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2

The Challenge and the Opportunity of Presenting "Unfinished Science"

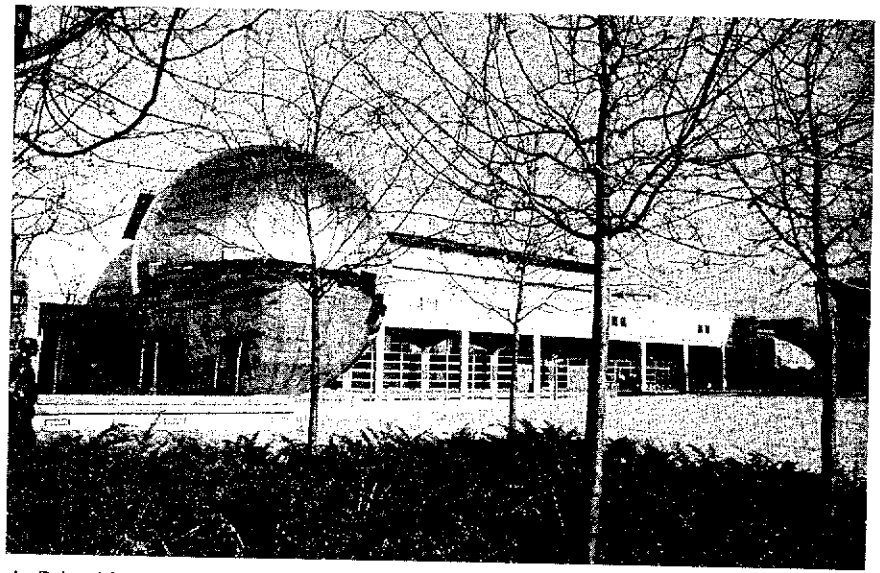
John Durant

The very close interdependence of science and society first came to be generally recognized only in the second half of the twentieth century. Prior to 1950, science was generally regarded as a thing apart. To be sure, the Great War, in which science played a pivotal role, provided some pretty strong clues. But when the eminent physicist J. D. Bernal announced in 1937 that Marxism "removes science from its imagined position of complete detachment and shows it as part, a critically important part, of economic and social development," he did not yet speak for the generality of scientists, scholars, and politicians (Bernal 1937). Following the Second World War, of course, Bernal's basic point came to be very widely accepted—and this not on the authority of his beloved Marxism, but rather on the plain evidence of the senses. In an age of nuclear power, nanotechnology, and the NASDAQ, it does not require sophisticated political philosophy to discern that science is a critically important part of economic and social development.

Today it is commonplace that science and science-based technologies occupy a central place in our society. This basic fact has multiple implications for science as well as for wider culture. It means, for example, that decisions about what science is done and how that science is done are influenced by factors far beyond the narrow confines of the professional scientific

community—by questions about the availability of research funding, about the potential distribution of benefits and risks, and about economic, environmental, ethical, social, and legal implications. By the same token, it also means that the wider community has a considerable stake in the outcomes of scientific inquiry. Across the industrialized world, citizens are increasingly reluctant to leave science to scientists, confident in the knowledge that "they know best." Reinforced by a general decline in deference toward authority and expertise of all kinds, the emergence of a critical cultural climate for science has placed new burdens and responsibilities on scientists themselves. No longer is it sufficient for scientists simply to obtain funding, to undertake research, and to publish results; increasingly, they find themselves obliged—by funders, other stakeholders and interest groups, and the mass media—to account publicly for what they are doing.

The shift of science to cultural center stage has profound implications for the work of science museums and science centers. For just as science and society are closely interdependent, so too are the science–society relationship and the work of science museums and science centers. In the nineteenth and early twentieth centuries, when science was still widely regarded as a thing



At-Bristol in Bristol, England, is a unique destination bringing science, nature, and art to life. Photo courtesy of At-Bristol

apart, cultural attitudes toward science and technology were generally celebratory. Mirroring these attitudes, the great scientific and technical museums of nineteenth-century Europe created exhibitions that were frankly triumphalist: row upon row of marvelous machines testified to the progressive harnessing of natural elements and forces to human purposes. In the mid-twentieth century, as cultural attitudes started to shift, there was increasing concern about the supply of scientifically and technically qualified labor to meet the needs of rapidly expanding industrial economies, and huge efforts were made to improve science and technology education. Once again, science museums responded to the challenge. Hands-on interactivity—pioneered at the Exploratorium and the Ontario Science Center in the late 1960s and then spreading rapidly across North America, western Europe, and other parts of the world—changed the focus of science museum exhibits from passive admiration of technical accomplishment to active learning of scientific and technological principles.

A young visitor at At-Bristol learns by doing. Photo courtesy of At-Bristol

To the cultural preoccupation with the supply of scientifically trained manpower has been added in recent years a growing concern to respond appropriately to the increasingly critical climate of public opinion about science and technology. Though the extent of public disenchantment with science has surely been exaggerated (particularly in western Europe), there is no doubt that the 1980s and 1990s witnessed a series of high-profile public debates across the industrialized world in which science and technology featured as villains—or at least prime suspects—rather than as heroes. In discussions about issues as varied as energy and the environment, agricultural biotechnology and genetically modified food, and the use of animals in biomedical research, concerned citizens challenged the judgments of scientists and science policymakers and claimed the right to a greater say in decisions about the direction and oversight of scientific research. Here, I suggest, is one immediate and important source of current interest within the museum world in closer engagement with scientific research. This interest represents our community's latest response to the changing social circumstances in which we operate.

Having said this, I want to emphasize that the shift in focus represented by the phrase "public understanding of research" has the potential to be every bit as significant for the work of science museums and science centers as the shift more than a generation ago from passive spectacle to active, discovery-based learning. This is because the focus on scientific research requires an almost entirely different approach to that adopted in conventional hands-on exhibitions, and this different approach has radical implications for museums' relationships—with the scientific and technological communities, with their visitors, and with one another. In this chapter, therefore, I want to reflect on the deeper implications of the move into public understanding of research. I suggest that this move represents an invitation to museums to become fundamentally different sorts of places in the community—not secular cathedrals, as they were in the nineteenth and early twentieth centuries, nor yet educational playgrounds, as so many of them became in the late twentieth century, but rather public forums for active engagement between scientists and citizens in some of the most interesting, intriguing, and important issues of the day.

HISTORICAL REPRISE

A little over ten years ago I wrote something that still captures what I believe is the essential challenge facing museums in the area of public understanding of research:

> I am struck by a curious shared weakness in the otherwise rather different contents of science centres and science museums. For both types of institution have a tendency to represent science in a way that divorces it from social reality. The image of science that I find in most science centres is one of clear, elementary principles waiting to be discovered by anyone with sufficient child-like curiosity and adult patience to search them out. By contrast, the image of science that I find in most science museums (including, it should be said, large parts of my own) is one of sure and solid progress in the mastery of nature. In both cases, science itself emerges as a fixed body of knowledge and practice, more or less totally beyond either doubt or dispute, and in both cases, two relevant social groups are strangely absent: first, the authors of all these achievements, scientists themselves; and second, the wider culture within which these people pursue their work.
>
> In my view, museums should strive to find new and more effective ways of portraying science in the making. For only in this way can we be true both to the nature of science itself and to the needs of a general public which is continuously exposed to new (and often conflicting) scientific knowledge claims in the mass media. (Durant 1992, viii)

This passage comes from the introduction to a collection of essays that I put together for the London Science Museum in 1992. North American readers should note that the contrast it makes between science museums and science centers rests on the conventional British English distinction—not widely adhered to in American English—between institutions that own and display collections of intrinsic value (science museums) and institutions that do not (science centers). The difference in interpretive style between these two types of institution was already in process of being undermined in the early 1990s, as more and more science museums chose to adopt the distinctively interactive style of hands-on science centers. Since then, this convergence has continued apace to the point where today it is hard to tell the difference between many science museums and science centers. Only in universities blessed with traditional museums of the history of science does one still commonly find displays based largely or wholly around sequences of objects designed to display the progressive intellectual and practical mastery of nature; and even here, such an approach is now widely regarded as rather quaint and old-fashioned.

My main point more than a decade ago was, of course, that neither science museums nor science centers were engaged very closely with current or ongoing scientific research. While the former were preoccupied with celebrating

the great scientific and technological achievements of the past, the latter were preoccupied with explaining well-established scientific and technological principles. In their different ways, therefore, both were involved mainly with the interpretation of what I term "finished science"—that is, science that has ceased to be the subject of serious debate among scientists themselves; neither group of institutions was substantially engaged in the radically different business of interpreting "unfinished science," or what Shapin terms "science-in-the-making" (Shapin 1992). This historical fact is somewhat paradoxical since most other forms of popular science communication (such as newspaper and magazine articles, books, and radio and television programs) have long concentrated on unfinished rather than finished science—and this precisely because the wider public has always been more interested in new or emerging scientific discoveries than in the discoveries of the past.

Since the early 1990s, a number of science museums and science centers on both sides of the Atlantic have become more interested in dealing with unfinished science. In the London Science Museum, for example, the attempt to engage with the world of contemporary science and technology represented the main thrust of exhibition development throughout the 1990s. Similarly, in the late 1990s, the Museum of Science in Boston undertook a major initiative designed to place the realities of ongoing scientific research in front of its visitors. The Wellcome Wing at the Science Museum in London (opened in 2000) and the Current Science and Technology program at the Museum of Science in Boston (launched in 2001) represent two significant—and significantly different—attempts on the part of relatively large and well-established museums to introduce the public understanding of research onto the museum floor in a vivid and sustainable way. The interest generated by the "Museums, Media, and the Public Understanding of Research" conference at the Science Museum of Minnesota in September 2002 testifies to the fact that these two museums were not alone in regarding this issue as of prime importance.

WHY FOCUS ON UNFINISHED SCIENCE?

Before going any further, I want to say a word or two about some key terms. I take the phrase "public understanding of research" to denote the analytical distinction between the intellectual products of science (such as data, evidence, models, hypotheses, and theories) and the intellectual processes of science (such as data collection, model making, hypothesizing, and theorizing).

All the intellectual products of science—past as well as present—are the results of research processes that are in principle open to being described and understood. Thus, a focus on public understanding of research need not necessarily imply an exclusive concern with the science of today as opposed to the science of yesterday. Rather, it implies a concern with the means by which scientific claims and conclusions are being or have been arrived at rather than with the contents of those claims and conclusions.

By contrast, the phrase "unfinished science" denotes what is essentially a sociological distinction between scientific claims and conclusions that are settled to the satisfaction of the scientific community (finished science) and scientific claims and conclusions that, for whatever reasons—the novelty of the subject matter, the availability of new research techniques, the absence or inconsistency of evidence, the paucity of theory—are unsettled within the scientific community (unfinished science). At any given moment in time, finished science represents the body of scientific knowledge that scientists take for granted as they go about their work, and unfinished science represents their work itself. Notoriously, finished science dominates the lives of most science teachers and students, whereas by contrast unfinished science dominates the thoughts and activities of working scientists.

Clearly, the boundaries between finished and unfinished science are not fixed. It is commonplace among exponents of science and scientific method that all scientific findings—however apparently "finished"—are open in principle to challenge and revision. This piece of conventional wisdom is reflected in the historical and sociological fact—familiar to anyone who has studied, say, the revolution in the biological sciences in the mid-nineteenth century or the revolution in the physical sciences in the early years of the twentieth—that what is taken for granted by the scientific community at one time (say, the fundamental truth of the axioms of Newtonian physics) can come to be regarded by that same community as in need of radical revision (say, following the Michelson–Morley experiment or the publication of Einstein's first paper on special relativity). A new observation, a new experiment, a new idea: these and many other things besides can change overnight the status of a particular body of scientific knowledge from finished to unfinished, and the results of such change are often profoundly disturbing as well as important.

If we are interested in public understanding of research, then clearly we can pursue this interest in any area of science—finished or unfinished, past or

present. In this chapter, however, I am particularly concerned with the potential of unfinished science as a resource for the public understanding of research for two principal reasons. First, while finished science is the result of discoverable research processes, the fact that we know (or think we know) the outcome of these processes in advance makes it particularly difficult to obtain a clear and disinterested view of them. This is because we are always at risk of proverbial "wisdom of hindsight"—what the historian E. P. Thompson once termed "the enormous condescension of history." To be sure, historians are professionally expert at avoiding the more obvious pitfalls of such condescension, and even some science popularizers manage to steer clear of them. But there is nothing quite like the radical uncertainty of manifestly unfinished science for forcing people's attention to the processes by which scientific knowledge is established. Here, no wisdom of hindsight is easily available, and condescension is not an available option. With unfinished science, scientists and citizens alike frequently have little choice but to explore the various points of view on offer and then try to make up their own minds about the issues as best they can.

A second reason for focusing on unfinished science has to do with its intrinsic interest and potential importance to the wider public. Newtonian physics, Daltonian chemistry, and Bernardian biology are all scientifically interesting and important, but on the whole they do not now figure prominently in the public domain since their everyday applications and implications are mostly so familiar and so well established as to be largely taken for granted. By contrast, at any given point in time a significant amount of unfinished science is extremely prominent in the public domain. This is partly because novelty itself is a news value in science, just as much as anywhere else, and partly because the unfinished business of science often has important applications and implications that are unclear, uncertain, and/or contested. Does cold fusion offer the prospects of cheap and easily available nuclear energy? Does the memory of water offer scientific substance to the claims of homeopathic medicine? Does GM food offer a cheaper and more environmentally friendly solution to the world's food supply problems? Over the past few years, these and dozens of similar questions have been raised by any number of different areas of unfinished science. The point for science communicators, of course, is that every one of these questions is a potential resource for the public understanding of research.

THE CHALLENGE AND THE OPPORTUNITY OF UNFINISHED SCIENCE

Having made the case for focusing on unfinished science, in the remainder of this chapter, I turn next to a closer consideration of some of the more obvious differences between finished and unfinished science as far as science communicators working in science museums and science centers are concerned. Some key contrasts are set out in table 2.1.

Table 2.1. Finished and Unfinished Science and the Challenge for Museums

Finished Science	*Unfinished Science*	*Challenge for Museums*
Story complete	Story incomplete	How to identify the story?
Unchanging	Changing	How to track the story?
Significance clear	Significance unclear	How to tell the story?
Characterized by knowledge	Characterized by ignorance	How to deal with partiality?
Characterized by certainty	Characterized by uncertainty	How to handle doubt?
Scientists mostly agree	Scientists often disagree	How to handle controversy?
Attention focused on pay-off—"so what?"	Attention focused on process—"what's up?"	How to handle human & cultural dimension?

Exhibitions tell three-dimensional stories. When exhibitors deal with finished science, they generally know where they are: in scientific terms, at least, the story is likely to be complete, experts are likely to agree on what is and is not the case, and the significance of what has been established (in scientific terms) is likely to be clear. Of course, where the focus is on public understanding of research rather than on public understanding of the results of research, there is still room for alternative approaches and views. History is inevitably interpretive, and even in the case of finished science there is plenty of scope for historians to disagree about how particular bodies of knowledge have come to be established. Such disagreement, however, is essentially historical or sociological rather than scientific in character; by definition, finished science raises few if any serious scientific disagreements. For all these reasons, exhibitors who deal with finished science have the great advantage of being able to set about the interpretation of what is likely to be a relatively stable and unambiguous knowledge base.

Contrast this situation with the position that exhibitors find themselves in when they turn their attention to unfinished science. Now it is much harder to identify, track, and tell the story; and as exhibitors struggle to do these difficult things, they frequently find themselves having to deal with partiality, provisionality, and controversy. Experts will often disagree about

what is and is not the case and why it is or is not important, and as often as not, attention will naturally come to focus—for scientific as well as historical reasons—on the processes, the personalities, and the politics of research. Lest all this should seem to be a recipe for disaster, however, it should also be observed that partiality, provisionality, and controversy are frequently the stuff of high drama. Unfinished science presents multiple opportunities to science communicators of all kinds—including exhibitors—precisely because the need to engage with the research process puts "the thrill of the chase" itself under the spotlight.

An example from my own experience will serve to illustrate the point. In the early 1990s, we developed in the London Science Museum a series of small, fast-turnaround, temporary exhibitions on contemporary science and technology. The exhibitions were called Science Box. A flexible, reusable exhibition display system allowed us to develop small (50–100 m^2) temporary exhibitions on single topics in periods of two or three months. One Science Box exhibition dealt with the health effects of passive smoking. At the time we worked on this subject, it was very definitely in the category of unfinished science. Expert evidence on the subject was still being actively collected and collated, and scientists differed on key questions such as the nature and the severity of the health effects of passive smoking. Argument was actively under way in the public domain, and partisan interest groups were actively lobbying on behalf of their various points of view.

All this presented the Science Box exhibition team with a considerable challenge. How should experts who were sharply critical of one another be consulted? How should lobbyists—some of whom applied direct pressure on us to deal with the issues in particular ways—be dealt with? And what about the commercial interests of the tobacco industry? Above all, how were we to ensure that we presented a clear and fair account of the issues to visitors? This last challenge was felt rather acutely, not least because as the exhibition team researched the issues, they found themselves increasingly persuaded of one particular point of view in the scientific debate. In the end, it was decided to minimize the risk of conscious or unconscious bias in the exhibition by being extremely open about both the exhibition and the scientific research processes. Visitors were informed that the health effects of passive smoking were currently under active scientific investigation, that experts disagreed among themselves, and that interest groups and lobbyists were campaigning

on both sides of the argument. Relevant scientific evidence was presented in unusual detail—up to and including specific references to the relevant research literature, all of which was made available in the Science Museum Library for visitors who wanted to pursue matters further for themselves. Finally, visitors were informed that in the course of preparing the exhibition, the exhibitors themselves had come to the view that the balance of the available evidence lay on one side of the argument.

Passive Smoking is an example of an exhibition that came to focus extremely closely on aspects of the research process precisely because it dealt with science that was both unfinished and extremely controversial. Nothing serves to illustrate the distinctive character and qualities of scientific inquiry quite as well as the need to make sense of active argument and disagreement between experts working at the cutting edge of a particular research field. Here methods and techniques are refined (and rendered obsolete), observations are made (and disputed), hunches are confirmed (and dismissed), theories are validated (and invalidated), fashions are established (and exposed), and reputations are won (and lost). The struggle to secure new knowledge about the natural world exposes the workings of science—warts and all—to public view, and this presents the museum exhibitor prepared to work in this challenging area with several important opportunities.

First, the presentation of unfinished science obliges museums to engage with science and scientists in new ways. Except in those cases (such as some of the larger natural history museums around the world) where museums host significant scientific research activity based around their collections, the decision to present ongoing research to visitors requires museums to build new and closer links with the scientific community. At the very least, some sort of journalistic effort must be made to track and report particular kinds of scientific research. But in addition, researchers may be brought in to advise museum staff and/or to report their work directly to visitors, and aspects of the research process itself may even be relocated in the museum—as, for example, in the Wellcome Wing at the London Science Museum's Live Science facility, which allows museum visitors to volunteer to become subjects in ongoing biomedical research projects. When unfinished science first becomes the subject of serious attention in a science museum, that institution becomes (or ought to become) imbued with the research ethos of the scientific enterprise itself.

Second, the presentation of unfinished science obliges museums to engage with their visitors in new ways. No longer can the museum pretend to "have all the answers," and no longer, either, can it presume that the role of the visitor is simply to look, to listen, and to learn. When the science is unfinished, the story must be open-ended, and the true import of what is being dealt with must remain open to question. This situation creates new and potentially creative possibilities in the relationship between the museum and the visitor. Indeed, given sufficient courage on the part of the museum, it can be allowed to introduce a measure of equality between the exhibitor/presenter and the visitor that is truly liberating. The museum exhibitor or presenter who has the intellectual confidence to freely confess and even revel in his or her ignorance about what is "really going on" has the potential ability to empower the visitor to participate more fully in science. If ignorance and uncertainty come to be understood as preconditions for rather than barriers to research, then ignorant and uncertain visitors may be better encouraged to set out on the adventure of research for themselves.

Third, the presentation of unfinished science leads inevitably to the reexamination of the professional relationships among science museums and science centers. The costs of tracking the ongoing research process are very high—too high, certainly, for any but the largest and best-endowed museums in the world to undertake in any but the most carefully restricted areas of scientific inquiry. Just as newspapers long ago abandoned the notion of individually and independently gathering, sifting, and presenting the world's news for their readers, so museums committed to presenting current science and technology are now beginning to feel the need to abandon their (generally deeply entrenched) methods of working in splendid isolation from one another. What we need, surely, is the museum equivalent of the news media's wire services, that is, recognized sources of high-quality, up-to-date information about the ongoing research process that can be rapidly and cheaply accessed by individual science museums and science centers for purposes of presenting exhibitions and programs about particular areas of ongoing scientific research.

It is too early, probably, to specify the exact form such museum wire services should take. Almost certainly, they will comprise specially commissioned digital multimedia that are capable of being easily repurposed by particular museums or science centers. The reason for this is that existing generic science news services, while certainly useful, do not lend themselves readily to the needs of many science museums and science centers; instead, they require too much work (and cost) for purposes of creating lively, up-to-date displays and public programs on current science and technology. This being so, what we need are museum-originated materials that have already been compiled with a view to the distinctive needs of the exhibition floor. There would seem to be no reason, for example, why particular areas of research should not be allocated to particular, well-placed museums for regular tracking, information gathering, and digital dissemination. In this way, a multiple "hub and spoke" process of information exchange across the science museum community could bring high-quality, fast-changing contemporary science displays and programs within the reach of a significant number of museums and science centers around the world.

A NEW ROLE FOR SCIENCE MUSEUMS AND SCIENCE CENTERS?

We stand on the threshold of a new era in science communication. Across the industrialized world, there are calls for new forms of engagement between scientists and citizens as an essential precondition for the maintenance of public confidence in the ongoing research and development processes. Everywhere, monologue is out, and dialogue is in; authoritative expert pronouncement is out, and informed public debate is in (U.K. House of Lords 2000). In this situation, our culture urgently needs to find new kinds of social spaces where scientists and citizens can meet as equals to consider the state of the research process and the options—scientific, technical, economic, environmental, ethical, social, political, and legal—that we face. There is a role here for science museums and science centers that are prepared to work together in new ways around programs designed to facilitate closer public engagement with research. Such work will transform science museums and science centers in the twenty-first century, and, given a lot of innovation and hard work, it may also help transform our culture in ways that will provide benefits both to science itself and to wider society.

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Section 2

PUBLIC UNDERSTANDING OF RESEARCH: THE BIG OPPORTUNITIES AND ISSUES

What are the central issues involved in presenting public understanding of research (PUR) programs in museums? After clarifying how PUR contrasts with "public understanding of science" and with "science literacy," we must decide how to deliver our strategy to our audience. We can achieve this only through a combination of good evaluation and inspired programming ideas that will almost certainly involve imaginative collaborations with research organizations and with other media. This is even more challenging than it sounds—in practice, PUR initiatives usually have to compete with more overtly populist programming.