

From natural history to science: display and the transformation of American museums of science and nature

Karen A. Rader* Virginia Commonwealth University

Victoria E. M. Cain** University of Southern California

Abstract

This paper explains how and why many American museums of science and nature moved away from the traditional content and methods of natural history in the period from 1930 to 1980. It explores diverse motivations for the shift from dead, stuffed displays to live, interactive exhibits, and the consequences of that shift for museums as both educational institutions and as institutions of research. Ultimately, it argues that debates over museums' content and display strategies drew strength from and reinforced a profound transformation in the institutional history of twentieth-century American science and technology: namely, the separation of research and public education. By the late 1960s, the American museum landscape had been transformed by this development. Older natural history museums competed for visitors and resources with 'new' style science museums, and although both remained popular cultural institutions, neither had achieved a coherent new institutional identity because debates about the role of the museum in science continued. Thus, we suggest, in the mid-twentieth century natural history and science museums were more important in both the history of biology and the history of science's public culture than has previously been acknowledged.

Key words: natural history, science centres, hands-on exhibits, United States

Introduction

By the mid-1930s, workers in American natural history museums understood that their institutions no longer possessed the scientific and social esteem they had enjoyed just a few decades earlier. In the introduction to her 1938 book *Education Work in Museums in the United States*, American Museum of Natural History ('AMNH') education curator Grace Fisher Ramsey argued that the decline had begun as early as 1900, when interest in descriptive natural history waned in the face of the laboratory study of life. This shift, she argued, had resulted in a gradual neglect of natural history museums and the collections they housed. 'By ... the close of the first century of American museums', Ramsey wrote, 'these conditions had created the stereotype that a scientific museum was a musty, dusty storehouse of stuffed animals and bugs with no popular interest' (Ramsey 1938: 1–2). A landmark study of 'museum conditions in the United States' published in *Science* confirmed Ramsey's sense of the institutional lay-of-the-land. University of Rochester Natural History Museum Director Edward Foyles sent questionnaires to 134 natural history museums, 'representing a fair cross section of the distribution throughout the United States'. 'Although there is no certain way of measuring the social value of museums', he argued, 'we are able to approximate it by a study of their activities'. Foyles' study reached two major conclusions: first, that while research remained an important activity at college museums, 'exhibition forms the chief activity of over 90 per cent. of the museums and is the principal method of conveying knowledge;', and second, that in natural history museums overall 'more emphasis is placed on disseminating knowledge than increasing it', noting that school service was 'rapidly becoming recognized as an important part of their work' (Foyles 1934: 476–7). Some of the nation's museums of natural history had begun to change their names in deference to the changing scientific and cultural landscape, noted Laurence Vail Coleman in

his 1939 study on American museums. When it came to choosing between ‘science or natural history’, ‘science was gaining ground’, he reported, though it had not replaced natural history altogether in American museums. Still, Coleman concluded, the term ‘better describes the present scope of this most venerable museum field’ (Coleman 1939, vol. 1: 47).

To founders, patrons, and public audiences in the interwar years, museums of ‘science’ seemed more current than natural history museums, in part because this label mapped neatly onto the laboratory sciences’ seeming triumph over older methods of studying the life sciences. Newer, more fashionable forms of scientific research demanded experimentation on living flora and fauna rather than the close scrutiny and preservation of dead specimens (Allen 1978). Scientists working in large natural history museums remained leaders in field sciences like ecology, palaeontology and systematics, and some extended their research into genetics, experimental physiology, and laboratory animal behaviour by the 1930s (Kohler 2002). Still, natural history seemed to have little to do with the era’s more highly publicized scientific successes and preoccupations: wartime industrial production, new military technologies, microbes, and antibiotics. By the end of World War Two, natural history and the research it inspired were still very much alive and well (Kohler 2006), but in terms of museums’ expanding public mission, these traditions were failing to entice visitors and young scientists into their halls.

Some early histories of natural history museums unintentionally reinforced the belief that these institutions became somehow marginal to the proper history of the life sciences after World War One. As Sally Kohlstedt has pointed out, historians of biology – even those who are ‘often attentive to other institutional developments’ – have tended to view museum work as irrelevant ‘even when key figures in their work depended on these facilities’ (Kohlstedt 1995: 593; for important early exceptions, see Rainger 1993, Winsor 1991). Museum studies scholars have also tended to neglect the complex history of natural history and science museums in the decades between 1930 and 1968, focusing attention instead on two more easily identified and described ‘bookends’ of museology: the early twentieth-century move away from ‘museum-as-library’ displays and the later twentieth-century, post-1960s expansion of ‘less directed and more multi-sensory approaches’ to exhibition (cf. Macdonald 1998: 9–15).

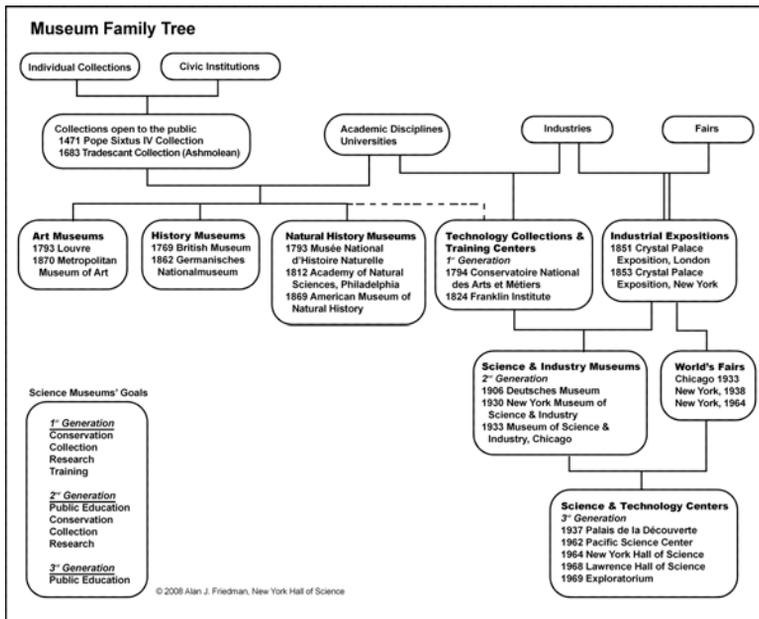


Fig 1: Alan Friedman’s “Museum Family Tree.” Note how he represents the development of natural history museums as arrested, especially in comparison to the more contemporary, more “evolved” third generation science and technology centers. Image © 2006 Alan J. Friedman, New York Hall of Science, used by permission

Administrators in contemporary science museums are similarly dismissive of natural history museums' contributions to their own institutions' development. In 1996, for instance, science museum leader Alan Friedman (a physicist and the Director of the New York Hall of Science) composed a flowchart depicting the history of museums, which represented the natural history museum as a moribund branch of science museums' ancestral tree (Friedman 1996: see fig.1; cf. Friedman 1997). In 2007, he republished this chart as a part of a *Curator* fiftieth anniversary issue article entitled, 'The Extraordinary Growth of the Science-Technology Museums', further perpetuating the historiographical view that science-technology museums grew at the expense of natural history museums in something of a zero sum game (Friedman 2007).

We challenge Friedman's progressionist view by returning to this transitional period and examining more carefully how and why many such American museums moved self-consciously away from the content and methods of natural history when creating display in this era. Just as important, we want to know what they moved towards. The so-called 'Allen thesis', first articulated thirty years ago by historian of science Garland Allen, postulates the emergence of a 'naturalist-experimentalist' divide in biology during the period from 1890 to 1950 (Allen 1978). Many scholars have revisited, debated, and revised this thesis from the perspective of the intellectual and practical history of the biological sciences (see, for example, Rainger, Maienschein and Benson 1988, Benson, Maienschein and Rainger 1991, Kohler 2002). We seek, instead, to focus on how perceptions of this divide – both inside and outside of museums – shaped museum culture and display practices. In other words, we are less interested in more precisely articulating the epistemological or practical boundary between natural history and experimental biology than we are in carefully examining how these categories were deployed by historical actors in museum contexts, in order to achieve desired ends (cf. Gieryn 1983, 1999). 'Science' museums, we propose, are best viewed historically through the dual lenses of what defined successfully doing 'science' and what defined a successful 'museum.' We argue that these problems were under heated consideration in mid-twentieth-century America, much as they still are today (cf. Semper 2007).

Historiographically, understanding the shift from 'natural history' to 'science' in American museums helps us to better understand natural history museums as places where various social worlds – political, cultural, and scientific – intersected. Exploring this phenomenon also allows us to better appreciate the relationship of display to the evolving institutional mission of natural history museums in the landscape of American public science during the middle decades of the twentieth century. Using archival and primary source evidence from a range of museums' histories (from large national museums to small local ones) this essay explores the diverse motivations for shifts in display strategies and sketch out a few of its consequences. Ultimately, we argue that, however local any individual natural history museum's struggles over display seemed to be, in retrospect these institutions were participating in a broader collective dialogue about the future of research and science education in the museum. We show how this dialogue engaged issues of scientific methodology but also re-envisioned museums' relationships to science policy and public culture. Thus, we suggest, during the mid-twentieth-century natural history and science museums were more important in both the history of biology and the history of science's public culture than has previously been acknowledged (cf. Starn 2005).

From Golden Age to disenchantment

Historians of European museums commonly describe the 1880s through the early 1900s as the decades when natural history museums were at their peak, but in the United States, natural history museums reached a pinnacle of cultural popularity in the 1920s and early 1930s.¹ Flush with cash, American natural history museums sent out record numbers of collecting and survey expeditions. Decades of borrowing from retail and entertainment techniques resulted in habitat dioramas and other compelling displays of the materials gathered. Museums celebrated the popularity of these dioramas, and bragged to the press about their unique ability to attract and educate the public. Interwar natural history museums in the nation's largest cities annually attracted a combined 10,000,000 visitors (Coleman 1939, 1: 54).

Amidst the financial turmoil of the 1930s, however, museums' budgets began to erode. Dissatisfaction crept into some of these thriving institutions, especially mid-sized institutions

and those dependent on fixed endowments or direct public funding. 'Much of our exhibition equipment is antiquated, and added personnel are required for its proper care and modernization', wrote Smithsonian Secretary Alexander Wetmore in his 1938 *Annual Report* (Smithsonian 1938: 3). The Smithsonian's National Museum budget had been slashed during both World War One and the Great Depression, and its once successful exhibits had begun to deteriorate. The public also protested this problem. One local citizen who visited the Museum during this period likened its atmosphere to that of a funeral parlour. Another thought its large open hallways looked like a bowling alley (Yochelson 1985: 86).

Curators across the nation also became disenchanting with natural history museums. Early twentieth-century museums' increased commitment to mass education forced many curators to devote their scarcest resources – money, time and space – to fundraising, supervising the preparation of elaborate diorama displays and communicating basic scientific information to the public. These activities, they believed, came at the expense of their research. Waldo Schmitt, the Smithsonian's Head Curator of Zoology, wrote in an exasperated memo to National Museum Director Frank Taylor: 'In working with and on exhibits, should we not give first consideration to our own self – not merely selfish – interest ... as one of government's leading research establishments?'² 'Although we are sending out more expeditions and getting more material than ever before, I have less and less time for study', the Chicago Field Museum's Wilfred Osgood complained: 'every new one makes us gasp for breath' (as cited in Kohler 2006: 122). Relations among museum staff grew more and more tense as the three-part mission of research, education, and exhibition tilted rapidly towards exhibition. While museum employees all agreed that natural history and science museums had a responsibility to educate the public, curators, educators and exhibit-makers argued over what form that education should take, how – or whether – education was distinct from museums' growing imperative to entertain visitors, and how to balance educational goals with scientific ones.

The Depression and World War Two only compounded these concerns. Funding sources for science became increasingly difficult to tap in the 1930s when public sentiment favoured placing a moratorium on research spending.³

Natural history museums slashed research budgets, and scientific staff struggled to finance their work by soliciting donations and foundation grants. Yet, in the name of public education, museums continued to build costly habitat dioramas. One 1943 study showed that administrators at the AMNH had, over the course of the previous two decades, devoted more than 70% of spending to display and public education. What's more, the 20% earmarked for research and care of collections was usually used for exhibition collecting rather than scientific fieldwork or surveying, and the care of collections budget went to maintaining the exhibits (Wissler 1943: 203).

Scientists working outside of museums believed that administrators' commitment to public education and spectacular display had compromised their commitment to scientific research. A dismayed Joseph Grinnell, for example, wrote that natural history museums' institutional priorities were increasingly misplaced: directors and famous curators spent more time thinking about improved methods of impressing the public and legislatures than they did about science (Grinnell as quoted in Kohler 2006: 150). Many curators had become equally scornful of museums' missions. They believed, one curator wrote, 'their institutions are fast becoming mere expositors of elementary facts and embarking upon extravagant schemes of nature-faking; often do we hear the term "kindergarten" applied continuously to present museum policy' (Wissler 1925: 173). Young scientists interested in research avoided museum staff openings, further ensuring museums' distance from the larger culture of scientific research (Andrews 1929: 59). Many scientists – in and out of the museum – believed administrators' commitment to habitat dioramas symbolized the erosion of the larger scientific mission of natural history museums. Research-oriented curators found themselves shouting at administrators who wished to use rare specimens for display (Wissler 1938: 107–8). Curators accused institutions of wasting money and energy on 'collecting expeditions' that were essentially glorified hunts for sportsmen and trustees. In 1937, Franz Boas warned American Museum director Roy Chapman Andrews that dioramas were 'armor[ing] the Museum, like a dinosaur, against change', for their extraordinary costs 'tied the Museum almost irrevocably, for many years to the exposition of one particular aspect of science and made it almost impossible

for it to respond to changing scientific interests'.⁴

Even those curators and museum directors committed to public education also began to question the educational effectiveness of natural history museums' traditional exhibition methods. 'A revolt has been stirring on the one hand against the self-sufficiency of the perfect reproduction of Nature in all its complexity, and on the other hand the dry as dust method of arranging objects in serried ranks like words in a dictionary', William K. Gregory, the American Museum's curator of Comparative Anatomy, wrote in 1935. 'How shall we make our Museum of Natural History not only an illustrated catalogue but a vital book of science?' Younger scientists like Gregory declared that neither taxonomically organized displays nor 'beautiful but scientifically innocuous' habitat dioramas effectively conveyed contemporary biological concepts to the public. Indeed, Gregory protested, both types of displays 'admirably concealed [natural laws] under a vast welter of accurate details' rather than provide clear facts or directed educational messages.⁵ In 1931, Jesse D. Figgins, the director of the Colorado Museum of Natural History, confided to a friend that habitat halls were no longer legitimate tools for teaching science. Instead, he wrote, they had become merely 'an over-gratification of the vanities of preparators'.⁶ Even curator Robert Cushman Murphy, who had worked on several of the habitat halls in the American Museum, admitted that such spaces, 'however impressive, can not stand as the final goal of exhibition', and recognized museums' 'need for distinctly new approaches' (Murphy 1937: 79).

Not only were museums' exhibition methods increasingly out of date, so too was the scientific content they presented. After a decade of dust bowls and Dutch Elm disease, Japanese beetles and failing fisheries, both systematics and idealized landscapes began to seem impossibly irrelevant scientific topics.⁷ Natural history museums presented the American public with aesthetically pleasing and organized views of nature, but provided little in the way of cutting-edge scientific solutions for the widely-publicized natural and environmental crises during the 1930s and 40s. Younger curators and directors, determined to improve Americans' understanding of scientific and natural laws gleaned through the research at their museums, pushed to build displays that depicted general biological processes, including animal behaviour, ecology, genetics and human physiology.⁸ They pressed their museums to make 'the unity rather than the diversity of nature the main theme of [their] educational exhibits', as Albert Parr, the incoming director of the American Museum, put it in 1943. Instead of attempting to 'distract with the lions of Africa', Parr concluded, American natural history museums needed to provide visitors with 'a widespread understanding of the laws of nature if democratic methods of procedure are going to prove successful in the nation's management of its country'.⁹

Display changes and exhibits modernization in the 1940s

The global politics of the 1930s and 1940s added fire to Parr's argument. Educators, scientists and members of the public alike perceived science education as a remedy for the nation's economic and political ills, and a potential antidote to future trauma. Parr and other museum administrators declared their work was directly tied to the 'attainment of a successfully functioning society'. 'We are fortunate enough to enjoy the advantages of the democratic form of government and it should be the duty of the museum, no less than that of all other educational institutions, to design its program in relation to this fact to the end that the democratic system may be made to function ever better', he argued.¹⁰ Determined to educate the public about science, museum staff began to reconsider the educational effectiveness of their iconic exhibition techniques.

In the 1940s, some museums rejected taxonomic displays and dioramas altogether, in favour of exhibitions they considered more 'modern' in content and style. In 1939, the trustees of the Boston Natural History Society hired National Geographic Society explorer and nature photographer Bradford Washburn to transform their institution into a more appealing and more public space. Washburn immediately changed the museum's name from 'The Boston Museum of Natural History' to 'The Boston Museum of Science'. This would, he said, 'broaden the scope and appeal' for visitors. The name change was accompanied by new displays that featured living and moving – not dead and stuffed – animals. Some were 'star' animals (cf. Mitman 1999, Davis 1997; cf. Lederer 1992) like 'Spooky', a Great Horned Owl (taken in by the museum after,

as a fledgling, he fell out of his nest onto its construction site) and 'Herekemiah' and 'Cuddles', pet porcupines. Still others featured animals in exhibit spaces specially designed to be dynamic and visitor-driven. Washburn described one newly installed display as 'a miraculous, revolving, push-button exhibit with thirteen cages for live New England snakes', where visitor could press buttons to make the live animals' cages revolve, light up, become visible.¹¹ At the American Museum, Curator of Entomology Frank Lutz had found habitat dioramas an underwhelming method of exciting visitor interest in insects – 'it is mighty difficult to make dead insects look happy on or under a sheet of celluloid water' – so he put bowls of water with live aquatic insects and plants in exhibition cases (Lutz 1930: 8). Encouraged by visitors' responses, he next exhibited a wire cage of 'trim, up-on-their-toes cockroaches', and, he reported, 'even New Yorkers stopped to gaze' (Lutz 1930: 8). Though the administration refused to fund such experiments in exhibition in the 1930s, Lutz persisted, using small external grants, and eventually gave the entire hall over to live insect displays. By the 1940s, the American Museum's Hall of Insect Life had become so popular that there was discussion about equipping the museum with a modern aviary.

Some natural history museums added film and sound to modernize exhibits, trying to create displays that engaged the visitor through more dynamic presentation of scientific knowledge. In the AMNH's Hall of Reptiles, for example, a short clip of William Burden's film of komodo dragons in action was added to a diorama of the beasts in the American Museum's Hall of Reptiles in 1927 (Mitman 1993: 13). But AMNH Department of Animal Behavior Head Gladwyn Kingsley Noble argued that such add-ons were not enough to bring natural history style displays into the modern era of experimental biology: curators must instead design exhibits that 'dissect and analyze Nature in such a way that the public will understand the principles controlling the life of the creatures portrayed' (Noble 1927). Accordingly, Noble conceived of the Hall of Animal Behavior (opened at AMNH in 1937) as a series of displays that would enable visitors to understand how animals themselves experienced their environment. Using the narrative trope of cinematic film – changing pictorial images, moving in front of a passive viewer – each display was a 'dynamic visual framework' that told 'a story of how the evolution of neurophysiological structures in the vertebrates has affected the sensory perception of organisms and determined the way in which animals relate to the external world' (Mitman 1993: 655). For example, in one display the visitor stood behind an installed picket fence, looking at a painting of hens and a rooster in a barnyard while a story was narrated over a loudspeaker. As the visitor heard the sentence, '[b]ut to the hen every other bird in the yard is a personality', light shone from behind the painting to reveal a new scene in which the rooster took on enormous proportions relative to the sizes of the hens. This, Noble argued, showed the concept of the dominance hierarchy in animal behaviour.

Yet many natural history museums in North America continued to build (albeit at a reduced rate) habitat dioramas and mahogany cases of specimens. For most museums, this decision was the result of institutional inertia combined with financial need. During the Depression, dioramas had given museums a convenient reason to ask for precious WPA funds: curators then spent their days instructing and supervising temporary armies of untutored leaf casters and rock painters. Throughout these years, collecting trips and habitat halls also continued to attract patronage from wealthy sportsmen and trustees.¹² In 1929, the Los Angeles County Museum had built an addition onto the original building, with 50 spaces intended for habitat dioramas; throughout the 1950s, it received sizeable donations to fill the 39 spaces that had gone unfilled during the lean years of war and depression. As late as 1956, the Smithsonian Hall of Birds renovation still made use of the stock mahogany cases – even while its curator noted that he had gone to great lengths to arrange the stuffed specimens in contexts that would allow dynamic perception and comparisons ('as if one was walking through a barnyard' – fig. 2).¹³ And when the Boston Museum of Science's permanent halls were opened in the fall of 1950, new small dioramas were installed over Washburn's protests precisely because the museum got several as 'targeted donations' from local Boston philanthropists.¹⁴

The Milwaukee Public Museum, the Colorado Museum of Natural History, the California Academy of Science and many other large and mid-size natural history museums continued to build dioramas well into the mid-1960s because they depended on the donations that accompanied such exhibitions and the collecting expeditions launched to fill them out.



Fig 2: The Hall of Birds at the Smithsonian's National Museum of Natural History, 1956. The exhibit's "barnyard" setting was intended to encourage visitors to look closely and compare the birds to one another. Smithsonian Institution Archives, Record Unit 95, image #SIA2008-5148 [MNH-1111A]

Although most museum leaders did acknowledge a need to reform displays, so-called 'modernization' plans undertaken before World War Two often failed as a result of conflicts between scientists and administrators about what qualified as 'modernization.' Director Frank Taylor began his first efforts to modernize exhibits at the Smithsonian National Museum of Natural History shortly before the war's end, but it took until June of 1948 for him to convince both curators and the stolid Smithsonian leadership to convene an institution-wide committee on the topic.¹⁵ Taylor and the committee found the National Museum's exhibits to be weak at best, according to the 'checklist' of criteria laid out by the group:

- What recent exhibits have turned out particularly well in the opinion of the staff?
- What recent exhibits appear to be most popular with the public?
- How are decisions made on what subject matter will be treated in exhibits?
- How do you feel about the following?
 - o Popular (genera) exhibits vs. study exhibits (detailed, specialized); combination?
 - o Assuming a high-school level of audience background?
 - o Life-size versus miniature (anthropology, geology, zoology, period rooms)
 - o Dioramas vs. cheaper form of art work (diagrams, charts, paintings, photographs)
 - o Intensive, forceful, educational type of exhibits vs. just showing what the visitor expects to see? (Hit him or let him browse?)¹⁶

The committee estimated it would cost \$4 million to bring them up to speed: newly appointed Smithsonian director Remington Kellogg – known informally by his staff as ‘the Abominable No-Man’ – instead gave Taylor a nominal amount of money to make small cosmetic updates – specifically to replace the worn brown monk’s cloth in the mahogany cases and ‘freshen up’ any overly worn exhibit labels. In the process of discussions surrounding these developments, curator Waldo Schmitt articulated a similar approach to modernizing exhibits, one common among older scientists in natural history museums. Rather than a dramatic overhaul of content or pedagogical method, Schmitt suggested exhibits merely needed more colour and punch. ‘[W]e must advertise!’, he exhorted his colleagues at one Exhibits Modernization Committee meeting,

Our exhibits are our show windows for displaying our wares and accomplishments; our advertisements are the publicity given those exhibits and the publications describing the material that they represent.... Unless the exhibits are attractively gotten up ... they will neither sell nor advertise successfully what we have for sale.¹⁷

New monk’s cloth and better lighting were not exactly the compelling innovations that Taylor and his committee had in mind, but tight wartime budgets prevented the reformers from pushing the issue further.

When the War ended, however, changes in leadership and institutional organization began to create a more favourable climate for the implementation of new display strategies in natural history museums. Several museums reorganized the division of labour between their curatorial and exhibits-making staff, and in the process, elevating exhibits-making staff to positions of greater institutional recognition and reward. The Los Angeles County Museum promoted its director of exhibit preparation to curatorial status, as did the California Academy of Sciences. Likewise, at the Smithsonian, Taylor’s constant criticism of the displays wore down the new Secretary, Leonard Carmichael: in 1955, Carmichael authorized the creation of a centralized Office of Exhibits.¹⁸ Such shifting institutional arrangements reflected, in part, a broader professionalization of museum exhibition and administration work taking place nationwide. As Frank Taylor later recalled, the post-war trend towards giving exhibits-makers greater measures of control over their work signalled new respect for the importance of display (Taylor 1982).

As a result of such developments, however, staff conflict increased. The older guard of scientist-curators who championed the systematic display of actual specimens – the stuff of science – and the traditions of Linnaean taxonomy and education through observation, fought fiercely with a younger generation of educators, scientists and exhibition staff who pushed for exhibits that would more aggressively integrate scientific content, appealing display and educational interpretation. To convey scientific concepts more effectively, the latter group was willing to take some liberties. Determined to familiarize the public with the subjects, rather than the objects of science, they eschewed specimens and taxonomic display in favour of illustrations and models. Rather than assigning particular departments authority over displays relevant to their specific collections of plants or shells or fossils, they encouraged interdepartmental cooperation to ensure interdisciplinary presentation of broader scientific themes. Debate over the merits of these different visions of display often devolved into violent argument. Take, for example, the efforts to modernize the Smithsonian’s Hall of Marine Life in the early 1960s. Older curators and the new exhibit office staff clashed repeatedly over the premise and scope of the renovation – would it present a series of separate and specialized research findings or a broader thematic narrative?¹⁹ The exhibits staff proposed showing marine habitat groups but emphasized a thematic approach:

A shore scene or coral reef [they wrote] could also carry the ‘survival’ theme of marine animals.... Other themes that could be developed include ... exploring the ocean (to include models of bathysub, gondola, echosounding, etc. and new phases such as TV and photography) [as well as] myths, beliefs, legends, monsters, mermaids.²⁰

While this kind of proposal was cutting-edge for the conservative Smithsonian, it wasn't a particularly radical approach to display. American natural history museums more committed to public education had been experimenting with immersion-style exhibits since the 1930s, though only a few had been able to realize their plans in grand scale. Still, the Smithsonian's older curators balked. They angrily protested that the theme would distract visitors from the scientific information the exhibit imparted – visitors would be confused, one curator argued, by the diversity of the subjects presented. As David Johnson (Curator of Mammals) wrote to Friedmann:

Some of the topics that are listed on the outline indicate a tendency to wander off into related fields rather than sticking to the subject of zoology.... [I]n the eyes of the visitor each of our [science] halls is a specialized element.... If each hall branches out into the field that are more expertly covered by others, we will end up with a patchwork arrangement.²¹

One curator was so opposed to the interdisciplinary approach that he would not cooperate with the exhibits staff at all: once on the collecting expedition for the new display, Joseph Morrison refused to dive for new specimens with the exhibit designer.²² Head of Exhibits John Anglim later told Taylor that Morrison and the other curators seemed to feel that a 1960 expedition to New Caledonia to collect for the Hall of Marine Life was 'a project schemed up by the exhibits office for the sole purpose of harassing them and interrupting their orderly way of life. We are in the untenable position of trying to force them to do a job that has been assigned to them by the Museum'.

Compromise was in order. Exhibit-designers agreed to use specimens – the actual stuff of science – in the hall, but placed them within the aesthetically pleasing frame of habitat dioramas located in side alcoves. The hall plans also featured more 'modern' exhibition techniques, designed to educate visitors through a two-pronged approach of emotional appeal

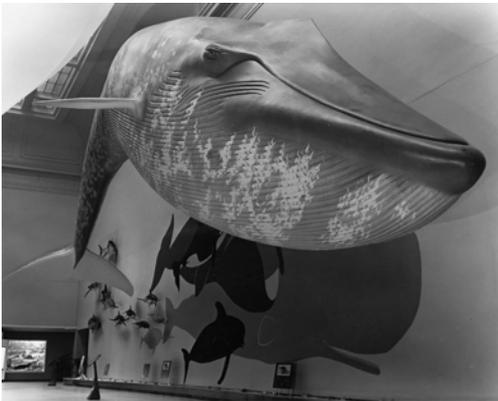


Fig 3b: This diagrammatic rendering is typical of exhibit modernization—it attempts to contextualize objects by providing simplified visual comparisons. Smithsonian Institution Archives, Record Unit 95, Box 44 Folder 21 [2002-12150]



Fig 3a: The entrance to the "Life in the Sea" exhibit at the National Museum of Natural History. The hall was painted dark blue to evoke the feeling of water, and featured a life-sized sculpture of a blue whale. Smithsonian Institution Archives, Record Unit 95, image #SIA2008-6149 [MNH-1115]

and diagrammatic imagery. Chief among them was a sculpture of a blue whale, commissioned in 1959 (figs 3a and 3b).²³ It wasn't a specimen, but it promised to evoke far more 'oohs' and awe than a whale skeleton would have.

Ultimately, museums more and more frequently adopted the 'modernization' ideas promoted by the exhibit staff – and museum administrators went out of their way to publicize these efforts. Frank Taylor used staff interviews with the media to promote the renovation of

the Smithsonian's exhibitions. Over the three years it took to install the Smithsonian's new Hall of Ocean Life exhibit, Taylor allowed media ranging from TV to film to magazines to newspapers to cover the building of the exhibit. In interviews, the exhibits staff made an effective case for abandoning older traditions of display. After noting that his work was based on first-hand observation of an actual whale (a 120-ton creature 'bagged off the island of South Atlantic – Georgia') lead artist John Widener pointed out that art could bring visions of marine life to the public that no specimen could. In an interview for a 1961 article entitled 'Smithsonian Builds a Plastic Monster: A Whale of an Undertaking', Widener explained that, in the completed hall, 'the Whale will be suspended gracefully from the ceiling'. This could not be done, Widener pointed out, with a real specimen because it would weigh 90,000 pounds (as compared to the 8000 pounds of the model) and because 'no one knows how to preserve a whale skin for stuffing.' 'The shoddy stuffed animals will be either repaired or retired', he promised, and would be replaced by more artistic, realistic models. Widener took pains to note that scientists made decisions about accuracy of these representations (even if they were somewhat idiosyncratic): the 'final check' of the whale sculpture, Widener noted, 'would be an "eye" survey by A. Remington Kellogg ... a man who has seen many a whale in the flesh.'²⁴ Despite his nod to the scientific staff, Widener's message was clear. The renovations to the Hall of Marine Life, he implied, were long overdue. It was time, Widener suggested, for the Smithsonian to embrace rather than run from such forward-thinking display techniques.

When the Smithsonian's Hall of Ocean Life opened in 1963, external scientific and popular reports stressed its exhibits' success with the public. Albert Parr, Director of the American Museum of Natural History in New York, argued that the new Smithsonian installation had solved both the problem of design and the problem of science by putting the visitor in a natural moment:

The gently curved shape of the ... balcony and its railing evokes memories of ships without straining actual credulity by imitation of form and structure. The stairs leading from the main floor to the balcony ... are unobtrusively reminiscent of companionways. By these, and other gently suggestive devices, the designers have very cleverly managed to imbue the space itself with a subtly nautical air that makes the whale, in defiance of all logic, seem a far more reasonable and attractive sight than it ever did before under a roof.²⁵

In 1963, *The Virginian* newspaper welcomed the accessibility of the Hall of Ocean Life exhibit: 'Washington's newest tourist attraction is an outstanding example of modern museum craftsmanship. The whale, although awesome enough, appears to be a jolly sort, sporting an ear to ear grin, the most celebrated smile seen in Washington since the Mona Lisa.'²⁶ Taylor effectively exploited this and other new displays to generate more political involvement in his museum – arranging, for example, for senators or congressman to have personalized tours of recently renovated Smithsonian halls. Ultimately, the Smithsonian's Hall of Marine Life represented one vision of new-style natural history displays – immersion-style exhibits designed around scientifically-mediated, lifelike art, rather than nature's own specimens.

Cold war shifts: museums and science policy

While established natural history museums moved to revamp their older exhibition halls, newer museums also began to embrace both life science content and alternative visions of what constituted 'modern' display. With younger scientific staff members and small (or sometimes non-existent) collections, few objected when these institutions chose to display models and exhibits that explained conceptual aspects of the new experimental biology and biomedical sciences rather than actual natural objects. Unburdened by entrenched curatorial practices and static permanent displays, newer museums could easily develop and change their halls to accommodate shifting public and scientific interests in these areas.

Drawing upon strategies first employed in European museums of science and industry (Macdonald 1998; cf. *Museums for a New Age* 1927), such new life science exhibits at first embodied a very limited vision of visitor interactivity – sometimes merely touching or manipulating a model, or pressing a button that triggered a light. Early examples from the Boston Museum

of Science alone included large-scale replicas of James Watson and Francis Crick's model of the structure of DNA (featured prominently in the entry hall); interactive plastic models of the heart and of other surgical procedures like an appendectomy; and a 'nuclear plant' exhibit, which was designed to demonstrate the presence of radioactive tracers ingested in live displayed specimens by allowing visitors to manipulate a Geiger counter over them.²⁷

Older natural history museums responded by installing similar or identical exhibits of their own. For example, the Smithsonian introduced a series of life science displays that had no connection to the research work of its natural history curators but nevertheless explored subjects that interested the public. In 1957, a new 'Hall of Health' was opened in the Arts and Industries building, the centrepiece of which was a 'Transparent Woman', mimicking exhibits popular in Europe in the 1930s. Using electronic sound and light, this figure demonstrated (in hourly guided 'performances') the function of the major organs and systems of the human body. The AMNH



Fig 4: Here featured at the AMNH in 1954, the Transparent Woman display could be found in museums all over the United States. Neg. #2a6293; American Museum of Natural History Photographic Print Collection.

had launched its own Transparent Woman display in 1954 (fig. 4) – as did the Boston Museum of Science in 1955 and Portland's new Oregon Museum of Science and Industry in 1957.²⁸

Throughout the 1950s and early 1960s, exhibit designers congratulated themselves on visitors' positive response to new displays in life science. Museum leaders, however, could not yet afford to pat themselves on the back, as they found themselves under pressure to defend recent trends in exhibition and education to an entirely new audience: American science policy-makers desperate to recruit young people into science and engineering careers in the wake of Sputnik. To this end, the National Science Foundation (NSF) established an 'Office of Scientific Exhibits' in 1960, which provided the first regular Federal source of funding for US science museum education, and museums, always desperate for money, jumped to attention. To win the attention of grant-makers, museum leaders proposed different models of how their institutions could accomplish the NSF's announced Cold War objectives. To Washburn in Boston and some others, changing exhibits frequently and encouraging what he called 'exposure to the whole broad vista of science at an early age' represented the best educational investment that the nation could make in museums.²⁹ But Washburn failed repeatedly to interest the NSF in his museum. 'We are', programme officers told him, 'fundamentally interested in *instruction rather than exposure* [original emphasis] to science.... We are interested in the real stuff, not the kind of thing that you appear to be doing now.'³⁰ Such struggles, then, reflected a new institutional crisis facing museums of science and nature around 1960: how best to create popular displays that also best embodied new educational (rather than scientific research) ideals.

Some natural history museum leaders, in turn, proposed alternative forms of public education and engagement in science: they argued that participation in the scientific enterprise could better encouraged by allowing visitors to see and do their own 'research' on the raw materials of science and nature that their museums were now seemingly working to hide.

Though Parr had pushed the AMNH to move away from static displays and rotting specimens, he concluded in 1962 that the new approach also proved insufficient in attracting visitor interest and genuine engagement. Whale models, 'transparent women' and habitat dioramas alike encouraged passivity, he wrote, making visitors feel that 'science is not actually inviting [them] in, but keeping [them] out with carefully planned and cleverly executed substitutes for the "real thing", deemed more appropriate for a layman's unsophisticated capacity for appreciation' (Parr 1962). Debates over authenticity, once conducted within the walls of museums and the pages of museum journals, exploded into broader discourse in this era. Museum workers, policy-makers and science educators entered into fraught political and cultural discussion about the educational effectiveness of actual scientific objects relative to models and other pedagogical strategies. Longstanding disputes about what constituted 'the real thing' continued to focus on specimens, but expanded to encompass the meaning of displays for science education and the kind of public interactions they evoked (Nyhart 2004). Exhibits had become a new battleground for both the definition of science itself, as well as how museums (as institutions of science) might best promote public engagement with it. This contest over science museums' relationship with the larger public mirrored the larger debate about the role of museums in society that had grown out of the rights movements and new social visions of the 1960s and 1970s.³¹

By the late 1960s, then, the American science museum landscape had been transformed by these debates over content and exhibit approach. The older natural history museums that remained competed for visitors and resources with 'new' style natural history and science museums. As a result of scientists' desire to mitigate public fear about science's apocalyptic power in the wake of the atomic bomb, as well as increasing Cold War pressures to celebrate recent achievements in science and technology, newer museums developed exhibits that concentrated more on abstract life science principles than on specimens and their relationship to the broader natural world (Barry 1998, cf. Hein 1990). Newer exhibits sought to convey the power of important biological ideas, the experimental method, and scientific thinking in modern citizenship, whereas older exhibits were retrofitted to account for a newer emphasis on biological processes, and molecular as well as ecological (though not always evolutionary) thinking (cf. Rudolph 2002).³²

The most important of these new museums was the Exploratorium, an institution developed by physicist Frank Oppenheimer (brother of Robert) who left a second career in high school science education in order to build a place that could 'develop public understanding of science and technology ... bridge the gap between the experts and the layman' (Oppenheimer 1968: 206; cf. Ogawa *et al.* 2008). Oppenheimer argued that achieving this goal would be possible only in a physical place (apart from the classroom) with what he called 'a laboratory atmosphere' – a place where people of all ages, from all walks of life, could enter and 'become familiar with science and technology and gain understanding by controlling its props'. 'Explaining science and technology without props', Oppenheimer wrote in 1968, 'can resemble an attempt to tell what it is like to swim without ever letting a person near the water' (Oppenheimer 1968, 206–7). Displays at his Exploratorium epitomized the ideal that genuine scientific education could come only through 'non-coerced' experiment. Oppenheimer argued in a 1972 *American Journal of Physics* essay that the Exploratorium was a 'playful museum'; his institution would 'respond to the criticisms and the tenor of its times' by providing opportunities for its visitors to 'become involved in their own [science] education process [in ways] that are difficult to achieve in school classrooms or through books, films, or t.v. programs'. This 'everyman his own scientist' pedagogical philosophy manifested itself at the Exploratorium in two ways: in exhibits with which visitors could easily interact and conduct mini-experiments, and in a nonlinear exhibit arrangement that encouraged free choice about how to move through the museum (Oppenheimer talked not of making visitors 'behave' but of designing the space in ways that 'relieve the visitor' of any 'obligations') (Oppenheimer 1972: 978, 980).

Although Oppenheimer conceived of the Exploratorium exhibits as constituting a collection – or what he called a 'chain of exhibits' that presented visitors with 'multiple examples in a variety of contexts' – he worried less about the objects on the floor or whether visitors perceived the connections between exhibits, than whether his exhibit designers could create interactions that would empower visitors to engage with and understand general principles of the natural world. For example, new curator of life sciences Evelyn Shaw, formerly of the

Department of Animal Behavior at the AMNH, hired exhibit designers with a background in both experimental science and art to create the first life science displays at the Exploratorium. Many of these exhibits featured live animals – such as the ‘Brine Shrimp Ballet’. Here a cylindrical tank filled with salt water and illuminated at the top housed thousands of primitive aquatic crustaceans; their movements all appeared to be in one direction – upwards. But when a visitor pushed a switch so that the light shone at the bottom of the tank, the tiny creatures turned in unison downwards toward the new light source. The biological phenomenon taking place is phototropism, and the visitor interaction came both at the moment of observing the initial movements of the shrimp, and at controlling them with the light source (Carlson 2006).

The emergence of more and more Exploratorium-style exhibits and other similar science centres like it throughout the 1970s forced an even broader confrontation among museum administrators and policy-makers over the meaning of specimens and collection in defining and legitimating their institutions. In April 1975, for example, the newly-formed Association of Science-Technology Centres (ASTC) clashed with the American Association of Museums (AAM) over proposed changes in the AAM accreditation procedures. ‘We feel’, ASTC President and Chicago Museum of Science and Industry Director Victor Danilov wrote, that ‘science and health museums are being discriminated against’ by AAM’s proposal to group collection-oriented museums in one category and assign separate categories for other types of museums: ‘the proposed alignment treats non-collection museums as second class citizens (regardless of how it is worded).’³³ By July of that same year, ASTC and AAAM had hammered out an agreement that allowed science and technology centres to be eligible for accreditation ‘even if they do not own collections of artifacts of intrinsic value – assuming they meet other professional standards’. Among these standards, most prominently featured was educational purpose – followed by having the ability to ‘meet effective standards both in the utilization of materials and resources and for the care of objects borrowed’ for exhibition and being ‘open to the public on some regular schedule’. Science centres, in the words of AAM leadership, had become ‘numerous enough and possess[ed] sufficient maturity of concept and breadth of experience’ to qualify as successful museums’.³⁴

Conclusion

Debates over what constituted effective science museum displays between 1930 and 1968 thus reflected and contributed to ongoing cultural conversations about the role museums should play in shaping relations between the sciences and their publics. While American citizens increasingly frequented science museums, leaders and policy makers asked whether and how these institutions could be held accountable in respect to their public role: should they be responsible for recruiting a new generation of scientists and engineers, or were their missions better conceived in terms of directly training a scientifically literate citizenry in knowledge of natural phenomena? Like the varying approaches to display in natural history museums that had come before, Washburn’s and Oppenheimer’s later models each conceived of what counted as ‘doing’ science differently, and each created a different array of possible relations between scientific practitioners and their publics.

With the benefit of time and more historical work, this transitional period thus appears both more complex and more important than most scholars have previously recognized. Science museums, Kohlstedt observes, ‘have not had a tidy history or a neatly defined set of characteristics during the period when they were, perhaps, most influential’ (Kohlstedt 1995: 152). For this reason, Lynn Nyhart has praised scholarly efforts that pay careful attention to the ‘sense of ambiguity and time dependence of museum meanings’ integral to shifts in museum history – rather than making ‘broad pronouncements about “what museums do” without regard to the nuances of time and location’ (Nyhart 2001: 190). At the same time, we would suggest, if museum history becomes too local, it can become equally decontextualized from larger trends in science and society that are driving shifts in both the content and the style of displays. Samuel Alberti and others have begun to explore the ways in which changing relations between British natural history museums and scientific disciplines shaped and were themselves shaped by national science policies (Alberti forthcoming; cf. Stearn 1981). Such work historicizes museum studies scholars’ attempts to come to terms with the impact of the international political contexts

on museum practices beyond their traditional focus on colonialism and natural history collecting.

As historians initiate more research on American museums' shift from natural history to science and on their transition from the tradition of didactic display to a paradigm that aspired to engaged interaction, we believe this work will reveal more about the complex relationship between policy, education and public culture in the US and worldwide. We concur with David Livingstone's argument that the places in which science is conveyed to the public can profoundly influence the development and nature of scientific inquiry (Livingstone 2003). Between 1930 and 1980 American natural history and science museums struggled to become new kinds of places. Their struggles – and their relative successes and failures, as measured at the time – merit further inquiry, for they resulted in new institutional and political configurations within the museum world and society more broadly. By the end of these decades science museums had new importance in US policy debates over the relationship between science education (especially, as we have discussed, natural history and biology) and its publics; post-Sputnik, this relationship became to a greater extent than ever before, a matter of state concern.

We also believe this period should be viewed as a crucial turning point in the transformation of museums. The gradual shift from specimen-display to non-collection exhibits – from natural history to science – that occurred in the mid-twentieth-century United States should not be seen as a dormant period in museum history but rather as an important moment in a longer history. Museum displays have evolved from the private cabinets of curiosity into neatly-ordered taxonomies of objects accessible for study, from visual catalogues of the earth's products to carefully edited displays designed to contextualize objects within aesthetically dramatic settings, and they continue to change (Findlen 1994, Conn 1998, Kohlstedt 2006, Nyhart 2004, 2009). We argue that the processes rather than the products of these changes are the richest resources for historians and museum scholars. The most important space in this ongoing history of display is located not in one of Friedman's progressionist boxes, but in the interstices between them. In these moments of discussion, 'traffic' (cf. Haraway 1989) between new practices and established modes is the most intense and the most contested, and the conversations that result from this 'traffic' illuminate the emergence of historically contingent pedagogies, epistemologies and social values.

In mid- to late-twentieth-century America, we argue that transformations in displays in science museums bring into sharp focus larger cultural attempts to redefine both science and museums (cf. Gieryn 1983). 'Science' now included visitors' as well as scientists' interactions with the natural world, made possible through exhibition, and 'museums' now included collections of educational expertise, embodied in new modes of display and learning. Viewed this way – as flexible, dynamic, historically contingent institutions – modern science and natural history museums might continue to be critically examined for what cultural 'premises they lay claim to' (Macdonald 1990: 225; cf. Vergo 1989), rather than evaluated for success or failure according to absolute museological norms.

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Notes

- 1 For an elaboration of this in broader historical context, see K. Rader and V. E. M. Cain, *Life on Display: Museums' Struggle to Capture the American Life Sciences*, manuscript in progress.
- 2 F. Taylor, Memo, 22 June 1948 RG 190, Box 89, 'Exhibits Modernization 1950', Smithsonian Archives, Smithsonian Institution, Washington, DC (hereafter 'SA').
- 3 On the federal 'science moratorium' in 1933 see Heilbron and Seidel 1989: 30–31 and Kevles 1978: 243–245, 249.
- 4 F. Boas to R. C. Andrews, 19 November 1937, as cited in Kennedy 1968: 204.

- ⁵ W.K. Gregory to H.E. Anthony, 24 May 1935, Department of Mammalogy Administrative Papers, Box 1 FF; Council of Scientific Staff: Correspondence I, 1934–5; American Museum of Natural History Special Collections (hereafter 'AMNH').
- ⁶ J.D. Figgins to A.M. Bailey, 24 September 1931, Box 501.Figgins 21 FF A. M. Bailey, Colorado Museum of Natural History Archives, Denver Museum of Nature and Science, Denver, CO (hereafter 'CMNH').
- ⁷ A.E. Parr, Address Delivered at the Meeting Commemorating the Fiftieth Anniversary of the Field Museum of Natural History, Chicago, 1943, p.11, in A.E. Parr Biographical File, AMNH.
- ⁸ A.E. Parr, Address Delivered at the Meeting Commemorating the Fiftieth Anniversary of the Field Museum of Natural History, Chicago, 1943, p.11, in A.E. Parr Biographical File, AMNH.
- ⁹ A.E. Parr, Address Delivered at the Meeting Commemorating the Fiftieth Anniversary of the Field Museum of Natural History, Chicago, 1943, p.11, in A. E.Parr Biographical File, AMNH.
- ¹⁰ A.E. Parr, 'On the Functions of the Natural History Museum', Department of Mammalogy Administrative Papers, Box 2, FF: AMNH CSS Correspondence IV (1940–1), AMNH, 2.
- ¹¹ On the snake exhibit and other live animal demonstrations, see Boston Museum of Science Member Newsletter, September 1950, Boston Museum of Science Archives, Museum of Science Library (hereafter 'MoSA'). Cf. Boston Museum of Science Member Newsletter, December 1950, front page photo of Herkemiah; MoSA.
- ¹² For more on the inadvertent contributions of habitat groups to science funding and collecting expeditions, see Star 1992 and Kohler 2006.
- ¹³ Smithsonian visitor surveys taken in the early 1970s suggested the Hall of Birds was one of the most popular exhibits in the Natural History museum: P. Henson, personal communication, 20 October 2005.
- ¹⁴ In his annual report of the same year, Washburn angrily suggested these displays might be to blame for the slightly reduced attendance: see 'Black Bear on Mount Washington', Boston Museum of Science Member Newsletter, June 1954; "'Shorebird" Superintendent', Boston Museum of Science Member Newsletter, December 1954; both MoSA. Many museum administrators also argued the opposite – that dioramas stimulated attendance.
- ¹⁵ F. Taylor, Memo, 22 June 1948, RG 190, Box 89, 'Exhibits Modernization 1950', SA.
- ¹⁶ F. Taylor to Committee on Modernization of Exhibits, attached to memo of July 1948, SA.
- ¹⁷ F. Taylor, 'Preliminary Report on Exhibits', October 1948, RG 190, Box 89, 'Exhibits Modernization 1950' (including Kellogg's reply), SA. Cf. Taylor 1982.
- ¹⁸ Office of Exhibits Central, Records, 1954 to 1979, Record Unit 503, SA.
- ¹⁹ F. Taylor and others, correspondence with A. J Friedmann, 2–3 October 1956; RG 363, Box 1, SA.
- ²⁰ E.A. Lachner to A.J. Friedmann, 25 Sept 1956, RG 363, Box 1, Folder 'Oceanic Scripts', SA.
- ²¹ Johnson was very rigid about this point: he suggested that 'mythological and primitive conceptions' of marine life belonged in anthropology, and exploration of the sea, in history. See D. Johnson, Memo, 27 April 1959, RG 363, Box 1, 'Scripts', SA.

- ²² J. Anglim to F. Taylor and J. C. Ewers, 28 June 1961, RG 363, Box 13, Folder 'Misc. Correspondence re: Permanent Halls', SA.
- ²³ Natural history museums had long featured skeletons of blue whales in their halls, and a few, like the British Museum of Natural History and the American Museum of Natural History, also featured iconic whale models in their own halls devoted to ocean life. For more on whale models, see Rossi 2007.
- ²⁴ For Kelley and other articles, see 'Newspaper Article Packet', RG 363, Box 1, 'Life in the Sea' drawings, SA.
- ²⁵ A. E. Parr, 'Concerning Whales and Museums', RG 363, Box 1, folder 'Whale...' SA.
- ²⁶ Newspaper Article Packet, RG 363, Box 1, SA.
- ²⁷ MoSA Newsletters for September 1953 and December 1953; cf. B. Washburn to A. Marble, 28 February 1957, Box '1957-58', Folder 'S', BW-MoSA, Boston Museum of Science Library.
- ²⁸ The Transparent Woman display in Portland was the centrepiece of a building initiative at the Oregon Museum of Science and Industry, formerly a one-room natural history installation in the Portland Hotel. Variations on the Transparent Woman exhibit reveal interesting relations between science museums and local public culture. For example, the Boston Museum of Science's Transparent Woman was built especially for them by the Deutsches Museum, and between 1955 and 1975 she gave nearly 50,000 performances – initially, accompanied by a score written especially for her by the Boston Pop's Arthur Fiedler, and a script in which she herself (in a female voiceover, translated from the German) explained the location and function of each of her organs. On donation and explanation of the Transparent Woman, see Museum of Science Ready Reference File: 'Transparent Woman', MoSA; on Fiedler and the Transparent Woman's debut, see MoSA Newsletter, September 1955, MoSA.
- ²⁹ Cf. B. Washburn to A. Sachar, 21 June 1963, Box '1963', Folder 'Correspondence'; Memo from B. Washburn to N. Harris, 20 September 1962, Box '1962', Folder 'Memos and Misc.'; B. Washburn to E. Peabody, 7 November 1962, Box '7-1962', Folder 'P' – all BW-MoSA. Others at the MoSA were concerned with accommodating adults – see F. Rowlands to Whom It May Concern, Memo re: 'Museum Crowds', 19 July 1962, Box 1961, Folder 'Memos and Misc.'; all from MoSA. In turn, Washburn proposed new programs such as summer workshops for science teachers to learn new scientific concepts from displays at the museum, but for these the MoSA received only minimal NSF support.
- ³⁰ B. Washburn to G. Rothwell (NSF), 7 December 1961, Box '1961', Folder 'Correspondence'; B. Washburn 'Memorandum – Visit by BW to NSF, 14 November 1962', Box '1962', Folder 'NSF'; cf. N. Harris to B. Washburn, 6 January 1959, Memo re: 'Summer Teachers Courses', Box '4-1959', Folder 'Education Dept.' – all MoSA.
- ³¹ One landmark in this gradual transformation of the relationship between museums and the broader public was the 1967 Smithsonian conference on 'Museums and Education', which Oppenheimer attended; see Larrabee 1968. Another similar project was 'Museums USA', a 1971–73 research study sponsored by the National Endowment for the Arts. The chapters of the resulting book indicate that museums devoted to radically different subjects were also engaged in soul-searching about institutions' educational responsibilities, in relation to the nature of display as well as museums' relations with their visitors. See National Endowment for the Arts 1974.
- ³² J. Rudolph notes that biologists were especially keen on developing educational policies that made clear the ways in which not only physics but biology contributed to wartime

science and the post-War US research enterprise. Furthermore, Rudolph argues, their approach was consonant with trends in progressive education dating from the 1930s. See Rudolph 2002: 18–22.

³³ V. Danilov (ASTC) to A. Wall (AAM), 23 April 1975; Exploratorium Collection, Bancroft Library, University of California (hereafter, 'EXPL'): 87/1498c, Box 6, Folder 17.

³⁴ Memo: V. Danilov to ASTC Members, 15 July 1975, EXPL: 87/1498c, Box 6, Folder 17.

References

Alberti, S. J. M. M. (forthcoming) *Nature and Culture: Objects, Disciplines and the Manchester Museum*, Manchester: Manchester University Press.

Allen, G. (1978) *Life Science in the Twentieth Century*, Cambridge: Cambridge University Press.

Andrews, R. C. (1929) 'My Museum Complex', *World's Work*, 58 (October) 59.

Barry, A. (1938) 'On Interactivity: Consumers, Citizens and Culture', in Macdonald, S. (ed.) *The Politics of Display: Museums, Science, Culture*, 99–117, New York: Routledge.

Benson, K. R., Maienschein, J. and Rainger, R. (eds) (1991) *The Expansion of American Biology*, New Brunswick, NJ: Rutgers University Press.

Carlson, C. (2006) Oral History Interview with K. Rader and S. Gassaway, San Francisco (February).

Coleman, L. V. (1923) 'A New Era for American Museums', *Science*, 58 (1497) 172–4.

Coleman, L. V. (1939) *The Museum in America: A Critical Study*, 3 vols, Washington DC: The American Association of Museums.

Conn, S. (1998) *Museums and American Intellectual Life, 1876-1926*, Chicago, IL: University of Chicago Press

Davis, S. (1997) *Spectacular Nature: Corporate Culture and the Sea World Experience*, Berkeley, CA: University of California Press.

Findlen, P. (1994) *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*, Berkeley, CA: University of California Press.

Foyles, E. J. (1934) 'Museum Conditions in the United States', *Science*, 80 (2082) 476-8.

Friedman, A. J. (1996) 'The Evolution of Science Museums', *Informal Science Education*, 1 (March–April), 14–7.

Friedman, A. J. (1997) 'Are Science Centers and Theme Parks Merging?', *The Informal Science Review*, 25 (1) 4–5.

Friedman, A. J. (2007) 'The Extraordinary Growth of the Science-Technology Museum', *Curator*, 50 (1) 63–76.

Gieryn, T. F. (1983) 'Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists', *American Sociological Review*, 48, 781–95.

- Haraway, D. J. (1989) *Primate Visions*, New York: Routledge.
- Heilbron, J. and Seidel, R. (1989) *Lawrence and His Laboratory*, Berkeley, CA: University of California Press.
- Hein, H. S. (1990) *The Exploratorium: Museum as Laboratory*, Washington, DC: Smithsonian Institution Press.
- Kennedy, J. M. (1968) 'Philanthropy and Science in New York City: The American Museum of Natural History, 1868-1968', Ph.D., Yale University.
- Kevles, D. J. (1978) *The Physicists*, Cambridge, MA: Harvard University Press.
- Kohler, R. E. (2006) *All Creatures: Naturalists, Collectors and Biodiversity, 1850–1950*, Princeton, NJ: Princeton University Press.
- Kohler, R. E. (2002) *Landscapes and Labscapes: Exploring the Lab-Field Border*, Chicago: University of Chicago Press.
- Kohlstedt, S. G. (1995) 'Essay review: Museums: Revisiting sites in the history of the natural sciences', *Journal of the History of Biology*, 28 (1) 151–66.
- Kohlstedt, S. G. (2005) "'Thoughts in Things": Modernity, History, and North American Museums', *Isis*, 96 (4) 586–601.
- Larrabee, E. (ed.) (1968) *Museums and Education*, Washington, DC: Smithsonian Institution Press.
- Lederer, S. (1992) 'Political Animals: The Shaping of Biomedical Research Literature in Twentieth-Century America', *Isis*, 83 (1) 61–79.
- Livingstone, D. N. (2003) *Putting Science in Its Place*, Chicago: University of Chicago Press.
- Lutz, F. (1930) 'The Use of Live Animals in Museum Work', *The Museum News*, 8 (6) 7–9.
- Macdonald, S. (1990) 'Posing Questions about the Purposes of Museums', *Current Anthropology*, 31(2), 225–8.
- Macdonald, S. (1998) 'Exhibitions of Power and Powers of Exhibition: An Introduction to the Politics of Display', in Macdonald, S. (ed.) *The Politics of Display: Museums, Science, Culture*, 1–24, London: Routledge.
- Mitman, G. (1999) 'From Flippy to Flipper: A Ringside Seat in the Making of an Oceanic Star', Conference on 'Representing Animals', Center for the Interactions of Animals and Society, School of Veterinary Medicine, University of Pennsylvania, March 19.
- Mitman, G. (1993) 'Cinematic Nature: Hollywood Technology, Popular Culture, and the American Museum of Natural History', *Isis*, 84 (4) 637–61.
- Murphy, R. C. (1937) 'Natural History Exhibits and Modern Education', *The Scientific Monthly*, 45, 76–81.
- Museums for the New Age: A Study in Progress* (1927), silent film produced by the Association for the Establishment and Maintenance of Museums of the Peace Arts for the City of New York, under the supervision of C. T. Gwynne. Copy provided to K. Rader by D. Wint, from Franklin Institute Library.

National Endowment for the Arts (1974) *Museums USA: Art, History, Science, and Others*, Washington, DC: US Government Printing Office.

Noble, G. K. (1927) 'Reptiles and Amphibians', *American Museum of Natural History: Annual Report of the President*, 59, 60–1.

Nyhart, L. (2001) Review of C. Yanni (1999) *Nature's Museums*, London: Athlone, *Isis*, 92 (1) 190–1.

Nyhart, L. (2004) 'Science, Art and Authenticity in Natural History Displays', in Chadarevian, S. de and Hopwood, N. (eds) *Models: The Third Dimension of Science*, 307–35, Stanford, CA: Stanford University Press.

Nyhart, L. (2009) *Modern Nature: The Rise of the Biological Perspective in Germany*, Chicago: University of Chicago Press.

Ogawa, R., Loomis, M. and Crain, R. (2008) 'Institutional History of an Interactive Science Center: The Founding and Development of the Exploratorium', *Science Education*, 7, 1–24.

Oppenheimer, F. (1968) 'Rationale for a Science Museum', *Curator*, 11, 206–9.

Oppenheimer, F. (1972) 'The Exploratorium: A Playful Museum Combines Perception and Art in Science Education', *American Journal of Physics*, 40, 978–84.

Parr, A. E. (1962) 'A Nice 'Gooky' Exhibit', *Curator*, 5 (2) 119–20.

Rainger, R. (1993) *An Agenda for Antiquity: Henry Fairfield Osborn and Vertebrate Paleontology at the American Museum of Natural History, 1890-1935*, Tuscaloosa: University of Alabama Press.

Rainger, R., Maienschein, J. and Benson, K. R. (eds) (1988) *The American Development of Biology*, Philadelphia: University of Pennsylvania Press

Ramsey, G. F. (1938) *Educational Work in Museums in the United States: Development, Methods, and Trends*, New York: Wilson.

Rossi, M. (2007) 'Corpus, Porpoise or the [Model] Whale, 1903–1974', presented at the History of Science Society Annual Meeting, Dallas, TX.

Rudolph, J. L. (2002). *Scientists in the Classroom: The Cold War Reconstruction of American Science Education*, New York: Palgrave Macmillan.

Semper, R. (2007) 'Science Centers at 40: Middle-aged Maturity or Mid-life Crisis?', *Curator*, 50 (1) 147–50.

Smithsonian Institution (1938) *Annual Report*, Washington, DC: Smithsonian Institution.

Star, S. L. (1992) 'Craft vs. Commodity, Mess vs. Transcendence: How the Right Tool Became the Wrong One in the Case of Taxidermy and Natural History' in Clarke, A. R. and Fujimura, J. H. (eds) *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences*, 257–86, Princeton, NJ: Princeton University Press.

Starn, R. (2005) 'A Historian's Brief Guide to New Museum Studies', *The American Historical Review*, 110, 68–98.

Stearn, W. T. (1981) *The Natural History Museum at South Kensington: A History of the British Museum (Natural History) 1753-1980*, London: Heinemann in association with the British Museum (Natural History).

Taylor, F. (1982) Oral History Interview (RU 9512), Smithsonian Archives, Smithsonian Institution, Washington, DC.

Vergo, P. (ed.) (1989) *The New Museology*, London: Reaktion Books.

Winsor, M. P. (1991) *Reading the Shape of Nature: Comparative Zoology at the Aggasiz Museum*, Chicago: University of Chicago Press.

Wissler, C. (1925) 'The Museum Exhibition Problem', *Museum Work*, 7 (6) 173–80.

Wissler, C. (1943) *Survey of the American Museum of Natural History: Made at the Request of the Management Board, 1942-3*, bound typescript (442 pages) in Rare Book Collection [call number 21-F], American Museum of Natural History Research Library, New York, NY.

Yochelson, E. L. (1985) *The National Museum of Natural History: 75 Years in the New National Museum*, Washington, DC: Smithsonian Institution Press.

* **Karen A. Rader** is director of the Science, Technology, and Society Initiative and associate professor of history at Virginia Commonwealth University; she formerly taught at Sarah Lawrence College. The author of *Making Mice: Standardizing Animals for American Biomedical Research, 1900-1955* (Princeton, NJ: Princeton University Press, 2004), she received a US National Science Foundation CAREER grant for a project entitled *Biology on Display: Museums and the New Life Sciences*.

Address

STS Initiative
Department of History
Virginia Commonwealth University
PO Box 842001
Richmond, VA 23284-2001
USA
email: karader@vcu.edu

** **Victoria E. M. Cain** received her Ph.D. (with honors) in American history from Columbia University. Her dissertation was entitled 'Nature Under Glass: Popular Science, Professional Illusion and The Transformation of American Natural History Museums, 1870–1940'. Formerly an Andrew W. Mellon / Shoah Foundation Postdoctoral Fellow in Visual History, she is now a Spencer Fellow at the University of Southern California. She is currently writing a book entitled *Worth a Thousand Words: Science, Visual Culture and the Revolution in Mass Education*.

Address

Department of History
University of Southern California
3520 Trousdale Pkwy, SOS 153
Los Angeles, CA 90089
USA
email: vemcain@gmail.com