left, Beck Tench; right, GZA.

Bottom row: left, Brian Greene and Paula Apsell; right, Emily Dawson.

Photos: Lisa Abitbol



The Story Collider

performance at the Middle East, a famed Cambridge music venue, on September 23, 2013 drew a standing-room crowd of locals. Top: Co-hosts Erin Barker and Ben Lillie. Below, clockwise from top left: storytellers Emily Graslie, Kishore Hari, Deborah Blum, and Alan Lightman, all of whom were also participants in the Evolving Culture of Science Engagement workshop.

Photos: Lisa Abitbol

shop participants stayed to mingle with and interview other members of the audience about their science engagement habits, preferences, and perceptions.

The second day of the workshop began with a conversation about what was learned from the interviews with the public at the *Story Collider* event. This was followed by a vigorous panel discussion among five science communication and learning researchers about what we already know, what we would like to know, and what we may not be able to know about the cultural dimensions of public engagement with science. Participants then self-selected into working groups to grapple with six new themes that the organizers had distilled from the discussions thus far:

1. Mainstreaming science—while keeping the ‘edge’
2. Civic engagement
3. Inspiring (a focus on external impact on the audience)
4. Expressing (a focus on the internal creative and sharing impulses of the communicator)
5. Affiliation and creating community
6. Learning

The full group reconvened that afternoon to report and further discuss their analysis of the six themes. (Learning actually warranted two groups, due to the number of people interested in discussing it.) Time was then provided for networking across and within practice areas to explore possible collaborations, including research collaborations in the next phase of the initiative. Finally, a facilitated closing session gave participants an opportunity to reflect on the two days and share final thoughts and questions.

Summaries of the workshop sessions and other documentation have been posted online at the initiative website, cultureofscienceengagement.net. The workshop was facilitated by the organizers and **Liz Monroe-Cook**, an organizational psychologist and consultant. Logistics were coordinated by **Julie Fooshee** of the Science Festival Alliance and **Linda Hosler** of AAAS.

Since then...

Immediately after the workshop, participants were asked to complete an online form, both to provide feedback about this unusual event and to contribute their suggestions of people and programs for a proposed database of innovative science engagement activities. The evaluation portion of the survey was conducted by staff at Slover Linett Audience Research, a Chicago-based firm specializing in culture and informal learning and co-led by one of the organizers (Peter Linett, founder of Culture Kettle); the report is available on request.

In the months since the workshop, we have continued the conversation with our advisors, several participants, and other colleagues around the field. The follow-up has included an informal debrief at the Association of Science & Technology Centers 2013 annual meeting and a plenary presentation to the 2014 International Public Science Events Conference.

findings

So what transpired? What did we learn over the course of those two energetic and energizing days? Our answers are summarized in this section, first in the form of some general insights about the science engagement field drawn from both days of discussions, then in analyses of the eight dimensions of change we discussed on the first day, and finally in a section on research and how it could deepen our understanding of the culture of science engagement.

Participants' passionate conversation, questioning, and debate confirmed the thesis that inspired the Evolving Culture of Science Engagement initiative in the first place: namely, that the culture of science communication is indeed changing profoundly and rapidly. (We can say this only of the US, UK, and Ireland, however, since our participants hail from those countries.) An exuberant sense of freshness and dynamism was palpable in the room, and participants frequently voiced their view that the assumptions and operative possibilities in these fields today differ fundamentally from those of even a decade ago. For many participants, the workshop seems to have been the first systematic opportunity to discuss the cultural dimensions of science engagement with their peers, an opportunity they eagerly embraced. These confirmations, along with the enthusiasm participants clearly felt about coming together from such a far-flung set of practice areas and professional or academic communities and the freedom they felt to express opinions and concerns that they hadn't been able to voice at other conferences (both described below), made the organizers and others feel that the workshop was a strong and exciting start for the initiative.

A. Broad observations

A nascent community—of interest, not practice

The diversity of forms, styles, and settings of science communication and education represented at the meeting was striking to many of the participants. "I'm just blown away by how many different kinds of engagement there are represented just in this room," one participant told us. Another said, "I went through the delegate list carefully and found myself saying, 'Oh my god, there's that, as well as that, as well as that!' There were things I knew about, but there were [also] lots of things I didn't know about." There was a consensus among participants that they had never attended this kind of meeting before—one that included innovators from across traditional categories, from institutional

as well as independent contexts, from the US and UK, and so on—and most found it valuable and stimulating to be part of such a wide-ranging group. Many expressed a desire to sustain the networking and conversation beyond the two-day workshop, revealing a latent need for a less siloed, more interdisciplinary, and more collaborative community in science engagement. Among other things, practitioners wanted better ways of keeping track of, and learning from, all the interesting things going on at the interfaces between science and the wider culture.

We include the need for such a clearinghouse in our “Next steps” discussion on pages 39–40. Here we would note the potential value to the field of creating more dialogue opportunities that integrate disparate practice areas and disciplines, especially across the traditional categories of informal science education and science communication.

Yet it would not be accurate to say that the group we brought together constituted, or hoped to constitute, a single community of *practice*. Participants were quick to point out that they don’t always share goals, audiences, settings, or priorities. They do, however, share an interest in fostering public connections to science of one kind or another, and an excitement about the new approaches to that work that are becoming possible. What they did form, and hope to continue and expand, was a community of *interest* in the wider field of science engagement and how it is evolving.

Mainstreaming science

That community of interest may have disparate goals and audiences for science engagement, but our participants shared a common commitment to the idea of *mainstreaming science*: breaking down the conceptual and contextual boundaries between science and the rest of culture and, in the words of one researcher in attendance, “normalizing or integrating science and its content and rhetoric into mainstream culture.” For many, this idea was primary—the objective of public science engagement efforts and the common denominator among the most successful and innovative contemporary approaches. As another participant put it:

To me this is the end goal, getting us to a place where science is just a part of the culture, and we don't need to bracket it off and say we're doing a science thing. We get to a place where it's just there.

That ideal helps explain why many of the trends we discussed at the workshop point toward contemporary cultural forms, including standup comedy, storytelling, nontraditional and social settings, participatory programs, and the use of the arts to convey (and reposition) science.

On the evidence of these conversations and the emerging science engagement activities they surveyed, **we may be witnessing a historic shift from a sequestered to an integrated model of science in culture**, from science-in-its-own-category to science-mixed-with-everything-else. If so, it is a shift with many implications, risks, and rewards, all of which call for further discussion. Mainstreaming offers a broader frame than “public understanding” or other current rubrics, and could suggest a useful reappraisal of funding priorities, programming strategies, and evaluation frame-

works. It also opens up a broader sphere of reference that science can draw on for relevance and connection; participants repeatedly mentioned the need for science engagement practitioners to look to the broader world of advertising, political campaigns, online and offline social movements and networking behavior, the arts, entrepreneurship, etc.—all domains whose “best practices” could be adapted to the goals of science engagement.

Participants indicated that mainstreaming science will require us to better understand both contemporary culture and the cultural dimensions of science engagement. They believe that those dimensions are understudied, at least by researchers working within the science communication and education fields, and they are interested in filling those gaps in the knowledge environment (see “Toward a research agenda,” below).

Beyond education: divergent thinking about goals

There was a remarkable divergence of thinking among our participants about the aims of science engagement. Some—especially but not only the museum practitioners and social scientists in the group—were particularly interested in facilitating and inspiring learning, by which they meant a broad range of cognitive, social, emotional, and identity changes that can transform individuals and communities in enduring ways. Others focused on inclusion and how participating in and learning about science can empower underserved populations and help create a more equitable society. Still others said their work was driven by the need to counter science denialism and increase awareness and acceptance of scientific ways of thinking, or to encourage more minorities and women to pursue STEM careers.

Those goals were familiar to the organizers from other conferences and literature in the field. But we suspected that there might be other perspectives among the innovative practitioners we had gathered for this workshop, and we tried to create an atmosphere and process that would allow those perspectives to emerge. Our hunch was confirmed: several practitioners stated that they weren’t aiming at any instrumental outcomes at all. Rather than hoping to change, improve, influence or inform their audiences, **these practitioners said they were trying to express or share something with them, to create compelling, often emotional and sometimes highly social experiences—without preconceived impacts or even a thought for utility.** That position is similar to an artist’s motivation for performing, writing, or painting: the starting point is the communicator’s internal vision, sensibility, or curiosity coupled with his or her desire to make that publicly sharable in some way; the impact on the audience, while important, is open-ended rather than predetermined. By contrast, in a pedagogical or other instrumentalist approach the starting point is some need on the part of the participant or learner, external to the communicator; the desired outcomes have already been identified. One practitioner made the radicalism of this position explicit, speaking for himself and two other attendees who tell science stories in various media:

All of us think of ourselves as artists, and we want to create art. If that’s what you want to do, then when people ask, ‘Well, what are people learning from this?’ you say, ‘That’s not what I’m doing.’ . . . I think this is at the heart of what this conference

is all about. [Janna Levin's] work is not about science . . . it's about creating art, and she does what artists always do. To me that's the new normal: people are starting to do science stuff that isn't science stuff, it just happens to be science. And that means doing all the normal cultural things.

It seems likely that this emerging position has been underrepresented in the discourse in the field, in part because such practitioners don't usually attend the "official" conferences or publish in journals, and in part because taking such a stance can be awkward given current policy and funding priorities. (One practitioner told us that he is routinely required to list learning outcomes in grant proposals even though he and his colleagues don't think of their program in those terms. Another attendee said that some of what he was regularly asked to support—and personally enjoyed—didn't "count" as public engagement work in the eyes of his employer because it was associated with no clearly identifiable learning outcomes.) Some workshop participants appeared to relish the opportunity to "come out" in the presence of funders and peers about the true nature of their science engagement work and their skepticism about the field's tendency to look at all kinds of science experiences through a learning-outcomes lens. In their view, that tendency acts as a brake on innovation in science engagement: "It's very hard to get financial support for any type of outreach that deviates from what the funders . . . think outreach should be."

Not surprisingly, many practitioners work not at either end of that spectrum but somewhere in the middle: they have broad aims and outcomes in mind for their audiences or participants (for instance, empathy with a scientist, interest in the subject matter), but they are also motivated by the pleasure of expressing and sharing their own passion, vision, and ideas in ways that lead to unpredictable, idiosyncratic outcomes. Needless to say, no one was *against* learning or other positive impacts, and no one denied that learning, broadly and incrementally defined, occurs among audience members even when the engagement professionals aren't focused on it.

Overall, there was a sense that the diversity of aims and ambitions was a good thing for science engagement and for the multiple publics that we serve. "It's okay that we all have different goals," said one participant. "The idea that we should be going for the same game is weird."

B. Eight dimensions of change

As described on pages 9–11, we structured the first day of the workshop around discussions of specific areas in which significant developments appear to be taking place in science engagement. Six of these were chosen in advance by the organizers (story[telling], humor, mystery and the unknown, informality/science as part of everyday life, artistic expression, and participatory engagement). Additional dimensions were nominated by participants at the meeting, from which two were selected for small-group discussion (emotion and power/barriers/belonging). In developing that list, we tried to focus on the *mechanisms* rather than the goals or outcomes of science engagement—the emerging sensibilities and strategies that are reshaping the public science landscape. In this

section, we summarize what we heard from participants in the course of the meeting about these eight dimensions.

1. Story(telling)

Storytelling is older than science, perhaps as old as the human species itself. Interestingly, the proliferation of new forms of multimedia and social networking in recent years has coincided with a renaissance of traditional storytelling, the kind that is told in the first person, often orally at a live social event but sometimes in written form, and is typically true, personal and self-revelatory. Such stories are the staple of hugely popular radio shows such as *This American Life* and *The Moth Radio Hour* and their many imitators throughout the English-speaking world. They are also increasingly at the heart of successful science engagement experiences, including The Story Collider (described above), online videos like “Seven Minutes of Terror,” and books by authors Janna Levin, Rebecca Skloot, Peter Ward, and others. Skloot’s international bestseller, *The Immortal Life of Henrietta Lacks*, for example, is a triple (auto)biography in which readers learn every bit as much about the subjective, lived experience of the biographer herself and of Henrietta and her daughter Deborah as they do about the they do about the worlds of 20th-century oncology research and HELA cells.

Some practitioners at the workshop viewed storytelling as a means of science communication and others as an end in itself. “It’s a subversive way to bring people in,” said one author in the former camp: a good story seduces people into the science. Because stories are fundamentally about people rather than facts or ideas, storytelling in a science context can humanize what might otherwise be bloodlessly abstract, thereby capturing the interest of people “who aren’t necessarily interested in [the scientific content of] what you’re telling them.” The latter camp countered that, precisely *because* stories are about people, telling a good story means setting aside any explicitly pedagogical objectives. The story must follow its own personal and emotional logic; explanation isn’t what makes it sing:

*The important thing is that the story is driven by something natural [to the teller]. . . Sometimes that’s science, but lots of stories are driven by other things. **Those other things are commonly the more powerful drivers.** We have a problem if we insist on making the science front and center. . . We want science to be there, but we need to let it have its natural place in the story.*

Both camps acknowledged that the use of storytelling in science engagement calls for a different kind of expertise than traditional forms of communication: it shifts the emphasis from scientific knowledge and explanatory skill to storytelling skill. Some participants worried this could lead to a loss of complexity or nuance (“The problem with narrative is that you leave out important facts,” said one) and thereby give the public a false picture of how science works. For students deciding on an academic focus, that may mean showing up in a physics course expecting it to be all about the stories and metaphors they read in the professor’s popular books on physics for the general reader; that physicist/author told us at the workshop that such students are often disappointed when he

explains how he actually teaches the course: “I’m like, ‘Look, you need to do the calculus and the algebra. That’s how you get to engage with the wonderful ideas.’”

On the other hand, the same physicist noted that storytelling can be a powerful tool not just for audiences but for the communicators. Telling a story about science involves recontextualizing, constructing new metaphors, and finding simple, human language for complex ideas, all of which “can spark new ideas and force you to think about [the science] in a different way.” And storytelling about science isn’t limited to scientists and professional science communicators; both Radiolab and The Story Collider, for example, often feature non-experts telling personal stories that revolve around interactions with science.

Several participants who work in online engagement noted that personal expression and subjective voice have become a dominant, indeed inescapable cultural form thanks to the web and particularly the blogosphere. “People are writing and reading each other’s personal stories,” said one practitioner. “Science bloggers infuse their stories with their own personalities. When I have something to say, that’s how I do it: I talk about personal experiences and add the science into it.” So storytelling is directly linked to the larger theme discussed above, “mainstreaming science” in contemporary culture. When storytelling is the mode of communication, science engagement becomes part of something much bigger.

2. Humor

Humor isn’t new in science communication and informal science education, but for most of the 20th century it was peripheral at most, and usually aimed at families and children. In recent years humor’s centrality and visibility have increased and it has “grown up,” as the title of Elise Andrew’s I Fucking Love Science page on Facebook (with over 12 million fans as of this writing) suggests. Other examples include astrophysicist and *Cosmos* host Neil deGrasse Tyson, who has studied the craft of comedy and works with professional comedians on his weekly radio show and podcast, Star Talk; the UK collaboration between physicist Brian Cox and comedian Robin Ince, The Infinite Monkey Cage; Steve Cross’s Science Showoff program, which trains scientists and other communicators in standup comedy techniques; online comics drawn by visual artists like Maki Naro and Randall Munroe; the many popular, humorous science video channels on YouTube, and much else.

As with storytelling, the rise of humor in science communication is part of the broader project to mainstream science. Observing the complex roles that comedy has come to play in other “serious” domains—especially the news, where shows like the Daily Show and Colbert Report offer a fluid mix of satirical humor and genuine commentary and debate—our workshop participants said that science communicators need to use humor if they want to win attention and be relevant in contemporary culture. Humor is linked to the rise of “science celebrities,” personalities capable of holding public attention alongside well-known actors, musicians, comedians, and other cultural figures. (It’s no coincidence that Tyson is frequently invited to appear on shows like *Colbert* and *Real Time with Bill Maher*.) In the online realm, science tweets, posts or videos are much more likely to be re-tweeted and reposted if they make people laugh. Likewise, on the broadcast airwaves one

science series, PBS's *NOVA ScienceNow*, earned its best ratings in years (and dramatically higher online viewership) after a new host, David Pogue, began taking a more comedic approach.

As one of our panelists observed, comedy depends on a very wide range of (continually updated) cultural connections and associations, so it can help science communicators link obscure material to familiar, everyday contexts. Successful humor both depends on and helps create “human compatibility,” in the words of another participant, an atmosphere in which the science specialist and the non-specialist can find themselves on a more level playing field. And because laughter is fundamentally a social phenomenon, humor in science settings can foster a sense of connection not just with the science figure but among audience members with disparate interests, perspectives, and backgrounds.

Here, as in several other areas of the workshop, participants distinguished between communicating science in order to foster learning and communicating science in order to create a positive, affective, often social experience that will inspire and motivate comfort with and enjoyment of science. “We shouldn’t feel the need to force learning all the time,” argued one panelist: There are plenty of knowledge resources available to people who are interested in and connected with science; the goal of at least some science communication should be to foster feelings of interest and connection that will lead people to want to make use of these resources in the first place. This emerging model of science engagement—roughly, “If they enjoy it, they will feel comfortable and may seek further knowledge later”—assumes that engagement precedes and sets the conditions for learning. That strikes the authors as notably different from traditional models, in which learning was implicitly assumed to precede and set the conditions for engagement (*If we explain it, they’ll find it interesting and be more interested in the topic and more connected to science*). A number of participants asserted that engagement is valuable on its own, even when not accompanied by learning something that can be recalled or articulated later.

Others were quick to note that using humor in science engagement carries risks. While some jokes help universalize and demystify science, others can exclude people who don’t get the references or who don’t enjoy that style of humor. Forging a sense of community among certain people—making them feel like insiders—can make others feel like outsiders. Other risks include trading on (and thereby reinforcing) stereotypes, which some participants noted in connection with the enormously popular sitcom *Big Bang Theory*; accidentally crossing a line into bad taste and offending some people; and trying to be funny but falling flat (as one participant recalled of a college professor whose attempts at humor were “just painful”). Some audiences, especially but not exclusively older adults, may simply prefer their science served straight and react negatively to any humorous approach. One size will not fit all. Likewise, some scientists and science communicators “take it all very seriously,” one panelist said, and are ambivalent or offended when their colleagues try to use humor in their work. As a consequence, some younger practitioners have begun incorporating humor in small ways in their organizations’ programs and communications, in an effort to stay “below the radar.”

For science communicators and educators who do want to use humor but may not think they're good at it, several participants argued that being funny can be learned, either through observation and practice of standup comedy or through workshops such as the *Science Showoff* program mentioned above. Others countered that this helps only to a point, because the ability to make people laugh, like other social skills, depends on hard-to-specify aspects of self and personality—"your way of being in the world," as one participant put it, and how appealing that "way" is to others. So humor is connected to the broader question of self-revelation in science communication discussed elsewhere in this report: it requires the communicator to bring his or her personality and worldview into the spotlight along with the science. When it works, the currency in this transaction is authenticity: rather than injecting levity into the science engagement experience whether it fits or not, the successful comedic communicator exposes a fundamental connection between the scientific content and his or her way of seeing both science and the world. Hence one prominent science presenter's offhand comment during our humor discussion: "The universe, by the way, is hilarious."

3. **Mystery and the Unknown**

The traditional goal of science communication has been to convey to the public the concepts and facts revealed by science. Yet there have always been other elements in that communication, if only in "trace amounts," including information about what remains unknown or poorly understood by science: the edges of scientific inquiry beyond which things remain mysterious. Our review of the science engagement landscape suggested to us that contemporary communicators may be increasing their emphasis on mystery and the unknown, shining a more direct light on the things that don't (yet) make sense and thereby acknowledging, even celebrating, science as an explorative process rather than a repository of knowledge—indeed, as a human process with human limitations. The radio show and podcast *Radiolab*, for example, often focuses on unanswered and in some cases, perhaps, unanswerable questions, bringing speculation, disagreement, wonder, and an essential humility into the discussion of science. Recent books for the general reader by physicists like Brian Greene and Lawrence Krauss openly discuss what scientists themselves are mystified by, taking readers on journeys that end not in a triumph of scientific understanding but at the places where certainty gives way to informed, often mind-bending conjecture.

Our workshop participants associated the topic of "mystery and the unknown" with both individual and collective lack of understanding: "I don't get it" as well as "We don't know yet." Several told us that such states of ignorance served as the starting point for their work and offered a powerful prod to inquiry, initially motivating them to pursue a career and continuing to spur them to explore a particular topic. The questions that haven't been answered, one communication researcher explained, are "what moves the whole field forward." This impetus is as much emotional as intellectual: mysteries in science are tied to feelings of wonder, awe, and excitement in scientists and science communicators and educators, emotions that both catalyze and reward further investigation.

The appeal is much the same for the public, participants said. Science communication that focuses on what we can't yet grasp (especially the "far reaches, either in time or space") taps into a basic human attraction to the unknown; it makes certain subjects "grabby" to non-experts. It also conveys to the public the idea that science isn't finished yet—that there is still plenty of room for contribution and participation in this shared, unfolding enterprise. Incompleteness lets non-scientists find a place for themselves in the story of science, if only imaginatively. Moreover, as one communicator pointed out, admitting ignorance and asking simple or "dumb" questions can show the public that it's okay not to understand, thus reducing the intimidation that many adults feel in connection with science.

However, emphasizing the unknown in science also raises concerns for some observers. Taken too far, it can mean "merely mystifying" a topic for the sake of accessibility—"turning it into a big, magical show," in the words of one participant, and sacrificing learning for entertainment. Others noted that mystery can be construed by some observers as evidence of a failure on the part of science, and might be used to discredit it or challenge its authority ("See? You don't know any better than we do"). Several participants worried that highlighting the gaps in scientific knowledge could be dangerous, if it is taken as a license to fill those gaps with religious belief or wild speculation.

This tension will not be easy to resolve, but it is worth further debate and research. One workshop participant contended that science and religion both stem from a deep-seated need to explore fundamental mysteries. Science engagement professionals often make use of that impulse in order to spark interest, but they're really only "flirting" with the boundaries of knowledge:

Science gives us some proximity [to mystery and awe], but it also sometimes says, 'No, your interest in the transcendent is illegitimate.' That's where we lose a lot of people, because we're unwilling to engage in that way. We're worried that if we do it the wrong way they're not going to believe what we want them to believe.

Other participants countered that science and religion treat the unknown in opposite ways, religion by filling the gaps with myth and dogma and science by preserving the questions. In theory, this should give the advantage to science, because people "want to ask questions about the world, not just be told." Yet religion, everyone agreed, is far better than science at building social context and community around various forms of mystery and awe. In order to win wider public engagement with science, communicators and educators need to be more willing to craft that sense of community, tradition, and "family" around not only scientific knowledge but also the questions that swirl just beyond it.

4. Informality/Science as Part of Everyday Life

Like other fields associated with prestige and authority, science is sometimes viewed as a rarefied realm set apart from everyday life, with a formality of language and soberness of demeanor to mark that separateness. But today a sense of informality, spontaneity, and playfulness can be seen in

many science engagement programs, some of which—such as *Guerilla Science*, which produces theatrical installations and pop-up “interventions” at music festivals and other unexpected places—explicitly aim to take science off its pedestal in order to make it more “relatable” and easier to question. The Field Museum’s Graslie and PBS NOVA host Pogue use irreverence, goofy charm, and pop-culture references to reconnect science to the rest of contemporary life. Both are open about not having scientific backgrounds, which paradoxically grants them a certain kind of authenticity: they act as “everyman” stand-ins for the audience in the world of science. A similar surrogacy role is played by Radiolab’s non-scientist co-hosts Robert Krulwich and Jad Abumrad, who strategically model ignorance, skepticism, and other personal responses in banter that feels casual and everyday. Authenticity and informality also go hand in hand at Nerd Nite, perhaps the most raucous live science engagement series, which currently has chapters in more than 75 cities around the world. Such programs fulfill a need our participants articulated for science communicators who are seen as “relatable, agenda-free, and therefore trusted.”

Participants also spoke of everyday life as an important common ground on which scientists and the public can interact. Science communicators need to be able to understand people who lead lives very different from theirs if they are to be able to generate relevant experiences for and with them. “Connecting to people’s everyday lives opens the door to a more informal kind of interaction where people feel empowered to ask questions,” said one practitioner; it lets science come to the people instead of expecting people to come to science. Moreover, participants pointed out, there is already plenty of science in everyday life, if only science engagement professionals would credit it and use it as a starting point: for example, the geometry used by a construction worker, the biology and genetics used by a gardener or farmer, the physics used by an electrician.

So everyday settings, topics, and language contribute to what one scholar-practitioner at the workshop called the “de-otherizing” of science, as do humor, storytelling, and the other dimensions we discussed. Informality is more than a manner of communication; it is, at least potentially, a shift in our assumptions about how science fits into people’s lives and communities, what science topics matter, what outcomes are desired, who gets to set the agenda, and how scientific authority carries itself in contemporary society. Those shifts raise a number of questions for science communicators, educators, funders, and the policy community; here, too, further discussion is warranted.

5. Artistic Expression

Nowhere in our workshop was the idea of mainstreaming science more central than in the conversation about artistic and creative expression of science. If the hope is to integrate science and its people and ways of thinking into the broader culture, what better vehicle than a television show like “Big Bang Theory,” a work of fiction that nonetheless incorporates real science and (as one real-life astrophysicist at the workshop noted) keeps a PhD scientist on staff for fact-checking. The characters on the enormously popular sitcom may be stereotypical abstractions, as several participants complained, but they give a vast audience some access to how scientists think and talk. And knowing how scientists think, another participant asserted, is just as important as knowing what

science is pursuing and learning today.

The mutual attraction of the arts and the sciences is nothing new, of course, and much has been written and debated about the role of creativity, imagination, and (as one participant termed it) “free play” in both artistic practice and scientific thought. But the interest by artists of various kinds in exploring science as a subject matter, and the range of collaborations between scientists and artists in diverse settings, seem to be increasing. We heard from participants about a science tent at the Burning Man festival in which biologists worked on microscopy as a contribution to the festival’s artistic celebration; a program in which research engineers at a technology company tell science fiction writers what they’re working on in order to get help imagining what the future will look like; a scientist-in-residence position at an art school in the UK and artist- or writer-in-residence positions in science departments; and an artist collective brought in to help teach a graduate course in synthetic biology. The “two cultures” notion that held sway for the latter decades of the 20th century was described by participants as artificial and outdated: “We created the cultural divide between art and science,” declared one, “[but] we all belong to one culture.”

What brings science and art together is a shared, restless interest in how the world works. In one conversation between a hip-hop artist who enjoys rapping about science and uses music to encourage urban youth to embrace intellectual identities, and a physicist and writer who creates works of nonfiction, fiction, and theater that engage deeply with science, the moderator asked each why he is drawn to the other’s domain. **The physicist replied, “Because art is a way of understanding the world.” The rapper replied, “Because science is a way of understanding the world.”**

Not that we ignored the differences between the two fields or the asymmetry of their interactions. Whereas scientific and technological advances can lead to artistic breakthroughs (for instance, in cinema), artistic innovations don’t usually influence the course of scientific research, except in design- and architecture-related fields like engineering. On the other hand, artistic creativity can help scientists think divergently and see old problems in new ways. For the public, creative depictions of science can lead people to become scientists in the first place (one astrophysicist reported that two of his post-docs had told him that “Big Bang Theory” was part of the reason they had entered the field).

The organizers share participants’ excitement about the ways science engagement is embracing, and being embraced by, the creative sector and becoming more embedded in contemporary culture as a result. As one practitioner summed it up, the goal is a cultural landscape in which artists use science as their muse:

When science becomes the purview of the artist, then we can claim that it has entered our culture. . . .When we study ancient towns and cities, at the top of the list of their achievements is the creativity of that civilization or culture, and often art is at the top of that list. If science gets folded into that [assessment], then we’ve completed the integration of science and culture.

6. Participatory Engagement

“The web is more than a tool,” one of our workshop participants observed: “It says you don’t need a prior qualification to have a voice.” The idea that regular citizens can and should contribute to decision-making and policy-setting in various areas, including science and technology, is not new. Nor is the involvement of “amateurs” in scientific research, which was once the rule and continued, though greatly marginalized, after the professionalization of the sciences in the late 19th century. But in both areas there has been significant and novel activity in recent years, which our participants discussed under the broad headings of civic and participatory engagement. From self-organized community efforts to solve a particular problem, to “town hall” conversations about the civic implications of science or technology policy, to the maker movement, hackathons, and public participation in scientific research, there seems to be increasing acceptance of the notion that (as one participant put it) “the culture of science is something that everyone can participate in.”

That activity may not be labelled “science” in every case, but science may nonetheless play an important role:

Think about what Will Allen is doing in Milwaukee. A former basketball player goes into a food desert and creates an urban farm. All kinds of science and technology has to happen, all kinds of learning and culture takes shape around a political and personal and social issue, which is food. . . So maybe instead of looking at ourselves [in the science field] we should look at some of those other places where science understanding is happening out of necessity.

This kind of social and civic engagement isn’t simply a “hook” for people to learn about science; it’s an effort to address shared challenges in which science learning sometimes plays a part. So it differs from much science literacy programming of the past, participants said. They also noted a shift in thinking about public dialogues on science policy issues: we used to assume that there was a scientific answer, one said, but now we accept that “it’s the creation of consensus itself that matters more.”

Meanwhile, **citizen science**, fueled by the internet and by what social network theorist Clay Shirky has called “cognitive surplus,” is transforming scientific research in some fields. Sites like SciStarter, Zooniverse, and the Cornell Lab of Ornithology’s Citizen Science Central serve as portals to an ever-increasing array of participatory projects in which volunteers can contribute to the collection or interpretation of scientific data and the advance of knowledge. In astronomy, for example, journal articles have been published with hundreds of authors, the vast majority of them volunteers without academic training or professional experience in that field. Dublin’s Science Gallery and other science centers have asked visitors to become the data themselves, providing skin swabs and even blood samples for analysis. Long-held assumptions about roles and relationships—professional and volunteer, subject and object, teacher and learner, included and excluded—are being overturned and new identities are emerging.

Attendees told us that participatory engagement can change the dynamic between professional scientists and “the people formerly known as the audience.” Some scientists are made anxious by that change and worry about losing control of their research or being exposed to unpredictable interactions with the public. Others take to the new, open environment “like fish to water,” enjoying the opportunity to let their hair down in a less authority-conscious context, enthusing on social media about what the citizen-participants should be looking for in the experiment—and enjoying new or faster opportunities for publication thanks to the additional people-power. For their part, the citizens often need persuading that they are genuinely welcome to get involved and that they’re capable of contributing meaningfully to the policy process or research. Once both sides take the plunge, they usually report benefitting greatly.

The motivation for citizen-participants, according to a practitioner who runs globally popular citizen science projects, is a complex weave of the intellectual, civic, and emotional. “Overwhelmingly the answer is: ‘I want to contribute, to be useful. This is more productive than simply watching TV. Plus, this is really cool. I’m actually looking at real data for the first time, and maybe I’ll discover something.’” That enthusiasm is not merely responsive to the data collection or analysis tasks requested by the professional scientists; increasingly, it’s also generative of new research directions:

We ask people to do boring things and they come up with much more interesting things. . . .The growing number of citizen science projects reflects people saying, ‘Let’s do this!’ We’ve changed our websites to make it easier for people to come up with their own ideas and initiatives. So it’s becoming easier for people to genuinely think of themselves as scientists, with their own questions.

So participatory engagement represents more than a democratization of the labor force for scientific research in a data-rich age, or an extension of the participatory democracy movement that began in the 1960s. In some cases it has become an open-source platform for a range of people and purposes that are scientific without originating within the science establishment. As one practitioner put it, **this fundamentally changes the “social contract” between scientists and the public, giving more kinds of people the opportunity and ability to think of themselves as scientists, among their other identities.**

The mental shift for scientists is equally profound. Used to representing the authority of science unilaterally in their interactions with the public, scientists and other science communicators must adopt a more dialogic, grassroots model. That transition depends on humility, our participants said; science engagement can gather larger and more enthusiastic communities around itself by giving up the identity of “provider” and repositioning itself as a resource. As one practitioner put it:

Maintaining humility even though you’re in a leadership position—that’s the best example you can set. To create a community, you can’t position yourself as ‘the leader.’ You can only be an anchor that lets other things spin around.

Looking ahead, attendees wondered how far public participation in research will spread beyond its “home base” in areas such as astronomy, meteorology, and natural history, which have long depended on various forms of mass observation, to other fields of natural and social science. Is the increasing availability of “big data” creating opportunities for what one contributor termed “skilled citizen science,” in which volunteers with, say, sophisticated programming skills can make genuinely novel contributions? And what’s the evolving relationship between participation in science-related dialogue and participation in scientific research?

7. Emotion

The topic of emotion had already come up during our discussions of storytelling, humor, mystery and the unknown, and artistic expression, so it was no surprise that participants nominated the topic for a discussion of its own. Although the affective dimension of learning has long been on the radar of informal science educators and some communicators, this workshop seems to have been a rare opportunity to focus on emotion itself and its various functions in science engagement.

An emotional connection, participants agreed, can be a powerful “way in” to a science experience for non-experts, capturing initial attention and increasing feelings of bonding with the communicator or other participants. As with any compelling story—a good novel or movie, for example—the emotions in science communication often have to do with the audience’s identification with the scientist or science communicator or some other “character” in the narrative, who goes on a “journey” involving risk, failure and/or triumph, and self-revelation. The emotions people feel in response, such as sadness, fear, excitement, frustration, suspense, or anger, can turn what would otherwise have been an abstraction into a human, relatable experience.²

Several participants noted that such emotions present a more authentic picture of science than is sometimes offered to the public, which can feel scripted or sanitized. One communicator observed that “when scientists talk to each other it’s about their challenges, frustrations, and what’s not working. The minute there is a public involved, they feel like they need to shift to ‘Science is making the world a better place!’” **So science engagement experiences that foreground emotion—especially frustration and other negative emotions associated with failure—represent a step toward transparency and vulnerability in the field. That vulnerability can feel inviting and excitingly real to non-experts, making science less faceless and narrowly cerebral.** But participants were concerned that emphasizing the positive emotions of scientific inquiry—the excitement, suspense, and sense of triumph—might lead to unrealistic expectations in the future science workforce and an *inauthentic* image of science in the public mind. “Science is a long journey,” said one; the positive emotions are only available with long commitment and hard work.

² Audiences can also experience powerful emotions not related to those of the scientist or communicator, feelings brought to or generated by the encounter with science. These emotions can be quite negative, as in the case of GMOs, childhood vaccines, or animal testing, and managing them can pose challenges for practitioners. Those challenges seem to have received more attention in recent years, particularly in the area of risk communication, than the positive emotional dynamics we discussed at the workshop.

And vulnerability can be a challenge for some practitioners. “Scientists are really good at turning off emotion,” said one participant, echoing points that were made in our discussions of humor and storytelling. Yet the emotions experienced and conveyed by the practitioner are closely tied to the emotions felt by the audience: the scientist or communicator must take the personal risk if she wants others to share her personal connection to the work of science.

Our participants described a potentially problematic relationship between emotion and learning. They were aware of studies demonstrating that emotional arousal leads to clearer and longer recall of the associated facts, compared to a more neutral encounter with those facts. Yet they also mentioned experiments showing that emotional priming decreases logical thinking and other cognitive abilities, which could be exploited by those seeking to discredit certain scientific ideas or demonize scientists for political or religious reasons. So while the facts themselves are clearly not enough in some cases, either for creating engaging public science experiences or for persuading someone to accept a particular scientific argument, the place of emotion in the equation is fraught. Some of our participants maintained that scientists and science communicators are too often reluctant to deploy emotion strategically in order to persuade the public, either because they’re worried about “contaminating” the objectivity of science or because they don’t want to stoop to the level of those who use the emotions of fear and anger to whip up support for anti-scientific views. Others felt that there is enough rage and hate in contemporary social discourse; science communicators shouldn’t pour fuel on the flames of emotional reactivity in their efforts to connect with a wider public.

8. Power, Barriers, and Belonging

Also nominated for further discussion was a cluster of concerns about the power dynamics inherent in science communication and education; ethnic and economic diversity in both the professional community and the audience for science; the boundaries and barriers that keep some people on the ‘outside’ of science; and how to defeat those barriers and encourage feelings of belonging and community around science. Those concerns differ from the other dimensions we examined in that they can be thought of as *goals* of science engagement as well as means or mechanisms for achieving engagement (like humor, storytelling, etc.). Indeed, the conversation about this set of concerns raised important questions about the relationship between those evolving cultural means and the desired ends of diversity and belonging. Does ‘warming up’ science communication with more subjective approaches involving humor, storytelling, informality, mystery, etc. make it easier for underserved audiences to enjoy and participate in science? Such questions deserve attention in future discussions and research studies (see “Toward a research agenda,” pages 31–34).

There was universal agreement that more diversity would be beneficial on a number of levels. Looking around the room at the (admittedly non-representative) group we assembled for this workshop, several participants pointed out that the community of science engagement practitioners is not sufficiently diverse in terms of gender, economics, race and ethnicity, or educational background, and that that lack of diversity is reflected in the public community or audience for

science engagement. On both sides of that equation, issues of class loom large. Practitioners from lower economic or educational backgrounds may be less likely to pursue public engagement work because it doesn't pay as well and is considered professionally riskier and less prestigious than scientific research itself. The 'leaky pipeline' to careers in science applies doubly to careers in science communication and informal education. So a largely white, educated and upper-middle class practitioner community develops, and not surprisingly draws to itself a demographically similar audience; science becomes viewed as a 'niche' culture, something for individuals or families with the luxuries of time and education and a tradition of finding entertainment-value in intellectual stimulation. To change this perception, several participants suggested that it will be necessary (not to mention easier) to diversify the practitioner base first, as a prerequisite and pathway to diversifying the audience.

Participants were cautiously heartened that attention to these issues has increased in recent years, thanks in part to pressure from funders and other stakeholders for change. This has been particularly true in science museums, universities, and other institutional settings, where there is often a staff member responsible for diversity-oriented programming; such personnel aren't typically found in media-based science communication contexts, much less in small start-up programs. But some attendees pointed out the question of diversity is often-discussed but little acted-upon. "Do we really want to change," one asked, "or are we just paying lip service to it?"

Perhaps the most promising idea is that science experiences can actually be used not just for the sake of science learning or literacy, but to reach across cultural, economic, and institutional barriers to engage communities on their terms and for their own, self-determined purposes.

That requires practitioners to think less about communicating or educating and more about empowering and involving—a reframing that entails nontraditional approaches to the choice of subject matter, the site or setting of engagement, and the power and authority dynamics between the scientists or communicators and the non-experts. Part of the challenge, we heard, is that such programs require ongoing patronage in the form of both financial and philosophical support, and may take years, even decades, to noticeably increase the inclusiveness of science engagement as a field.

On the whole, participants had more questions than answers about this set of concerns, and they articulated an urgent agenda for further inquiry. What attracts different kinds of people to public science experiences, and which elements help create a feeling of belonging? Conversely, what keeps people away, and which elements act as barriers? What's the interplay between generational, ethnic or cultural, and economic barriers—both among professionals and audiences? What would an ideal science engagement experience look like from the point of view of people or communities who currently feel excluded or just uninterested? Do participatory forms of engagement offer a more inclusive and empowering connection to science for diverse populations? And more broadly, how do we get beyond the idea that science engagement is the province of professional science communicators only, and activate a wider community of "connectors" to integrate science into people's everyday lives?

We recognize that these questions are by no means unique to our convening and that significant work is being done in this area by researchers, policymakers, and practitioners in several countries. These and related questions should be included in the research agenda developed in the next phase of this initiative.

C. Toward a research agenda

In the findings sections above, we've tried to capture some of the most important and thought-provoking ideas about science engagement shared by participants during the two-day convening, including descriptive assertions about what's happening in science engagement and normative statements about what *ought* to be happening. But in addition to assertions, we heard a great number of questions, only a handful of which are cataloged in this report. The questions were accompanied by frequent reminders that the whole dialogue was being conducted on the empirically shaky grounds of anecdotal observation, intuition, and speculation. Time and again, participants noted that we can't really say what's happening—how public science engagement is changing—because we don't have the data, either about the landscape as a whole or about the specific sensibilities, strategies and experiences we were discussing.

We couldn't agree more. While we hope that the workshop and this report will inform the relevant conversations and thereby be of some immediate utility to organizations and individuals working in or supporting public science engagement, it is by design and necessity only a beginning. **The purpose of the convening was to take a fresh look at contemporary practice and, in that new frame of reference, raise empirical questions that we might not have thought to ask in the previous frames.** This is indeed what happened, and we heard an enthusiastic and impatient desire to answer those questions and put the whole analysis on a more solid foundation. So one possible next step, as shown in the diagram on page 3, would be to develop a collaborative research agenda that organizes and prioritizes the questions articulated during those two days in Cambridge, then develop research proposals to pursue the most promising lines of inquiry.

In the present report, we set the stage for that process by summarizing some important points made by participants about research itself and its relationship to practice and policy, especially during a panel discussion on the second day of the meeting which featured four of the social scientists and learning researchers in attendance.

1. The research is out there—but sometimes in distant disciplines

Many of the cultural questions we were discussing, said the researchers, have been addressed either theoretically or empirically in other fields. Humor, for example, has been studied by linguists, folklorists, psychologists, and philosophers. Emotion and its relationship to thinking is currently a hot topic in behavioral economics and neuroscience. Culture itself is the subject of scrutiny by anthropology, sociology, media studies, and of course cultural studies, not to mention applied fields like marketing and political campaigning. Science engagement professionals might make good use of

those literatures, but there are barriers: we may not know how to find the relevant papers, we may not be able to make sense of them (for instance, if they're technical in ways our own training hasn't prepared us for), and their implications for our practice may be far from clear. "Would it tell me what to do? Probably not," mused one researcher. Yet as we begin to take a more cultural view of science engagement, those outside disciplines become increasingly important—including the humanities and the humanistic social sciences. "People who have spent centuries thinking about how to engage with human beings are probably useful," said a rhetorician on the panel. The nascent field of learning sciences, as its plural name suggests, is an attempt to bring the tools and perspectives of multiple disciplines to bear on phenomena like science engagement, and its current and potential contributions were mentioned by several participants.

2. **Culture matters—not just ours, but theirs**

The ways in which citizens respond to science are intimately bound up with their own identities and the cultures (plural) that they inhabit, several researchers told us. So it's less important to understand "the culture of science engagement" than it is to understand the cultures of the people and communities we hope to engage and serve. As one researcher asked:

Who's culture counts? What I hear when I listen to you is that science's culture counts, in a way that it's very authoritative, very powerful, and that . . . might be seen as very western, very male, very middle class. It might be tied up with power in ways that we're not being very explicit about.

The idea is to think about science *in* culture, rather than science *as* an autonomous culture. This is especially important when engagement practitioners work with economically disadvantaged, less empowered communities, the kind that have traditionally been on the periphery of the field. It's also essential to understanding how people perceive and process information about climate change and other risk and policy issues: "It's always politics, it's always culture," said another researcher, "it's always hopelessly braided."

What we don't know is *how*, exactly, culture matters in science engagement, and how differences among cultures shape what's possible. But there is keen interest in studying these questions. One researcher described wanting to find out why some communities feel alienated by science: "What alienates them? What pisses them off, or makes them feel uncomfortable?" Another stressed the need to understand identity—a cultural as well as personal construct—and its effects on engagement. "Identity," he said, "is central to people's willingness and ability to learn," but it's tricky to study since it can be situationally fluid and shifts over time.

3. **Let's stop pretending we can preordain outcomes**

In what may be the clearest policy implication to arise from the workshop, several researchers asserted that the science engagement field must become more modest and open-ended in its thinking about outcomes. They were concerned less about claims that specific outcomes occur and

more about the basic notion that outcomes can be predicted or controlled at all. “Learning is so idiosyncratic, so bound by personal beliefs, attitudes, and context, that it’s impossible to predict what they’ll learn in any given situation.” The same might be said of other outcomes, such as interest in, perceptions of, or self-identification with science (all of which are modulated by learning in any case). You can only know by studying what’s happening. That complexity and unpredictability, coupled with the almost infinite set of influences on people’s attitudes and identities, make traditional forms of outcomes measurement a fool’s errand, according to one researcher:

One question I get asked a lot is, ‘Can you do some research and prove the impact of my work?’ And I can’t do that. . . . The impact of one intervention, one show, one podcast, one program, is really hard to assess in the context of a whole life.

So while there was abundant enthusiasm for new directions of *research*, there was deep skepticism about *evaluation*, at least in its typical “outcomes evaluation” guises. That skepticism came not only from the researchers but from practitioners, as well (as perhaps it always has), and is tied to what we called the artistic motivation of certain science communicators in the section on pages 16–17 (“Beyond education—divergent thinking about goals”). Independent programs like Nerd Nite and Story Collider can create significant cultural impact without first undertaking the kind of systematic consideration of learning outcomes and other objectives so often expected of science engagement practitioners by funders. Indeed, it may be that relaxing those expectations would help foster further innovation and risk-taking in the field, at least while the field’s understanding of the cultural dimensions of science engagement catches up to the evolutions and revolutions on the ground.

4. **We need to study science engagement as a system—and chart people’s pathways through it**

One note that was sounded often in the research conversation was the importance of understanding the science engagement ecosystem as a whole, not just at the level of individual programs or at the level of categories or goals (science museums, science journalism, science literacy, etc.). What is the landscape of options for adult non-scientists to connect to science? How do they enter that landscape and make their way through it? What comes first, and what leads to what—or fails to lead anywhere? Which kinds of audiences are choosing which options? Which communities have access, and to which forms of engagement? **We simply don’t have answers to these macro-level questions, participants said; there’s a need for new empirical research.** “We need to know more about the links between schooling, television, mass media, new media, and the more niche science communication activities we’ve been hearing about” at the workshop, one researcher noted, in order to understand the roles that science engagement plays in people’s lives.

The methodological and resource challenges involved in conducting that system-level research may be considerable, but that should be no barrier to, first, articulating the questions more fully and, second, conceiving rigorous, original ways of answering them. Ideally that research would be designed and conducted via partnerships between researchers and practitioners, including the kind

of creative, emerging science communicators and educators whose programs and audiences have not been on the radar of the research community. We look forward to seeing that empirical work take place in the next phase of the Evolving Culture of Science Engagement initiative, and we welcome suggestions and indications of interest from researchers, practitioners, and the funding and policy community.



conclusions

The cultural shifts we've discussed in the foregoing pages don't appear to be limited to public science engagement. They seem to be characteristics of contemporary culture more broadly. Imagine a latter-day Rip van Winkle who fell asleep twenty years ago, in 1994, and reawakened in 2014. The most disorienting changes, perhaps, would be related to technology. But there would be other surprises and discontinuities. Observing certain developments in areas as diverse as journalism and news, music and the arts, politics and government, business and advertising, fashion, food, and language, our sleeper might be surprised at how domains once characterized by some formality and seriousness, by an emphasis on professionalism, objectivity, and institutional authority, and by clear categories and hierarchies (especially "high" and "low" culture) are now often marked by informality and social activity, playfulness and irony, amateur and participatory contributions, a new prominence for subjectivity and personality, a more decentralized, independent view of authority, and a flatter, "messier" landscape in which traditional category boundaries and value hierarchies have become blurred. He would notice, too, that the new norms and values haven't replaced those of the earlier era so much as arisen alongside them, widening and complicating the set of options available to the public. Yet, being evolutionarily minded as well as culturally astute, our Rip wonders if the unfamiliar cultural forms could be competing with the older ones for attention and support—whether we might be at a kind of "boundary moment" between two periods of culture, with new forms emerging and some traditional forms likely to die off.

Thinking along those lines, one participant in our workshop noted that the new norms may represent a break with the 20th century but are actually a return, in some ways, to the situation that preceded it. It may be the 20th century, rather than the 21st, that proves to be the anomaly:

The 20th century is very unusual. It's the centralization and professionalization of everything. Before and after the 20th century, it's much more about narrative, much more one to one, much more small talk. . . . Journalism was what you heard at the bar, my personal leaflet that I cranked out in my basement. Which is like blogging today.

Another agreed, adding that, while professionalization allowed science to make "huge leaps" in the late 19th and 20th centuries, we're now entering a different era.

Whether or not that broader proposition is correct, there does seem to be a consensus, at least among the practitioners and other thinkers we gathered for the Evolving Culture of Science Engagement workshop, that these are times of profound and rapid change in the fields of science communication and informal science learning, with innovations proliferating and new “rules of engagement” being explored and embraced by both producers and participants. We offer this report as an attempt to take stock of this moment in ways that may differ from previous and parallel efforts, specifically by emphasizing cultural dimensions of science engagement that are sometimes overlooked or relegated to an afterthought in a discourse focused on specific outcomes and the most efficient and effective means to achieve them. There is some irony in the possibility that the cultural mechanisms we’ve been discussing may in fact *be* among the most effective means for achieving some of those outcomes, and that they may be neither incidental to public engagement nor peripheral to the professional and academic discourse on the subject. At a minimum, the workshop conversation suggests that we need to know much more about how those cultural mechanisms influence attention, learning, identification, accessibility, interest in STEM subjects and careers, diversity of both the profession and the participant base, community engagement, acceptance of scientific facts and ways of thinking, and other outcomes.

In addition, we value and support the other conversations taking place in this domain, including the National Academies’ influential Sackler Symposium on “the science of science communication,” the second iteration of which took place—unavoidably, as it turned out—on the same days in September, 2013 as our workshop. The “science” and the “culture” of science communication are complementary, essential frames of reference, and are likely to be even more productive when brought into dialogue.

We hope that the contribution we’re trying to make with this initiative—to round out the picture by looking at the full range of ways adult non-scientists connect to science and the apparently shifting cultural assumptions that shape those interactions—is valuable even to those who are already experimenting with, supporting, and studying those new cultural forms. As we noted in the introduction to this report, the problem isn’t a lack of fresh, interesting activity in the science engagement field, or even of financial support for that activity; it’s a lack of theoretical and empirical frameworks that are culturally attuned and holistic enough to make sense of what’s going on—to understand how and why it works, evaluate it, and encourage more of it. In the words of one participant at the workshop, “The models need to shift for measuring our new goals.” The problem is also a lack of communication and awareness across the many practice areas and professional communities working in the field. Our workshop was only the beginning of a solution to both of those problems, and only one contribution among many taking place in the field.

Mainstreaming won’t be easy

One of the overarching themes of our conversation was the desire to “mainstream” science in contemporary society—but without losing the “edge” associated with any truly creative, culturally relevant venture. As that “but” suggests, the desire for science to become an everyday part of

culture is accompanied by some ambivalence. After all, decades of respect, prestige, and authority for science were premised in part on the idea that science was a distinct, highly specialized domain set apart from everyday life and “layman” ways of thinking. Even successful science popularizers like Carl Sagan often encouraged that separation with a tone of reverence, lofty or poetic language, and an emphasis on the transcendent.³ So it wouldn’t be surprising if some in the science engagement community were concerned about the possible loss of that distinctiveness and prestige as science becomes more assimilated into the wider culture. Indeed, assimilation may be a useful metaphor here: there is an abundant literature on the tensions in immigrant communities between “fitting in” and preserving distinct, meaningful cultural identities, languages, and practices. Science engagement appears to be facing analogous questions.

If our Rip van Winkle hypothesis about the historical shifts now underway is correct, it’s possible that any such losses will be balanced by a new kind of relevance and public embrace. It may be that, in the 21st century, scientific authority gains rather than loses by presenting itself as everyday, informal, personal and subjective, playful, socially mediated, and operating at least partly outside of institutional structures. That, at any rate, is one plausible explanation for the roles played in contemporary culture by figures such as Neil deGrasse Tyson, “I Fucking Love Science” proprietor Elise Andrew, and Radiolab hosts Jad Abumrad and Robert Krulwich, among many others. Moreover, similar dynamics—and similarly influential and culturally resonant figures—can be observed in fields other than science.

Even though it may entail some diminution of the “specialness” traditionally associated in the public mind with science as a discipline, many of our participants were excited about mainstreaming science, suggesting that they believe the gains will outstrip any losses. The goal is embeddedness: getting to the point where science and its stories, questions, and people are included naturally, as a matter of course, in multiple domains of life. That goal, and the changes it requires, has important implications for policy, funding, and the training of scientists, science communicators, and science educators.

A fresh look at the logic of engagement

Another recurring theme in the workshop discussions was the related notion that some forms of science engagement are—and should be—less about building public understanding or conveying scientific knowledge and more about creating an audience for science in the first place: offering science experiences that “warm up” and humanize the image of science and recast it as fun, active, emotional, social, relevant, and “relatable.” For audiences of newcomers to science, attention and interest can’t be assumed; they must be earned *on their terms*—which is to say, on the terms of contemporary culture. Humor, storytelling, emotion, mystery, music, social participation, and the other strategies and sensibilities we discussed at the convening help draw and reward attention to

³ Interestingly, the same might be said of a beloved popularizer in the arts who was Sagan’s contemporary: the conductor and composer Leonard Bernstein. Only in retrospect does Bernstein, like Sagan, appear to be a product of his time rather than an outlier.

science among people who are not already identified with it. Those rewards are irreducibly hedonic: people without a professional or educational need to connect with science are likely to connect with it only if doing so is enjoyable—if it makes them happier in some way. **So a rationalist view of interest, curiosity, and relevance misses the point. Engagement precedes and sets the conditions for interest, curiosity, learning, and identification, not the reverse** (see also discussion on page 21). If so, *explaining* science or communicating “interesting” scientific information is not necessarily the best starting point, at least when the goal is to broaden the audience for science.

Hence the centrality of the cultural dimensions we’ve been focused on: they set the conditions for engagement. Take, for example, relevance and “relatability,” which are often thought of in terms of the familiarity or importance of the subject matter to the audience (or the ability of the communicator to connect it to something familiar and important). In this new context, they seem to be about something else, as well: the personality and emotions of the communicator, the alluring mystery or *unfamiliarity* of the content, the social or virtual community in which participation takes place or the sense of identity it confers, or some other engaging attribute of the experience.

This new logic—in a nutshell, that some science engagement might best be regarded as engagement first and science second—is closely related to the observation, discussed on pages 17–18, that there is wide divergence among science engagement professionals in the area of goals and outcomes. Our workshop participants not only have *different* outcomes in mind for their programs and audiences; some of them reject the idea that they should be thinking about goals or outcomes at all, at least in the sense often required by funders. The latter group may be a minority, but it appears to include some highly creative, successful, and influential communicators. It is these professionals, along with others who do think about goals and outcomes but frame them broadly, who seem most aligned with the proposition that science engagement should focus less on conveying information or facilitating learning and more on attracting audiences and weaving science into contemporary life.

This emerging view among some science engagement professionals may be mirrored in a new view and approach by audiences. In some formats, such as a science café or a television documentary, it seems likely that the decision to attend or view is premised in large part on the individual’s interest in the topic at hand. (“I love whales, I’d like to watch that.”) But it seems *unlikely* that the decision to attend a Nerd Nite or Story Collider event, or view an Xkcd comic, or listen to a Radiolab episode, is premised on interest in the specific science content that will be discussed. In the case of Nerd Nite, participants may not even be aware of the speakers’ topics in advance; they attend in order to do something fun, relaxing, and entertaining with friends, and they expect the communicators, host, and performers to be...well, entertaining. In the case of Story Collider, the very question of topic isn’t really germane; the personal story is given precedence over the science content, and the appeal lies in the storytellers themselves and in the communal experience of listening, drinking, and enjoying.

These new ways of thinking raise questions for funders and policymakers about the role of “intended outcomes” in the funding process for public engagement. In the last decade, many foundations

and corporate supporters have broadened the goals and success-metrics in their grant programs, and some individual donors and philanthropists have long taken an instinctive approach in their support decisions. But even so, grant applicants in science communication and informal science learning are often still required to stipulate in advance a set of outcomes against which their program will be evaluated—and those outcomes are often specific to the scientific content at hand, even in programs where that content is not the main point. **Are our frameworks for goal-setting and evaluation keeping pace with our evolving vision and strategies for public engagement?** Have we developed the right metrics for the kinds of cultural affinity with science that some practitioners are now aiming for? Are our evaluation methods suited to those goals and to the settings and modes in which science engagement now operates? Is it time to rethink the whole notion of *a priori* determination of outcomes—should we be looking at what actually happens instead, so we can incorporate emergent findings in our assessments? A conversation focused on these questions could be helpful to the field.

Recommended next steps

This report offers a snapshot, a description of one moment in the rapidly evolving culture of science engagement. As with any snapshot, it is immediately out of date. So we hope the snapshot will become a “motion picture” through continued conversation, empirical investigation, and programmatic experimentation. We recommend several steps to those who share that hope, and we look forward to helping anchor and facilitate these efforts:

1. **Soliciting responses, widening the conversation.** We invite comment, questions, and debate about this document from workshop participants as well as the wider communities of practice, research, policy, and funding. In order to diversify and extend this line of inquiry, the conversation should be broadened beyond the small group that attended the workshop. That wider conversation should take place within and across existing professional and academic networks, and would ideally include commentary in the general media where science and culture are covered. The initiative website (cultureofscienceengagement.net) can serve as a hub for some of that wider discourse. **Readers are invited to post comments at the site or email the authors directly; we can be reached collectively at team@cultureofscienceengagement.net.**
2. **Developing an online database of science engagement programs.** Workshop participants called for the creation of a central, frequently updated online database of science engagement programs that would include not just mainstream and institutional offerings but new, small, independent, virtual, community-based, and one-off activities as well as relevant work in other fields. The idea stemmed from the realization, mentioned on page 15, that even innovative practitioners have only a partial picture of what’s going on in the field and that access to the full picture could provide context and inspiration, lead to new partnerships, and extend the community. We concur, and we would add that such a database will be a necessary foundation for the system-level research we envision (see pages 33–34). We already have information about an interesting but small and by no means representative set of public engagement experiences, which could serve as the kernel of such a database.

The challenge would be ensuring that it is as comprehensive as possible and stays current, which may require a combination of initial and ongoing online research and crowdsourced nominations from science communicators, educators, researchers, funders, and members of the public. It is an undertaking that could be of real service to the science engagement community.

3. **Developing a research agenda.** As we've noted throughout this document, the September gathering was intended to begin laying the conceptual foundations for new empirical research into how, why, and with what effects the culture of science engagement is changing. The need for such work was also voiced independently by our participants, who noted that this inquiry is new territory for the field and that we lack data on almost every cultural dimension we discussed. Our summary of the research implications of the workshop are discussed on pages 30–33. Provisionally, we envision two layers of research. The first would be a system-level inquiry in which the full range of science engagement options available to the public would be mapped; that map would then be dimensionalized in terms of the cultural qualities we've identified (serious to humorous, formal to casual, etc.) and other factors; then empirical research would be conducted to understand how people make use of that landscape and move through it over time. That last question will be challenging to answer and may require a new national population survey of science engagement—perhaps something analogous to the National Endowment for the Arts' Survey of Public Participation in the Arts, which has been conducted six times since 1982.

The second layer would involve more focused investigations into the motivations, experiences, and outcomes of people who connect with science via culturally innovative science experiences, which have not been well studied to date. What happens in the audience, exactly, when a communicator gets choked up with emotion while telling a science story (as happened at the Story Collider performance shown on our cover)? How does laughter influence perceptions of science or interest in a subject, and what kind of humor “works” for which audiences in which settings? What role does the personality of the communicator play in helping foster identification with science? How do artistic expressions of science shape engagement and understanding? This layer might involve, among other methods, in-depth ethnographic studies of particular science engagement settings and communities.

Those are just a few of the possible structures and approaches for exploring the scores of questions raised at the workshop, and of course subsequent conversations will generate additional and alternative questions from other practitioners, researchers, and funders. We recommend a collaborative, interdisciplinary process to prioritize and organize the key questions in a new research agenda, parts of which can be implemented in empirical studies in Phase 2 of the initiative.



acknowledgements

The Evolving Culture of Science Engagement workshop would not have been possible without the generosity of Ron Ottinger, Penny Noyce, Ann Bowers and the Noyce Foundation; Doron Weber and the Alfred P. Sloan Foundation; and Jeff Ubois, Lauren Pabst and the MacArthur Foundation. The organizers are deeply grateful for their support and collegueship. We are also grateful to Vince Thomas and the Intel Corporation for making possible the two very valuable and convivial evening events associated with the workshop, and to Clare Matterson and Stephanie Sinclair at the Wellcome Trust for making the gathering something of a transatlantic summit by providing travel support for a number of UK-based individuals. Deborah Fitzgerald, Kenan Sahin Dean of MIT's School of Humanities, Arts and Social Sciences, and Marc Kastner, MIT's Dean of Science at the time, both provided crucial additional support, as did the university's Department of Physics, the Knight Science Journalism Fellows Program, and the Program in Science, Technology & Society.

We also thank Tiffany Lohwater and Linda Hosler from the American Association for the Advancement of Science (AAAS) for their crucial insights and advice during the planning process. In addition to participating in the workshop, Linda ably directed a team of note-takers, timekeepers, and breakout-group facilitators that included Jessie Billingham, Sung Kim, Joy Rankin, Annie Storr, Michaela Thompson, and Kenrick Vezina.

Angela Healy and Michael Burns of the Rowland Institute at Harvard were generous hosts for the second day of the workshop. Erin Barker produced and winningly co-hosting the Story Collider event with Ben Lillie. Liz Monroe-Cook was an expert co-facilitator of the workshop sessions and offered valuable design and process suggestions. Julie Fooshee of the Science Festival Alliance was a tireless and talented coordinator.

Finally, we offer deepest thanks to the advisory committee members listed on page 4, as well as to David Ucko, Zahava Doering, and Karyn Traphagen for their early and wise counsel on the initiative.



appendices

The remainder of this document consists of the following materials:

Appendix A: About the organizers/authors

Appendix B: Workshop participants

Appendix C: Workshop agenda

APPENDIX A: About the organizers/authors

The Evolving Culture of Science Engagement initiative is a collaboration between MIT and Culture Kettle.

Following are brief bios of the organizers (who are also the authors of this report) and a brief description of Culture Kettle. The organizers can be reached collectively at team@cultureofscienceengagement.net.



David Kaiser is Germeshausen Professor and Department Head of MIT's Program in Science, Technology, and Society and a member of MIT's Department of Physics. His books include *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics* (2005) and *How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival* (2011). A Fellow of the American Physical Society and recipient of the Pfizer Prize from the History of Science Society for best book in the field, Kaiser has also received MIT's highest awards for excellence in teaching. His work has been featured in *Science*, *Nature*, *Scientific American*, the New York Times, the *London Review of Books*, and the *Huffington Post*, as well as on NOVA television programs, NPR, and the BBC. He is currently writing two books about gravity: a

textbook, with his colleague Alan Guth, on gravitation and cosmology, and a history of research on general relativity over the twentieth century.



John Durant has been director of the MIT Museum and adjunct professor in the Science, Technology & Society Program since 2005. He is a founder of the international Science Festival Alliance and founding editor of the quarterly peer-reviewed journal *Public Understanding of Science*, as well as the author and editor of numerous books, essay collections and scholarly articles in the history and the public understanding of science. His research focuses on public perceptions of the life sciences and biotechnology, the role of public consultation in science and technology policy-making, and the role of informal media and institutions (especially museums) in facilitating public engagement with science and technology.

He received his BA in natural sciences from Queens' College, Cambridge in 1972 and went on to take a PhD in history and philosophy of science, also at Cambridge, in 1977. He has served as assistant director and head of science communication at the Science Museum, London and chief executive of At-Bristol, an independent science center in the West of England.



Peter Linett is founder of Culture Kettle (see below) and chairman & chief idea officer of Slover Linett Audience Research, a social research firm for the culture and informal learning sectors. He and his Chicago-based team of social scientists help performing arts organizations, museums of all kinds, and cultural funders understand their audiences, evaluate their impact, and experiment with new strategies for participation. His clients range from Carnegie Hall, the Getty Museum, and Dance/USA to the American Museum of Natural History, the National Science Foundation-funded Art of Science Learning initiative, and the Irvine Foundation. Linett is an associate of the Cultural Policy Center at the University of Chicago, where he earlier pursued graduate work in philosophical aesthetics. From 2002 to 2013, he served on

the editorial staff of *Curator*, the museum field's leading peer-reviewed journal. He is the co-author, most recently, of "New Data Directions for the Cultural Landscape: Toward a Better-Informed, Stronger Sector" for the Cultural Data Project (with Sarah Lee). He lives in Santa Fe, New Mexico with his wife and twin daughters.

(continued)



Thomas Levenson is Professor of Science Writing at the Massachusetts Institute of Technology. He is the author of four books on science and the history of science, most recently *Newton and the Counterfeiter* (2009) and *Einstein in Berlin* (2003). He has also produced, directed, written, and or executive-produced more than a dozen science documentaries, most recently the PBS mini-series *Origins* (2004) and the “Back to the Beginning” episode in that series, for which he received the 2005 National Academies Communication Award and the Foundation for the Future Walter P. Kistler Prize for best science documentary. Prior to *Origins*, Levenson produced directed and wrote the “Dome” episode in the PBS series *Building Big* (2001), for which he shared George Foster Peabody Award. He received the AAAS

Science Communication award for his NOVA film “Eclipse of the Century.” His writing has appeared in a wide range of newspapers, magazines and digital publications. Levenson earned his bachelor’s degree in East Asian Studies from Harvard University.



Ben Wiehe is manager of the Science Festival Alliance, an international network dedicated to encouraging more and better science festivals everywhere. Based at the MIT Museum, the Alliance was founded in 2009 with a three-year grant from the National Science Foundation. Ben was previously Outreach Program Director at the public media organization WGBH, where he supported the grassroots growth of science cafes. His experience includes education and fundraising in museums, natural parks, and public schools. He received his MA in the social sciences from the University of Chicago and holds a bachelor’s degree in philosophy and physics from Bowdoin College.



Culture Kettle is a new accelerator for knowledge and progress in the cultural sphere. We ask big-picture questions about how public participation is evolving, and we collaborate with game-changing practitioners and thinkers to answer those questions through dialogue, research, and experimentation. We step outside traditional categories and hierarchies to look at culture as a whole and see how the gears are turning, so we can contribute new insights to the quest for relevance, resilience, and diversity. From art, science, media, music, and museums, to food, sustainability, entertainment, urban design, and community development, we see culture without the capital “C,” shining light not just on nonprofit, institutional participation but on all the ways people explore, express, connect, learn and play today.

The Evolving Culture of Science Engagement initiative is Culture Kettle’s first project and sets the template. Culture Kettle will bring together forward-looking cultural creators, distributors, funders, and scholars to challenge each other and reframe the conversation. Then we’ll work together to figure out how things operate in that new frame—and what else is possible—by conducting fresh, creative empirical research. Finally, we’ll partner with a wide range of colleagues to incubate and model those new possibilities for the field in live, public experiments. The result will be a more nimble, adaptive cultural domain and a more valuable range of cultural options for more kinds of people. For more information, email Culture Kettle’s founder & firekeeper, Peter Linett, at peter@culturekettle.org or visit www.culturekettle.org.

The Evolving Culture of Science Engagement

AN INITIATIVE OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY & CULTURE KETTLE
IN ASSOCIATION WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)

Workshop Participants List

(actual attendance)

Note: Practitioners and researchers are listed first, followed by policy stakeholders & funders.

Practitioners and researchers

	Last name	First name	Title/role(s)	Affiliation	Bio/profile	Program link
1	Alexander	Melissa	Director of Public Programs	Exploratorium	http://www.linkedin.com/pub/melissa-alexander/4/476/626	www.exploratorium.edu
2	Andrew	Elise	Blogger, Founder	"I Fucking Love Science" page on Facebook	http://en.wikipedia.org/wiki/Elise_Andrew	https://www.facebook.com/IFeakingLoveScience
3	Apsell	Paula	Executive Producer	NOVA/WGBH	http://www.pbs.org/wgbh/nova/about/apse.html	http://www.pbs.org/wgbh/nova/
4	Barker	Erin	Senior Producer	Story Collider	http://themoth.org/posts/storytellers/erin-barker	http://storycollider.org/podcast/2012-06-14
5	Bartusiak	Marcia	Professor of Science Writing	MIT	http://cmsw.mit.edu/profile/marcia-bartusiak	http://www.amazon.com/Marcia-Bartusiak/e/B001HMN8D6
6	Beck-Hofmann	John	Director/DP	Independent Filmmaker	http://en.wikipedia.org/wiki/John_Beck_Hofmann	http://www.jpl.nasa.gov/video/index.php?id=1090
7	Berlin	Heather	Neuroscientist	Mount Sinai School of Medicine	http://en.wikipedia.org/wiki/H._A._Berlin	https://www.youtube.com/watch?v=3pZxt0SiHhw
8	Blakley	Johanna	Managing Director and Director of Research	Norman Lear Center, University of Southern California	http://www.learcenter.org/html/about/?cm=blakley	http://www.ted.com/talks/johanna_blakley_social_media_and_the_end_of_gender.html
9	Blum	Deborah	Professor of Journalism	University of Wisconsin	http://deborahblum.com/Autor.html	http://www.amazon.com/The-Poisoners-Handbook-Forensic-Medicine/dp/014311882X
10	Braun	Ashley	Web Editor/Writer	NOAA	http://ashleybraun.com/	http://blogs.scientificamerican.com/incubator/2012/11/26/introducing-ashley-braun/
11	Brinkman	Baba	Rapper and Playwright		http://www.bababrinkman.com	http://www.youtube.com/watch?v=F8U9TON4RyQ
12	Cavalier	Darlene	Founder	SciStarter and Science Cheerleader	http://www.sciencecheerleader.com/about-us/darlene-cavalier/	http://discovermagazine.com/2011/dec/17-the-citizen-scientist#.UI08R8bkvX4

	Last name	First name	Title/role(s)	Affiliation	Bio/profile	Program link
13	Chang	Sophia	Manager/producer in music and education		http://www.linkedin.com/profile/view?id=45496333	
14	Cross	Steve	Head of Public Engagement / Founder of Science Showoff	University College London	http://www.ucl.ac.uk/news/news-articles/1011/10112404	http://www.scienceshowoff.org
15	Dallas	Duncan	Founder	Café Scientifique		http://www.cafescientifique.org/
16	Davis	Pryce	Graduate student in Learning Sciences	Northwestern Univ.	http://www.sesp.northwestern.edu/profile/?p=18394&PryceDavis/	http://www.sesp.northwestern.edu/learning-sciences/index.html
17	Dawson	Emily	Lecturer in Science Engagement & Communication	Kings College London	http://www.kcl.ac.uk/sspp/departments/education/people/academic/Dawson,-Emily.aspx	http://www.tandfonline.com/doi/abs/10.1080/21548455.2011.628503#.Ui1E3sbkvX4
18	Day	Tracy	Co-founder and Chief Executive Officer	World Science Festival	http://www.worldsciencefestival.com/participants/tracy_day	www.worldsciencefestival.com
19	DeGrasse Tyson	Neil	Astrophysicist and Director of the Hayden Planetarium	American Museum of Natural History	http://www.haydenplanetarium.org/tyson	http://www.startalkradio.net/
20	Eveleth	Rose	Freelance journalist and producer		http://www.roseveleth.com/	http://www.thesciencestudio.org/
21	Flatow	Ira	Executive Producer & Host	ScienceFriday	http://www.sciencefriday.com/about/about-ira-flatow.html	www.sciencefriday.com
22	Friedman	Alan	Consultant for Museum Development and Science Communication		http://friedmanconsults.com/	http://friedmanconsults.com/yahoo_site_admin/assets/docs/Scientists_Sharing_Science.127151628.pdf
23	Garbarino	Jeanne	Director of Science Outreach	Rockefeller University	http://www.doublexscience.org/author/jeanegarbar/	http://www.nature.com/spoton/in/new-york/
24	Gorman	Michael John	Director	Science Gallery Dublin	https://sciencegallery.com/team	https://sciencegallery.com/
25	Grabill	Jeff	Professor of Rhetoric	Michigan State University	http://cs3.msu.edu/people/profile/grabill-jeffrey/	http://www2.matrix.msu.edu/wide/
26	Graslie	Emily	Chief Curiosity Correspondent	Field Museum / The Brain Scoop	http://thebrainscoop.tumblr.com/aboutus	http://www.youtube.com/thebrainscoop
27	Greene	Brian	Physicist, author, co-founder of World Science Festival	Columbia University	http://www.briangreene.org/	http://www.ted.com/talks/brian-greene-why-is-our-universe-fine-tuned-for-life.html
28	GZA		Hip-hop artist	Wu-Tang Clan, Rap Genius	http://www.wutang-corp.com/artists/wu-artist.php?id=3	http://rapgenius.com/artists/Science-genius
29	Hari	Kishore	Director, Bay Area Science Festival	University of California–San Francisco	https://plus.google.com/101895817057324722830/about	http://www.bayareascience.org/

	Last name	First name	Title/role(s)	Affiliation	Bio/profile	Program link
30	Helmreich	Stefan	Professor of Anthropology	MIT	http://web.mit.edu/anthropology/people/faculty/helmreich.html	http://www.amazon.com/Allen-Ocean-Anthropological-Voyages-Microbial/dp/0520250621
31	Hilts	Phil	Director, Knight Foundation Science Journalism Program	MIT	http://ksj.mit.edu/about/faculty-staff/phil-hilts	http://ksj.mit.edu/
32	Kneebone	Roger	Surgeon / Wellcome Public Engagement Fellow	Imperial College London	http://www1.imperial.ac.uk/medicine/people/r.kneebone/	http://www.youtube.com/watch?v=dWtILWOYwpQ
33	Krulwich	Robert	Co-host	Radiolab	http://www.radiolab.org/people/robert-krulwich/	http://www.radiolab.org/
34	Levin	Janna	Professor of Physics and Astronomy	Columbia University/Barnard College	http://www.jannalevin.com/bio.html	http://www.amazon.com/Janna-Levin/e/B001IXTNZQ
35	Lewenstein	Bruce	Professor of Science Communication	Cornell University	http://lewenstein.com/cornell.edu/	http://www.youtube.com/watch?v=uD847XRuOIE
36	Lightman	Alan	Novelist, essayist, physicist and educator	MIT / Catalyst Collaborative	http://writing.mit.edu/people/faculty/homepage/lightman	http://www.centralsquaretheater.org/about_ccmit.html
37	Lillie	Ben	Co-Founder	Story Collider	http://storycollider.org/podcast/2010-12-12	http://storycollider.org
38	Livingston	Troy	Vice President for Innovation and Learning	Museum of Life and Science	http://www.nisenet.org/users/troy-livingston	http://lifeandscience.org/
39	Manning	Colleen	Director of Research	Goodman Research Group	http://www.grginc.com/staff.html#colleen	http://archive.informalscience.org/evaluation/show/633
40	Mayas	Rabiah	Director, Science and Integrated Strategies	Museum of Science and Industry, Chicago	http://tedxwindycity.com/2009/12/19/dr-rabiah-mayas/	http://www.msichicago.org/education/
41	Mittelbach	Margaret	Curator/Co-founder	Secret Science Club	http://www.environment.nyu.edu/object/environment.margaretmittelbach	http://secretscienceclub.blogspot.com/
42	Mnookin	Seth	Author/Journalist	Associate Director, MIT Graduate Program in Science Writing	http://sethmnookin.com/bio/	http://www.amazon.com/Panic-Virus-Story-Medicine-Science/dp/1439158649
43	Naro	Maki	Comic artist	www.sci-ence.org	http://sci-ence.org/about/	www.sci-ence.org
44	Podolak	Erin	Science Writer	Dana-Farber Cancer Institute	http://erinpodolak.com/	http://sciencedecoded.blogspot.com/
45	Pogue	David	Technology columnist, PBS NOVA host	New York Times / PBS / CBS	http://www.davidpogue.com/	http://www.pbs.org/wgbh/nova/sciencenow/
46	Popova	Maria	Founder and Editor	Brain Pickings	http://www.fastcompany.com/most-creative-people/2012/maria-popova	www.brainpickings.org

	Last name	First name	Title/role(s)	Affiliation	Bio/profile	Program link
47	Rockwell	Tom	Director of Exhibits and Associate Director for Program	Exploratorium	http://www.exploratorium.edu/about/senior-management	www.exploratorium.edu
48	Rosin	Mark		Guerilla Science	http://www.math.ucla.edu/~msr35/Mark_Rosin/Welcome.html	http://guerillascience.co.uk/
49	Selvakumar	Meena	Acting Vice President for Strategic Programs	Pacific Science Center	http://www.linkedin.com/in/meenaselvakumar	http://www.pacificsciencecenter.org/Portal-to-the-Public/portal-initiative.html
50	Sherin	Bruce	Associate Professor, School of Education and Social Policy	Northwestern University	http://www.sesp.northwestern.edu/profile/?p=82	http://www.springer.com/education+%26+language/learning+%26+instruction/journal/10758
51	Simpson	Robert	Researcher / Developer	Oxford University / Zooniverse	http://orbitingfrog.com/	www.zooniverse.com
52	Stemwedel	Janet	Associate Professor of Philosophy	San Jose State Univ.	http://blogs.scientificamerican.com/doing-good-science/about.php?author=39	http://www.scientopia.org/blogs/ethicsandscience/
53	Storksdieck	Martin	Director, Board on Science Education	National Research Council, National Academies	http://sites.nationalacademies.org/dbasse/bose/dbasse_066193#.UVYmchykptg	http://www.youtube.com/watch?v=QKXvvCof-mU
54	Sykes	Kathy	Professor of Sciences and Society	University of Bristol	http://www.bristol.ac.uk/ias/people/kathy-profile	http://www.cheltenhamfestivals.com/science
55	Tench	Beck	Director of Innovation and Digital Engagement	Museum of Life and Science, Durham, NC	http://www.slideshare.net/btench	http://lifeandscience.org/about-us/newsroom/experiment-harace
56	Traphagen	Karyn	Executive Director	ScienceOnline	http://scienceonline.com/leadership/	http://scienceonline.com/
57	Vikan	Gary	Former Director of the Walters Art Museum	Vikan Consulting, LLC	http://www.salzburgglobal.org/current/includes/FacultyPopUp.cfm?IDSPECIAL_EVENT=2961&IDRecords=139641	http://articles.baltimoresun.com/2010-01-24/entertainment/baltimore-walters-24jan24_1_museum-director-gary-vikan-walters-art-museum-brain-institute
58	Ward	Peter	Paleontologist, author	University of Washington	http://www.ess.washington.edu/dwp/people/profile.php?name=ward--peter	http://www.youtube.com/watch?v=RQ3CXO4aLn0
59	Wasowski	Matt	Big Boss	Nerd Nite	http://mattwasowski.com	http://nerdnite.com/
60	Yunes	Nico	Professor of Physics	Montana State Univ.	http://www.physics.montana.edu/faculty/yunes/public_html/home.html	http://www.einstein.montana.edu
61	Zimmer	Carl	Columnist	The New York Times	www.carlzimmer.com	http://phenomena.nationalgeographic.com/blog/the-loom/
62	Zivkovic	Bora	Blogs Editor	Scientific American	http://blogs.scientificamerican.com/a-blog-around-the-clock/about.php?author=11	http://blogs.scientificamerican.com/

Stakeholders & Funders

	Last name	First name	Title/role(s)	Affiliation	Bio/profile	Program link
63	Epstein	Sonia	Program Associate for Science and the Arts	Alfred P. Sloan Foundation	http://www.sloan.org/about-the-foundation/staff-directory/show-staff/show/people/sonia-epstein/	http://www.sloan.org/major-program-areas/public-understanding-of-science-technology-economics/
64	Hosler	Linda	Program Associate, Public Engagement	AAAS	http://www.linkedin.com/pub/linda-cendes/a/870/436	http://www.aaas.org/programs/centers/pe/
65	Joynes	Carroll	Board member	Culture Kettle; Univ. of Chicago Cultural Policy Center	http://www.norc.org/Experts/Pages/carroll-joynes.aspx	http://www.nytimes.com/2012/06/28/arts/design/study-shows-expansion-can-be-unhealthy-for-arts-groups.html
66	Lohwater	Tiffany	Director of Meetings & Public Engagement	AAAS	http://www.linkedin.com/in/tiffanylohwater	http://www.aaas.org/programs/centers/pe/
67	Noyce	Penny	Trustee	Noyce Foundation	http://tumblehomelearning.com/about-us/the-team/	http://www.noycefdn.org/
68	Pabst	Lauren	Program Officer in Media, Culture, and Special Initiatives	John D. and Catherine T. MacArthur Foundation	http://www.macfound.org/about/people/186/	http://www.macfound.org/programs/media/
69	Power Brown	Steve	Chief Evangelist and Futurist	Intel Labs	http://www.gelecekgunu.org/eng/konusmacilar/steve-brown.html	http://www.intel.com/content/www/us/en/research/intel-research.html
70	Schatz	Dennis	Program Director, Division of Research on Learning in Formal and Informal Settings	National Science Foundation	http://www.dennisschatz.org/bio.html	http://www.nsf.gov/div/index.jsp?div=drl
71	Sinclair	Stephanie	Project Manager	Wellcome Trust	http://uk.linkedin.com/pub/stephanie-sinclair/21/325/90	http://www.wellcome.ac.uk/Funding/Public-engagement/index.htm
72	Thomas	Vince	Brand Strategist	Intel	http://www.linkedin.com/pub/vince-thomas/2/66a/8b	
73	Ubois	Jeff	Program Officer	John D. and Catherine T. MacArthur Foundation	http://www.macfound.org/about/people/113/	http://www.macfound.org/programs/media/
74	Weber	Doron	Vice President, Programs	Alfred P. Sloan Foundation	http://www.sloan.org/about-the-foundation/staff-directory/show-staff/show/people/doron-weber/	http://www.sloan.org/major-program-areas/public-understanding-of-science-technology-economics/

APPENDIX C: Workshop agenda

MONDAY 9/23

Venue: Microsoft NERD Center

One Memorial Drive, Cambridge, MA

8:00–8:30 AM Breakfast

Food and beverages served

Please arrive between 8:00 and 8:15am.

8:30–9:00 Welcoming remarks, setup, and process

Our goals for day one: 1) to quickly get a diverse crop of vivid examples of contemporary science engagement on the table; 2) to begin grappling with the six pre-selected dimensions and the questions they raise, and nominate additional dimensions for discussion.

9:00–10:45 Quick Colloquies

Three 35-minute sessions, each starting with a panel discussion and concluding with small-group brainstorming and conversation.

- **Dimension 1: Story(telling)**
Catalysts: John Beck-Hoffman, Janna Levin, Ben Lillie
- **Dimension 2: Humor**
Catalysts: Elise Andrew, Steve Cross, Neil deGrasse Tyson
- **Dimension 3: Participatory engagement**
Catalysts: Darlene Cavalier, Rob Simpson, Beck Tench

10:45–11:00 Break

Coffee and snacks served

11:00–12:00 Lightning pairs

Three 15-minute reciprocal interviews by pairs of participants, followed by a 15-minute group reaction to all three conversations.

- **Dimension 4: Mystery/the unknown**
Catalysts: Brian Greene, Robert Krulwich
- **Dimension 5: Artistic expression**
Catalysts: GZA, Alan Lightman
- **Dimension 6: Informality/science as part of everyday life**
Catalysts: Emily Graslie, David Pogue

12:00–1:00 Lunch

Good food and continued conversation

1:00–1:20 Brainstorming additional dimensions

What are we not yet talking about?

Your chance to nominate additional dimensions of science engagement to add to our conversations.

1:20–2:30 Small-group discussions

What does each dimension change or make possible?

What challenges or risks does it bring? What else do we need to know about it?

All participants will be assigned to groups to discuss a dimension. Each group will be given discussion questions, a facilitator, and a helper to capture key ideas. Each group will choose a representative to join the panels that follow.

2:30–2:45 Break

Coffee and snacks to fuel the homestretch

2:45–4:00 'Roll up' discussions

Three themed discussions on a broader, 'roll up' concept under which several dimensions naturally group.

An alternative to breakout-group reporting, these 25-minute discussions will begin with a moderator and a panel of two or three discussants (one representative from each of the relevant breakout groups), before bringing the full group into the conversation.

- **Topic A: Personality & subjectivity.** Discussants from the breakouts on Story and Humor, plus one of the newly nominated dimensions if applicable.
- **Topic B: Authority.** Discussants from Participatory engagement and Mystery/the unknown, plus one of the newly nominated dimensions if applicable.
- **Topic C: Popular culture.** Discussants from Artistic expression and Informality/Science as part of everyday life, plus one of the newly nominated dimensions if applicable.

4:00–4:30 Outputs discussion

Full-group brainstorm about the possible work products of this gathering

4:30–4:50 Charge for the evening/Day 1 wrap-up

Instructions to all participants for the evening's Story Collider event and conversations with the public.

PUBLIC EVENT

Venue: Middle East Downstairs

480 Massachusetts Ave, Cambridge, MA

7:30–9:30 PM Story Collider/audience feedback evening

- All workshop participants are asked to attend.
- 7:00 Doors open: *Public pays \$10 admission but workshop participants show badges for free admission. Cash bar, free food, and DJ.*
- 7:30 Story Collider begins: *Four workshop participants pre-selected by Story Collider tell personal stories.*
- 8:30 Audience conversations: *Host tells audience about this special discussion opportunity and invites them to stay for a free buffet dinner and share their thoughts with the science communicators/educators in the audience. This will be our chance to informally interview members of the public about how and why they engage with science.*

TUESDAY 9/24

Venue: Rowland Institute

100 Edwin Land Blvd., Cambridge, MA

Please enter from Cambridge Parkway (river side)

8:30–9:00 AM Breakfast

Food and beverages served

Please arrive between 8:30 and 8:45 AM.

9:00–9:05 Welcoming remarks

Our goals for day two: 1) to begin converging on a set of observations and lessons learned about contemporary engagement practices; and 2) to identify what else we need to learn about engagement and what experiments might be worth trying.

9:05–10:00 Debrief from interviews with the public

What did we learn? Any implications for the practices snapshot and research-and-experimentation agenda we'll be developing today?

Moderated full-group discussion.

10:00–10:45 Researchers panel

What's already known about the dimensions we've been discussing? What are some of the open questions?

Moderator: Bruce Lewenstein

Discussants: Pryce Davis, Emily Dawson, Jeff Grabill, Martin Storksdieck

10:45–11:00 Self-selection into working groups

Based on input from Day 1, the organizers will have distilled a set of 6–8 topics for these working groups. (These may be different from the dimensions we've been working on.) Participants will join the group focused on the topic they're most interested in.

11:00–NOON Working groups

Multi-disciplinary breakout discussions to outline sections of the practices snapshot and research-and-experimentation agenda.

At a bullet-point level, without wordsmithing, each group will:

- develop a rough outline of a specific section of the snapshot document,
- identify open questions about that dimension and potential programming experiments, for possible inclusion in the research-and-experimentation agenda.

12:00–1:00 PM Lunch

Good food and informal conversation

1:00–2:00 Plenary reporting/Snapshot assembly

Each group will quickly share its outline of key points, with questions only for clarification (7–8 min. each). We will progressively assemble the complete outline at the front of the room. At the end of the hour, we'll review the resulting snapshot and agenda together.

2:00–2:45 Professional community discussions

So far, our discussions have been multi-disciplinary, involving practitioners and researchers from all walks of science engagement. Now we'll huddle with others from our own practice community to discuss what this work means for each sub-field and how to advance it in those quarters. Participants will be given a chance to assign themselves to one of the following groups:

1. Media
2. Writing & publishing
3. Live events
4. Science centers/museums
5. The arts
6. Participatory, community, and training programs
7. Research/social sciences
8. Funding & policy

2:45–3:15 Networking for downstream collaborations

Seek out potential collaborators and discuss possible future work on some aspect of the research-and-experimentation agenda. Refreshments provided.

3:15–3:30 Closing

Next steps for the initiative

Participants invited to share a brief, informal sampling of ideas for collaborations that have emerged in the last two exercises. Organizers will briefly discuss next steps in the initiative and how to keep in touch post-workshop.

3:30–4:00 Mingling

Refreshments available for those who can stay

6:00 Optional: ScioBeantown tweetup at Meadhall

4 Cambridge Center, Cambridge, MA 02142

The ScienceOnline community's Boston-area members have invited workshop participants to join the group's monthly get-together.

The Evolving Culture of Science Engagement

Comments? Questions?

The authors invite you to visit the initiative website, www.cultureofscienceengagement.net, and to get in touch via email. We can be reached collectively at team@cultureofscienceengagement.net.

