Behind the Exhibit

DISPLAYING SCIENCE AND TECHNOLOGY AT WORLD'S FAIRS AND MUSEUMS IN THE TWENTIETH CENTURY

Edited by Elena Canadelli, Marco Beretta, and Laura Ronzon

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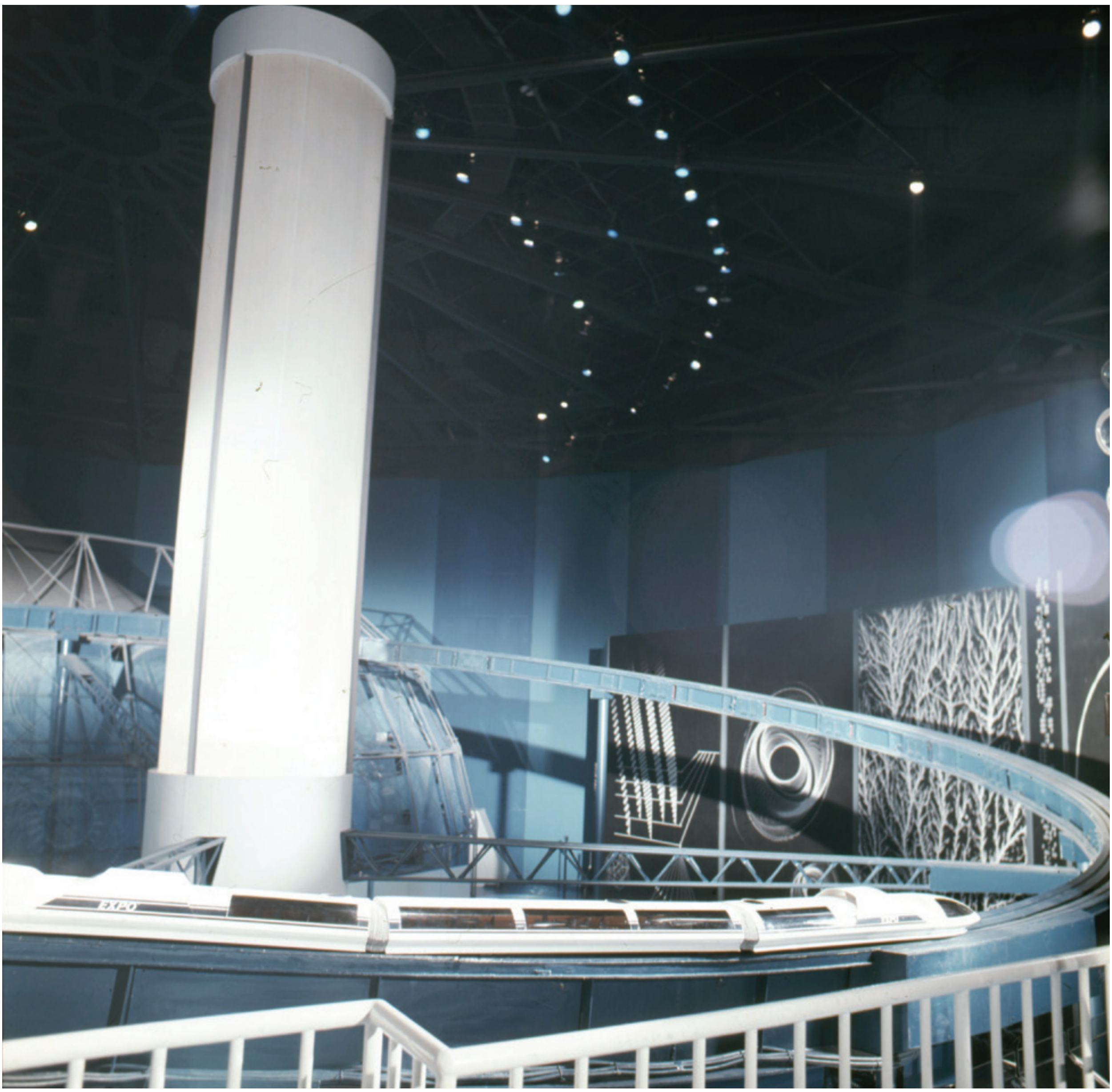
STUDIES IN THE HISTORY OF SCIENCE AND TECHNOLOGY



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STUDIES IN THE HISTORY OF SCIENCE AND TECHNOLOGY
volume 12

Smithsonian Institution Scholarly Press

Washington, D.C.
2019

The series "Artefacts: Studies in the History of Science and Technology" was established in 1996 under joint sponsorship by the Deutsches Museum (Munich), the Science Museum (London), and the Smithsonian Institution (Washington, D.C.). Subsequent sponsoring museums include Canada Science and Technology Museum; Museo Galileo—Istituto e Museo Nazionale di Storia della Scienza; Medicinsk Museion København Universitet; MIT Museum; Musée des Arts et Métiers; Museum Boerhaave; Národní Technické Museum, Prague; National Museums of Scotland; Norsk Teknisk Museum; Országos Műszaki Múzeum Tanulmánytára (Hungarian Museum for S&T); Technisches Museum Wien; Tekniska Museet–Stockholm; The Bakken; Whipple Museum of the History of Science.

Published by SMITHSONIAN INSTITUTION SCHOLARLY PRESS
P.O. Box 37012, MRC 957, Washington, D.C. 20013-7012
https://scholarlypress.si.edu

Cover image: Model of a maglev, a magnet-levitated train, displayed at the Japanese Pavilion during the Japan World Exposition in Osaka in 1970. Courtesy of the Osaka Prefectural Expo 1970 Commemorative Park Office.

Library of Congress Cataloging-in-Publication Data

Names: Canadelli, Elena, 1977– editor. | Beretta, Marco, editor. | Ronzon, Laura, editor. | Smithsonian Institution Scholarly Press, publisher.
Title: Behind the exhibit : displaying science and technology at world's fairs and museums in the twentieth century / edited by Elena Canadelli, Marco Beretta, and Laura Ronzon.
Other titles: Displaying science and technology at world's fairs and museums in the twentieth century | Artefacts series ; v. 12.
Description: Washington, D.C. : Smithsonian Institution Scholarly Press, 2019. | Series: Artefacts: Studies in the History of Science and Technology ; volume 12 | Includes bibliographical references and index. | Smithsonian Institution Copyright 2019
Identifiers: LCCN 2018034218| ISBN 9781944466220 (paperback) | ISBN 1944466223 (paperback) | ISBN 9781944466237 (online) | ISBN 1944466231 (online)
Subjects: LCSH: Science—Exhibitions. | Technological innovations—Exhibitions. | Exhibitions.
Classification: LCC Q105.A1 B46 2018 | DDC 507.4—dc23 | SUDOC SI 1.2:EX 4
LC record available at https://lccn.loc.gov/2018034218

ISBN-13 (print): 978-1-944466-22-0
ISBN-13 (online): 978-1-944466-23-7

Printed in the United States of America

♾ The paper used in this publication meets the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials Z39.48–1992.

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Series Preface

Prefaces to the previous volumes in this series have noted that Artefacts was founded on two goals: to encourage effective use of objects in studies of the history of science and technology, whatever the medium; and to bring together curators and academic historians in a congenial setting where they can discuss this and other issues of mutual interest. The present publication is based on our twentieth annual meeting, and we take the opportunity to reflect on what has been achieved.

It is fair to say that the second goal has been admirably accomplished through the meetings. Artefacts has become a critical ground for exchanges between academics and museum professionals, stimulated by a relaxed program format and ample time for discussion. Furthermore, these contacts have extended far beyond our yearly affairs.

There are several ways in which we have pursued the first goal. We have added sixteen cosponsoring museums to our original three and have met in a dozen different venues. We have a website (http://www.artefactsconsortium.org/) that features current and past programs along with other useful information. And we have made the contents of most of our books immediately and freely available in electronic form.

The topics of our early meetings were subject-oriented: medicine, electronics, transportation, and the like. After a few years, we began to include broader historical themes: globalization, national styles, and the anthropocene. More recently, we dealt with museum problems: relationships between science and technology as expressed in exhibits, conceptualizing, collecting, and presenting recent science and technology, and, in the present volume, differences between world's fairs and museums in their treatment of objects.

These analyses suggest that we do indeed know how to treat our collections as more than assortments of representative icons. What we know, however, is not necessarily what we practice.

Museums still too often display objects simply to illustrate a narrative text, and not as evidence that might reshape this narrative or form the basis of an alternative perspective.

When we reflect again at the end of another decade, I hope we will see that this knowledge has been translated into products that are richer in meaning because of the ways the three-dimensional objects have been interpreted and brought into our understanding of historical experience.

Bernard Finn
Emeritus, National Museum of American History, Smithsonian Institution
Series Editor

Introduction

> "The idea is to sell—or should I say, to *project*—an image of the British character. Looking at things . . . both historically and culturally—and also scientifically. We're trying to look back, of course, on our rich and varied history. But we're also trying to look forward. . . . Back into the past, but also forward to the future. Both at the same time, if you catch my meaning."
>
> J. Coe, *Expo 58*[1]

As suggested by the English writer Jonathan Coe in his novel set in the 1958 Brussels Exposition, world's fairs are highly symbolic places, where the representations of the past and the imagination of the future are intermingled in a very intriguing way. Struggling between nationalism and internationalism, nations strove to show their "character" and achievements, constructing manifold narratives. Science and technology, variously related to the idea of history, played a great role in terms of the ideas of progress, civilization, identity, nation-state, and education of the masses. In the national or thematic pavilions of world's fairs, the concepts of tradition and modernity were displayed and interpreted by different actors and communities for thousands of visitors by means of a manifold series of objects, artifacts, and exhibits. These displays changed radically through the decades, from those that featured hundreds of goods as symbols of national advances in inventiveness and production during the second half of the nineteenth century, to the educational and dynamic exhibits of the twentieth century. If nineteenth-century international exhibitions celebrated the achievements of the Industrial Revolution, twentieth-century fairs aimed mostly at shaping the future and defining modernity in a more conflicting and ideological political background, both in the interwar period and in the postwar scenario marked by the Cold War and the Atomic and Space Ages. As recently stated by Kargon et al. (2015), "by the beginning of the twentieth century, world's fairs began to assume a somewhat different coloration. Instead of concentrating mainly on displays of industrial prowess for purposes of trade, they began to emphasize national economic, military, and scientific might."[2]

International exhibitions, as well as great national fairs, were temporary and fleeting[3] playgrounds where it was possible either to experiment with new display devices or to interpret already tested solutions. Focusing on the less-studied twentieth century, this volume looks in greater depth at how science and technology have been materially transmitted through these mega events, which objects the organizers and the communities behind these exhibitions have displayed, which narratives of science have been staged, and what roles have historical scientific artifacts played. As shown by the 12 essays gathered in the volume, the panorama is extremely diverse. Nevertheless, it is possible to identify some leitmotivs. On the one hand, international exhibitions increasingly sought to satisfy the demand of science dissemination and education to the masses by displaying dynamic models, copies, replicas, footages, experiences, and demonstrations of subjects related to scientific research, technological innovation, and history of science. On the other hand, scientific artifacts on display were strictly connected to national political agendas, not only to the regime propaganda during the 1930s, but also, to the Russian and American space programs or the representation of Japanese technology at Osaka '70 in the 1960s and 1970s.

Another pivotal topic of the volume concerns the multilayered, symbiotic, and complex relationship that world's fairs and science museums have had over the years. It is important to remember that museums and world's fairs were influenced by the proliferation of temporary exhibitions about science, technology, and their history, and were organized at a national level around these topics, starting in particular from the interwar period, as is well illustrated by the Italian case study on the 1930s. Here several mass events on science, technology, and their history were organized in different cities, such as the Exhibition on Leonardo da Vinci and the Italian Inventions, inaugurated in 1939 in Milan in the Palazzo dell'Arte, or the autarkic Exhibition of Italian Minerals held in Rome from 1938 to 1939. That world's fairs have significantly contributed to the foundation and development of science museums since the second half of the nineteenth century is indisputable. With few exceptions, technical museums owe their existence to international exhibitions, which shaped their objectives. Such is the case for the Science Museum in London, the Technisches Museum Wien, the Museum of Science and Industry in Chicago, and the Palais de la découverte in Paris, to mention just a few. Exhibitions offered unique occasions for gathering financial resources, public endorsement, collections, and sometimes even dedicated buildings, although only few attempts succeeded, as shown by several of the essays published in the volume. Thus, as stated by Robert W. Rydell, "world fairs were showcases of scientific and technological innovation. From air conditioning through escalators to x-rays, world fairs introduced mass publics to the building blocks of modern civilization. But more than this, exposition authorities sought to use the power of display to convince the public of the necessary connection between scientific and technological innovation and national progress."[4]

In the opinion of American historian of technology Eugene S. Ferguson, it was precisely the inability to break the bond between fairs and museums that was to mark the negative fate of these institutions after the Second World War. In a 1965 *Technology and Culture* article, he writes:

> In too many cases, technical museums continue to reflect, both in philosophy and practice, the international exhibitions that gave them birth. As long as technical museums are equated, by public and curator alike, with a permanent trade fair, so long will the museums continue to be immensely popular and largely vacuous. Their uncritical emphasis upon the superficial and spectacular and their failure even to suggest the unsolved problems posed

by the "progress" to which the whole show is dedicated can only add strength to the accelerating movement toward undiscriminating mechanization of man's environment.[5]

More than half a century later, we can temper Ferguson's negative view of the connection between world's fairs and technical museums and say that both were products of the same progressivist zeitgeist. In this way, it is important to underline that world's fair exhibits have had a positive influence on modern museums—on their design, use of film and media, vitality, and concern for attracting audiences. These benefits are shown explicitly or implicitly in many of the essays, from the Palais de la découverte during the interwar period to the American exhibitions of the second half of the twentieth century. While thoroughly reassessing science and technology museums, we have returned to the roots of some of these institutions to clarify the processes behind their formations as well as their successes or failures, contributing to a conscious reinterpretation of their history and public use of historical collections. As recently stated in an article dedicated to science museums in *Isis*, the leading journal for the history of science, we are also convinced that "what connects contemporary science museums in the end is an ongoing pursuit of the best ways to preserve historical scientific objects and to present the history of science to a wide array of audiences in a museum setting."[6] On the other hand, it is important to keep in mind that the wider challenge of contemporary museology requires new collaborative and participatory approaches to cultural heritage aimed at social cohesion.

It is safe to say that during the past 25 years, the amount of literature on the history of universal exhibitions has steadily increased, as has the number of studies on the history of science museums. Nevertheless, Rydell was right when, in 2006, he pointed out that "there is surprisingly little scholarship on the connections between world fairs and the creation of museums of science and industry."[7] Despite several scholarly publications,[8] much remains to be done with regard to representations and uses of science and technology in twentieth-century world's fairs, especially in the second half of the century starting from Brussels 1958. This is particularly true if we relate international exhibitions to the profound transformations experienced by science museums in the twentieth century, as clearly outlined by Karen A. Rader and Victoria E. M. Cain.[9] While world's fairs struggled to be "indicators of modernity," the constant debate on the utopian "museum of the future" increased, starting from the very beginning of the century and going through the interwar period and the postwar economic boom and Cold War. The organization of great international exhibitions like Paris 1937 or Seattle 1962 was conducted in parallel with the continual debate over the reform of displays and exhibits in science museums in the name of the increasing relevance of science popularization. The implications for museums were clear. As George Brown Goode, Assistant Secretary of the Smithsonian Institution, said in a talk in 1889, they had to let the masses in to transform themselves "from a cemetery of bric-a-brac into a nursery of living thoughts."[10] As several essays demonstrate, the rhetoric of the "living museum" was very strong, well before the establishment in 1969 of the Exploratorium by Frank Oppenheimer. The twentieth-century museum scenario is far from being one-sided, in a constant crossover between representations of science at world's fairs and museums. Traditional institutions of historical artifacts, such as the Smithsonian Museum of History and Technology (now the Smithsonian's National Museum of American History) in Washington, D.C., coexisted with new science centers. Innovative museums like the Palais de la découverte existed in the same city side by side with the more traditional Conservatoire des arts et des métiers; whereas at an important world's fair like Chicago 1933, replicas and models of an Italian pavilion were displayed alongside scientific shows, astronomical spectacles, and exhibits like the Transparent Man. The fetishism of original space objects, such as the U.S. Apollo 11 artifacts collection or the objects in the Russian Kosmos pavilion, coexists with the immaterialities of processes and thoughts that were performed more than displayed in places such as the Palais de la découverte and the Exploratorium.

The idea of presenting the interconnections between international exhibitions, artifacts, and science museums in the twentieth century was triggered by the Artefacts XX conference hosted between 20 and 22 September 2015 at the Leonardo da Vinci National Museum of Science and Technology in Milan during Expo Milan 2015. The majority of the authors took part in the conference. In line with the aims of the Artefacts Book Series, this volume brings together museum curators and historians of science and technology dealing with the problematic question of displaying science, technology, and history to the general public. We are well aware that in contemporary society the fate of museums is repeatedly challenged, as clearly pointed out by Bernice L. Murphy in her introduction to the volume *Museums, Ethics and Cultural Heritage* (2016). She explained: "Today there is an unprecedented interest by public media worldwide in ethical issues and museums," while heavy financial pressure and market-driven forces challenge the fundamentals of their mission. During the twentieth century, science and technology museums have faced major changes driven by the birth of science centers and the increase in public understanding of science. Today, these museums are wondering how to cope with their history and their historical collections, and how to rethink their identities, which are deeply rooted in the nineteenth-century ideas of science, progress, production, and development—whether we like it or not. To better understand how science has historically been presented to people, this volume focuses on the narratives beyond exhibits and artifacts on display at international and national exhibitions as well as in museums, and investigates how exhibitions and museums have influenced each other.

Twelve case studies show how, during the course of nearly a century, world's fairs and science museums became public spaces for the representation of scientific discovery and technological innovation in relation to national rhetoric, use of history, and the challenging idea of modernity. The essays follow a chronological order, from the end of the nineteenth century to 1970, with a focus on the interwar period. Geographically, they cover the United States, Europe, Russia, and Japan, offering fruitful comparative analysis. We chose to analyze not only international exhibitions and world's fairs, but also national exhibitions that significantly affected the debate. Thus, some essays focus on very specific case studies, while others adopt a broader perspective.

The first two essays, by Marco Beretta and Tina Kubot, deal with the legacy of nineteenth-century exhibitions. Beretta explores the Musée Centennal de la classe 87: arts chimiques et pharmacie, endorsed by the political influence of Marcellin Berthelot at the Paris World Exhibition of 1900. On this occasion, there was an unprecedented interest in French scientific heritage. For the first time, a rich collection of instruments and documents related to the history of French chemists, especially of Lavoisier, was displayed to the public and opened a debate on the fate of these collections that, in the end, did not lead to the foundation of a permanent museum of French chemistry. Interestingly, when the Maison de la chimie was inaugurated in 1934, the display of historical heritage was no longer on the agenda, having lost its strength over a few decades. Kubot focuses on Germany and on communications and telegraphy artifacts displayed during *fin de siècle* international electric exhibitions. Furthermore, she analyzes how these temporary displays affected the exhibitions of these objects at the Deutsches Museum. Kubot states that these artifacts not only stand as technological milestones, but they mirror the story of nation-building and national heroes. The three telegraphs created by Sömmering, Schilling von Cannstatt, and Morse, symbolizing the birth of telegraphy, were thus true symbols of a national branding practice typical of the late nineteenth century.

The next six essays are devoted to the interwar period, particularly the 1930s, when the rhetoric of nationalism became increasingly stronger, as did the competition among nations for political leadership. At that time, history, science, and tradition played a great role in defining and representing modernity, even in mega events such as world's fairs. Moreover, while many fairs in Europe and the United States were organized in the same years, there was an ongoing, lively debate about the modernizing of the content and pedagogical approach of museum displays, as underlined by Rader and Cain. Therefore, the 1930s is a particularly relevant decade for examining the relationship between fairs, museums, and public representations of science.

In 1929, Spain and Italy held international and national exhibitions in right-wing dictatorship contexts. Both dealt with the idea of scientific heritage and the rediscovery of scientific traditions in relation to different political agendas. Jaume Valentines-Álvarez focuses on how the so-called Catalan forge was envisioned by engineers as a symbol of the "technological soul" of the Catalan nation. At the 1929 Barcelona International Exhibition, a Catalan forge was displayed with archaeological materials in a shadowy room, reproducing the atmosphere of the original workshops in the Pyrenees. The construction of a technological past for Catalonia was part of the multilayered project by industrial engineers to obtain a leading role in the design of the new Catalan autonomous government. When the Museum of Popular Art—which should have preserved the Catalan forge display at the end of the 1929 exhibition—was finally inaugurated in 1942, it was devoted to reinforcing the Spanish nationalist discourse. There was no intention of recovering the Catalan forge, and the display was ultimately lost. Meanwhile in Italy, the First National Exhibition of the History of Science was held in Florence, with more than 9,000 items on display—instruments, machines, books, portraits, and other kinds of memorabilia related to the history of Italian science. The exhibition addressed mainly the domestic audience and was endorsed by the Fascist government. As made clear by Francesco Barreca's essay, the exhibition aimed at protecting and showcasing Italian scientific heritage, and in 1930 it led to the foundation of the National Museum of the History of Science in Florence. For the first time, scientific collections were conceived as cultural and historical objects that deserved to be preserved, displayed, and studied as part of the Italian culture. Claudio Giorgione recalls that a few years later, Italian participation at the Century of Progress World's Fair in Chicago dealt with the celebration of the Italian scientific achievements. In 1933 a large group of objects—mostly replicas and scale models, rather than originals—had been created by the regime to be displayed in the United States, and they later became part of the collections of two museums: the Museum of Science and Industry in Chicago and the National Museum of Science and Technology in Milan. Giorgione's case study retraces the complex fate, circulation, and changes of meaning and ownership of a particular set of artifacts between international exhibitions and museums.

The essay by Pedro Raposo is dedicated to another exhibit at the 1933 Chicago world's fair, A Century of Progress International Exposition. Raposo focuses on the spectacular astronomical show staged at the fair by the Adler Planetarium and Astronomical Museum, arguing that the affirmation of the first modern planetarium in America cannot be reduced to the antagonism between cultural credibility and entertainment. The organizers sought a compromise between the solemnity of a science museum with a valuable collection and the atmosphere of entertainment of Century of Progress. Four years later, the Palais de la découverte opened at the Paris International Exhibition of 1937. The Palais was imagined from the start as a "museum of living science," devoid of collections and largely leaving aside history and technology. Andrée Bergeron and Charlotte Bigg argue that the Palais was influenced by Chicago's Century of Progress, as reflected in the decision to put scientists in charge, the emphasis on modern science and spectacular displays, and the creation of powerful experiences. Taking the astronomy section as an example, the authors look into the practical ways in which scientific thought was displayed and analyze the layered meanings and ambiguities of the contemporary notion of "living science." Bigg and Bergeron compare the Palais with the Literature Museum at the 1937 Paris International Exhibition, proving that the Palais was an expression of the overall strategy of the organizers to showcase intellectual labor as part of a broader social, economic, and political program. The Palais had a strong influence on the ways of displaying science in fairs and museums, as seen in the Italian Exhibition of Universal Science, which was supposed to first open in 1942 at the never-realized Universal Exhibition of Rome (EUR), commonly known as "E42," and then be transformed into a permanent science museum in Rome. Elena Canadelli retraces the history of this exhibition in the context of the Italian many-sided debate on science museums during the 1930s. Looking at the 1937 Paris exhibition, the organizers of the E42 planned an exhibition conceived as a "living" visual and material handbook of the history of basic sciences by means of models, replicas, photographs, diagrams, and footages. Despite its failure, the Exhibition of Universal Science actually gave birth to a permanent museum—even though this was its rival—the Museum of Technology, planned by the engineer Guido Ucelli in Milan.

The final four essays are devoted to postwar exhibitions and science museums between the Atomic and Space Ages and the landscape of the Cold War. At the time, such major events continued to show the commitment of national governments to promote industrial growth and political authority, at least until the turning point of Expo 1967 in Montreal, which was more concerned with issues of environmental sustainability than industrial progress.[11] The exhibitory competition between the United States and the Soviet Union begins with Brussels 1958 and continues, having nuclear energy and space exploration as their pivotal technological focus. Working nuclear reactors, full-scale space models, original capsules, and rockets were the artifacts that could be seen in national and international exhibitions worldwide, displayed as new icons of power and instruments of the new cold war narrative and propaganda. We focus more on space exhibitions than on nuclear exhibits. Compared to world's fairs of the interwar period, some of the postwar exhibitions and museums returned to the allure of original objects that are on the way to becoming historical artifacts, like the television, the Sputnik, or the Apollo. They were not historical as was, say, Lavoisier's instruments, but rather they were modern objects selected to leave a mark on future human history.[12]

In his comprehensive essay, Arne Schirrmacher compares different events taking place in North America in the 1960s, such as the Seattle World's Fair in 1962 and the New York World's Fair in 1964, that clearly show the recurring relationship between world exhibitions and the birth of permanent science and technology museums in the postwar period. They also testify to the evolving discussion about museum-display techniques and narratives as well as the role and nature of artifacts in an ever-increasing competition between so-called living science and material icons, opening up the science centers' era. The scenario is manifold: whereas Seattle 1962 used a Palais de la découverte display approach and was later transformed into the Pacific Science Center, New York 1964 had a heavy commercial orientation, and its Hall of Science focused on the linear model that connected pure science to technological development and national power. The project of transforming the New York Hall of Science into a permanent museum ran into troubles from the outset. Moreover, in 1964, after a long time planning, the Smithsonian Museum of History and Technology opened in Washington, D.C. In 1968, Frank Oppenheimer published his "A Rationale for a Science Museum,"[13] which eventually led to the opening of the Exploratorium in San Francisco the following year.

The essays by Cathleen Lewis and Allan A. Needell discuss space artifacts and how they have been displayed nationally and internationally, including different communication strategies: Americans believed in the open display of actual hardware to emphasize their techno-scientific competence while Soviets preferred to keep technical details and programs secret. In particular, Lewis uses the Exhibition of Economic Achievements (VDNKh) as a case study to explain the changing narrative of the Soviet-Russian space race through the exhibition of artifacts since the 1960s. The 600-acre exhibition park outside Moscow was used from 1935 onwards to translate nationalistic narratives from world's fair exhibitions to the domestic audience, though never becoming a museum. Lewis focuses on two main events that show how the Russian complex of nationhood has changed over time: (1) In 1966, the *Vostok* rocket and the Kosmos pavilion replaced the statue of Stalin and the All-Union Agricultural Exhibition of the 1930s, and (2) in 2014, a test article of the 1981 *Buran* space plane was transferred to the VDNKh from a Gorky Park restaurant. The exhibition of real space artifacts was also fundamental to publicizing American achievements nationally and internationally, but here the aim to preserve this new cultural heritage was clear from the beginning. As discussed by Needell, the National Aeronautics and Space Administration (NASA) and the United States Information Agency (USIA) managed the artifacts for political events and tours—the most prominent being the 1970 World Exposition in Osaka and the 1970–1971 mobile exhibit tour of 50 U.S. state capital cities—whereas the Smithsonian National Air Museum (NAM; now the National Air and Space Museum) struggled to get the icons of the space race permanently "transferred" and "musealized."

The climax of the public confrontation between the two sides of the Iron Curtain was reached during Expo 1970 in Osaka. Japan was living its economic miracle and had a formidable opportunity to show its modernity, despite its collapse during the Second World War. Nobumichi Ariga analyzes the artifacts displayed in the huge Japanese pavilion through the lens of the so-called *gijutsu-kakushin* concept (technological innovation). On the one hand, big industrial exhibits such as the Giant Steel Wall and the model of an industrial complex were used to convey the necessity of national heavy industrialization. On the other hand, examples of cutting-edge Japanese technologies—such as a big model of the Maglev (magnetic levitation) train, the electron microscope, a large molecular model of urea, or an exhibit on earthquake-proof skyscrapers—supported the necessity of basic research as fundamental to developing "independent technology."

The comprehensive essay by the historian of technology Robert Friedel closes the volume. He takes into account the problematic relationship between world's fairs and scientific museums during the course of the twentieth century until today, when objects seem to be displaced by experiences both in expos and museums. Indeed—he points out—at Expo 2015 in Milan, artifacts claiming historical significance were conspicuously absent. Starting from the seminal paper by Ferguson, Friedel deals with what cultural theorist Tony Bennett meaningfully called "the exhibitionary complex" in a 1988 article,[14] dialoguing with the main topics debated in the volume and highlighting the shared interests in display, power, and knowledge between expositions and museums.

This brief sketch of the rich contents of the volume clearly shows how complex and entangled are the narratives behind the public display of scientific artifacts in national and international exhibitions and science museums during the twentieth century. In spite of the specificity of each case, some points can be emphasized: the constant tension between basic science and technological applications, the multilayered role of history, the constant appearance and disappearance of collections of artifacts, and the search for a balance between entertainment and education. We hope that the volume will be useful to historians of science as well as to museum curators, offering a common ground for discussion and a better understanding of the narratives behind public displays of science.

Acknowledgments

The editors are especially indebted to Robert Bud and Helmuth Trischler for bringing the 2015 Artefacts Annual Conference, Artefacts XX, to the Leonardo da Vinci National Museum

of Science and Technology in Milan, Italy, as the event was the intellectual foundation for this publication. Their precious insight, together with Martin Collins's valuable advice, has helped shape and structure the book. Special thanks also to Bernard Finn and Robert Friedel for their vision and profound considerations. The editors also thank all authors deeply for their invaluable contributions and the staff of the Leonardo da Vinci National Museum of Science and Technology for their constant assistance. In addition, this work would not have been possible without the generous research grant offered by the Beretta family and the support of Fiorenzo Galli, general director of the Leonardo da Vinci National Museum of Science and Technology.

Elena Canadelli
Assistant Professor, Department of Historical and Geographic Sciences and the Ancient World, University of Padua

Laura Ronzon
Head of Collections and Curators, Leonardo da Vinci National Museum of Science and Technology

Marco Beretta
Professor, Department of Philosophy and Communication Studies, University of Bologna

Notes

1. J. Coe, *Expo 58* (Boston: New Harvest, 2014), 6–7.
2. R. H. Kargon, K. Fiss, M. Low, and A. P. Molella, *World's Fairs on the Eve of War: Science, Technology & Modernity 1937–1942* (Pittsburgh, PA: University of Pittsburgh Press, 2015), 4.
3. We are referring to the seminal book by A. C. T. Geppert, *Fleeting Cities: Imperial Expositions in Fin-de-Siècle Europe* (London: Palgrave Macmillan, 2010).
4. R. W. Rydell, "World Fairs and Museums," in *A Companion to Museum Studies*, ed. S. Macdonald (Malden, MA: Blackwell Publishing, 2006), 143. Among others, see also the essays by A. Roca-Rosell, "Science and Technology in World Exhibitions," 29–36, and P. Brenni, "Universal and International Exhibitions and the Birth of Museums of History of Sciences and Technology," 115–129, in *Esposizioni Universali in Europa. Attori, pubblici, memorie tra metropoli e colonie, 1851–1939*, eds. G. L. Fontana and A. Pellegrino, Special issue, *Ricerche storiche* 45, no. 1/2 (2015).
5. E. S. Ferguson, "Technical Museums and International Exhibitions," *Technology and Culture* 6 (1965): 46.
6. L. Bergers and D. van Trijp, "Science Museums: A Panoramic View," *Isis* 108, no. 2 (2017): 370. In the "Introduction" to the *Focus. Why Science Museums Matter: History of Science in Museums in the Twenty-First Century*, Ad Maas interestingly wrote: "How can history of science museums present the sophisticated views of professional historians, on the one hand, and win the fleeting attention of the modern museum consumer, on the other?" 363.
7. Rydell, "World Fairs and Museums," 143. On the relationship between world's fairs and science museums in the nineteenth century, see for instance A. C. de Matos, I. Gouzévitch, and M. C. Lourenço, eds., *Expositions universelle, musées techniques et société industrielle* (Lisboa: Edições Colibri, 2011) and M. R. Levin, "Inventing a Modern Paris: The Dynamic Relationship between Expositions, Urban Development and Museums," in *The World Exhibitions and the Display of Science, Technology and Culture: Moving Boundaries*, ed. A. C. de Matos, C. Demeulenaere-Douyère, and M. H. Souto, Special issue, *Quaderns d'Història de l'Enginyeria* 13 (2012): 35–56.
8. For example, Kargon, Fiss, Low, Molella, *World's Fairs on the Eve of War*; Fontana and Pellegrino, eds., "Esposizioni Universali in Europa"; C. Demeulenaere-Douyère and L. Hilaire-Pérez, eds., *Les expositions universelles. Les identités au défi de la modernité* (Rennes: Presses Universitaires de Rennes, 2014); de Matos, Demeulenaere-Douyère, and Souto, eds., "The World's Exhibitions and the Display of Science, Technology and Culture." See also all the bibliography by R. W. Rydell, among others, his *World of Fairs: The Century of Progress Expositions* (Chicago: University of Chicago Press, 1993). See also the two workshops, "The World's Fair since '64" and "The World's Fair since 1945," held during 2014 in Washington, D.C., and during 2015 in Milan, respectively, thanks to a partnership of the University of Milan, the Lemelson Center for the Study of Invention and Innovation, Johns Hopkins University, and Drexel University.
9. K. A. Rader, and V. E. M. Cain, *Life on Display: Revolutionizing U.S. Museums of Science & Natural History in the Twentieth Century* (Chicago: The University of Chicago Press, 2014).

10. G. B. Goode, 1901, in Rydell, "World Fairs and Museums," 139.
11. See R. W. Rydell, "Preface," in *Meet Me at the Fair: A World's Fair Reader*, ed. L. Hollengreen, C. Pearce, R. Rouse, and B. Schweizer (Pittsburgh, PA: ETC Press, 2014).
12. On the idea of cultural heritage in relation to ethnographical exhibitions see A. Schwarz, "Reshaping Legacies: Content and Meaning of Cultural Heritage at Universal Expositions," in Fontana and Pellegrino, eds., "Esposizioni Universali in Europa": 37–45.
13. Frank Oppenheimer, "A Rationale for a Science Museum," *Curator* 1, no. 3 (Sept 1968): 206–209. https://doi.org/10.1111/j.2151-6952.1968.tb00891.x
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Nineteenth-Century Legacy: History and Heroes

CHAPTER 1

Lavoisier and the French Chemical Heritage at the Musée Centennal of the Paris World Exhibition (1900)

Marco Beretta
Professor of History of Science
Università di Bologna
Italy

The records of early modern science have survived primarily in form of manuscripts, letters, and printed works. With the exception of a few emblematic cases, natural collections, instruments, apparatus and machines have rarely attracted the attention of historians, even when they were mostly scientists, as was the case until the beginning of the twentieth century. Unless these material sources could be used for didactic purposes of contemporary science or in the display of ephemeral shows, they were dispersed. Exceptions to this trend are the cases in which an instrument or a device has become a historic relic that evokes the heroic personality and the scientific achievements of its owner. Typical examples of this are the telescopes of Galileo, which were immediately cherished as symbols of the power of science as well as of their inventor. The survival of such relics is more due to contingent circumstances than to a deliberate design to preserve them in association with historical records that document their creation and cultural context.

The history of science has been characterized by both the didactic and the symbolic power of scientific heritage until recent times, when it finally became an integral part of the historical narrative. Within this problematic framework, the preservation of the chemical heritage had to face additional difficulties; the relative simplicity and recyclability of the apparatus, the deterioration of the collections of chemicals and the low epistemological status of chemistry are all factors that have contributed to the dispersal of historical collections. Indeed, in comparison with other sciences, medicine, physics, and astronomy in particular, it took a long time before chemistry and its material culture became a topic that attracted the attention of both historians and museum curators. In its early stages, the fate of chemical heritage was connected to the reverence paid to emblematic figures, such as that of Antoine-Laurent Lavoisier, whose biographies helped to elevate the social status of chemistry. Regardless of the role attributed to Lavoisier during the chemical revolution, both his contemporaries and historians agree that he did contribute to the enhancement of chemistry as a theoretical science and emancipated it from its ambiguous ties with alchemy.[1] The emphasis on the central importance of pneumatic chemistry brought a radical change to the apparatus used in chemical laboratories and the precision required by the new instruments attracted general attention. By fortunate circumstances, the fate of Lavoisier's collection is interwoven with the reassessment of scientific heritage that followed the outbreak of the French Revolution.

This process of enhancing scientific heritage and organizing its public display was favored by the dramatic changes brought about by the French Revolution. A decree of the Convention Nationale dated 6 February 1794, ordered the members of the Commission temporaire des arts and of the Commission d'instruction publique to "make an inventory and to bring together all the scientific and artistic objects in suitable depots, be they from formerly religious houses, from émigrés, from conspirators or from the civil list."[2] The vast collections of the instruments and natural specimens confiscated by the Republic and stored in various Parisian institutions now needed to be inventoried and preserved. At that time, the political circumstances seemed to be favorable for such novel undertakings.

The closing of the royal academies in July 1793 had forced scientists to seek new forms of institutional organizations and to justify the social value of science and technology to the Republican authorities and the country's representatives. The public display and demonstration of scientific heritage seemed to satisfy the widespread need of understanding what made science such an important endeavor. Public scientific demonstrations, no doubt, began to attract the attention of Enlightenment audiences decades before,[3] but they were more the effect of individual performance and ephemeral fashions than of a deliberate and systematic campaign. Furthermore, the appreciation of scientific heritage was not as prominent as during the years of the French Revolution. Indeed, with the fall of the *Ancien régime*, the time was ripe to weigh the progress made by the sciences and arts and to celebrate the irreversibility of all that had been gained. Within the comprehensive reforms of public education that followed the outbreak of the Revolution, it was not surprising that the evaluation of scientific heritage was given a central ideological importance. In response to the invitation given by the anatomist Felix Vicq D'Azyr to extend the recent notion of heritage to science and technology, on 29 September 1794 the Abbé Henri Grégoire submitted his *Rapport sur l'établissement d'un conservatoire des arts et métiers* to the Convention Nationale. Influenced by Francis Bacon's utilitarian vision of science, Abbé Grégoire underlined that the dangers threatening the Republic from 1791 through 1793 had been warded off by technical inventions, which helped the republican army obtain unprecedented successes and demonstrated the decisive and strategic role of scientists in the survival of the nation. Accordingly, scientific heritage, which made the birth of a new nation possible, should be considered an indispensable resource of a modern and renewed culture. To facilitate a full evaluation of such a heritage, which had been ignored for many years, a new type of institution, alongside the museums, archives, and libraries, should be conceived and created.

The principal purpose of an institution designed to preserve past inventions then lay in the recognition of the social and political value of arts and sciences:

> You want all the sciences to be directed towards a useful goal, and the point of convergence for all their discoveries to be the physical and moral prosperity of the Republic: you want each citizen to be able to earn his living by practicing some art, whatever it may be. We think that we have understood your views when we propose to use the vast collections of machines as soon as possible by establishing a conservatory that will unite them in one building.[4]

The purpose of the preservation, cataloguing, and public exhibition of collections of instruments and inventions would then be to reveal the material nature of scientific and technical practice to contemporaries and posterity, and to allow the general public to understand what had previously been perceived as the mysteries enshrouding the world of arts and crafts.

The Chemical Heritage Saved by the Chemical Revolution

The Conservatoire des arts et métiers set a model that other institutions followed. Its successful effort, which allowed important scientific collections to be preserved, excluded chemistry, and exhibitions focused on chemical arts instead. The reason for such an exclusion was twofold: first, the reputation of chemistry as a science at the beginning of the nineteenth century was still problematic. The chemical revolution identified with the work of Lavoisier helped to change the image of chemistry and erase its links with the alchemical tradition. However, the position of chemistry among other sciences had not yet substantially improved. While the protagonists of the progress in exact sciences emphasized the importance of the theoretical and philosophical sources of their inspiration, the most successful chemists of the first half of the nineteenth century (Justus von Liebig, for example) focused on the artisanal and applicative aspects of their science. Furthermore, academic chemistry was seen as a practical art with ambiguous relation to the emerging pharmaceutical and chemical industries. But there is another important factor that deterred the collection and exhibition of chemical heritage. As briefly mentioned previously, the historical collections of the Conservatoire des arts et métiers and of the European institutions that followed its model primarily served a didactic purpose. Jean Nollet's collection of instruments of experimental physics or Jacques de Vaucanson's collections of mechanical devices could still serve, at the beginning of the nineteenth century, for public demonstrations as an introduction to physics and mechanics. That was not the case in chemistry; on the rare occasions they survived, historical chemical apparatuses could not be successfully used in public demonstrations. Moreover, because of the rapid deterioration they suffered under the constant actions of fire or chemicals meant that they were not intended for durable use. Last but not least, until the 1770s the composition of the apparatuses was extremely simple and made by artifacts that could be found in a common pharmacy or even in the kitchen. It is not surprising then that nearly nothing from early modern celebrities such as Paracelsus, Robert Boyle, or Georg Ernst Stahl, has survived besides their written words.

The change in this situation came with Lavoisier. As it is well known, Lavoisier built up one of the most sophisticated chemical laboratories in Europe during the 1770s and 1780s. He was guillotined on 8 May 1794, and his tragic end at the very moment when the discussion on the preservation of scientific heritage had reached its peak, soon made him the most distinguished martyr of science. Lavoisier's martyrdom helped to encourage a new attitude both towards chemistry and its main hero. Indeed, Lavoisier's wife created a sort of museum devoted to the memory of her late husband soon after his death.[5]

Madame Lavoisier's salon, housed in a beautiful residence in *Rue d'Anjou*, today *Faubourg St. Honoré*, was frequented by scientists such as Pierre-Simon Laplace, Jean-Baptiste Biot, and Joseph Louis Gay-Lussac, and by philosophers such as Pierre Jean Georges Cabanis, Benjamin Constant, and François Guizot. As reported by Delahante, one of the privileged members of this group, Madame Lavoisier's house became a sort of reliquary, where the reminders of her husband were revered with the greatest devotion.[6] It is thus hardly surprising that during the nineteenth century Lavoisier became a symbol of French chemistry, and that as early as the 1830s Jean Baptiste Dumas conceived the grand design to initiate the national edition of his collected works. Following the nationalistic wave rising throughout Europe, this project aimed to show the superiority of the French chemical tradition over those of the German and the British. The fame of Lavoisier and the publication of the first volumes of his collected works raised a fierce controversy between French and German chemists over the role Lavoisier played in the history of chemistry during the late 1860s; the debate was intensified with the outbreak of the Franco-Prussian War in 1870. Adolphe Wurtz's famous incipit to his work on the evolution of chemical concepts stating that chemistry was a French science founded by Lavoisier[7] was rebutted by the German chemical community, and the history of chemistry suddenly became an important field that attracted the attention of the most authoritative chemists of the time.[8] Within this context, artifacts also began to play an important role. On the occasion of the grandiose exhibition of scientific instruments and apparatuses at the South Kensington Museum in March 1876, scientists from all over the world competed to vindicate the venerable and prestigious achievements of their national traditions. Although the organizers initially took the Conservatoire des arts et métiers as a model and wished to create a "Science Museum," the final result was in fact quite different.

> In International Exhibitions a certain amount of space is allotted to each country. These spaces are then divided by the Commissioners of each country among its exhibitors, who display their objects—subject to certain general rules of classification—as they consider most advantageous, retaining the custody of their own property. The expenses of transport, arrangement, etc., are borne by the countries who exhibit. And the Exhibitions appeal naturally, more or less exclusively, to the industrial or trade-producing interests of those countries.[9]

This was not the idea of the proposed Loan Collection at South Kensington. For that Collection it was desired to obtain not only apparatus and objects from manufacturers, but also objects of historic interest from museums and private cabinets, where they are treasured as sacred relics, as well as apparatus in present use in the Laboratories of Professors. The transport of all objects was undertaken by the English government, and they were to be handed over indefinitely to the custody of the Science and Art Department for exhibition; the arrangement being not by countries but strictly according to the general classification.[10]

Relics and historic collections were extensively used to cultural and educational purpose.[11] Galileo's and Newton's instruments were for the first time attracting the attention of tens of thousands of visitors. While British, German, and Italian exhibitions were organized with the greatest care in order to emphasize their prominent role in the history of science through the display of historic artifacts, France was not equally successful, and especially so in chemistry. Lavoisier's calorimeter—one of the landmarks of the chemical revolution and the only piece from the French chemist's collection brought from Paris to the exhibition—was displayed in the section devoted to heat, between exhibits devoted to thermometry and conduction. Furthermore, the apparatus was displayed without any reference to its historical background. In the section about chemistry, situated in the West Gallery, a "historical" subsection exhibited several balances from the collections of Joseph Black, Henry Cavendish, and Joseph Priestley, and left visitors with the vivid impression that pneumatic chemistry was primarily a British invention and that the standard of precision in the chemical laboratory anticipated Lavoisier's efforts by decades. Nineteenth-century chemistry was dominated by British and German collections and the shows provided overwhelming material evidence of this. The London Exhibition clearly showed that the enhancement of ancient scientific instruments could successfully be used to promote an ideological and nationalistic view of science, and it did not take too long before this view was shared by French chemists as well.

Not surprisingly, the French revival of chemical heritage revolved around Lavoisier, the national hero of the chemical revolution. During the early 1860s, Jean Baptiste Dumas promoted the publication of his collected works,[12] and during the late 1830s, the heirs donated a significant part of Lavoisier's manuscripts as well as 40 instruments from his laboratory to the Académie des sciences. The donation consisted of six areometers;[13] Fortin's air pump made in 1792;[14] Naudin's calorimeter of 1782;[15] 30 decimal units for measuring capacity, probably used during the reform of weights and measures of 1789;[16] the balance made by Chemin in 1770;[17] a balance made in 1775;[18] Mégnié's two famous gasometers made in 1787;[19] Lavoisier and Laplace's ice calorimeter;[20] a few tubes to be used in the construction of thermometers;[21] the glass vessel with electrodes used by Lavoisier and Meusnier de la Place for studying the combustion of hydrogen in the presence of oxygen under a constant flow of the reacting gases;[22] Fortin's apparatus for the combustion of oil;[23] as well as his apparatus for studying wine fermentation, both made in 1789;[24] Mégnié's barometers (1778);[25] and a burning glass.[26] This important donation was divided: while the manuscripts and books remained at the Académie, the instruments were deposited, sometime after 1866, to the Conservatoire des arts et métiers. The collection was probably displayed only years later, possibly after the South Kensington exhibition of 1876.[27] Most of the Lavoisier's instruments preserved at the Conservatoire were displayed in a large glass showcase, and although there was no apparent order in their disposition, the ensemble made its own figure. Since the showcase was not large enough to keep all the instruments, only a few apparatuses, such as the those used by Lavoisier in his experiments on vinous fermentation and on the combustion of oils, were displayed on the sides of the case. The show was of considerable importance because this was the first historical collection of a chemist to be exhibited in a public museum. The publication of Lavoisier's *Oeuvres*, the donation made to the French government by the heirs, and the rising controversy over the role of Lavoisier in the history of chemistry, inspired further historical research. In 1888 and 1890 two important biographies were published, authored by Edouard Grimaux and Marcellin Berthelot, respectively. The heirs, still in possession of the large collection of Lavoisier's instruments, made it their duty to preserve them in their original state at the Château de la Canière in Puy de Dôme.

In 1879, a professor of chemistry of the University of Clermont-Ferrand, P. Truchot, published the first and last extensive report on Lavoisier's collection of instruments:

> His [Lavoisier's] chemical laboratory and his physical cabinet have been piously conserved by Mme Lavoisier's family and I'm indebted to Etienne de Chazelles, its present fortunate owner, who has given me the pleasure, not to say the happiness, of being able to get to know the collection by making an inventory and touching one by one, understandably not without emotion, all the objects that remind us of the prolific work of by the immortal founder of Chemistry . . . [28]

> Let us now open the cabinet. *The large amount of apparatus accumulated there shows the respectful care with which the family of Lavoisier has felt it a duty to save even occasionally commonplace objects from destruction*.[29] [emphasis by M. Beretta]

The end of the nineteenth century marked the preparation of the centennial celebration of the French Revolution, and one of its main protagonists happened to be both a chemist and a distinguished historian: Marcellin Berthelot. Besides being an influential scientist, Berthelot occupied prestigious and influential political positions, such as that of minister of foreign affairs and minister of public instructions.

The Chemical Heritage at the Musée Centennal

Under the auspices of the Académie des sciences, the French chemical community, guided by Berthelot, decided to celebrate the achievements of Lavoisier as the founder of modern chemistry with a monumental statue. Between 1894 and 1900, more than 100,000 francs were collected in France, Russia, among many other European countries, and in the United States. The statue (Figure 1) was completed in July 1900. In his speech at the statue's inauguration, Marcellin Berthelot emphasized that the French chemist, "established the points of the departure of modern science," and that the law of conservation of mass was the foundational tenet of modern chemistry—so much so that chemical atomism would have been inconceivable without it.[30] The image of the scientist was becoming that of an anonymous hero. Lavoisier now represented the symbol of French science, and its achievements were most often used to celebrate the strong national identity, which, from Dumas to Berthelot, pervaded French chemistry.[31]

The date of its inauguration coincided with the opening of the international congress of pure and applied chemistry and preceded by a few months the opening of the *Exposition universelle internationale de 1900,* where Berthelot and Louis Troost organized an exhibition, and the *Musée Centennal de la classe 87,* which celebrated Lavoisier and French chemistry. (Figure 2) The congress, the exhibition, and the symbolic unveiling of the statue were all the result of an energetic campaign by which Berthelot sought to show the primacy of chemistry, Lavoisier, the French nation, and, to some degree, himself.[32]

The Musée Centennial was one of many exhibitions at the time that were devoted to arts and crafts, but it was the most important because it focused exclusively on the history and achievements of a French science: chemistry. It should be noted that the exhibition was subtitled *Arts chimiques et pharmacie: materiel, procédés et produits,* and by this choice, was aimed at presenting chemistry as a useful art rather than a theoretical and speculative science. The connection with industries and manufactures was indeed emphasized by many of the items displayed in the show, but their arrangement followed a quite ambitious design. The objects, instruments, and chemicals were in fact displayed in a way that narrated a history of great French chemical scientists, inventors, and entrepreneurs. Although several showcases displayed the recent achievements of the science, the overall perspective of the show was historical. This choice was inspired by several factors:

1. The organizers probably wished to emulate the success of the South Kensington exhibition, which, as we have already shown, put a great emphasis on the history of scientific instruments.
2. The French chemists wished to vindicate the prominence of their national tradition, and historical collections—particularly that of Lavoisier—provided a compelling picture.
3. Marcellin Berthelot, one of prime movers of the exhibition, was also a distinguished historian of chemistry, and he extensively used examples and stories taken from the past to design the boundaries of contemporary French chemistry.

Figure 1. The statue of Lavoisier by Louis Ernest Barrias inaugurated in 1900. Private collection.

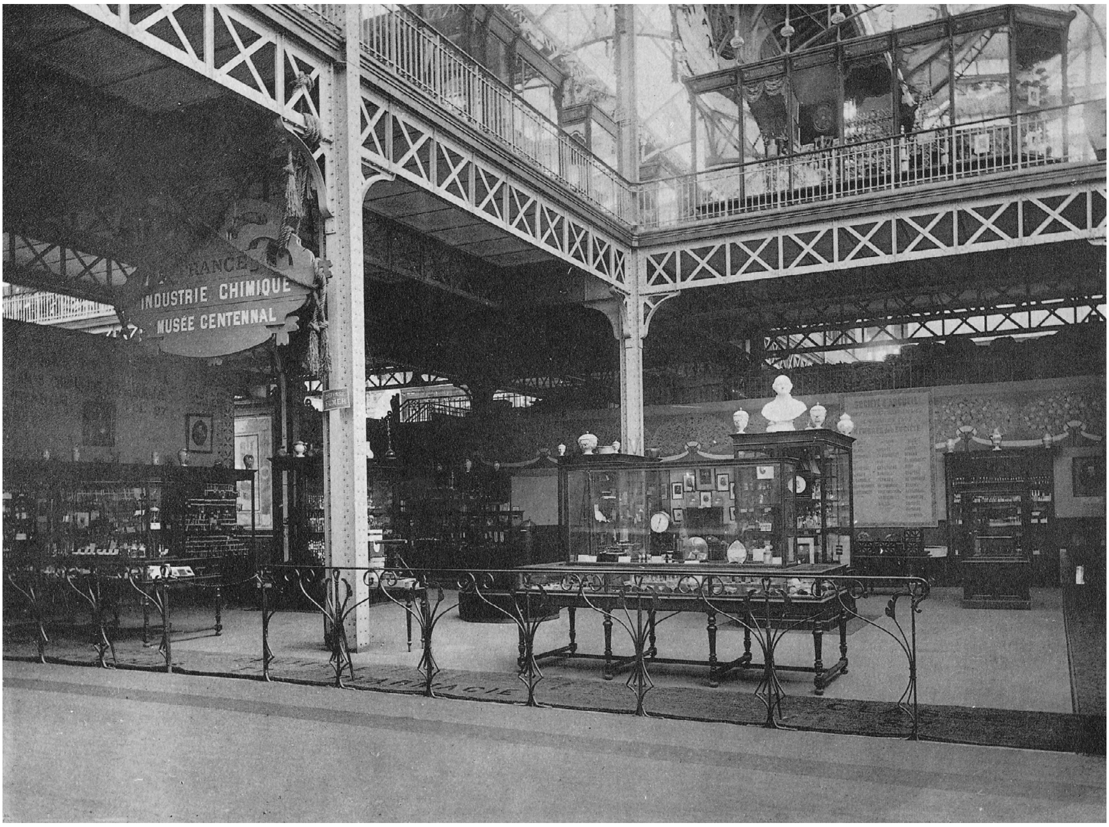

Figure 2. View of the Musée Centennal de la classe 87, 1900. From the *Musée Centennal de la classe 87, Arts chimiques et pharmacie* catalog (1900).

Like the Conservatoire des arts et métiers, the Musée Centennal proposed an exhibition mixing chemical heritage and contemporary artifacts. The former, however, was much more consistent in celebrating the firsts of French chemistry. Moreover, it did so by highlighting the contributions of individuals. The Musée Centennal was in fact the first time that French chemistry was presented historically through its artifacts, instruments, machines, chemicals and, in lesser measure, written documents left by its main protagonists. It is significant that the exhibition was limited to the French chemists. "Science," admitted the anonymous author of the introduction to the catalog, had "no fatherland," but for the sake of consistency it was found necessary to focus on the French context. The logic behind the nationalistic choice was historical. As Lavoisier was the "founder of modern chemistry," only the French lineage of chemists, from Berthollet to Berthelot, could reveal in the purest form its rapid progress. The catalog of the exhibition, illustrated with many interesting photos, focused on the protagonists of French chemistry and on their short biographies rather than on the objects and the apparatuses. By doing so, the catalog deviated from the aim of the exhibition, which, as its subtitle explicitly announces, wished to illustrate to the public the products of the chemical research. The emphasis on the personalities and on the achievements of the heroes of science was not in contradiction to the very nature of their science, which was appropriately embodied into the Centennial Museum of Arts and Crafts. In many respects, the 1900 French exhibition is a response to the British chemical show of 1876, and the French chemical community made it clear that it had both a venerable history and a strong identity. Apart from the ideology that had inspired this initiative, the Musée Centennal of chemistry was a very fine exhibition where, among other things, various instruments, manuscripts, and iconographic items were displayed for the first time. Many private enthusiastic collectors were successfully involved and, thanks to their contributions, important collections found their way to a new home. In this connection, it is interesting to mention the donation of Charles Frédéric Gerhardt's collections of chemicals and apparatus, made by his son, to the exhibition and to the faculty of science of Paris.[33] The exhibition followed a chronological order, but as it turned out, the relics and collections available did not always represent the most important chemists of whom, apart from printed works and manuscripts, nothing survived. Dense showcases displayed furnaces, glassware, chemicals, instruments, balances and, in a few cases, large models (Figure 3). The collections came mainly from the principal research institutions of France: the Académie des sciences, the École polytechnique, the Sorbonne, the Conservatoire des arts et métiers, the École normale, the École des mines, the Muséum d'histoire naturelle, and the science faculties of Rennes, Dijon, Montpellier, and Nancy.

In addition to this massive participation of academic institutions, it is worth noting the loans made by the glass manufacturer of Saint Gobain and of the Musée d'art et d'industriel de Lyon. Such loans demonstrate that, along with the extraordinary development of German chemical industries, France also had a competitive history of success, culminating in the leading role played by Berthelot who, like Lavoisier, divided his time between theoretical and applied chemistry. Indeed, the general image one gets from the exhibition and its presentation catalog is that of a useful science that takes pride in revealing its historical ties with industrial arts and applications and that it was precisely because of these ties that chemistry could successfully presents itself to the public of the Musée Centennal and, more generally, to that of the universal exhibition. Chemistry, unlike other sciences, had a pervasive presence in all the societal activities and French chemists provided outstanding contributions to the development of the nation.

This nationalistic narrative of the history of French chemistry was not the only purpose of the exhibition. The intention of the organizers was in fact to build up a permanent museum of French chemistry, but for various reasons this project was never carried out and the collection was again dispersed. The outbreak of World War I and the prominent role of chemical warfare redirected the attention of French chemists to more urgent issues. During the war years, the history of science and concerns over the preservation of scientific heritage lost the importance they had in 1900. When, after World War I, the French chemical community sought to give a new institutional strength to their community, the display of historical heritage was no longer on their agenda. In 1927, coinciding with the celebration of the centenary of Marcellin Berthelot's birth, the first steps were taken towards the foundation of the Maison de la chimie. When in 1934 the institution was finally inaugurated in the spacious halls of the sumptuous Hôtel de la Rochefoucauld d'Estissac, no space was allocated to a museum or exhibition illustrating the history of

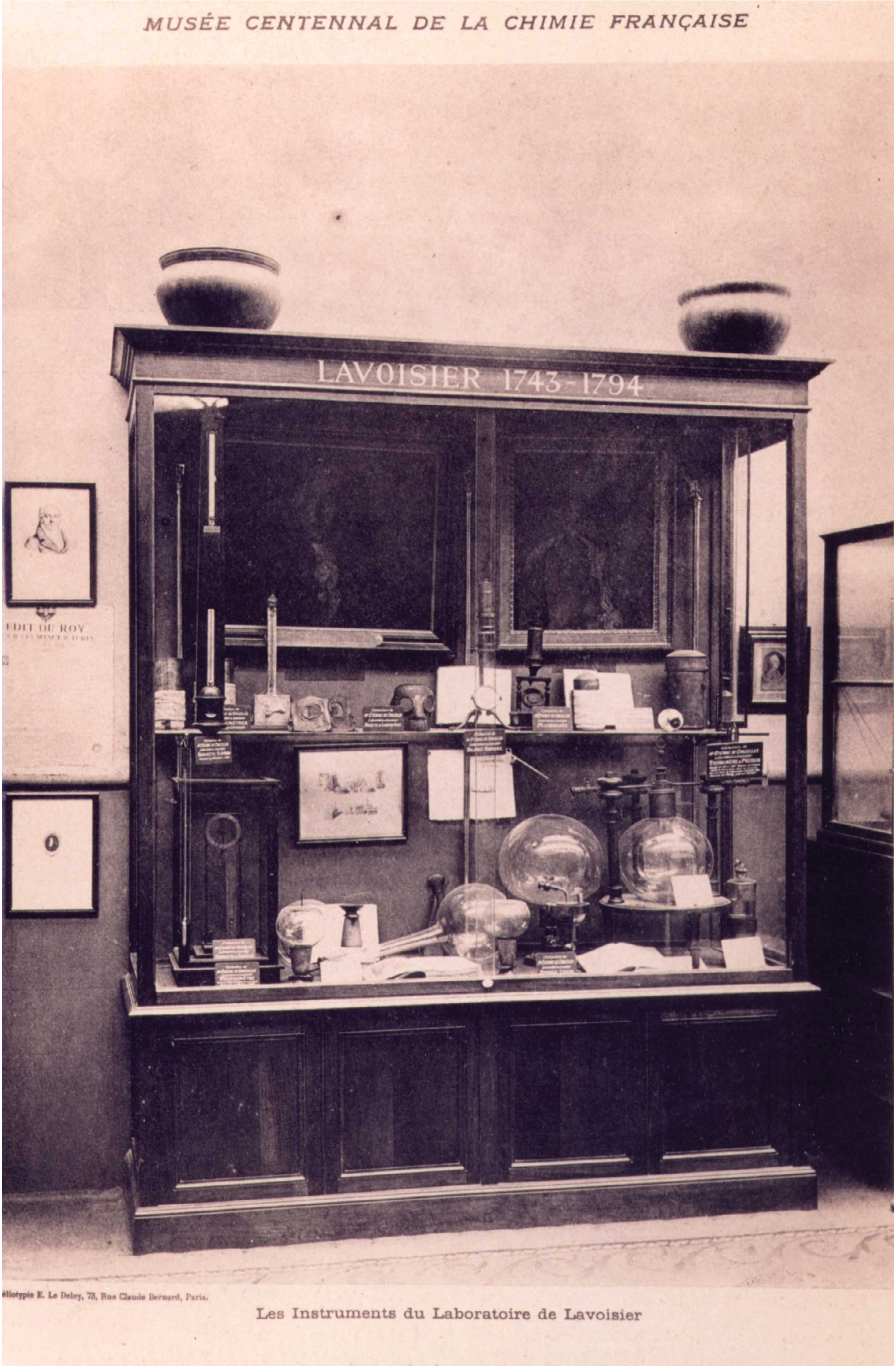

Figure 3. The showcase of the Musée Centennal, devoted to Lavoisier, displayed several instruments and iconographic items that were eventually dispersed. From the *Musée Centennal de la classe 87, Arts chimiques et pharmacie* catalog (1900).

French chemistry, and the perilous fate of the collections exhibited in 1900 remained in the hands of the universities and private owners.

Notes

1. M. Beretta, "Transmutations and Frauds in Enlightened Paris: Lavoisier and Alchemy," in *Fakes!? Hoaxes, Counterfeits and Deception in Early Modern Science*, eds. M. Beretta and M. Conforti (Sagamore Beach: Science History Publications/USA, 2014), 69–108.
2. "Inventorier et faire réunir dans des dépôts convenables, tous les objets de sciences et arts provenant, soit des maisons ci-devant religieuses, soit des émigrés, soit des conspirateurs, soit de la liste civile." Quoted in Auguste Anastasi, *Nicolas Leblanc. Sa vie, ses travaux et l'histoire de la soude artificielle* (Paris: Hachette, 1884), 33.
3. B. Bensaude-Vincent and C. Blondel, eds., *Science and Spectacle in the European Enlightenment* (Bodmin: Ashgate, 2008).
4. "Vous voulez que toutes les sciences se dirigent vers un but utile, et que le point de coïncidence de toutes leurs découvertes soit la prospérité physique et morale de la République: vous voulez que chaque citoyen puisse assurer sa subsistance par l'exercice d'un art quelconque. Nous croyons entrer dans vos vues en vous proposant d'utiliser au plus tôt ces vastes collections de machines par l'établissement d'un conservatoire qui les réunira dans un local commun." Abbé Henri Grégoire, *Convention Nationale. Instruction publique. Rapport sur l'établissement d'un conservatoire des arts et métiers. Séance du 8 vendémiaire, an 3* (Paris: 1794).
5. M. Beretta, "Lavoisier's Collection of Instruments: A Checkered History," in *Musa Musaei: Studies on Scientific Instruments and Collections in Honour of Mara Miniati*, ed. M. Beretta, P. Galluzzi, and C. Triarico, (Florence: Leo S. Olschki, 2003), 313–334.
6. A. Delahante, *Une famille de finance au XVIIIe siècle*, 2 vols. (Paris: Hetzel, 1880), vol. 2, 546.
7. "La chimie est une science française: elle fut constituée par Lavoisier, d'immortelle mémoire," in C. A. Wurtz, *Histoire des doctrines chimiques depuis Lavoisier jusqu'à nos jours* (Paris: Hachette, 1869), 1.
8. M. Beretta, "The Changing Role of the Historiography of Chemistry in Continental Europe since 1800," *Ambix* 58 (2011): 257–276.
9. "Their Lordships stated their conviction that the development of the Educational, and certain other Departments of the South Kensington Museum and their enlargement into a Museum somewhat of the nature of the Conservatoire des arts et metiers in Paris, and other similar institutions on the Continent, would tend to the advancement of science, and be of great service to the industrial progress of this country." *Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum* (1876), 3rd ed. (London: Eyre, 1877), vol. 1, xi.
10. *Catalogue of the Special Loan Collection of Scientific Apparatus*, xiii.
11. R. Bud, "Responding to Stories: The 1876 Loan Collection of Scientific Apparatus and the Science Museum," *Science Museum Group Journal*, 1 (Spring 2014), http://journal.sciencemuseum.ac.uk/browse/2014/responding-to-stories/ (accessed November 2016). http://dx.doi.org/10.15180/140104/006
12. C. Demeulenaere-Douyère, "A propos d'une entreprise intellectuelle: la publication des Œuvres et de la Correspondance de Lavoisier," *La Vie des Sciences, Comptes rendus, série générale,* 11 (1994): 319–332.
13. Musée des arts et métiers–Paris. N° 07508-0000. These were the instruments ideated by Lavoisier in 1768.
14. Musée des arts et métiers–Paris. N° 07517-0000.
15. Musée des arts et métiers–Paris. N° 07520-0000. This instrument was also used by Laplace during the experiments on heat.
16. Musée des arts et métiers–Paris. N° 07542-0001 and 07542-0002.
17. Musée des arts et métiers–Paris. N° 07544-0000.
18. Musée des arts et métiers–Paris. N° 07545-0000.
19. Musée des arts et métiers–Paris. N° 07547-0001.
20. Musée des arts et métiers–Paris. N° 07547-0002 up to N° 07547-0030.
21. Musée des arts et métiers–Paris. N° 07547-0004.
22. Musée des arts et métiers–Paris. N° 07548-0000.
23. Musée des arts et métiers–Paris. N° 07549-0000.
24. Musée des arts et métiers–Paris. N° 07550-0000 and 07551-0000.
25. Musée des arts et métiers–Paris. N° 07658-0000 and 08761-0000. The latter item was donated by Léon de Chazelles in 1867.
26. Musée des arts et métiers–Paris. N° 08229-0001. This item was donated by Léon de Chazelles in 1867.
27. The first official mention of the public permanent display of Lavoisier's collection at the Conservatoire dates from 1894 and coincides with the centenary of Lavoisier's death.
28. P. Truchot, "Les instruments de Lavoisier. Relation d'une visite à La Canière, où se trouvent réunis les appareils ayant servi à Lavoisier," *Annales de chimie*, 5e série, 18 (1879): 289–319.
29. "Son laboratoire [Lavoisier's] de Chimie, son cabinet de Physique ont été pieusement conservés par la famille de Mme Lavoisier, et je dois à M. Étienne de Chazelles, qui en est actuellement l'heureux possesseur, le plaisir, je devrais dire le bonheur, d'avoir pu en prendre connaissance, en dresser l'inventaire et toucher un à un, non sans émotion facile à comprendre, tous ces objets qui rappellent les travaux féconds de l'immortel fondateur de la Chimie. [. . .] Ouvrons maintenant le cabinet. *La grande quantité d'appareils qui y sont accumulés témoigne du soin respectueux avec lequel la famille de Lavoisier a cru devoir préserver de la destruction des objets quelquefois vulgaires*" (My italics), Truchot, "Les instruments de Lavoisier," 291–292.

30. “Telle est la base scientifique de toutes nos équations chimiques de composition et de constitution [. . .] La théorie atomique moderne n’aurait pu se constituer, tant que l’intervention de la chaleur et des agents analogues dans la formation des corps pesants était regardée comme un axiome [. . .] La balance des profits et des pertes en chimie appliquée repose sur cette grande loi, continuellement invoquée.” M. Berthelot, *Inauguration du monument érigé à Lavoisier par une souscription internationale, sous le patronage de l’Académie des Sciences, le 27 Juillet, 1900* (Paris: Firmin Didot et C.ie, 1900), 14–15.
31. On the national identity of French chemistry and its ideology see the comprehensive study by U. Fell, *Disziplin, Profession und Nation. Die Ideologie der Chemie in Frankreich vom Zweiten Kaiserreich bis in die Zwischenkriegszeit* (Leipzig: Leipziger Universitätsverlag, 2000).
32. Significantly, one year later, on 24 November 1901, the international scientific community celebrated at a meeting at the Sorbonne Berthelot’s 50 years of scientific activities. The transactions of the meeting were published in 1851–1901, *Cinquantenaire scientifique de M. Berthelot* (Paris: Gauthiers-Villars, 1902). In 1927 the centennial of Berthelot was celebrated with the erection of a statue and his commemoration in the Pantheon; much of the rhetoric spent in 1900 to celebrate Lavoisier as the champion of French chemistry was re-used to commemorate Berthelot. On this, see *Centenaire de Marcelin Berthelot, 1827–1927* (Paris: 1929) and the informative essay by R. Fox, “Science, Celebrity, Diplomacy: The Marcellin Berthelot Centenary, 1927,” *Revue d’histoire des sciences* 69, no. 1 (2016), 77–115.
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CHAPTER 2

Telegraphs and National Heroes

A Case Study of Telegraphy as a Mirror of National Branding

Tina Kubot
Museum für Kommunikation Frankfurt, Germany

Much has been written about creating national identity, especially in the era of the second industrial revolution spanning the second half of the nineteenth and the beginning of the twentieth century.[1] During this time, national strength was equated with modernity, which was defined "in terms of rationalization, mechanization and technological advance."[2]

The world and special exhibitions of this era were the platforms for bringing the state-of-the-art in science and technology together from around the globe. Technical museums, committed to the education of the public, were reflecting the displays of the major electricity exhibitions and world's fairs. As leading-edge technologies, communications and telegraphy in particular were must-haves for both exhibitions and museums. The choice of artifacts in their collections and how the objects were displayed can bear witness to a nation's eagerness to prove its superiority.

Telegraphy and the question of its inventor came into focus particularly in the second half of the nineteenth century, as nations strived to show they had the most brilliant minds. This competition was partially based on a rather free interpretation of historical facts, so the artifacts not only stand as technological milestones, but they also mirror stories of nation building. Unlike the controversies about the invention of the telephone between Alexander Graham Bell and Elisha Grey, or between Bell and Johann Philipp Reis, which are well illuminated from many different perspectives, the details of inventing the telegraph are not exhaustively discussed in the literature. Technical books offer very detailed perspectives only on the technological development. In books on the history of telecommunications, this still dominant perspective is accompanied by some reflections on the economical background. Most historians agree that the electrical telegraph does not have an inventor; rather, it emerged when the time was ripe, between 1832 and 1837.[3] The development was a prototypic cumulative technological progress.[4] There are some protagonists whose contributions were essential inventions without which electrical telegraphy would not have become a mature technology, including Samuel Thomas Sömmering (1755–1830), Carl Friedrich Gauss (1777–1855), and Wilhelm Weber (1804–1891); Paul L. Schilling von Cannstatt (1787–1836), William Fothergill Cooke (1806–1879), and Charles Wheatstone (1802–1875); and Samuel Morse (1791–1872). Their original inventions or replicas of them are part of every collection that aims to reflect the history of telecommunications, such as the telecommunication collection of the Deutsches Museum. This essay looks more closely at three of the most impressive: Sömmering, Schilling, and Morse, whose telegraph concepts symbolize the birth of telegraphy itself.

World's Fairs and International Electricity Exhibitions in the Nineteenth Century

In the nineteenth century, a time when the lighter workloads for common workers and the rise of prosperity brought by steam engines and progressive mechanization swept away the skepticism towards technology, technological development was a general focus. International exhibitions, rooted in the French industrial expositions and beginning with the Great Exhibition of the Works of Industry of All Nations, in 1851 in London, were the places where the general public gained access to the latest developments, with their full potential shown off in impressive displays. It did not take long until the competitive nature of these exhibitions was recognized as a powerful means to present a nation's superiority.

"National identity is an individual's notion of being part of a people or society with specific characteristics, which make it different from other peoples or societies."[5] Nowhere else was the presentation of national identity stronger, more vivid or colorful than at these international exhibitions, where countries could present themselves at their best with an enormous degree of freedom. Some world's fairs set a thematic frame, but within that frame everything was possible. There were few restrictions on a participant's presentation, and it was in their hands to decide which objects and technologies were shown in what ways. The catalog for the Special Loan Collection of Scientific Apparatus at London's South Kensington Museum in 1876 reported that, at world's fairs, "a certain amount of space is allotted to each country. These spaces are divided by the commissioners of each country among its exhibitors, who display their objects . . . as they consider the most advantageous."[6] An ideal opportunity for a nation to show its superiority was through choosing the most impressive objects and presenting them in an aesthetic and contextual way similar to museum objects. International exhibitions served as a stage for countries to brand themselves, not only through the impressive architecture of the national pavilions (established from 1873–1900) or the idealized view of a certain representative region, but also through technological ability, shown in typical industrial and craft products, in the latest developments in new technologies, or in having laid the cornerstone of an important modern world invention. Therefore, each presentation was something between a museum and a warehouse.[7]

Since the famous first Great Exhibition in 1851 in the Crystal Palace in Hyde Park, London, the character of international exhibitions has changed through the decades. The focus has moved from technology in the industrialization era to cultural themes in a world still shaken by two world wars, to presenting colorful, positive displays designed to improve a nation's image in the current time of globalization.

In the first era of world's fairs, from the era of industrialization in the middle of the nineteenth century through the first third of the twentieth century, the fairs focused on economic and technological advancements. Historian Eve Duffy stated that the fairs "equated technological advances with national strength and narrated the story of European progress as a continuous movement from primitive to modern. The displays employed (implicitly or explicitly) a linear narrative of progress, wherein 'primitive' societies were defined as lacking the benefits of the technology of more advanced Western nations."[8] The same applied to the more specialized equivalent of the world's fairs, the international electricity exhibitions. Beginning with the first Exposition Internationale d'Électricité in Paris in 1881, these exhibitions were showcases for high-tech industries and always a major attraction for the public.

The second half of the nineteenth century saw the first large-scale use of electricity. In Berlin in 1879, electric motors drove small trains around the fairgrounds of the Industrial Exhibition, and later powered trams in the city streets. Huge generators provided the energy to illuminate streets, exhibition venues, and the most spectacular displays, such as the legendary electrically illuminated fountains of the Exposition Universelle of 1889 in Paris, which glowed in different colors, or the Palace of Electricity, illuminated by 5,000 bulbs and spotlights with electricity generated by 92 steam engines. Beside high-power applications, another field benefited much from this technology: communications.

Not 10 years passed between the first experiments with electrical telegraphs and their practical application in the British railway. The technology advanced rapidly, and during the last decades of the nineteenth century, telegraphy became one of the most important applications of electricity. Telegraphs were displayed at most world's fairs and at every international electricity exhibition. These exhibitions featured historical sections, which presented the most important milestones of the technologies shown, including telegraphy as a low-power application. The best known, most often published and scrutinized of these is the historical telegraph exhibition of the German Telegraphen-Verwaltungen for the Vienna World's Fair in 1873.[9] With the enthusiasm for technology in the late nineteenth and early twentieth centuries, achieving technological superiority was the perfect opportunity to create heroes, and communications, as the technology with the most influence on people's awareness of space and time, was the key. With telephony still an underdeveloped technology, leading in telegraphy meant a claim to leadership over the entire strategically important sector of communications. A nation's technological superiority was not only demonstrated in developing the most recent and advantageous telegraph technology, like the Indo-European telegraph system or the high-speed telegraph, but was also embedded in the technology's foundation.

How Significant Is Technological Significance? Electrochemical Telegraphy

The development of telegraphy—transmission of a sequence of signs to transfer a message of variable content not known to a receiver—began around 1800 with the French optical telegraph system of Claude Chappe. That system became widely known in Bavaria for its role in the successful defense against the Austrian army through the tactical advantage of rapid transmission of information to French reinforcements. Although the French optical telegraph line was intended to extend through Bavaria, Minister Maximilian Joseph von Montgelas wished to establish his own telegraph system for the Bavarian authorities. A member of the Munich Academy of Sciences, physician and anatomist Samuel Thomas Sömmering was commissioned to develop the telegraph system.

Sömmering was familiar with the drawback of optical telegraphy: it required daylight with a clear view for operation, which limited its usefulness to only a few hours a day (on a good day). With British professor of chemistry Humphry Davy's development of an electrolytic cell, Sömmering decided to use electrolysis of a weak acid, instead of an optical system, to transmit messages. His setup (Figure 1) included a voltaic pile (or battery) and two glass tanks with 27–35 isolated contacts (for signalling the letters "a" to "z" and the numbers "0" through "9"), a blank, and a return contact, connected by a bundle of wires. Upon closing the electric circuit by touching a contact at the transmitting end, bubbles were produced by electrolysis at the corresponding contact of the receiving end. By observing the letters at the contacts, it was possible to transmit a message letter by letter. To signal the start of a transmission, the blank contact, which had a lever above it, was touched. The lever collected the developing hydrogen until it rose and dropped a metal ball onto the bell. This telegraph was independent of direct sight and weather conditions and did not require as many manned relay stations as did the optical telegraph.

Sömmering presented his prototype (Figure 1) starting in 1809, but without much success. For Napoleon and the French court, it was a reason to smile at a typical "*idée germanique*,"[10] referring to the romantic idea of nature and technology in Germany at that time, but also insinuating an inelegant and complicated solution. Due to problems with the customs authorities, the prototype never reached Humphry Davy in England, so this practical application of Davy's invention remained unknown in England. Neither Sömmering's concept, nor any other telegraph concept based on the principle of electrolysis ever became of any practical significance.

Figure 1. The telegraph of Samuel Thomas Sömmering, 1809. InvNr 4363. Courtesy of the Deutsches Museum, Munich, photo by Konrad Rainer.

Which Nation's Hero? Electromagnetic Needle Telegraphs

The next technological milestone came in the 1830s, with the development of electromagnetically produced electricity. Paul Ludwig (Pavel L'vovitch) Schilling von Cannstatt, also known as Paul Schilling, was born in 1786 in Reval (now Tallinn), Estonia. He came to Munich with his mother and stepfather, who was the Russian envoy at the Bavarian Royal Court from 1802 until 1805. In 1805, Schilling consulted Sömmering as a physician. The men became friends, and Sömmering inspired Schilling's interest in electricity. For political reasons, Schilling and his family returned to Russia in 1812 and settled in St. Petersburg.

In the same year, he started his own experiments with electrical devices. Building on his military background, he did experiments on the remote ignition of mines from opposite sides of the Neva river. He used caoutchouc-insulated cables, which he had developed in Munich. During the Napoleonic Wars and on a subsequent expedition, he was kept from resuming his work on an electrical telegraph until 1832. He returned to St. Petersburg in March 1832 and worked intensely to finish his electromagnetic telegraph. During a tour through western Europe, Schilling presented parts of his telegraph on several occasions: to Alexander von Humboldt in Berlin in 1832 and to Emperor Nicholas I in Bonn in 1835, while attending the Meeting of the Natural Scientists and Physicians. On his return from Bonn, he visited Carl Friedrich Gauss and Wilhelm

Eduard Weber in Göttingen and Sömmering's son in Frankfurt, where he presented his telegraph to the Physikalischer Verein.

Schilling's telegraph (Figure 2) was based on the principle of electromagnetism, discovered by Danish physicist and chemist Hans Christian Oersted in 1820. The telegraph consisted of a galvanoscope, where electric current flowing through a coil would produce deflection of a needle hung on a silk thread. Cardboard circles on the threads rotated with the needle when current flowed, making the telegraphic symbols clearly visible. Schilling used up to six galvanoscopes, with a common return conductor and an extra line for an "Alarum," a bell operated by current flowing through the coil as the needle rotated. Signs—the characters that formed the message—were sent using a keyboard. The 1832 invention is well documented because of extensive discussions about its significance as the first electromagnetic telegraph. It was especially important to establish this fact, because Gauss and Weber had created an electromagnetic telegraph in 1833 that worked on the principle of electromagnetic induction as well. Ernst Feyerabend, a high-ranking official and a historian of telecommunication technology, argued that they were the first to use electromagnetic force or electricity for telegraphy.[11] In fact, Schilling never argued he was the first to invent the telegraph *based on the principle of induction*. In a letter dated April 1837 to Minister Alexander Sergeyevich Menschikoff, chairman of the evaluation commission of his telegraph, Schilling named British electrical engineer Francis Ronald as the inventor of the electric telegraph, as in 1823 he had powered one with an electric discharge from a Leyden jar.[12]

Figure 2. Telegraph of Schilling, 1833. InvNr 8967. Courtesy of the Deutsches Museum, Munich, photo by Konrad Rainer.

Schilling's telegraph attracted a great deal of attention as it was much easier to operate than either Gauss and Weber's or August Steinheil's 1836 version. A number of replicas of Schilling's telegraph were made. One went to Heidelberg and inspired William Fothergill Cooke and Charles Wheatstone to build their own telegraph, which worked on the same principle but the means of deciphering transmitted messages was easier to learn and use. The British railway made use of their telegraph as of 1837.

Schilling could have sold his patents to the British government, as Great Britain's railway was the only service advanced enough to use them. Yet he declined because he wanted to save it for his homeland, Russia. Schilling died unexpectedly of an infection on 25 July 1837 in St. Petersburg. Shortly before his death, on 19 May, he received a letter from Minister Menschikoff with an order from the Russian emperor for a telegraph line between Kronstadt—on an island 30 km off the coast of St. Petersburg—and Peterhof, on the coast 29 km west of St. Petersburg. His death deterred the completion and application of his telegraph system.[13]

Might Makes It Right? The Writing Telegraphs

As with any commercial endeavor, telecommunications were driven by the need for economic success. With the speed of the transmission depending on the speed of the operator, needle telegraphs transmitted only a few dozen words per minute. To increase their effectiveness, it was necessary to increase the speed of transmission or reduce manual work. The Morse writing telegraph used code consisting of dots and dashes, developed by Clemens Gerke and Alfred Vail, Morse's partner in finance and development. Providing both speed and reduced labor, use of the writing telegraph quickly became widespread. In 1850, the Morse telegraph became standard in Europe, and in 1851 Morse code was made the standard telegraph language. Morse is still widely known as the inventor of telegraphy, and "Morse telegraphs" are part of every communications collection. But a closer look at the first telegraph built by Morse paints a different picture.

Samuel Finley Breese Morse was an American painter and professor of art history. He studied religious philosophy and mathematics at Yale College (now Yale University) where he attended lectures about electricity even during his early academic education. Much of his early adult life was spent in Europe, broadening his education and perfecting his painting techniques. On his return, travelling by ship from Le Havre to New York in October 1832, he saw demonstrations of electrical experiments with electromagnets and galvanic cells by American scientist Charles Thomas Jackson. A discussion emerged about the use of electricity for signaling and transmitting messages, and as Morse tells the story in his 1837 book, *Modern Telegraphy*, the idea of using electromagnetic effects for the transmission of messages struck him. He sketched his telegraph concept and built it as soon as he was back home.[14] Because Morse was a professor of art and a painter, it is not surprising that his first apparatuses were constructed from an easel and a canvas stretcher. He hung a pendulum with a pen from the wooden frame; the tip of the pen touched a ribbon of paper that was drawn forward by a clockwork mechanism. When current flowed through an electromagnet, the pendulum was attracted to it, and the deflected pen drew a spike on the ribbon. On the transmitting device, the signal was produced when a wooden bar with metal spikes was moved under a lever that closed an electric circuit when a spike passed.

Morse had to move frequently and was without funds for a time, so he could not finish the practical realization of his telegraph before 1835. The prototype (Figure 3) could transmit an electrical pulse, but over a distance of only about 12 meters. Morse—unlike Schilling—showed his prototype to a very limited circle of people before he had the means to complete two apparatuses, so he could demonstrate both sending and receiving. One of those people was Leonard Gale, professor of chemistry at New York University. Gale introduced Morse to Joseph Henry's work on electromagnets. Applying Henry's theoretical work allowed Morse to transmit signals over more than 15 kilometers of wire. On 6 October 1837, he applied for a patent for his telegraph, an act that initiated long and vigorous litigation.[15]

The "Cradle of Telegraphy"

At the beginning of the twentieth century, exhibitions and museums had a great deal in common; both were venues for displaying objects aesthetically and with context, enabling presenters to generate deliberate narratives. In the historical sections, the presentations were marked by ambivalence; the simple technical processes of original objects, or contemporary reproductions in some cases, belied the objects' rather insignificant contributions from a technical point of view, but emphasized a nation's major contribution to the modern world.

Many nations presented achievements in telegraphy at world's fairs or at international exhibitions, but none claimed to be the cradle of telegraphy as aggressively as Germany, Russia, and the United States.

Although Sömmering's concept was not put into practice, in most world's fairs or international electricity exhibitions, the telegraph could be found as a part of the German exhibit—Bavaria had joined the North German Confederation in November 1870—alongside the technologically significant devices of Steinheil, and of Gauss and Weber, who all enjoy international prestige to this day. For example, the catalog of the 1873 World Exhibition in Vienna reports about the section of the *Reichspost*, the German postal service, which was also responsible for telegraphy, that it exhibits the "great-grandfather of telegraphy" by Sömmering and comments that "the very first telegraph built in 1805 could not come to any practical significance because of its complexity, slow working and so on." Denmark presented a bust of Oersted, which had also been at the 1855 Exposition Universelle in Paris, and highlighted several of his apparatuses as the starting point of electrical telegraphy. For the French, the honor went to André-Marie Ampère, whose discoveries were, according to the catalog, the inspiration for the work of Schilling and for Cooke and Wheatstone.[16] Germany had "exact copies of the oldest telegraph devices by Sömmering, Gauss and Weber, Steinheil" in their telegraphy collection.[17]

The catalog of the 1881 Exposition Internationale d'Électricité in Paris lists the exhibition of apparatuses by Sömmering, Gauss and Weber, Steinheil, and Werner von Siemens in the German section.

Figure 3. Telegraph of Samuel Morse, 1837. InvNr 2840. Courtesy of the Deutsches Museum, Munich, photo by Konrad Rainer.

The telegraphy portion of the Russian section exhibited the "first electromagnetic telegraph from 1832, invented in Russia by baron Schilling von Canstatt, born in Reval in 1785, died in St. Petersburg in 1837" together with "a portrait photography of baron Schilling von Cannstatt, inventor of the telegraph" (translated from French).[18] Although contemporary literature lists 1833 as the year of construction for his telegraph, Schilling demonstrated parts of his telegraph starting in 1832.

There is no doubt about the importance of Schilling's telegraph in the development of electrical—and especially electromagnetic—telegraphy as the predecessor of and inspiration for Cooke's and Wheatstone's first needle telegraph with practical application. A subject for debate, however—beside the later emerging discussion about Gauss and Weber's or Schilling's priority of invention—was his contribution to the nation. Both Russia and Germany claimed Schilling as a citizen, as he was the grandson of Russian military officers but descended from an old German noble dynasty. The Russian claim on the invention of the telegraph was based on Schilling's birth in Tallinn, then belonging to Russia, and his service as an officer in the army of the Czar, like his father before him. Schilling's grandfather, a descendant of an old noble family, was born in Germany and had come to Reval during his military service. Detmar Sömmering, the son of Samuel Thomas, considered Schilling to be German because of his family descent and his education in Munich.[19]

According to the catalog of the 1882 Internationale Elektricitäts-Ausstellung (International Exhibition of Electricity) in Munich—Sömmering's hometown—the history of the electromagnetic telegraph started with Oersted, who inspired Ampère and William Ritchie; but Schilling, the "Russian Counsellor," is credited for reducing the number of wires required between telegraphhy stations to two. Although reproductions of his telegraph were available in Germany, none was brought to the exhibition,[20] most likely due to the lack of a promoter.

The exhibition guide made note again in the German section of "two very special apparatuses at the top: Sömmering and Steinheil." Sömmering's telegraph, brought to the exhibition by Sömmering's grandson, Thomas Carl Sömmering, was even granted space in the catalog for an illustration.[21] These two were the only historic telegraphs in the exhibition. The electricity exhibitions had a strong focus on application, not on the underlying physics or the origin of technological developments. The majority of the devices were built by Emil Stöhrer and widespread in Bavaria in spite of their technological shortcomings. The post office in Berlin had "a large collection of historical apparatuses on display, which were in operation in Prussia and the North German Confederation," along with "30 Morse telegraphs, from the first strange historical apparatus of 1846 to modern ones," and busts of Morse next to busts of Gauss, Weber, Steinheil, and Philipp Reis.

While Steinheil's apparatus based on the work of Gauss and Weber may have been the first telegraph with practical application, the choice of Sömmering's telegraph for display was due mainly to the promotional efforts of his grandson, who wanted to strengthen his grandfather's claim to having made a significant contribution to the development of telegraphy.

Although the Morse system was the most widespread telegraph in use—and was therefore included in exhibitions in many different modern forms—it is difficult to find any hint of Morse's first telegraph in the 1882 Munich international exhibition of electricity, either an original or a replica.

A model of his improved telegraph of 1844, patented in 1846, was shown in 1884 at the Philadelphia International Electrical Exhibition and was copied afterward by Daniel Ballauf in Washington, D.C. That copy was brought to the Museum für Kommunikation (Post Museum) in Berlin in 1897 but was not mentioned in any catalog.[22] It was, however, part of the museum's exhibition.

Morse was an official American representative at the 1867 Exposition Universelle in Paris, bringing along a letter to defend his claims, especially against British attacks. The focus of the letter was that his idea for a telegraph dated back to 1832, which he claimed should be regarded as the date of the invention. He also noted that the word *telegraphy* meant "writing in the distance," which was what his telegraph had done for the first time. Prior concepts had been mere semaphores, giving evanescent signals in the distance.[23] Morse completely ignored Steinheil's writing telegraph of 1836, which was clearly not a semaphore according to Morse's definition.

In Morse's mind, to date an invention to the time of the idea was valid only for Morse himself, not for Gauss and Weber, and not for Schilling, who also developed their ideas for telegraphs long before they could be realized.

This debate is reflected in contemporary records during three time frames. The first debate took place in the 1860s and 1870s, a climax of technological enthusiasm and the time of the great exhibitions. In 1863, Detmar Wilhelm Sömmering published a biography of his father's work on telegraphy, based on the diaries that Samuel Thomas Sömmering kept until eight days before his death in Frankfurt. He concluded that his father was "fully aware of the meaning and potential of his invention," so the "first invention and realization of an electric telegraph is proven to belong to a German and no one else." The "honor of the idea to use electricity and galvanism of telegraphy, for which Russians, British, and Americans still fight, certainly belongs to a German, hopefully forever."[24] The biography was published only in German.

The main part of the discussion focuses on Morse's claims and what other telegraph concepts Morse had known before developing his telegraph. Undoubtedly, the article on electromagnetism published in 1831 by Joseph Henry in the *American Journal of Science* was recommended to Morse by Leonard Gale. Morse also knew about Henry's demonstration setup, which consisted of an electromagnet that exerted mechanical force across a distance when a signal was given. Morse used the basic principles and electric parts of the setup in his telegraph, relying heavily on the empirical results and technical developments Henry had made. Henry was a scientist at heart: he did not patent his invention and had no intention of making money from it; he wanted to make it accessible to all who could make use of it. As success of the Morse telegraph grew, apparently with no credit given to Joseph Henry—quite the contrary, Henry's involvement and contributions were withheld, and Morse laid claim to the basic principles as well—a dispute emerged about the priority of scientific discovery versus the invention as technological implementation. The conflict reached its climax when Henry was forced to give testimony in court related to infringement suits brought against Morse by other telegraph inventors. The conflict did not end until the deaths of both men. Morse led a fierce fight to claim his right to the discovery and invention of the electromagnetic telegraph and its principles, and he did not mind using questionable methods.

Concerning the European telegraphs, Morse himself alleged that they were unknown to him. However, *Le Moniteur Universel*, a French newspaper, reported on 14 February 1865 that Morse had been to Europe and had taken note of Steinheil's writing telegraph and the relays of Wheatstone, uniting these concepts to develop the "most universal telegraph of this time." But Shaffner's *The Telegraph Manual* of 1867, a widely read book on the history and technology of telegraphy, shows a message from a Morse "demonstration at a public exhibition at New York City University, at the distance of one third of a mile," where the words "successful experiment with telegraph, November 4th, 1835" were transmitted.[25] This date precedes the invention of Steinheil's telegraph in 1836, so Morse could not have known anything about the German telegraphs, especially Steinheil's writing telegraph. A similar message is depicted in "A Short History of Electric Telegraphy," based on the exhibition of historical telegraphy in the German empire. In this telegramm a half spike at the end of the message was missing compared to Shaffner's, but this difference had no impact on the content of the message.[26]

In 1837, *The American Journal of Science*, which originally published Morse's telegraphy experiment, published a picture of the "Specimen of Telegraphic writing made by means of electricity at the distance of one third of a mile." The picture is the same as was included in Shaffner's book, but the year is different: in this transmission, the final character translates to a seven instead of a five—two spikes more on the paper ribbon than in Morse's first transmission. If the year was 1837, the demonstration occurred after the invention of Steinheil's writing telegraph.[27] In spite of the litigation, the dominance and monopolistic use of the Morse telegraph, combined with Morse's vigorous attempts to claim the invention, led to its success. To this day, Morse is considered the inventor of telegraphy—and not only in America, as shown by the German children's book *Was ist Was? Das erste Telegramm.*

With the rise of the National Socialist German Worker's Party in Germany in the 1930s and the Cold War in the 1960s, the discussion about the nationality of Schilling emerged again. German historian Ernst Feyerabend used the family tree of the Schillings in his 1933 book *Der Telegraph von Gauss und Weber im Werden der elektrischen Telegraphie* and other publications on the history of telegraphy to prove that "Paul Lwowitsch Schilling is of pure German descent." concluding that, with Gauss, Weber, and Schilling all being German, the cradle of telegraphy lies without any doubt in Germany.[28] The Soviet historian Jarozkij, in his 1963 biography of Paul Schilling, published during the Cold War, declared Schilling the inventor of telegraphy and claimed his invention for Russia.[29] This type of nationalism in the twentieth century was reflected in exhibits and literature, and, to some degree, is apparent in museum collections.

The Three Telegraphs on Exhibition at the Deutsches Museum

Visitors expect technical museums to show timelines of the relevant artifacts that led to the refinement of a particular technology—to exhibit "the truth." Such expectations apply to this comparison of the presentation of three artifacts in the Deutsches Museum with presentations at international exhibitions and in the literature.

Sömmering's telegraph came to the Deutsches Museum because of personal contacts and on the special wish of Oskar von Miller, the museum's founder, given by the Physikalischer Verein Frankfurt in 1905. It was exhibited in its own showcase in the Hall of Fame of Telecommunications in a prominent position next to the devices of Gauss and Weber, Steinheil, and Werner von Siemens (Figure 4).

The museum's 1925 guidebook describes a "complete display of the development of telegraph devices, from the first electrical telegraph of Sömmering to the modern high-speed telegraph of Siemens," including the telegraphs of Schilling, Gauss and Weber, Cooke and Wheatstone, Fardeley, Siemens, Steinheil, and Morse.[30] Yet Sömmering was not chosen as one of the twelve fathers of telecommunication, whose portraits were commissioned for the accompanying Hall of Fame of Telecommunication gallery.

The museum's 1933 guidebook, *Das Deutsche Museum. Geschichte, Aufgaben, Ziele,* pictures Sömmering's telegraph, along with a bust of the inventor, in a prominent showcase as well

Figure 4. The Hall of Fame of Telecommunication, 1933–1944, showing Sömmering's telegraph in the hexagonal showcase (left), Gauss and Weber's (right), and Steinheil's (far right). In the background are the first prototype of Morse's telegraph next to those of Siemens, Cooke and Wheatstone, Fardeley, and Schilling. Deutsches Museum, Munich, Sammlungsbau, Abteilung Nachrichtentechnik (alte Ausstellung vor 1945), Saalansicht Telegrafie, Archiv, BN03775.

as a selection of needle telegraphs, Morse's telegraph, and the telephone of Philipp Reis.[31] In 1937, Feyerabend promoted the German inventors, including Schilling.[32] That Morse could have invented the electrical telegraph was denied outright.[33]

In the 1960s and 1970s, when the museum had no telecommunications exhibition, except for a section of "Picture Telegraphy and Television" in its physics exhibition, Sömmering's device was pictured in museum catalogs and guidebooks next to Reis's telephone. In 1966, although pictured in the guidebook, none of the devices were described in the text. Sömmering is mentioned, however, in every publication on a telegraphy or telecommunication exhibition.[34]

In the museum's next two telecommunications exhibitions, the first in the 1970s and the second in the 1990s, the telegraphs of Gauss and Weber and of Steinheil had the most prominent positions, sitting at the exhibition entrance. Sömmering's shared a showcase with that of Schilling, representing a technological development equal to the devices of Schilling, Cooke and Wheatstone, Morse, Baudot, and Siemens. The 1970s display text—echoing the purely technological focus of this time period—notes that "the device had no practical significance."

The texts and pictures from the publications of the Deutsches Museum tell a different story. The exhibition guides from the 1970s continue to describe Sömmering's device as the "first preserved electrical telegraph,"[35] without further mentioning another telegraph.[36]

In the End, It Doesn't Really Matter

Whether an inventor wanted and embraced the role of being first, like Morse, or avoided it, like Schilling, he was made part of the national contribution to the field. Some contributed by technological significance, like Sömmering's telegraph; some through descent and nationality, like Schilling, and others through the significance of the invention itself, like Morse. Early telegraphs, which can be found in most telecommunication collections, are not only technical artifacts, but also symbolize nations' capabilities, modernity, and attitude about the future. If an inventor had a claim, it was important to have the backing of others. Along with being specialists in appropriate professional positions, like collectors or directors of institutes with collections, these supporters were often sources for objects acquired for technological collections. For example, Sömmering's claim was maintained by his son and grandson, especially in Munich; his original telegraph came to the Deutsches Museum via the city's Bavarian Academy of Science and Humanities. Despite being of noble descent, Schilling had no children or other family with sufficient technological affinity or interest in his work to promote his cause. Yet his presentation in Frankfurt attracted a significant amount of attention, and replicas of his telegraph were made for almost all the important institutional collections. The originals were donated to the Imperial Academy of Science in St. Petersburg and, in 1876, were loaned to the Loan Collection of Scientific Apparatuses. Morse's claim was not championed by a specific individual after his death, but the success of his telegraph spoke for itself. Along with modern telegraphs, it was part of every world or electrical exhibition, and it is still part of every telecommunications collection.

Notes

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2. E. Duffy, "Oskar von Miller and the Art of the Electrical Exhibition: Staging Modernity in Weimar Germany," *German History* 25, no. 4 (2007): 520; for example, H. Knauer, *St. Louis und seine Weltausstellung Eindrücke und Erlebnisse* (Berlin: Bernstein, 1904).
3. R. Sabine, *The Electric Telegraph* (London: Virtue Brothers & Co., 1867), 40; V. Aschoff, *Geschichte der Nachrichtentechnik* (Berlin and Heidelberg: Springer, 1985), 94.
4. P. Flichy, *Tele. Geschichte der modernen Kommunikation* (Frankfurt/M.: Campus-Verlag, 1994), 68.
5. From Tjaco Walvis, *The Branding of Nations*, unpublished manuscript.
6. *Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum* (London: Printed by G. E. Eyre and W. Spottiswoode, for H. M. Stationery Office, 1877), xiii.
7. J. Zander-Seidel and R. Prügel, eds., *Wege in die Moderne. Weltausstellungen, Medien und Musik im 19. Jahrhundert* (Nuremberg: Verlag des Germanischen Nationalmuseums, 2014), 21, 28.
8. Duffy, "Oskar von Miller and the Art of the Electrical Exhibition," 519.
9. K. E. Zetzsche, *Kurzer Abriß der Geschichte der elektrischen Telegraphie* (Berlin: Springer, 1874), 1.
10. "Die Geschichte der deutschen Telegraphie, Ernst Keil," *Die Gartenlaube*, 20 (1864): 318–320.
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12. V. Aschoff, "Paul Schilling von Canstatt und die Geschichte des elektromagnetischen Telegraphen," *Abhandlungen und Berichte des Deutschen Museums* 44, no. 3 (1976): 18.
13. Aschoff, "Paul Schilling," 47.
14. S. F. B. Morse, *Modern Telegraphy: Some Errors of Dates and Events and of Statement in the History of Telegraphy Exposed and Rectified* (Paris: Printed by A. Chaix, 1867), 18.
15. Morse, *Modern Telegraphy*, 31.
16. *Bericht über die Weltausstellung zu Wien im Jahre 1873* (Triest: Friedrich Bömches, 1874), 333f.
17. *Exposition Internationale d'Électricité, Paris 1881, Catalogue Officiel* (Paris: Lahure, 1881), 72.
18. *Exposition Internationale d'Électricité, Paris 1881, Catalogue Officiel*, 134.
19. D. W. Sömmering, *Der elektrische Telegraph als deutsche Erfindung Samuel Thomas von Soemmerring's aus dessen Tagebüchern nachgewiesen* (Frankfurt am Main: Boselli, 1863), 13.
20. P. Carl, *Catalog für die Internationale Elektricitäts-Ausstellung* (Munich: Knorr & Hirth, 1882).
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23. Morse, *Modern Telegraphy*, 5.
24. Sömmering, *Der elektrische Telegraph*, 19.
25. *The American Journal of Science and Arts*, 20 (1831): 340–343.
26. T. P. Shaffner, *The Telegraph Manual* (New York: D. Van Nostrand, 1867), 409.
27. Zetzsche, *Kurzer Abriß der Geschichte der elektrischen Telegraphie*, 27.
28. *The American Journal of Science*, 33 (1837): 185–187.
29. Feyerabend, *Der Telegraph von Gauss und Weber*.
30. A. V. Jarozkij, *Pavel L'vovic Silling 1786–1837* (Moscow: Izdat. Akad. Nauk SSSR, 1963).
31. Deutsches Museum, *Amtlicher Führer durch die Sammlungen* (Munich: Knorr & Hirth, 1925), 238f.
32. C. Matschoss, *Das Deutsche Museum. Geschichte/Aufgaben/Ziele*, 3rd ed. (Berlin: VDI-Verlag, 1925), 201f.
33. E. Feyerabend, "Entwicklung der Telegraphie auf Drahtleitungen," *Abhandlungen und Berichte des Deutschen Museums* 9, no. 5 (1937): 109–145.
34. Feyerabend, "Entwicklung der Telegraphie auf Drahtleitungen," 112.
35. Deutsches Museum, *Wegweiser durch die Sammlungen*, 10th ed. (Munich: Deutsches Museum, 1966), 62; W. Panofsky, *Deutsches Museum München* (Munich: Winkler, 1978), 63.
36. Deutsches Museum, *Ausstellungsführer* (München: Dt. Museum, 1997), 122; O. Mayr, ed., *Museen der Welt. Deutsches Museum* (München: Beck, 1990), 129; Deutsches Museum, *Führer durch die Sammlungen*, 3rd ed. (München: Beck, 1991), 297.36. Deutsches Museum, *Ausstellungsführer*, 304.

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Rethinking Science Display: Interwar Exhibitions

CHAPTER 3

The Quest for the Technological Soul of a Nation

The Catalan Forge and the Display of Politics (1914–1949)

Jaume Valentines-Álvarez
Post-Doctoral Fellow
CIUHCT | Interuniversity Center for the History of Science and Technology
Nova University of Lisbon
Portugal

During the last days of July in 1914, two young Catalan engineers hurried to flee from France and crossed the border towards home.[1] World War I had started. They brought in their baggage plenty of papers with notes, maps, drawings, and data collected from some of the quietest, most remote, and least populated areas in the Pyrenees mountains. Santiago Rubió (1892–1980) and Antoni Gallardo (1887–1942) had been looking for the "technological soul" of Catalonia:[2] the legendary *farga catalana* (Catalan procedure, or Catalan forge).[3] The material remains of the *farga* were supposed to be the footprints of Catalonia's lost "golden age" of metallurgy, which was traced back to the Middle Ages. World-renowned from the seventeenth century until the mid-nineteenth century, this technology had been appropriated throughout Europe and the Americas, from Minas Gerais in Brazil to Vermont in the United States.[4] Rubió and Gallardo wrote about the oblivion of Catalonia's technological past in a romantic and nationalist way: "Now that the spring floods of the rivers have roughly pushed downstream the tools and remains of work lost; now that the mallets are quiet, the anvils are silent, and the drop hammers do not ring, it is still possible to find the last proofs of the work at the forges which spread the name of our land all over the world."[5]

With the aim of recovering these "last proofs," the engineers traveled through green valleys and tiny rivers by car and walked along narrow paths throughout the Catalan-speaking Pyrenees belonging to Spain, France (Roussillon), and Andorra (Figures 1 and 2).[6] As "industrial archaeologists," they mapped the geographical location of the forges, surveyed sites, took photographs of buildings, drew layouts of structures, preserved samples of minerals and slags, collected artifacts, and interviewed old inhabitants who retained the know-how and associated skills.[7] The fieldwork was just part of the activities in the search for this "technological soul." In the Pyrenees, they also consulted ecclesiastic and administrative archives in towns and villages, visited local museums such as the Sant Pere Museum in Ripoll, and studied the traditional smith industries and their final products, including nails, arms, keys, locks, and anvils.

In Barcelona, at the libraries of the School of Industrial Engineers and the Association of Industrial Engineers, the travelers came across old technological studies that ranged from contemporary geological and water engineering reports to classic metallurgical treatises by Philippe-Frédéric de Dietrich (1786), Henri C. Landrin (1859), Charles-Edouard Jullien (1861), John Percy (1864), and Luis Barinaga (1879). They also consulted more recently published treatises, such as the one by a Catalan professor of architecture in which the Catalan procedure was extensively described (Figure 3).[8]

Besides, a different kind of reference work was key for the young engineers: books that dealt with the historical origins and geographical milieu of the so-called "Catalan civilization," and

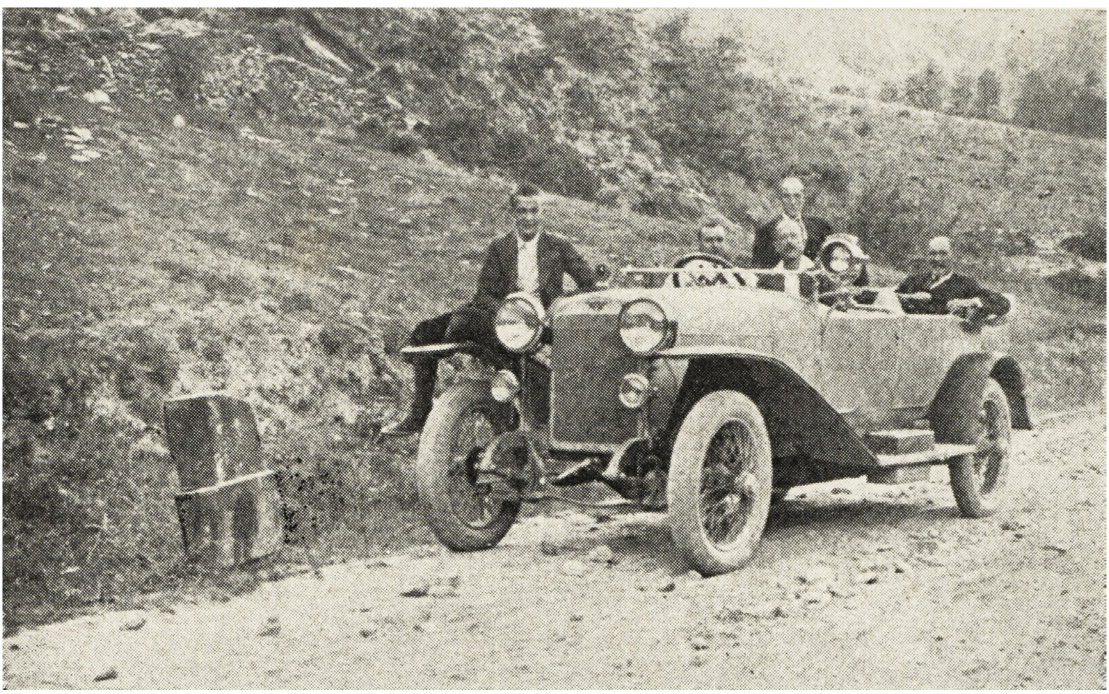

Figure 1. Raiders of the Lost Forge (next to an ancient iron workshop in the Catalan mountains). [M. Tell]. From A. Gallardo Garriga, and S. Rubió Tudurí, *La farga catalana: Descripció i funcionament, història, distribució geogràfica* (Barcelona: Exposició de Barcelona, 1930). Published with permission of the Biblioteca Nacional de Catalunya.

Figure 2. Archaeological fieldwork in the Pyrenees. From A. Gallardo Garriga, and S. Rubió Tudurí, *La farga catalana: Descripció i funcionament, història, distribució geogràfica* (Barcelona: Exposició de Barcelona, 1930). Published with permission of the Biblioteca Nacional de Catalunya.

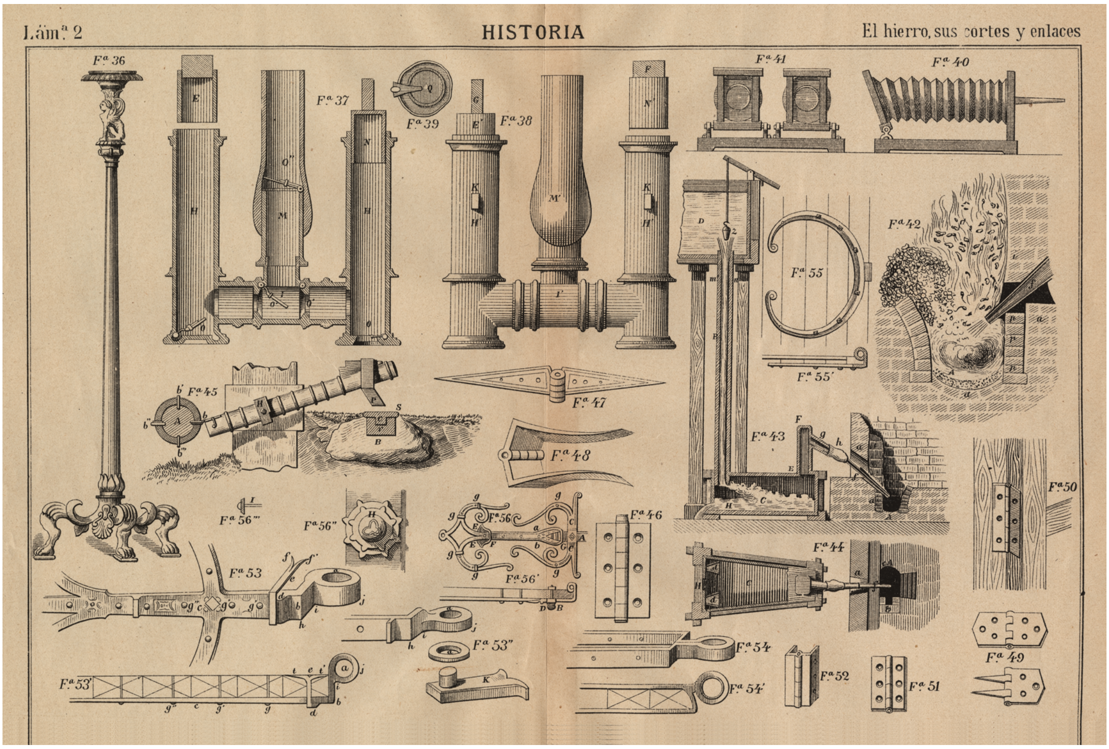

Figure 3. Techniques and objects of Catalan iron history, as depicted by Rovira Rabassa in his metallurgical treatise (on the Catalan forge, see figures 42–45). From A. Rovira Rabassa, *El hierro, sus cortes y enlaces* (Barcelona: Libr. Alvaro Verdaguer [1910]), Lamina 2. Published with permission from the Biblioteca Nacional de Catalunya.

which were entangled with the rise of Catalan proto-nationalism.[9] Rubió and Gallardo made the Catalan forge part and parcel of a pastoral "Catalan soul"—in the words of anthropologist Llorenç Prats—which had been idyllically set in the farmlands and mountains of Catalonia in the nineteenth century.[10] The image of the innocent and pristine (but often challenging) "patriarchal life" in rural areas continued to be spread during the first decades of the next century, in particular by engineers, architects, and other science and technology professionals.[11] In his book devoted to scientifically organizing Catalan economy, for example, industrial engineer Lluís Creus worshiped the countryside's purity, writing that it is "sound, brightness and harmony . . . This is the life in our fields which are covered with radiant grass. Symbol of our patriarchal agriculture, here you have an eclogue, under the regard of the Puigsacalm mountain."[12]

This time, "the machine" did not seem to produce feelings of anxiety or dislocation when it entered "in the garden"; the idyll was not interrupted.[13] Rubió and Gallardo stressed that the technological legacy was also an unavoidable part of the "radiant" green landscapes and of Catalan quintessence. Besides the forge, the two engineers were also very interested in cataloging the medieval Romanesque architecture in the highest Catalan towns, as well as the most popular farm constructions, the *masias*.[14] They studied this heritage by entering in the alleged core of the national territory: the hinterland of Catalonia, especially the farthest mountains in the Pyrenees.[15] According to some of the first key ideologists of Catalan nationalism, the Pyrenees were the "entrails of the Catalan mother."[16] Walking along valleys and climbing mountains were acts of breathing in pure air as well as national essences. Hiking and going on excursions had become a bourgeois hobby linked to hygiene theories, natural sciences, and nationalism, especially since the creation of the Catalanist Association for Scientific Excursions in 1876; love of country was supposed to mature when being "watered" by scientific knowledge.[17] Neither technology nor science were at odds with the pastoral "national nature." The mountains were undoubtedly far away from the huge amount of new technology that had been put on display in Barcelona by engineers, especially since the 1888 Barcelona International Exhibition.[18] Nonetheless, the newest technologies, such as funicular railways, rack railways, and cable railways, were promoted as means to gain access to and enjoy these landscapes. In fact, Rubió designed a funicular in 1917 to reach the gorgeous location of the Núria Sanctuary in the Pyrenees, which was surrounded by several peaks of nearly 3,000 meters.[19]

In addition to the young engineers, senior fellows of the profession also strengthened this vision of a quiet, hilly core of the nation as well as the relevance of past national technologies. These proponents included engineer and economist Carles Pi Sunyer (1888–1971), who served as secretary of the main association of owners of textile industries, the Federació de Fabricants de Filats i Teixits de Catalunya, during the 1920s, and became head of the Department of Culture of the Catalan government at the end of the 1930s. He wrote some "sketches on the history of Catalan cotton industry" in 1924 and, in 1929, his influential book on the "economic aptitude of Catalonia."[20] This latter explained that the people of the Pyrenees were the “skeleton of the Catalan personality” because of their alleged capacity for “ethnic conservation.” Ingenuity, humble industriousness, enterprising dynamism, and technical skills characterized this “personality.”[21] The remains of the Catalan forges were understood to be the bones of that “skeleton,” and the ancient metallurgy—alongside other iconic technologies such as the Catalan vault, the spinning machine *Bergadana*, the submarine *Ictineu*, and the cork industry—seemed to be clear evidence of how the “national intelligence” had contributed to universal science and technology.[22]

Displaying Relics at the Pavilions of the International Exhibition (1929–1931)

The industrial heritage recovered by the young engineers was supposed to be displayed at the Barcelona Exhibition of Electric Industries in 1917. The exhibition had been promoted by the urban economic elite—especially those linked to the energy sector—as well as by the *Mancomunitat* of Catalonia, the first attempt at an autonomous government for the whole region. Since 1914, the *Mancomunitat* had enhanced a right-wing political program to “modernize” the nation through new cultural institutions and large technological networks, such as hydroelectric, telephone, and road systems.[23] Nevertheless, the exhibition was postponed due to the outbreak of World War I and, after the war, to local circumstances. During the first years of Miguel Primo de Rivera’s dictatorship (1923–1930), the project was again taken up as an international exhibition of arts, sports, and industry.[24]

Finally, the Barcelona International Exhibition was held in 1929 by the Spanish government, Barcelona’s city hall, the Catalan “civil society” (in Gramscian terms), private companies, and, last but not least, professional associations.[25] It epitomized the expression of technological sublime and enthusiasm in the city up to that moment. With its engineered fountains, lights, gardens, transport networks, and amusement rides, this exhibition represented what was called the “triumph” of the Catalan engineering profession.[26] The engineer-in-chief and orchestra conductor of this high-sounding event was Mariano Rubió, Santiago’s father. Mariano was a renowned military engineer who had been involved in the organization of the Exhibition of Electric Industries from the mid-1910s onward.[27] Santiago Rubió was in charge of the design of transport facilities, such as the funicular railway ascending to the prominent National Palace of Montjuïc hill. At that time, he was an expert in transport engineering and had already designed the first line of the Barcelona subway as well as two funicular projects reaching religious and symbolic epicenters of Catalan nationalism: the aforementioned Núria Sanctuary and the mystical Montserrat mountain, which houses the black Madonna statue *Moreneta*.

No trace of the “golden” metallurgical past of Catalonia appeared, however, when the exhibition opened its doors. Santiago Rubió publicly attributed this fact to full occupancy of the pavilions by international and local stands, but there must have been political reasons that he preferred not to mention. The 1929 international exhibition was sponsored by the regime of Primo de Rivera, who promoted a wide range of right-wing policies against workers’ organizations and non-Spanish nationalisms. The dictatorship fervently wished to "de-Catalanize" the exhibition and the city. One of the clearest examples of this was the destruction in 1928 of four high columns that represented the Catalan flag and stood in front of the National Palace. When the military dictator fell during the first weeks of 1930, the political context seemed much more suitable for showing the "relics" of the Catalan forge. This was the case starting 28 May 1930.[28]

Although the 1929 international exhibition officially ended in January 1930, many stands and displays remained and new ones were set up, such as the *farga* exhibition, which could be visited from 9 PM to 2 AM. At the Palace of Electricity and Metallurgy, exhibits in a gloomy 130-square-meter room, with both replicas and originals, sought to reproduce the atmosphere of ancient workshops in the Pyrenean valleys (Figures 4 and 5). Members of the public were meant to emotionally immerse themselves in the environment and the ancient techniques. With the light

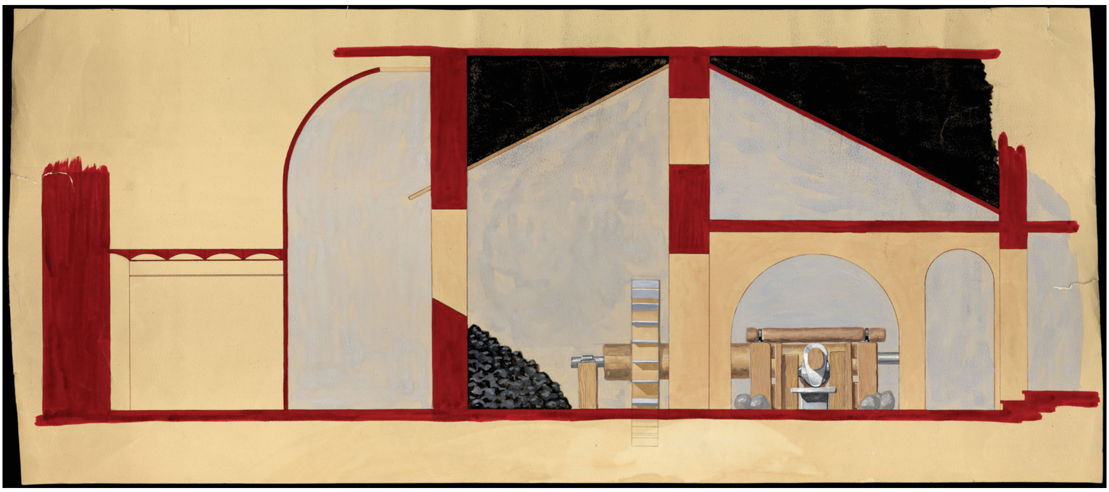

Figure 4. The *farga* at the pavilions of the 1929 Barcelona International Exhibition, cross section. From Arxiu Històric de la Ciutat de Barcelona, Tuboteca, 2955–2959. With the permission of the Arxiu Històric de la Ciutat de Barcelona.

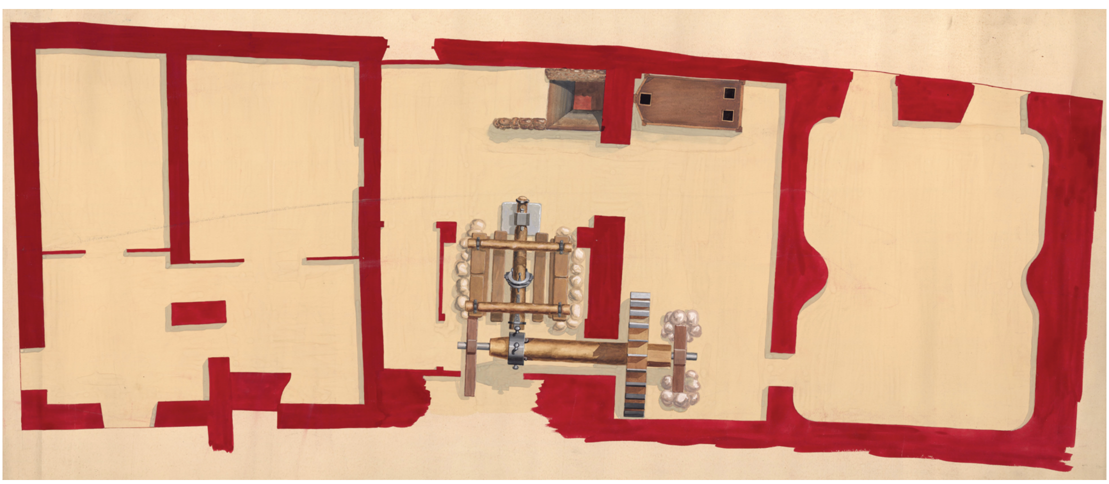

Figure 5. The *farga* at the pavilions of the 1929 Barcelona International Exhibition, floor plan. From Arxiu Històric de la Ciutat de Barcelona, Tuboteca, 2955–2959. With the permission of the Arxiu Històric de la Ciutat de Barcelona.

of a single sunbeam that came across the wood ceiling joist "as it usually entered in the ancient forges," the visitor could recognize the different elements that characterized the Catalan forge: the low furnace with a truncated square pyramid shape; the horn (or trompes), which substituted for a bellows thanks to the water flow and the Venturi effect; the hydraulic wheel; the big drop hammer; and the charcoal tank.[29] Mallets and other original instruments that had been collected from forge workshops in ruins hung now on the faux stone walls or rested on the ground, as if ready to be used by forgers.[30] Other museographic resources contextualized the pieces and architectures, and gave the visitor a comprehensive view of this technological artifact/architecture/procedure: a diorama representing the Pyrenees (painted by the famous stage designer Oleguer Junyent); a drawing showing skilled staff making ore into a high-quality, low-carbon iron; graphics, posters, and texts, which defined the technical nomenclature, described the specific parts of the furnace, drop hammer, and horn, and explained how they worked; and photographs showing current forges that hybridized the former procedure with new materials and energy sources. In addition, next to the *farga* room, an exhibition about the popular art of Catalan blacksmiths displayed old, everyday objects such as knockers, hangers, lamps, flowerpot stands, and religious images. For the occasion, low-ranking technicians and members of the Barcelona Association of Locksmiths and Blacksmiths highlighted the role of iron as an "ancestral tradition of our homeland."[31]

Certainly, engineers and technicians sought to recover the technical past so as "not to let our things be lost," as Rubió summed up, and also to let new things be Catalan. He wrote, "love to old things . . . is nothing to do with hating progress."[32] The display of the *farga* in the pavilions complemented the display of contemporary "national inventions" and new industry sectors developed in Catalonia.[33] These included a novel automatic system for railway signals, cutting-edge engines developed by the Hispano-Suiza automotive company, and several products from the Asland cement factory, which—nationalist journal *Ciència* wrote—"[honored] Catalonia abroad" as they were made "with Catalan materials, workers, technicians and capital."[34] The past could seem a mirror for the future, reflecting a blurred but powerful image when a nation sought independence from foreign machines, technicians, and raw materials, and promoted new industrial sectors, in particular new metallurgical industries. Engineers asked for the "rebirth" of the national iron industry, though they were in fact asking for the development of imported blast furnace techniques in Catalonia (significantly, not low furnace techniques, which were characteristic of the Catalan forge).[35]

The year 1929 became a landmark in the rise of the engineering profession in Catalonia: the success at the international exhibition, the global financial crack along with the forthcoming local crises, and the collapse of the Primo de Rivera dictatorship allowed Catalan industrial engineers to ask for a more radical, numbers-based management of the factory and the nation, built upon scientific principles and technical planning.[36] Especially since the proclamation of the Second Spanish Republic (1931–1939) and the Autonomous Government of Catalonia (1932–1939), the multilayered project to rationalize, standardize, and streamline industrial and social production went hand in hand with a professional nationalism aimed at making Catalonia technological as much as making (old and new) technology Catalan.[37]

Building a Temple in the Museum of Popular Art (1931–1939)

When the pavilions of the Barcelona International Exhibition definitely closed their doors, the set of artifacts displaying the Catalan procedure had no place to go. No national museum of technology existed in Barcelona, and the challenging proposal by Mariano Rubió to create the world's largest technical museum in the former pavilions of the international exhibition was just a vague idea that was never realized.[38]

Nonetheless, an opportunity to keep alive the metallurgical past arose at the end of 1931. An institutional agreement transferred the pieces exhibited at the Palace of Metallurgy to the Barcelona Board of Museums, a public but privately sponsored institution created in 1907 to preserve and curate artwork, especially medieval paintings and architecture.[39] At that time, the board was planning the creation of the Museum of Popular Art. The leading figure of this institution, Joaquim Folch Torres, made the objectives of the museum clear: on one hand, to show the works and results of the folklore "activism" that had allegedly enhanced "the Catalan rebirth"; on the other hand, to develop "scientific means" for new ethnographic research following the path of Scandinavian and German museologies.[40] One of the sections of the museum was to be devoted to the preservation of the "industries of popular art that are dying" and to show the "workshops in which the smith forges, the weaver weaves, and the old printer prints."[41] The *farga* exhibit was perfectly suited to the project, complementing other installations such as the Auditorium of Popular Songs and the Live Section of Fiestas, Dances and Christian Mysteries.

Beginning in November 1931, the board was in charge of the Spanish Village,[42] a kind of open-air theme park created in 1929 as part of the international exhibition and Primo de Rivera's Spanish nationalist program. Buildings reproduced traditional architectural features from every region of Spain except the Canary Islands. Although the initial project (called *Iberiona* and drafted by the engineer and art promoter Miquel Utrillo in 1923) was not conceived according to this nationalist program, the Village was regarded and politically appropriated as a representation of the unity of Spain.[43] After visiting it, philosopher José Ortega Gasset summed up his feelings: "The site as an art archive is impressive. It will give to foreigners a clear and categorical idea of what Spain is."[44] After the exile of the dictator—and especially after the proclamation of the Second Republic—the Village was considered a representation of a different Spain, more in tune with the original ideas behind *Iberiona*: a federal state built upon several regions and cultures. During the first anniversary of the Village on 15 May 1930, a popular Catalan festival was celebrated. While the Pyrenean *farga* was exhibited at the Palace of Metallurgy, at the Village, a Pyrenean traditional marriage was acted out, "starring" a bride and a groom in traditional costume, musicians with ancient tambourines and whistles, folklore dancers, horses, mules, and hens.[45]

In 1932, Santiago Rubió described a new proposal for exhibiting the forge in the journal of the Board of Museums: the *farga* should be located in the so-called "Catalan neighborhood" of the Spanish Village, which already hosted a smithery from the Barcelona Association of Locksmiths and Blacksmiths in its central square, Fountain Square (Figure 6).[46] He pointed out that "despite it having the virtue of crossing borders . . . , the origin was in our home."[47] The square was framed by "typical Catalan façades" of buildings that had big keystones as well as Gothic and Romanesque motifs and were from all the provinces of Catalonia.[48] In fact, there were also other compelling museological reasons to locate the *farga* in this "neighborhood" (Figure 7). On the outskirts of the Village, an evocation of the Pyrenean landscape would add to the historical reconstruction of the workshop that was displayed at the international exhibition. Rubió stated, "the Romanesque monastery and the more and more lush portion of forest will keep the old forge company and will remind the visitor of . . . those valleys that day and night had heard the loud and unhurried sound of the drop hammer."[49]

Besides Santiago Rubió, other engineers and technicians spread the new national technological icon across the Catalan territory during the 1930s. The most relevant example might be engineer Rafael Campalans (1887–1933). Founder and leader of the Catalan socialist party USC (1923), he was one of the few members in the official commission in charge of writing the Statute of Autonomy (1932), the home rule for Catalonia until the end of the Spanish Civil War in 1939. At that time, he was teaching one of the first official courses devoted to the history of science and technology, the theoretical–practical course History of Sciences at the School of Library Studies for Women in Barcelona.[50] One of the sections of this course was specifically about the Catalan procedure. But the icon traveled still farther from Barcelona, reaching even

Figure 6. Fountain Square, the core of the "Catalan neighborhood" in the Spanish Village (with ironwork behind its arches). From *Exposición Internacional de Barcelona: Pueblo Español MCMXXIX* (Barcelona: Concesiones Gráficas, 1929). With the permission of the Biblioteca Nacional de Catalunya.

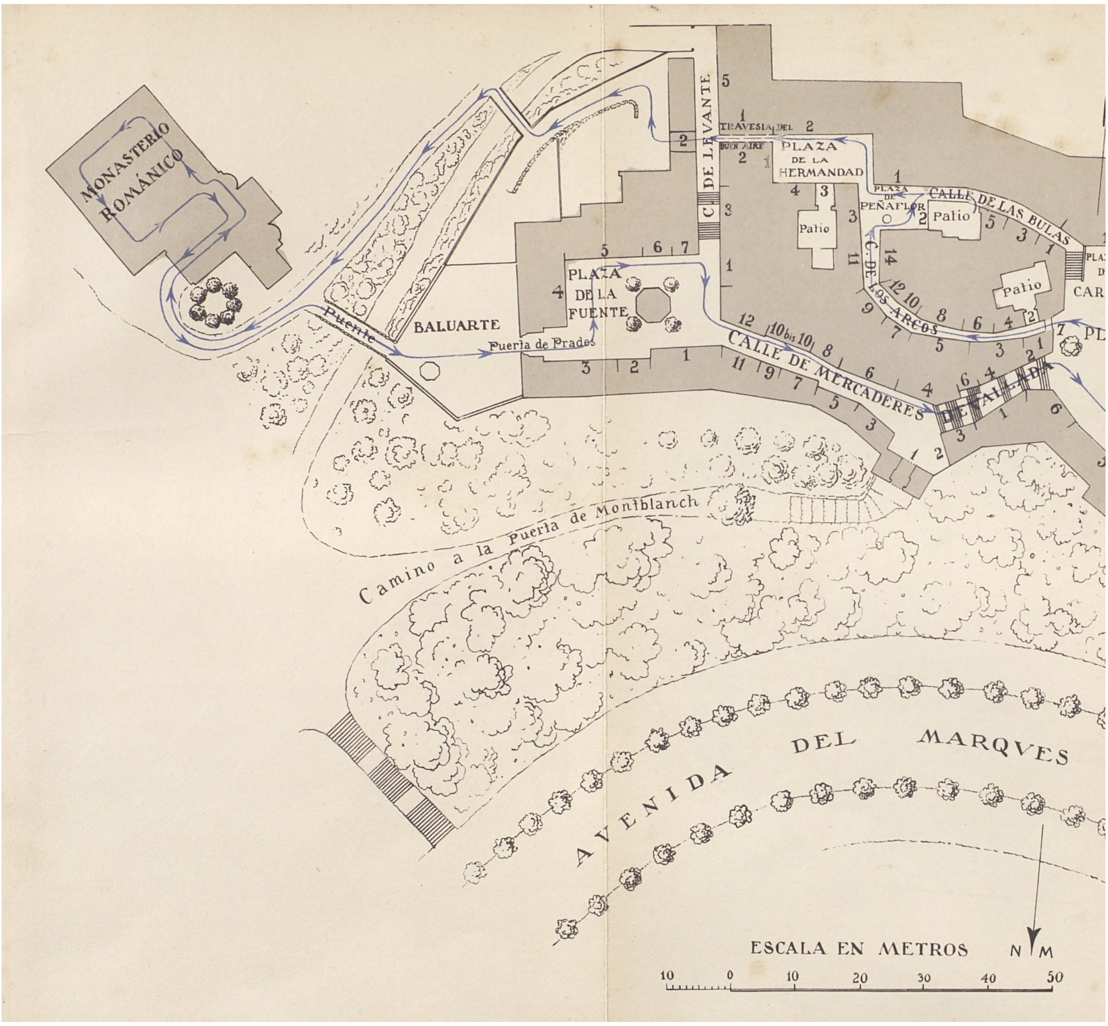

Figure 7. The "Catalan neighborhood" surrounded by the "Pyrenean atmosphere" (the Romanesque church, the bridge, the trees, the trails . . .), as drawn in *Guía del Pueblo Español* (Barcelona: n.d., ca. 1929), follows p. 39. With the permission of the Biblioteca Nacional de Catalunya.

the historical core of this technology; 100 kilometers away, close to the Pyrenees, students of the Arts and Craft School in Ripoll could listen to engineer Ramon Casanova Danés (1892–1968) speak about the technical and symbolic features of the old metallurgy. They took notes on his detailed descriptions of procedure, tools, and skills while learning that "this procedure perfectly suits the minerals, the fuels, and the ethnic character of our country."[51] They also learned that the arts and craft schools in the peripheries of Catalonia needed to connect the old forge tradition with the most advanced technologies in the world in order to bring again "the richness of the iron activities to our country."[52] Casanova Danés was the grandson of the "last forger" in the Pyrenees, and his father owned a successful metallurgical company that earned three medals in the 1888 Barcelona International Exhibition. Even more relevant, he was the entrepreneur who introduced new stamping machines and innovative tool designs into the traditional metal workshops to produce supplies for high-tech companies based in Barcelona, such as Hispano-Suiza, the internationally renowned automotive company devoted to production of luxury cars and aircraft engines.[53]

As the creation of the Museum of Popular Art was delayed, in mid-1935 the wealthy businessman and director of Hispano-Suiza in Barcelona, Miquel Mateu, agreed to pay all the costs for moving the large, heavy pieces of the *farga* exhibition to a new museum,[54] the Cau Ferrat Museum (1933) in Sitges, a tourist and bourgeois seaside town near Barcelona.[55] This museum was also managed by the Board of Museums and held rich collections of popular arts, especially of iron, glassware, ceramics, and furniture arts. In fact, art-nouveau painter Santiago Rusiñol founded it from a collection of wrought iron. "Ferrat," in fact, means "adorned with iron" in Catalan.[56]

Epilogue: Burying the *farga* (1936–1949)

During the Spanish Civil War (1936–1939), the main metallurgical companies in Barcelona such as Hispano-Suiza and La Maquinista were recycled into collectivized and government-held war industries, producing armored cars, weapons, aircraft engines, and machine tools (Figure 8).[57] While trying to overcome the technological challenges and pitfalls of the military and economic war,

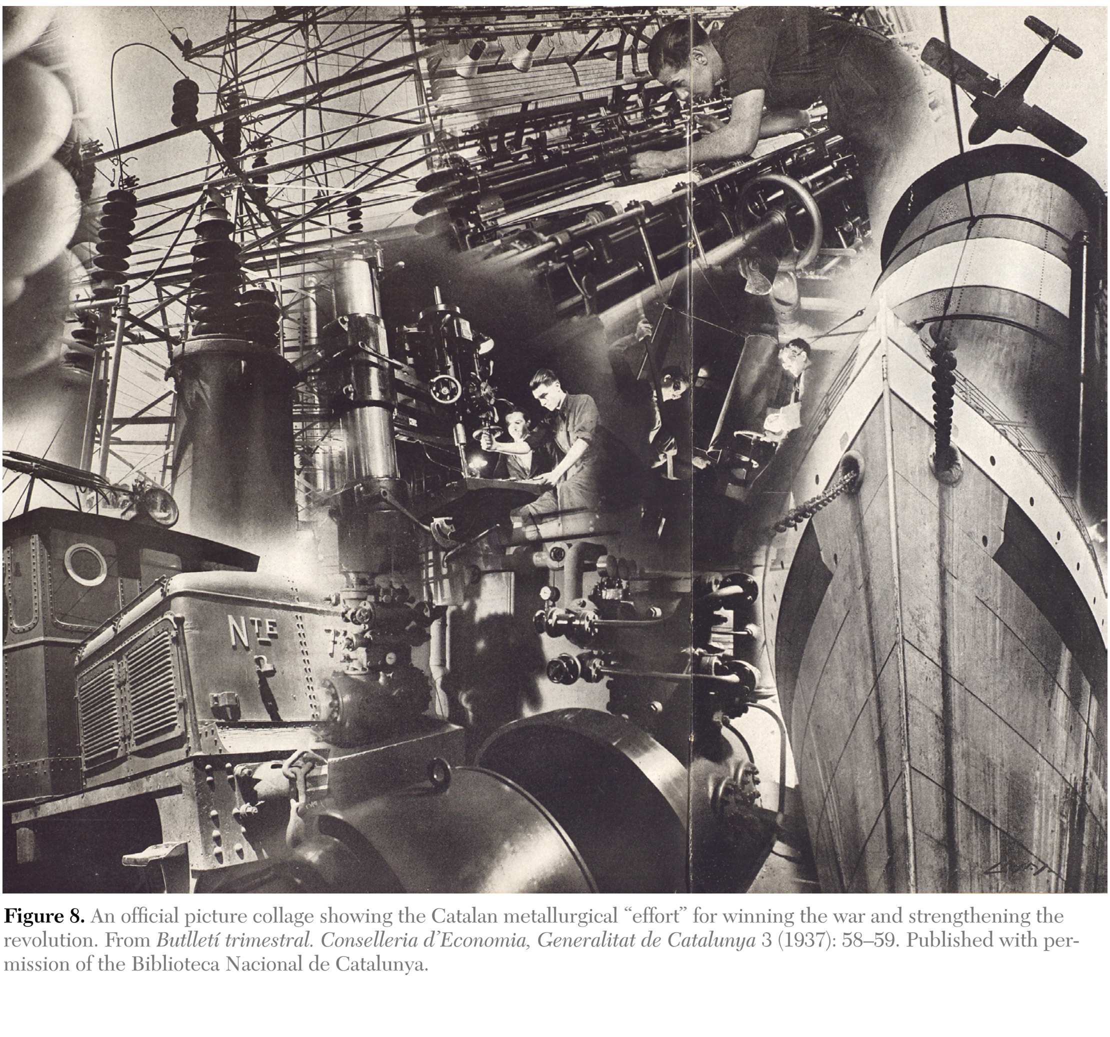

Figure 8. An official picture collage showing the Catalan metallurgical "effort" for winning the war and strengthening the revolution. From *Butlletí trimestral. Conselleria d'Economia, Generalitat de Catalunya* 3 (1937): 58–59. Published with permission of the Biblioteca Nacional de Catalunya.

Catalan engineers on the Republican side continued evoking the "technological soul" of the nation. The metallurgical past was now used as an incentive to make Catalonia technologically capable enough to defeat fascism and to strengthen the revolution (Figure 9).[58] At that time, Santiago Rubió was president of an ambitious official project called CAIRN, which planned to survey all the material and energy resources of the nation, particularly the so-called "landscapes of wonder" in the

Figure 9. The idyllic melding of the old and the new, with the smith in the center. From *Economia: butlletí mensual del Departament d'Economia de la Generalitat de Catalunya*, 1 (1937). With the permission of the Biblioteca Nacional de Catalunya.

Pyrenees.[59] When asking for renewed exploitation of the Catalan iron mines as part of this project in order to obtain high-quality steel through ironworks and new techniques, Rubió had not wanted to forget that "our land was once producer and exporter of the iron of the famous forges."[60] Moreover, Rubió was one of the few experts behind the hurried design of an ambitious museological project, the Technology Museum of Catalonia. The *farga* remnants from the 1929 International Exhibition might have been part of the museum section II, which was to be devoted to metallurgical and mechanical production,[61] but instead, as with the displays of the Catalan forge at the museums of Popular Art and Cau Ferrat, the Technology Museum of Catalonia was never initiated. The Second Spanish Republic and the Catalan Autonomous Government were defeated by the armies of Franco, Mussolini, and Hitler several months before the outbreak of World War II.

After the Spanish Civil War, the drop hammers and other material evidence of Catalan techno-nationalism were put aside. The Spanish National-Catholic regime "buried" any icon that could recall Catalan nationalism (while burying in mass graves thousands of people who had opposed fascism, especially anarchists and Marxists).[62] The new politicians and governors in Catalonia had no intention of reviving the *farga,* such as Miquel Mateu, who governed Barcelona with an iron fist during a period of great repression and brutality, just after the victory of the fascists (1939–1945) (Figure 10).[63] When the Museum of Popular Art (at the time, named Museum of Popular

Figure 10. The fascist Victory Parade in Barcelona on 21 February 1939; dictator Franco waves from a shiny Hispano-Suiza (probably the car Miquel Mateu gifted to Franco in 1938). AMCB. Fons Ajuntament de Barcelona: B101 Actes protocolaris, exp. 5/1939. Published with permission of the Arxiu Municipal Contemporani de Barcelona.

Industries and Arts) was finally established in the Spanish Village in 1942, it sought to reinforce the Spanish nationalist discourse. This discourse was strengthened soon after with the Spanish imperialist rhetoric at the Ethnological and Colonial Museum in 1949 in Barcelona, which featured objects coming from the Spanish colonies and ex-colonies such as Equatorial Guinea and the Philippines.[64] Remains of foreign traditions of crafts and technologies promised a "rebirth" of another kind of national grandeur in the fascist and Catholic New Spain. No (literal) room was left for the "technological soul" of Catalonia.[65] Ultimately, focusing attention on the "politics of display" in international exhibitions and national museums sheds light on "the display of politics" in specific ideological and nationalist contexts.[66] After 1939, the remains of the *farga* exhibited in the pavilions of the 1929 Barcelona International Exhibition became definitively lost.[67]

Acknowledgments

I greatly appreciate the comments and suggestions for this chapter by José Pardo-Tomás, Alfons Zarzoso, Sophia Vackimes, Jaume Sastre-Juan and Francisco Pinheiro, and by the editors and reviewers of this volume. This research has been developed in the framework of the post-doctoral project "Technocrats for the Nation or the Nation for Technocrats? Technology, Governance and Citizenship in Southern Europe, 1929–1975" (SFRH/BPD/93264/2013, FCT, Portugal), and the project "From the Cabinet of Wonders to the Popular Anatomical Museum: Regimes of Exhibition and Material Culture of Medicine" (HAR2015-64313-P, CSIC, Spain). This chapter is dedicated to Cal Farré.

Notes

1. A. Gallardo Garriga, and S. Rubió Tudurí, *La farga catalana: Descripció i funcionament, història, distribució geogràfica* (Barcelona: Exposició de Barcelona, 1930), 87.
2. The search for "technological souls" and, particularly, the making of old technologies into national icons was contemporaneously promoted in other countries during the first decades of the twentieth century, e.g., the Newcomen's and Watt's steam machines in England, the milling machine and the machine tools in the United States, the electrical and chemical industries in Germany, the Viking ships and John Ericsson's hot-air machines in Sweden, and Leonardo da Vinci's inventions in Italy. See, for instance, P. Morris, ed. *Science for the Nation: Perspectives on the History of the Science Museum* (Palgrave: London, 2010), esp. 333–339; J. Sastre-Juan, Un laboratori de divulgació tecnològica: el New York Museum of Science and Industry i la política de la museïtzació de la tecnologia als Estats Units, 1912–1951 (Ph.D. diss., Universitat Autònoma de Barcelona, Barcelona, 2013), 131–137 and 155; E. Duffy, Representing Science and Technology: Politics and Display in the Deutsches Museum, 1903–1945 (Ph.D. diss., University of North Carolina, Chapel Hill, 2002), 66–111 (esp. 100); A. Houltz, "Modern Accounts of Past and Present: The Gothenburg Exhibition of 1923," in *Modernism and Rationalization*, ed. C. Jørgensen and M. Pedersen (Aalborg: Museum of Northern Jutland, The Heritage Agency of Denmark, 2006), 117–132; E. Canadelli, "Le macchine dell''ingegnere umanista': Il progetto museale di Guido Ucelli tra Fascismo e Dopoguerra," *Physis. Rivista Internazionale di Storia della Scienza* 51 (2016): 93–104; G. Somsen, "Science, Fascism, and Foreign Policy: The Exhibition 'Scienza Universale' at the 1942 Rome World's Fair," *Isis* 108, no. 4 (2017): 769–791 (for the Italian case, see also the chapters by Elena Canadelli, Francesco Barreca, and Claudio Giorgione in this volume).
3. Two biographies: G. Lusa Monforte, *Los tres directores de la Escuela durante la Guerra (1936–1939). Santiago Rubió i Tudurí* (Barcelona: Universitat Politècnica de Catalunya, 2015), 5–111; R. Matheu, *Notes biogràfiques de Antoni Gallardo i Garriga* (Barcelona: 1962).
4. In nineteenth-century North America, it was common to name any type of bloomery a "Catalan forge." For the circulation and appropriation of this technology and these terms, see: F. Overman, *The Manufacture of Iron: In All Its Various Branches* (Philadelphia: Henry C. Baird, 1854), 245–249 (section "The Catalan Forge") [e-reprinted in the collection *Making of America* by Applewood Books]; R. B. Gordon and D. J. Killick, "The Metallurgy of the American Bloomery Process," *Archeomaterials* 6 (1992): 141–167. See also: E. Tomás, "The Catalan Process for the Direct Production of Malleable Iron and its Spread to Europe and the Americas," *Contributions to Science* 1, no. 2 (1999): 225–232; F. R. Morral, "The Catalan 'farga' in the New World (1500–1900)," in *La farga catalana en el marc de l'arqueologia siderúrgica*, ed. E. Tomàs (Andorra la Vella: Ministeri d'Afers Socials i Cultura, 1995), 125–129.

5. Gallardo and Rubió, *La farga catalana*, 8–9.
6. Rousillon was part of the historical Principality of Catalonia and became part of France with the Treaty of the Pyrenees (1659).
7. It is worth pointing out that Rubió and Gallardo never used the terms "industrial archaeology." Nonetheless, before their broad use in England in the 1950s, this term had been proposed by the Portuguese journalist and historian Francisco Marques de Sousa Viterbo in the article "Arqueologia industrial portuguesa: os moinhos" (*O Archeologo Português*, 1896). Moreover, "archaeology" applied to industrial evidences had been used even before, for example, in the paper by I. Fletcher, "The Archaeology of the West Cumberland Coal Trade" (*Transactions of the Cumberland and Westmoreland Antiquarian and Archaeological Society*, 1878), as noted in K. Hudson, *Industrial Archaeology: An Introduction* (London: University Paperbacks, Methuen, 1965), 13–14.
8. A. Rovira Rabassa, *El hierro, sus cortes y enlaces* (Barcelona: Libr. Alvaro Verdaguer, [1910]), 55–61.
9. J. Balari Jovany, *Orígenes históricos de Cataluña* (Barcelona: Instituto Internacional de Cultura Románica, 1964 [1899]), 674–675; F. Carreras Candi, *Geografia General de Catalunya* (Barcelona: Albert Martín, 1908–1918).
10. L. Prats, *El mite de la tradició popular: els orígens de l'interès per la cultura tradicional a la Catalunya del segle XIX* (Barcelona: Edicions 62, 1988), 175 and 198.
11. Concerning architecture professionals in Catalonia, see: J. M. Puigvert Solà, *Josep Danés i Torras. Noucentisme i regionalisme arquitectònics* (Barcelona: Publicacions de l'Abadia de Montserrat, 2008), esp. 35–42. The search for an authentic and innocent nature to renew and modernize Spain is extensively studied in S. Casado de Otaola, *Naturaleza patria: ciencia y sentimiento de la naturaleza en la España del regeneracionismo* (Madrid: Marcial Pons, 2010) (concerning Catalan nationalism, see: 192–202, 244–252 and 268–269). Further periods are covered in C. Tabernero, ed., "La invención del patrimonio natural en España: Política, academia, activismo y comunicación," Special Issue, *Arbor* 192, no. 781 (2016).
12. L. Creus Vidal, *Visió econòmica de Catalunya. Riquesa antiga i actual, i possibilitats econòmiques de Catalunya* (Barcelona: Llibreria Catalonia, 1934), 46b (and 302b).
13. See: L. Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 2000 [1964]).
14. A. Gallardo Garriga, *Els nostres claustres romànics* (Barcelona: 1918); A. Gallardo Garriga, *Del Mogent al Pla de la Calma* (Barcelona: Centre Excursionista de Catalunya, 1938). On the role of professionals of architecture in the pastoral construction of the *masia* as the core of an idyllic rurality: J. M. Puigvert Solà, "L'elaboració del discurs pairalista a la Catalunya contemporània: la contribució dels arquitectes i els estudiosos de la masia, 1908–1936," *Estudis d'Història Agrària* 12 (1998): 77–108; J. Moner, and J. M. Puigvert Solà, "Els estudis danesians de la masia, revisitats," in *Materials per a l'estudi de la masia*, ed. Josep Danés Torras (Girona: Documenta Universitaria, 2010), 11–56.
15. Rubió was also very interested in the philological heritage of the Catalan Pyrenees (especially, in the non-Latin etymology of the names of its towns). S. Rubió Tudurí, "Noms de lloc explicables per l'èuscar," *Butlletí del Centre Excursionista de Catalunya* 43, no. 460 (1933): 364–375 (associated manuscripts on Basque toponymy are preserved in Santiago Rubió Tudurí's Personal Records, at the National Archive of Catalonia).
16. P. Estasén, *Cataluña. Estudio acerca de las condiciones de su engrandecimiento y riqueza* (Barcelona: F. Seix, 1900), 6–7, 103–118.
17. About the "patriotic-scientific" endeavor of hiking in Catalonia, see: J.-L. Marfany, *La cultura del catalanisme: El nacionalisme català en els seus inicis* (Barcelona: Empúries, 1995), 293–306; J. Martí Henneberg, *L'excursionisme científic i la seva contribució a les ciències naturals i a la geografia* (Barcelona: Alta Fulla, 1994); J. M. Camarasa and A. Roca Rosell, "One Hundred Years of Science Policy and the Institute of Catalan Studies," *Coneixement i societat. Knowledge and Society. Journal of Universities, Research and Innovation* 14 (2008): 6–51.
18. See, for instance: O. Hochadel and A. Nieto, eds. *Barcelona: An Urban History of Science and Modernity, 1888–1929* (New York: Routledge, 2016).
19. The funicular project was ultimately not implemented in favor of a rack railway, which was inaugurated in 1931. About the technological construction of the Núria Sanctuary (especially in terms of religious buildings and tourism facilities), see: J. M. Puigvert Solà, *Josep Danés i Torras*, 102–122. Among the literature dealing with the technological production of "national parks," see, for instance, L. F. McClelland, *Building the National Parks: Historic Landscape Design and Construction* (Baltimore: Johns Hopkins University Press, 1998).
20. C. Pi Sunyer, "Apunts per a la història de la indústria cotonera catalana," *Butlletí de l'Associació de Fabricants de Filats i Teixits*, May 1925: 74–78.
21. C. Pi Sunyer, *L'aptitud econòmica de Catalunya* (Barcelona: La Magrana, 1983 [1927–1929]), 71–73, 296–298.
22. Pi Sunyer, *L'aptitud econòmica de Catalunya*, 71–72; R. Soler Vilabella, *Essai on the Catalan Cotton Spinning Frame known as the Bergadana or Marxerina Machine / Ensaig sobre la màquina catalana de filar cotó coneguda per bergadana o maxerina* (Barcelona: J. Horta, [1911]). About the "Catalan vault" (or tile arch), the "Catalan cotton spinning frame," and the Ictineu submarine, see: R. Graus Rovira, Modernització tècnica i arquitectura a Catalunya, 1903–1929 (Ph.D. diss., Universitat Politècnica de Catalunya, Barcelona, 2012); À. Solà Parera, "Filar amb berguedanes: Mite i realitat d'una màquina de filar cotó," in *La indústria tèxtil: Actes de les V Jornades d'Arqueologia Industrial de Catalunya*, ed. L. J. de Cisneros (Barcelona: Marcombo, 2002), 143–168; C. Puig-Pla and A. Roca Rosell, "Narcís Monturiol (1819–1885), Pioneer of Submarine Navigation," *Contributions to Science* 5, no. 2 (2009): 147–157.
23. *L'obra realitzada: anys 1914–1923* (Barcelona: Mancomunitat de Catalunya, 1923); A. Roca Rosell, "Ciencia y sociedad en la época de la Mancomunitat (1914–1923)," in *Ciencia y sociedad en España*, ed. J. M. Sánchez Ron (Madrid: El Arquero/CSIC, 1988), 223–252.
24. Due to the lack of primary sources, I cannot answer key questions on the debates about heritage design and musealization before 1929; for example: which forges remain; how many of them; where, how, and by whom preserved; and in which buildings and ways should the collections be exhibited.

25. J. Ehrenberg, *Civil Society: The Critical History of an Idea* (New York: New York University Press, 1999).
26. J. Valentines-Álvarez, Tecnocràcia i catalanisme tècnic a Catalunya als anys 1930: Els enginyers industrials, de l'organització del taller a la racionalització de l'estat (Ph.D. diss., Universitat Autònoma de Catalunya, Barcelona, 2012), especially 63–67.
27. About this clan of engineers and its role in the making of Barcelona city, see: J. Sastre-Juan and J. Valentines-Álvarez, "Technological Fun: The Politics and Geographies of Amusement Parks," in *Barcelona*, ed. Hochadel and Nieto, 92–112 (especially 107–110).
28. Outstanding projects for national museums were developed during the years that followed, such as the Art Museum of Catalonia (1934), the Archaeological Museum of Catalonia (1935), and the Maritime Museum of Catalonia (1936).
29. *Venturi effect* is the reduction of pressure caused by liquid flowing through a narrowing or constricted section of pipe. Gallardo and Rubió, *La farga catalana*, 48, 87–89. Descriptions are also based on photographs and newspaper articles, especially the articles published in *La Vanguardia* on 1 May 1930, 21 May 1930, 28 May 1930, 29 May 1930, and 30 May 1930. The original plans of the display preserved at the Arxiu Històric de la Ciutat de Barcelona (AHCB) have also been taken into account: "Farga Catalana. Planta amb indicació de les obres a fer" (2959), "Farga Catalana: Tall A-b amb indicació de les obres a fer" (2955), "[La Farga Catalana]" (2956) and "Exposició Montjuich. Farga Catalana" (2957–2958).
30. Despite the scarcity of archive sources about the organization of the *farga* exhibition, *La farga catalana* (1930)—published specially for the event—suggests that Rubió and Gallardo were in charge of the museological design of the exhibition as well as being the consultants in technical, geographical, and historical issues. Only some original plans are preserved in the Arxiu Històric de la Ciutat de Barcelona (AHCB) and no record is available in the National Archive of Catalonia (Santiago Rubió Tudurí Personal Records) or in the Arxiu General Fira de Barcelona (AGFB). I thank Santi Barjau (AHCB) and Marià Hispano (AGFB) for their work.
31. "Exposición de Hierros de Arte," *La Vanguardia*, 21 May 1930: 8.
32. S. Rubió Tudurí, "La farga catalana de l'Exposició al Museu d'Art Popular del Poble Espanyol," *Butlletí dels Museus d'Art de Barcelona* 12 (1932): 159–160.
33. About the internationalized "nationalization" of new inventions, see: R. Brain, *Going to the Fair: Readings in the Culture of Nineteenth-Century Exhibitions* (Cambridge: Whipple Museum of the History of Science, 1993); P. Fritzsche, *A Nation of Flyers: German Aviation and the Popular Imagination* (Cambridge: Harvard University Press, 1992); S. Lindqvist, "An Olympic Stadium of Technology: Deutsches Museum and Sweden's Tekniska Museet," in *Industrial Society and Its Museums*, ed. B. Schroeder-Gudehus (Langhorne: Harwood Academic Publishers, 1993), 37–54; D. Edgerton, *The Shock of the Old: Technology and Global History since 1900* (London: Profile Books, 2008), 103–113 (about the specific case of the Spanish inventor Juan de la Cierva, see p. 103). See also the bibliography quoted in note 2, since the making of new technologies into national icons was entangled with the construction of a "pedigree" for them.
34. "Companyia General d'Asfalts i Portland Asland," *Ciència* 5, no. 36 (1930): 679–680.
35. A. Homs, "La siderúrgia a Catalunya: Consideracions a propòsit del Palau de la Metallúrgia de l'Exposició de Barcelona," *Ciència* 5, no. 36 (1930): 646–652.
36. J. Valentines-Álvarez, "Seeing like a Factory: Technocratic Nationalism in Catalonia, 1930–1939," *History and Technology*, 34, no. 3–4 [forthcoming].
37. Valentines-Álvarez, "Seeing like a Factory"; Valentines-Álvarez, *Tecnocràcia i catalanisme tècnic a Catalunya*.
38. About this failed museological proposal, see: J. Valentines-Álvarez and J. Sastre-Juan, "The Failed Technology Museum of Catalonia: Engineers and the Politics of the Musealization of Technology in Barcelona, 1929–1939," *Nuncius. Journal of the Material and Visual History of Science* 34, no. 1 (2019).
39. "Resum d'adquisicions, donatius i dipòsits per als nostres museus, 1931–1932," *Butlletí dels Museus d'Art de Barcelona* 20 (1933): 15. About the Barcelona Board of Museums since 1930, see: E. March, "L'acció de la Junta de Museus des de la caiguda de la Dictadura de Primo de Rivera fins a l'esclat de la Guerra Civil (1930–1936)," in *Cent anys de la Junta de Museus de Catalunya, 1907–2007*, ed. A. Garcia (Barcelona: Abadia de Montserrat, 2008), 105–133 (esp. 105–115).
40. J. Folch Torres, "El Museu d'Art Popular del Poble Espanyol," *Butlletí dels Museus d'Art de Barcelona* 15 (1932): 242–245 (esp. 243–244); M. Vidal Jansà, *Teoria i crítica en el Noucentisme: Joaquim Folch i Torres* (Barcelona: Abadia de Montserrat, 1991), 347–351.
41. Folch Torres, "El Museu d'Art Popular," 244.
42. The headquarters, the library, and the restoration laboratories of the board were moved to the Spanish Village in 1934. "El trasllat, l'ampliació i la metodització dels museus," *Butlletí dels Museus d'Art de Barcelona* 7 (1931): 219–222 (especially 221).
43. Miquel Utrillo was a student at the Barcelona School of Industrial Engineering, and he completed his engineering studies in Paris.
44. Quoted in S. Bengoechea, *Els secrets del Poble Espanyol* (Barcelona: Poble Espanyol, 2004), 155.
45. Bengoechea, *Els secrets*, 161.
46. *Guía del Pueblo Español* (Barcelona: n.d., ca. 1929), 44. See also: *Guide of the Spanish Village: Montjuich Park* (Barcelona: Junta de Museus, [1930]); *Exposición Internacional de Barcelona: Pueblo Español MCMXXIX* (Barcelona: Concesiones Gráficas, 1929).
47. Rubió, "La farga catalana," 160.
48. *Guía del Pueblo Español*, 23–25.
49. Rubió, "La farga catalana," 160.
50. R. Campalans, Història de les ciències, apunts presos per Rosa Leveroni Valls (1930–1931), Biblioteca de Catalunya, ms. 3326.

51. R. Ballús, "La farga de Campdevànol," in *Memòria. Associació d'Alumnes i Ex-Alumnes de l'Escola Menor d'Arts i Oficis de Ripoll* (Ripoll: Tipografia Ripollesa, 1934), 40–44 (esp. 41); "Conversa de Ramon Casanova Danés," in *Memòria*, 33–34.

52. "Conversa de Ramon," 34. About the relevance of epistemic and geographic peripheries in the history of technology: M. Macedo and J. Valentines-Álvarez, "Technology and Nation: Learning from the Periphery," *Technology and Culture* 57, no. 4 (2016): 989–997.

53. A. Jiménez, "La farga Casanova," *Annals de l'Institut d'Estudis Gironins* 46 (2005): 285–342 (esp. 289–294); M. Lage, *Hispano-Suiza 1904–1972: hombres, empresas, motores y aviones* (Madrid: LID, 2003).

54. "'Maricel' per a la ampliació del 'Cau Ferrat,'" *Butlletí dels Museus d'Art de Barcelona* 51 (1935): 246–256 (esp. 256).

55. March, "L'acció de la Junta," 125–126.

56. Nonetheless, it seems that the move of the *farga* exhibition to the Cau Ferrat museum was finally not implemented. The minutes of the Barcelona Board of Museums preserved at the National Archive of Catalonia (ANC) contain no reference to the *farga*. See: "Acta de la sessió de la Junta de Museus de Barcelona" (16/01/1934– 06/07/1936), ANC1-715 / Junta de Museus de Catalunya, Arxiu Nacional de Catalunya. Moreover, the archives of the Art Museum of Catalonia and of the Cau Ferrat Museum have no evidence of this heritage in their inventory files, catalogs, or record books. I am grateful to Elisenda Casanova (Sitges Heritage Consortium) for her help in trying to provide me with any evidence.

57. F. J. de Madariaga Fernández, Las industrias de guerra de Cataluña durante la Guerra Civil (Ph.D. diss., Universitat Rovira i Virgili, Tarragona, 2005); M. Lage, *Hispano-Suiza*; J. Corral i Martí, *El caixer de 'La Hispano' Suïssa: vida, treball i mort en una gran indústria de guerra catalana, 1936–1939* (Barcelona: Ajuntament de Barcelona, Duxelm, 2016).

58. Valentines-Álvarez and Sastre-Juan, "The Failed Technology Museum of Catalonia."

59. M. Carrió, "La CAIRN," *Economia. Butlletí mensual del Departament d'Economia* 2 (1937): [s.n.]; "Conferencia acerca del aprovechamiento industrial de las riquezas naturales de Cataluña," *La Vanguardia*, 19 February 1937: 3.

60. M. Carrió, "La CAIRN", [s.n.].

61. I use "might" because there is no record of the detailed museological report that the Steering Committee of the Technology Museum of Catalonia had to deliver in June 1937 to the official Permanent Industry Committee of the Department of Economy. The official documentation of this committee was mainly lost at the end (or in the aftermath) of the war, although it is quite likely that the report was never completed due to the war affairs. About the project (and genealogy) of this failed national museum of technology, see: Valentines-Álvarez and Sastre-Juan, "The Failed Technology Museum of Catalonia."

62. P. Preston, *The Spanish Holocaust: Inquisition and Extermination in Twentieth-Century Spain* (New York: W. W. Norton, 2012).

63. M. Marín Corbera, *Els ajuntaments franquistes a Catalunya: política i administració municipal, 1938–1979* (Lleida: Pagès, 2000).

64. C. Huera Cabeza, "El Museu Etnològic de Barcelona," *Revista d'Etnologia de Catalunya* 3 (1993): 160–164.

65. I am totally aware that heritage is something more than just a political tool for creating a "national culture," but my point is that Catalan engineers were experts in that kind of tool as much as in machine tools, dams, and engines. About the agency on and of heritage, see: C. Brumann and R. Cox, eds. *Making Japanese Heritage* (London, New York: Routledge, 2010), 1–18; R. Samuel, *Theatres of Memory: Past and Present in Contemporary Culture* (London: Verso, 1994); T. H. Eriksen, *Ethnicity and Nationalism: Anthropological Perspectives* (London: Pluto Press, 1993).

66. A seminal work on the "politics of display": S. MacDonald, ed. *The Politics of Display: Museums, Science, Culture* (London: Routledge, 1998). See also: S. MacDonald, ed. *A Companion to Museum Studies* (Malden, Oxford: Blackwell, 2006) (concerning the entanglement between world fairs, museums and politics, see the chapter by Robert W. Rydell).

67. Unfortunately, the primary sources to answer how, when, where, and why the *farga* remains were lost are not available. During the war and the postwar periods, like many metal pieces such as bells, the drop hammer, mallets, and other iron pieces could have been melted to produce arms or other products. In fact, a telling example is the case of a heavy half-drop hammer that was collected by an engineer in the Pyrenees during the 1960s. The other half had been sold by an inhabitant of a close parish in the aftermath of the war (once he smashed the hammer with explosives and broke it into pieces). One of my deepest memories of my childhood is the image of a man without hands who lights a cigarette with a match while I am buying jelly bellies in La Perlera, next to Cal Farré, in Bellcaire d'Urgell (Lleida). *Cal Farré* can be translated as "the Smith's House." The village is just a few kilometers away from one of the long-lasting and dreadful frontlines in Catalonia during the Spanish Civil War, and the man with the burning cigarette had lost his hands picking up nonexploded bombs and shrapnel to sell their iron after the conflict.

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CHAPTER 4

From Instruments of Science to Instruments of History

Andrea Corsini and the Birth of the Museo Galileo

Francesco Barreca
Museo Galileo
Florence, Italy

The First National Exhibition of the History of Science, held in Florence from 8 May to 11 November 1929, was in many respects a unique event. With more than 9,000 items on display—instruments, machines, books, portraits, and other kinds of memorabilia related to the history of science from 80 Italian cities and more than 200 institutions—it was and arguably remains the largest exhibition specifically devoted to the history of science ever held. Its success made it possible to establish in Florence a national Museum of the History of Science, now the Museo Galileo, in 1930, which would soon become one of the world's leading institutions in the field. The commitment it generated among a wide spectrum of Italian cultural institutions helped to put the issue of the protection and evaluation of scientific collections on the national agenda, and its design contributed to raising the general public's interest in the history of science.

Yet if one looks at it from a broader perspective, while this exhibition stood out for its size, it appeared as part of an international movement that increasingly considered artifacts from science and history of science as objects of musealization.[1] For example, also in 1929, an international exhibition in which science played a prominent role was held in Barcelona, Spain. The conviction that museums were privileged environments to enact the idea of a "national identity" and, thus, constituted an effective instrument of "mass education" was quite common at the turn of the twentieth century and was further amplified by the rise of local nationalism. Paired with the positivist view of science as a progressive enterprise leading humanity from a state of superstitious ignorance up to the ethereal regions of truth, this conviction eventually led to the creation of institutions whose primary aim was displaying and popularizing science, such as the Deutsches Museum, founded in 1903.

The main designer and promoter of the First National Exhibition of the History of Science in 1929 was Andrea Corsini (1875–1961), a Florentine physician and historian of medicine who became interested in historical scientific collections after having been involved in the setup of the historical section of the 1912 International Exposition of Social Hygiene held in Rome. On that occasion, he gathered information about Italian historical collections and established a network of international relationships with historians of science involved in various musealization projects around Europe. During the 1910s and 1920s, he maintained contacts with, among other science historians, George Sarton, Charles Singer, Arnold C. Klebs, Karl Sudhoff, and Jan Gerard de Lint, which allowed him to stay up to date with current trends in the development of museums and institutes of history of science. Through the exchange of letters, Corsini learned that Singer and his wife, Dorothea, had successfully established a special section devoted to history of science at the University of Oxford's Bodleian Library; an exhibition of history of science held in Leiden in 1907 had convinced both the academic world and the public of the importance of creating a national museum of history of science in the Netherlands; and places like the Wellcome Institute for the History of Medicine in London and the Institute for the History of Medicine in Leipzig were soon to be considered standard models for a twofold commitment to research and musealization.

Comparing what was happening in Italy with what was going on elsewhere, Corsini found the former to be very discouraging. In Italy, the musealization of historical scientific collections was generally tied to the hagiographic narrative of science dating back to the middle of the nineteenth century. This was eloquently expressed in the layout of the Tribuna di Galileo (Tribune of Galileo), an institution with few or no ties whatsoever with libraries and archives that contented itself to being a silent and austere reliquary devoted to a man uncritically celebrated like a Christian saint. On the other hand, the musealization of historical scientific artifacts was marked with localism. This was mostly due to the lack of political unity. Even after unification, localism continued to be a central feature of the Italian approach to historical scientific collections. For example, during the Paris International Exposition of 1867, the Italian special commission for the History of Labor featured famed historians such as Pasquale Villari and Luigi Passerini yet failed to get Italian museums involved in the event. The Italian exhibit was eventually set up thanks to antiquarian Alessandro Castellani, who personally borrowed artifacts from French collectors. Three years earlier, the city of Faenza had begun collecting documents and artifacts related to physicist and mathematician Evangelista Torricelli, and in 1908, in a glaring show of localism against rival town Imola, it organized an exhibition of history of science called *Esposizione Universale*

Torricelliana that had no aim other than to lay claim to being Torricelli's homeland. The exhibition eventually led to the creation of a small museum that celebrated the figure of Torricelli merely as a "great Faentinian."

It was as if historical scientific artifacts were not part of the "national" identity and thus should be confined to institutions like the Tribune of Galileo so as to be alternatively regarded as objects of adoration or as curious evidence of an ignorant, superstitious past. In this context, the importance of the First National Exhibition of the History of Science lay in having taken Italian localism to its culmination point and then in having surpassed this by spreading the idea that scientific collections could be considered part of the Italian cultural heritage. In being an exhibition mostly addressed to a domestic public, it was a groundbreaking, pivotal event not only because it created the new National Museum of the History of Science, but because of its very idea: a museum of history of science specifically aimed at preserving and studying historical scientific collections as cultural objects. The exhibition benefitted from the support of the fascist government, which was particularly interested in establishing itself as the restorer of Italian national dignity, and thus shared many of the ideological features of the fascist propaganda. This, however, should not distract from recognizing the exhibition's genuine cultural and political stances.

The Protection of Cultural Heritage in Post-Unification Italy

Corsini's main aim was "to do for history of science what has already been done for the history of art."[2] The protection and evaluation of Italy's invaluable artistic and cultural heritage had indeed been one of the main issues on which the earliest Italian governments had focused. In 1861, the newly instituted Italian state commissioned art historians Giovanni Morelli and Giovanni Battista Cavalcaselle to prepare an inventory of the artifacts held in Umbria and Marche that the state had acquired after the secularization of ecclesiastical properties. In their final report, Morelli and Cavalcaselle urged the government to strengthen measures to protect cultural artifacts against deterioration, art theft, and export. As a first step, they suggested preparing inventories as complete as possible. Two years later, claiming that it was necessary to intervene rapidly, Cavalcaselle directly addressed the government in a memorandum outlining a feasible and effective cultural policy. He proposed the establishment of a governmental authority to supervise and train cataloging staff and coordinate restoration activities as well as the appointment of local inspectors to guard against illegal exportations of artifacts. "It is on the Government," Cavalcaselle remarked, "that falls the task of preserving the glorious artistic tradition of the Country."[3]

After the formation of an advisory board in1867, the government established a directorate-general within the Ministry of Public Education in 1875 and charged it with compiling a general catalog. It was a very compelling task, for in 1866 the Italian state had acquired many artifacts previously held by religious orders, but now some local administrations that were supposedly in charge of their preservation were in fact selling them to get their own budgets back on track. The directorate (first called Direzione generale centrale degli scavi e musei del Regno and then, from

1881, Direzione generale per le antichità e le belle arti) opened regional offices in 1891, from which the so-called Sovrintendenze (or Soprintendenze [superintendents]) followed in 1904. Three years later, the Sovrintendenze were defined by law, and finally, in 1909, the "Rosadi Act" decreed what ought to be subject to their care and surveillance. According to the Rosadi Act, the Sovrintendenze should oversee everything, mobile and immobile, "of historic, archeological, paleontological, or artistic importance." Also, it imposed some restrictions on private property, conferring to the Italian state preemption rights and, under certain conditions, the right to expropriate. Export was forbidden, unless explicitly authorized by the Sovrintendenze, which were still required to maintain an up-to-date catalog of objects, buildings, and artifacts.[4]

Officially, these measures applied to historical scientific collections, too, but they had modest or no effect. Appointed officials of the superintendents were either art historians or archaeologists who generally had little, if any, interest in the history of science. Moreover, history of science was not fully acknowledged as an academic discipline. Voluntary classes in history of science, usually held by scientists, had been suppressed in 1911, and historians of science were often regarded by humanists as wannabe philosophers and by scientists as failed researchers. "History of science is held in dubious esteem by those who work for the progress of science," mathematician Federigo Enriques would later affirm. "For the most part, it interests only aged scientists who, as they grow weary of studying new things, complacently turn their attention to researching the nobility titles of their discoveries."[5] During the 1910s, Enriques had championed the cause of a scientific philosophy in which history of science should have been the necessary bridge between humanistic and scientific culture, but he was met with harsh criticism from philosophers. Benedetto Croce, who considered scientific notions as mere pseudo-concepts, publicly exhorted him to get back to mathematics and leave philosophy and history to philosophers.[6]

Early Italian governments, however, soon realized that history of science could be a helpful instrument for strengthening national sentiment and promoting scientific education, and therefore began to support public initiatives such as building monuments, creating exhibitions, and publishing books. Great scientific personalities were celebrated as exemplary figures, idealized as models of probity, and idolized as universal geniuses. Characters like Leonardo da Vinci, Andrea Cesalpino, and Galileo Galilei were celebrated as the bright and masterly minds behind human progress, alternately admired, envied, and looted by foreigners, and yet too often unacknowledged and forgotten by Italians.[7] The major public initiative during the period following Unification was the Esposizione Voltiana (Volta Exhibition) held in Como in 1899, one hundred years after Alessandro Volta invented the battery. The exposition covered more than 15,000 square meters and was entirely enclosed in a wooden structure consisting of several pavilions. At the top corners of the facade, two huge battery-shaped towers dominated the vista. The exposition featured exhibitions of electricity, industrial machinery, fine arts, floriculture, furniture, and Italian handcraft. Regrettably, the exhibition lasted only 50 days; on the morning of 8 July, a ruinous fire almost destroyed it completely in less than an hour. The surviving relics were transferred to the Museo Civico of Como and then, in 1927, to the Tempio Voltiano, the building loosely inspired by the Tribune of Galileo erected that same year thanks to businessman and politician Francesco Somaini.[8]

With the advent of fascism, celebrations of scientists grew more and more common as fascist propaganda increasingly stressed the primacy and excellence of the Italian genius. The regime urged cultural institutions to retrace the footprints of the great Italian intellectuals, endorsing the idea of a "living museum," analogous to the Deutsches Museum of Munich, to show the crucial role played by Italy in technological and scientific progress. Historians felt that there were many opportunities for history of science, and began to put forward large-scale projects. Aldo Mieli, for example, in an open letter addressed to Minister of Public Education Giovanni Gentile in September 1923, endorsed the creation of a national library and museum of history of science to be established in Rome by gathering books, manuscripts, and artifacts from all over Italy. In Florence, physicist and Podestà Antonio Garbasso planned to create a "Galilean City" in Arcetri by establishing a historical museum in Galileo's place of death, the so-called Villa il Gioiello.

Andrea Corsini and the Historical Scientific Heritage

On 21 September 1922, Andrea Corsini, a 47-year-old Florentine physician and historian, was in Bologna attending the conference of the Società di storia critica delle scienze mediche e naturali, a society of which he was a member of since its foundation in 1909. The society used to meet once a year to discuss themes related to the history of medicine, and Corsini himself had contributed papers on several occasions. That year, however, he was not going to deliver the usual speech about some physician of the past or the importance of the history of medicine; instead he called the attention of his colleagues to a different subject, an issue he had been dealing with for a long time: the disgraceful condition of the historical scientific collections.

The son of a manager of the Habsburg-Lorraine Tuscan Estates Directorate, Corsini had graduated in medicine at the University of Florence in 1899 and went on to become assistant to Giorgio Roster at the Institute of Hygiene in Florence. While working with Roster, he became interested in the history of medicine and planned to write a history of epidemics in Florence from the Middle Ages to the twentieth century.[9] The project was never realized because Corsini was led, almost accidentally, to the study of the historical scientific heritage. In 1911, in preparation for the International Exhibition of Hygiene that was to be held in Rome the following year, he had begun gathering information about Florentine historical scientific collections. Impressed by their richness and variety, he continued pursuing his research after the exhibition closed, asking librarians, archivists, and museum curators about the collection's location, composition, and condition. What he found was discouraging: neglected instruments heaped up in depots, manuscripts haphazardly stashed in warehouses, mouse-nibbled books bound for pulpers, catalogs and inventories nowhere to be found, personnel who hardly knew what they were talking about. "Whoever has the chance of combing through scientific and bibliographic material," Corsini later remarked at the beginning of his speech in Bologna, "can see that a large part of it is doomed to ruin and dispersion, as it lies untidy, neglected, and unsupervised."[10]

The provisions proposed by Corsini at the meeting in Bologna reflected his sound practical sense. They were intended to "save and capitalize on this asset, increasing the nation's credit," and were modeled after what had already been done for fine arts. First, it was necessary to get as clear an idea as possible of the extent of the collections, preparing catalogs and inventories; then, keen and competent supervisors should be appointed; finally, small exhibitions and museums could be established. The public, he maintained, needed to be stimulated, but one cannot arouse enthusiasm over something one does not have within oneself. "Since when scientists themselves got away from the rooms housing the scientific collections to hole up in laboratories," Corsini complained, "scientific museums, which nobody hears anything about anymore, are empty and depleted."[11] To engage the public, Corsini thought, it was necessary to blur the distinction between research, teaching, and popularization. "Scholars must get out of their ivory tower and go deal with the public," he urged. Bring history of science to the people, and the people will repay you.[12]

Bridging the gaps between the broader public and the community of scholars had been one of Corsini's main aims since very early in his career. While still a student at the University of Florence, he had founded the Associazione Pro Cultura, an organization concerned with the promotion of scientific and literary education among lower classes by means of conferences, evening courses, and small exhibitions. Later, as an activist of both the Special Commission for the Prevention of Alcoholism and the National Federation for the Fight against Tuberculosis, he had written pamphlets and joined campaigns directed at common people. Once engaged in the history of science, he strongly championed its popularization. In 1912, on the occasion of the first meeting of the Società di storia critica delle scienze mediche e naturali, he presented a paper titled, "On the Importance and Methods of Spreading Knowledge of the History of Science in General, and of History of Medicine in Particular," in which, basically, he transferred his ideas about awareness raising to the field of the history of science. "We should persuade ourselves that, at the moment, our main task must be to publicize and spread the word," he admonished. "Drawing attention to our studies and appealing to a wider audience is the only way to assert ourselves to institutions and higher committees."[13] According to Corsini, history of science could benefit from the wave of nationalism sweeping through the whole of Italy. Children, Corsini argued, are naturally interested in science; it is scholars' fault if youth drift away from this interest as they grow up. "We need to edit catalogs that fit with the broader public's attitudes and culture," he stated. "They should be richly illustrated and contain plenty of information to arouse the nonspecialist audience's curiosity."[14]

The First National Exhibition of the History of Science: The Florentine Primacy and the Galilean Tradition

During the 1920s, Corsini managed to put his ideas into practical effect by promoting the creation first of the National Scientific Heritage Protection Group in 1923 and later of the Institute of the History of Science in 1925. He was joined in these enterprises by physicist and politician Antonio Garbasso (who at the time was mayor of the city of Florence) and by businessman Piero

Ginori Conti. The two of them granted Corsini the political and financial support he needed to realize a project he had been thinking about since he first began to deal with historical scientific collection: an exhibition of history of science. What Corsini had in mind was an exposition of instruments, books, and machines that would offer an account as detailed as possible of Italian science in its historical development. His original idea was to exhibit instruments and functioning machines—be they originals or replicas—arranged in chronological order to show their progressive development. This, in turn, could form the central nucleus of a permanent exposition showing the history of Italian science.

Exhibitions of history of science had been held in Italy since the end of the nineteenth century; still, they were often of limited scope, focusing on individual scientists or topics, and they seldom, if ever, were organized as independent events. Corsini's exhibition, however, was to be specifically and exclusively focused on Italian science, or, more correctly, on Italian scientific collections. As he put it, it was necessary to undertake this to defend the nation's historical scientific heritage in the same way that others had successfully defended art: "As for ourselves, we will be happy if the exhibition succeeds in demonstrating the necessity of establishing in Italy the kind of museums that are being established abroad; if we get a first and large catalog of the relics and documents related to history of science existing in our nation; if the government realizes that it is time to create, besides the superintendents for the arts, monitoring bodies to watch over the historical scientific heritage."[15]

These proposals found fertile ground in the Florentine cultural and political environment. Lacking an industrial economy on the order of northern cities like Milan and Turin, and still facing financial difficulties after the expenses incurred during the brief period it had served as capital city of Italy from 1865 to 1871, Florence was trying to redefine its identity as the Italian capital of art and culture, looking to tourism as a means of economic development. Among the many initiatives that flourished during the 1910s and the 1920s, the most significant had surely been the creation of the Ente per le Attività Toscane (EAT, Authority for Tuscan Activities), which journalist Enrico Barfucci wrote about in 1923. A partly state-controlled institution, the EAT sought to promote cultural tourism stressing the intellectual primacy of Florence and drawing upon the rediscovery of folk traditions and the promotion of its artistic heritage. It held the support of intellectuals like Giovanni Poggi, the writer Giovanni Papini, and the publisher Enrico Bemporad, as well as of politicians like the future Minister of National Economy Alessandro Martelli, and founder of the first fascist formation of Florence and Deputy Italo Capanni.[16] In 1926, the EAT was busy organizing a historical exhibition of illustrated books, so it is no surprise that Barfucci and his associates became interested in the project of a national exhibition of the history of science, and eagerly agreed to give their support. For the EAT, establishing a National Museum of the History of Science alongside the National Library and the Uffizi Gallery would have meant restoring "Tuscany's intellectual exarchate" eulogized by Vincenzo Gioberti eighty years before.[17]

Thanks to the backing of Garbasso and Ginori Conti, Corsini won the support of the fascist government as well, with Mussolini himself taking up the role of honorary president of the exhibition. At that time, the regime was busy securing itself a "cultural legitimacy" by stressing itself as the purest realization of the Italian character. The fascist regime was presented through propaganda as the culmination of Italian history and as the most complete realization of the "Italian spirit" which had animated people such as Dante, Machiavelli, Leonardo, and Galilei. In this process of creating "cultural acceptance" for fascism, a special emphasis was placed on history. The regime had been posing as the restorer of Italian glories and thus supported and ignited initiatives that could help sustain that narrative: a number of institutions devoted to history were created; monuments and museums were erected; and celebrations of great Italian individuals were solemnly held.

A significant amount of fascist cultural propaganda was built around the myth of the "Italian genius." This theme was already present in Italian culture, but fascism boosted it to its full extent. According to the regime's narrative, Italians had always been "exporters of civilization." Their contribution to world history, however, had been obscured because of the ineptitude and weakness of their political leaders; fascism was now restoring the "Italian primacy." In this perspective, figures such as Leonardo da Vinci and Galileo Galilei were celebrated as "Italian heroes" whose ideas and discoveries had been usurped by foreigners. Hence, Corsini's initiative was seen by the government as a powerful propaganda tool for spreading this view among the population.

According to the original plan, the First National Exhibition of the History of Science was meant to be structured into five disciplinary sections: (1) natural sciences, (2) medicine and pharmacy, (3) mathematics, physics, and chemistry, (4) astronomy and geography, and (5) technology. This arrangement, however, conflicted with the long-standing Italian tradition of localism. As soon as it was communicated to local committees, rumors began to spread that the actual goal of the exhibition was to give life to a national museum of history of science and that objects sent to Florence would not be returned. Many local committees decided, therefore, to withdraw their participation in the event unless they were provided with appropriate guarantees of the artifacts' return. In the end, an agreement was reached: the exhibition was to be "a collection of regional exhibitions" and each participant was to choose what to put on display (Figure 1).

The exhibition, then, was arranged geographically, and this made it impossible to display the historical development of individual science as Corsini had originally planned to do. Cities and institutions were invited to sort out items in their possession and were allowed to design and manage their own exhibits. This freedom resulted in a general lack of coherence. Exhibits presented themselves one after another without apparent order other than the fact that they happened to come from the same city or region. Moreover, even though the organizers would have preferred to put on display original items, participants were allowed to present replicas or even photographic reproductions of originals. As historian of science Giuseppe Montalenti put it, this geographical order undermined both the historical and didactical value of the exhibition, making it just an inordinate succession of shows with no ties to one another.

On the positive side, the geographical ordering made the task of designing the show immensely simpler. It also implicitly invited visitors to compare the participating cities, thereby

Figure 1. Advertising poster for the National Exhibition of the History of Science held in Florence, Italy, 1929. From author's private collection.

underscoring the richness of the Tuscan heritage in general and of the Florentine heritage in particular.[18] As the attempt to show a national tradition through chronological and disciplinary arrangement proved unfeasible, the organizers took a reductionist approach by equating the Italian tradition with the Galilean–Florentine one. This was an idea especially favored by Garbasso. For him, Galileo stood out as the prototype of the Italian genius and the Galilean tradition basically summed up the whole Italian scientific tradition. Every great advance in science, according to him, could be traced back to the "experimental method" envisaged by Florentine physicians like Taddeo Alderotti in the Middle Ages, enhanced by Leonardo da Vinci during the Renaissance, and fully developed by Galileo in the seventeenth century. If the exposition was a show of local traditions, then the Florentine effort could be presented as the original Italian tradition whence others had grown like flowers from a stem.

The Palazzo delle Esposizioni, or Palace of Expositions (Figures 2 and 3), was a large building that was located at the edge of the city's center and housed many Florentine exhibitions until its demolition at the end of 1930s. It was made up of two large central halls on the ground floor leading into smaller rooms all around (see Figure 4). The layout was ideal for exhibitions and was ably exploited by their organizers. The two large halls were, in fact, reserved for the Tuscany and Florence shows. These focused on Leonardo and Galileo respectively, as the ideal representatives of the Italian scientific genius and as founding fathers of the national scientific tradition. Significantly, to prepare the Tuscan room, the organizers not only combined the individual

Figure 2. The Palazzo delle Esposizioni (Palace of Expositions) in the center of Florence. Postcard, late 1920s. From author's private collection.

exhibits of 10 cities but also broke their own rule of geographical arrangement. At the center of the hall stood a "Tribuna di Leonardo" prepared with contributions from the Biblioteca Ambrosiana in Milan and the Naples committee.[19] The centerpieces of the Leonardo section were the reconstructions of parts of the "flying machine" designed by the illustrious Tuscan. Corsini had actively promoted the project. In 1928, he had contacted Raffaele Giacomelli,[20] a consultant to the Ministry of Aeronautics, chief editor of the magazine *L'Aerotecnica*, librarian of the Istituto Sperimentale di Aeronautica in Rome, and—since 1926—author of research studies on Leonardo codices on flight later published in the volume *Gli scritti di Leonardo da Vinci sul volo*.[21] Giacomelli had extracted a series of measurements from the *Codex Atlanticus*, the *Codex B*, and the *Codex on the flight of birds*. He forwarded the data to Giuseppe Schneider, a draftsman at the Stabilimento di Costruzioni Aeronautiche in Rome (an aeronautical construction facility), who prepared the blueprints. The models were built at the Stabilimento in Rome and at the Istituto Tecnico Leonardo da Vinci in Florence headed by Alberto Picchi, who assigned the institute's master craftsmen Mario Bucci and Vasco Menici to the task.[22] When the exposition closed, the models built in Florence stayed there in the new National Museum of the History of Science, while those made in Rome were donated to the Science Museum in London. Schneider's blueprints, together with photographs of the models and Leonardo's sketches, were displayed at the Aeronautical Italian Exposition in Milan in 1934, thus inaugurating a fruitful practice of exchange and collaboration between institutions and contributing to the establishment of the Florentine museum as a leading international center for the study of scientific objects.[23]

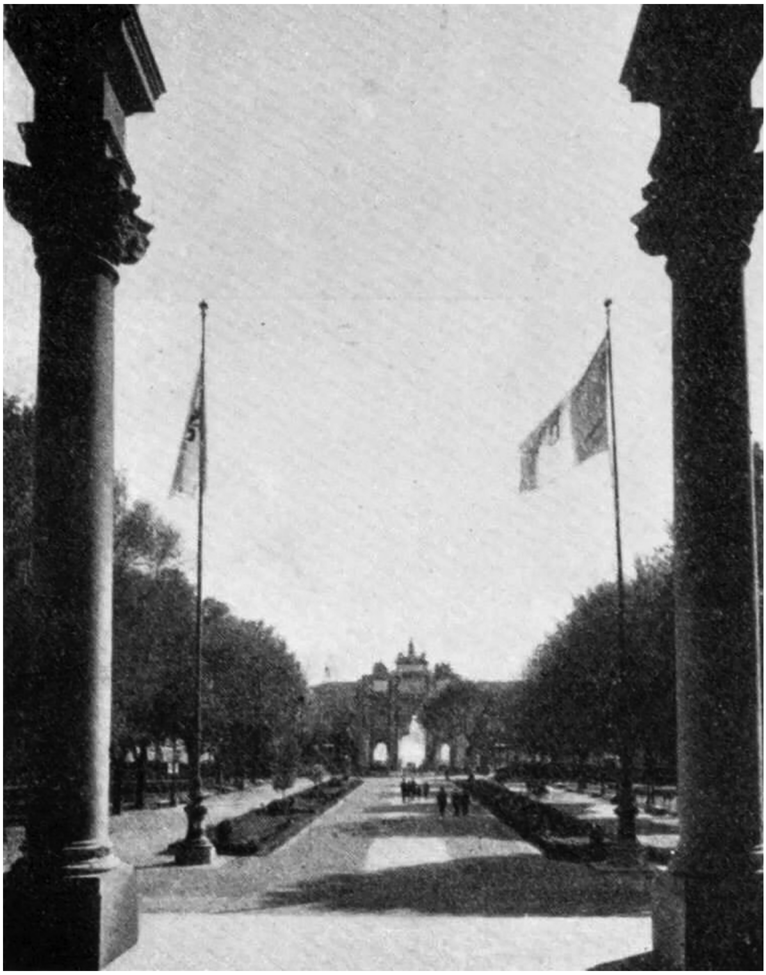

Figure 3. The parterre seen from the entrance of the Palace of Expositions. Postcard, late 1920s. From author's private collection.

Displaying Historical Scientific Collections

The decision to let each participant curate its own show, while preventing the exposition from offering a unified view of the development of Italian science, allows us to see different approaches to exhibiting historical scientific collections in action. In general, all the shows featured at the exposition shared a commendatory purpose as they were meant to celebrate local traditions, yet the strategies each deployed to reach this goal differed significantly.

The first and most common approach was the hagiographic one adopted by small and peripheral cities and largely focused on individuals. In it, artifacts were treated as relics and exhibits as reliquaries; hence, written material, portraits, and memorabilia such as medals, plates, pieces of furniture, and clothes were given prominence over instruments and machines. The best example of this approach is the exhibition of Bergamo that was managed by the director of Bergamo's Civic

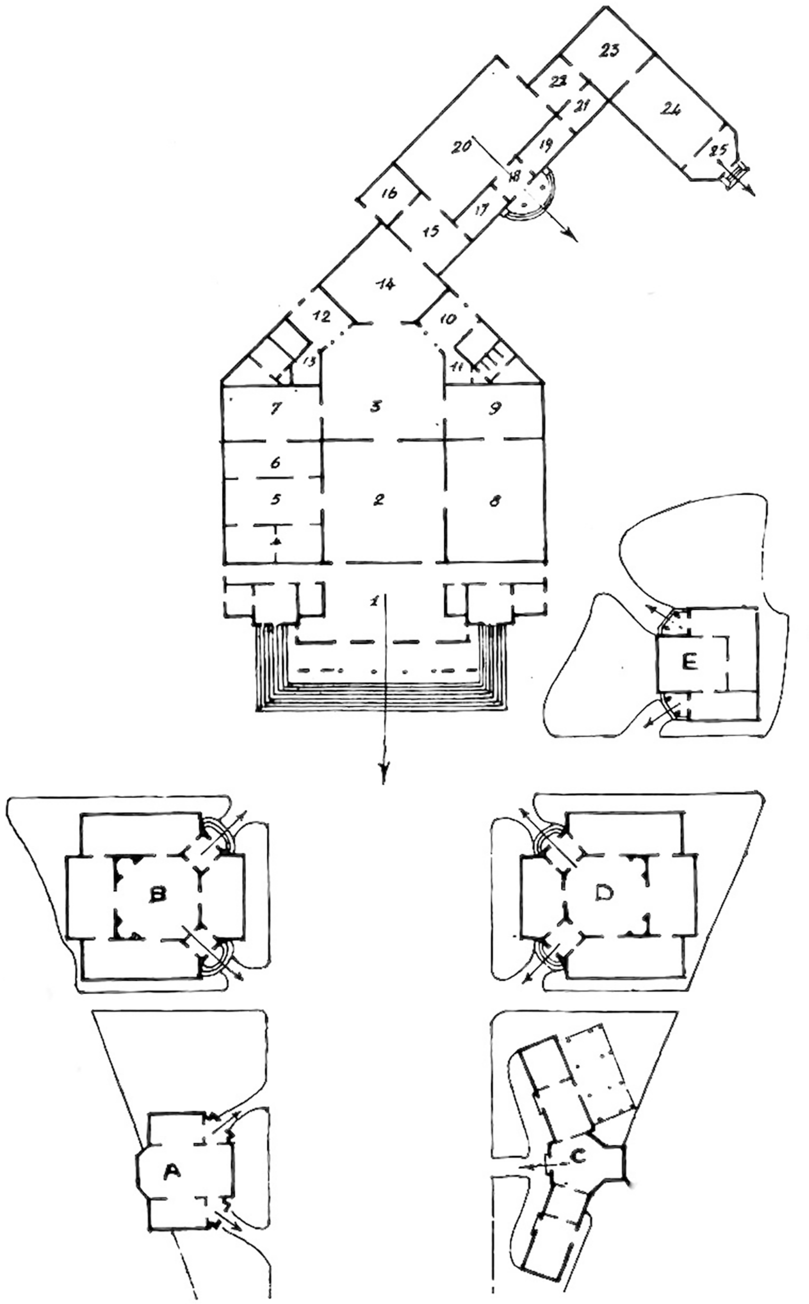

Figure 4. A floor plan of the exhibition area in the Palace of Exposition. The Tuscany and Florence exhibits were staged in rooms 2 and 3, respectively, while the others were staged in the smaller rooms all around them. From author's private collection.

Library, Giuseppe Locatelli, and mostly devoted to the Bergamese explorer Giacomo Costantino Beltrami; not only were Beltrami's writings and maps on display, but also his trousers and aprons.

The second extensively adopted approach focused on institutions rather than individuals. Though celebratory in tone like the hagiographic approach, it emphasized publications, portraits, scientific instruments, and laboratory apparatuses as attestations of the research activities carried out in the institutions they belonged to. The case of Bologna is particularly illustrative of this approach. The committee established in 1927 featured some of the leading scientific personalities of the town, representatives from city museums and archives, university professors, and delegates of the city council, the Provincial Council for Economy, and Bologna Savings Bank. The setup of the room was managed and curated by an executive board consisting of mathematician Ettore Bortolotti, professor of geodesy and topography Paolo Dore, archeologist Pericle Ducati, professor of anatomy Ercole Giacomini, and agronomist Dino Zucchini. At that time, Bologna was an active center of research on historical scientific collections. The university had already staged an exhibition of antique science books in 1922, and at the time of the Florentine exposition, another exposition in honor of Luigi Ferdinando Marsili the founder of the Bolognese Institute of Science, was slated to be held in 1930 on the second centenary of his death. The central theme of the room was the celebration of the University of Bologna—the oldest continuously operating university in the world—which in 1928 had celebrated the 840th anniversary of its foundation. "The main idea followed by the Bolognese Committee was to celebrate the high scientists who worked at the University," an official statement of the committee declared in 1929, "and to play up, albeit sketchily, the continuity of Bologna's contribution to observational, experimental, and speculative science."[24] The idea was to highlight the continuity of a tradition that started with Gerolamo Manfredi and Ulisse Aldrovandi; was renewed by figures like Raffaele Bombelli, Marcello Malpighi, Giovanni Domenico Cassini, Luigi Ferdinando Marsili, and Luigi Galvani; and culminated in Augusto Righi and—above all—Guglielmo Marconi, the prototype of a Fascist scientist, whose instruments and inventions, orderly displayed in a glass case, testified to the renewed strength of the University of Bologna.

If the institutional approach adopted by cities like Bologna retained some element of hagiography, a more decisive step toward displaying historical scientific artifacts as cultural objects was taken in the exhibits of Florence, Milan, and Rome. In these shows, artifacts were presented not as mute evidences of the scientific life of individuals or institutions but as essential elements of cultural identity. By celebrating local traditions, artifacts were meant to show the role and ambitions of the communities that produced them. From this perspective, re-creations, replicas, and scale models of original artifacts acquired a fundamental role; as the main aim of the objects was to convey the idea of active cultural communities, it was of minimal importance whether or not they were originals. Within the hagiographic approach, however, there was no point in showing replicas of scientific instruments and machines, for the value of the objects derived from them belonging to the scientists they were celebrating.

We have already looked at Florence—a city trying to redefine its identity as the capital of Italian culture—so let us turn our attention now to Milan and Rome. The Milanese committee was presided over by Francesco Somaini—the member of parliament who had promoted and financed the construction of the Tempio Voltiano in Como in 1928 and featured representatives from the City Council of Milan, the Brera Observatory, the Braidense and Ambrosiana Libraries, and the Superintendency for Fine Arts. The city council staged two exhibits on aeronautics and navigation. The exhibit on aeronautics was staged thanks to Achille Bertarelli, who donated the collection to the city, and consisted of documents and materials on aeronautical experiments performed by Francesco Zambeccari and Vincenzo Lunardi. The exhibit on navigation featured pictures of ships that were from the naval museum created by Filippo Camperio and Federico Jarach and donated to the city of Milan in 1922. The Brera Observatory, directed by Emilio Bianchi, sent a number of publications documenting its research activities since 1777; Tommaso Gnoli, director of the Braidense Library, curated an exhibit on the history of geography that featured texts and objects from the Braidense and the Ambrosiana libraries. Carlo Calzecchi-Onesti, Milan's superintendent of Fine Arts and son of physicist and inventor Temistocle, provided instruments and other materials that belonged to his father. The center of the room was occupied by a Magrini electric engine, one rotor from the first turbine built by the Riva-Monneret company, and a model of the first locomotive engineered in a workshop near Porta Tosa in 1853. Overall, the Milan room was meant to suggest the idea of a dynamic industrial city. Its main theme—transportation—conveyed the idea of uninterrupted technological development and its continuity with the International Exhibition of 1906. At the same time, the emphasis put on industries and technology signaled the role that Milan was trying to secure in those years as the most appropriate seat for a national museum of science, industry, and technology. Since 1927, engineer and entrepreneur Guido Ucelli had been rallying Milanese cultural and political institutions toward this end. Milan was then redefining its identity as the preeminent industrial and scientific center of Italy, much like Florence was rushing to be acknowledged as its cultural capital. Throughout the 1920s, significant initiatives like the founding of the University of Milan in 1924, the enlargement and improvement of the Brera Observatory in 1926, the inauguration of the National Institute for the Cure from Cancer in 1928, and the completion of Italy's largest planetarium in 1930 had vouched for Milan's renewed push on science and technology. Thus, when Ucelli's project was announced, reactions were enthusiastic and not much different in their celebratory tone from those uttered in Florence at the news of a possible museum of history of science. "We must not tolerate any discussion about the location," a Milanese newspaper remarked. "Only Milan, as the mother and queen of the Italian industry, is worthy of the duty and honor of housing such a great institution."[25]

The Roman collections were housed in a room that was next to the Tuscany room and large enough to accommodate almost 300 objects. In Rome, a local committee was established in 1927 that was made up of a great number of personalities from the political, cultural, scientific, and military worlds and was presided over by Federico Millosevich (rector of "La Sapienza," University of Rome). The appointed curators chose to focus on astronomy, medicine, and technology. Part of the Copernican Museum's collections—consisting of, among other things, 31 telescopes, 13 astrolabes, 12 armillary spheres, 18 celestial globes, 26 microscopes, and 41 sundials—were put on display side by side in three showcases. A significant portion of the room, however, was devoted to the celebration of imperial Rome, in a fashion that was characteristic of fascist colonial propaganda. In 1928, the Fascist Regime had acknowledged the Istituto Coloniale Fascista (Fascist Colonial Institute) as the only institution officially authorized to pursue colonial propaganda, and entrusted it with the task of shaping a "colonial awareness" among the Italian population. The institute published books and periodicals, managed school programs, promoted both local and national initiatives, and participated in major events such as exhibitions and trade fairs.[26] At the Florence exhibition, a great emphasis was placed on "Rome's civilizing mission." An entire wall was covered with plaster casts of Trajan's column representing siege engines, military bridges, ships, cranes, aqueducts, and sewer systems, so as to highlight the level of sophistication reached by Roman technology and how Rome's military campaigns helped to spread this technology around the world—a not-too-subtle allusion to Mussolini's unconcealed wish to rebuild the "Italian Empire." In the center of the room stood a sculpture of the Capitoline Wolf, a symbol of the "Third Rome" Mussolini yearned for: "ample, neat, powerful, just like it was back in the times of Augustus."[27]

Scientific Collections as Cultural Objects

Even though the National Exhibition of the History of Science failed to achieve its primary objectives of establishing special superintendent for the history of science and producing a general catalog of Italian scientific relics, it nonetheless contributed to the understanding of scientific collections and artifacts as an integral part of the Italian cultural heritage. In other words, thanks to the exhibition, scientific collections that were once dismissed as useless and hence stashed in warehouses began to be regarded as cultural objects.

Before the exhibition, the issue of conservation and display of scientific memorabilia had been almost exclusively addressed by a narrow circle of specialized journals, and discussed in largely theoretical terms by a handful of historians of science. Now, these issues were covered by the general press, attracting the attention of the public at large. The notion that founding a national museum of the history of science in Florence should be the logical—and, in a sense, expected—outcome of the exposition was accepted even outside the city itself and the circle of Florentine historians of science. The exhibition had therefore succeeded in demonstrating to the whole nation the importance of protecting and showcasing the historical heritage of science. At the same time, it had conveyed the idea, reiterated by Corsini, that Florence had a central role to play in this enterprise.[28] By way of confirmation, in his speech at the exposition closing ceremony, Ginori Conti explained:

> To create this National Museum, we do not need, in Florence, to divest University laboratories and civic museums of the relics they so jealously preserve. To us, the instruments that Florence already possesses suffice, as well as those in the hand of private citizens. . . . To implement this program, we shall be better off if we are not deprived of help from the Authorities and especially from the Municipality, which by doing its utmost to help us will have the pride of fostering the emergence in our city (which is and must remain one of the most important centers of Italian study and culture) a Museum unique in its kind in our Nation, which, eventually, can be a subject of pride for Florence.[29]

This outcome was the result of the idea that the Galilean tradition basically summed up the Italian tradition. The museum established right after the exhibition housed the collections previously on display in Galileo's Tribune; yet the collections were now recognized as the main elements of traditions of the nation rather than just of Florentine. From this perspective, the new museum was a hybrid institution like no other in the Italian panorama. In being funded almost exclusively by the City of Florence, it was a civic museum; as its collections were property of the University of Florence, it was a university museum; and, as it displayed the Galilean tradition, which supposedly was identical to the Italian tradition, it was a national museum.

In a more general sense, the National Exhibition of the History of Science showed that historical scientific collections could be the subjects of events addressed to a general public and that organizing such events ought to be the first preliminary step toward the creation of permanent expositions. The Museum of Natural History of Trento, for example, turned its show into a permanent exposition; and in Naples, a special section devoted to the history of technology was established within the National Museum of Archeology. This new section, inaugurated on 3 December 1932, featured the models built for the exhibition of 1929 and new ones executed for the occasion. Among them were hand and horse millstones, parts of the *fistulae* (water pipes) that used to carry water to *Calidarii* models of olive presses, *epistomia* (faucets), scales, and a scale model of a Roman pool. Another museum of history of science devoted to Antonio Pacinotti was created in Pisa, and in Livorno Piemontese the city council installed a museum in Galileo Ferraris's house. In Padua, the exposition ignited the debates about the opportunity of creating a "museum of machines" dedicated to the engineer Enrico Bernardi (the museum would be eventually inaugurated in 1941). This outcome shows that the exposition of 1929 played a fundamental role in shaping the Italian approach toward historical scientific collection and contributed enormously to the shaping of Italy's geography of historical scientific museums.

What Corsini hoped for was far from being realized, however. He pictured an ecology of historical scientific institutions, a network of local museums that shared information about their collections with a national museum that was charged with the task of maintaining an up-to-date catalog of objects. Not until 1993 was a team from the Institute and Museum of History of Science in Florence (the successor to the original National Museum of the History of Science), was able to fulfill, at least in part, Corsini's vision with the creation of a cataloging scheme for scientific objects, the Scheda per la catalogazione degli strumenti scientifici, or STS, which is now the cataloging standard recognized by Italy's Ministry of Cultural Heritage and Activities and Tourism.

Notes

1. The word "musealization," or "musealisation" in European countries, comes from the German *Musealisierung* and roughly means the "institutionalization of the past" enacted when an artifact is deemed worthy of being publicly displayed. I use it in the sense discussed by S. MacDonald in *Memorylands: Heritage and Identity in Europe Today* (New York: Routledge, 2013), 138.
2. A. Corsini, "Per il patrimonio storico-scientifico italiano," *Archivio di storia della scienza* 5 (1924): 348.
3. G. B. Cavalcaselle, *Sulla conservazione dei monumenti ed oggetti di belle arti e sulla riforma dell'insegnamento accademico* (Torino: Tipografia la Subalpina, 1863), 5.
4. A. Emiliani, "Musei e Museologia," in *Storia d'Italia: I documenti, V* (Torino: Einaudi, 1973), 1615–1655.
5. F. Enriques, *Il significato della storia del pensiero scientifico* (Manduria: Barbieri, 2005), 11.
6. On these topics, see M. Ciliberto, "Scienza, filosofia e politica: Federigo Enriques e il neoidealismo italiano," *Studi Storici* 22 (1981): 861–886.

7. See, for example, M. Bucciantini, "Galileo e le passioni del Risorgimento," in *Il caso Galileo: Una rilettura storica, filosofica, teologica: Convegno internazionale di studi. Firenze, 26–30 maggio 2009*, ed. M. Bucciantini, M. Camerota, and F. Giudice (Firenze: Olschki, 2011), 347–366; M. Cini, "L'ambigua costruzione di un'identità nazionale: le celebrazioni di Galileo Galilei a Pisa (1864)," in *Galileo e Bruno nell'immaginario dei movimenti popolari tra Otto e Novecento*, ed. F. Bertolucci (Pisa: BFS Edizioni, 2001), 67–84.
8. *Como e l'Esposizione Voltiana, 1899* (Como: 1899); A. Gamba and P. Schiera, eds., *Fascismo e Scienza: Le celebrazioni voltiane e il Congresso Internazionale dei Fisici del 1927* (Bologna: Il Mulino, 2005); A. Marino, *Como al tempo del decoro e dell'orgoglio. L'Esposizione Voltiana, l'incendio e la ricostruzione. Gli occhi del mondo sulla sfida di una piccola città* (Como: 2012).
9. For a full biography see the entry in *Dizionario Biografico degli Italiani* (hereafter cited as *DBI*). The *Dizionario* can be found at the following link: http://www.treccani.it/biografico/index.html
10. Corsini, "Per il patrimonio storico-scientifico italiano," 348.
11. A. Corsini, "La Specola di Firenze," *Archivio di storia della scienza* 5 (1924): 377–378.
12. Corsini, "La Specola di Firenze," 378.
13. A. Corsini, "Relazione sull'importanza e i metodi di divulgare la conoscenza della storia delle scienze in genere e della medicina in ispecie," in *Atti del I Congresso nazionale della Società italiana di storia critica delle scienze mediche e naturali, Roma, 1912* (Grottaferrata: 1913), 12 (offprint).
14. Corsini, "Per il patrimonio storico-scientifico italiano": 353.
15. Translated by this author. "L'Esposizione di storia della scienza," *il Giornale d'Italia*, 27 July 1928.
16. For more about the Authority for Tuscan Activities (Ente per le Attività Toscane, or EAT), see A. Pellegrino, *La città più artigiana d'Italia: Firenze 1861–1929* (Milano: FrancoAngeli, 2012), 80–82.
17. V. Gioberti, *Del primato morale e civile degli italiani: Seconda edizione corretta e accresciuta dall'autore coll'aggiunta di una nuova avvertenza* (Brussels: Meline e Cans, 1845), 501.
18. On this topic, see G. Montalenti, "La Prima Esposizione Nazionale di Storia della Scienza a Firenze," *Archeion* 11 (1929): 239–241 (Montalenti had curated the Rome exhibit room), and S. Timpanaro, "Nel mondo della scienza: alla Mostra scientifica di Firenze," *Italia letteraria*, 2 June 1929.
19. The Naples commission, chaired by Roberto Marcolongo, had prepared a replica of the instrument that Leonardo had used to solve the "Alhazen's problem" concerning reflection. The replica was displayed in the Tuscany room.
20. R. Giacomelli, "I modelli delle macchine volanti di Leonardo da Vinci," *L'Ingegnere* 5 (1931): 3 (offprint).
21. R. Giacomelli, ed., *Gli scritti di Leonardo da Vinci sul volo* (Rome: 1936); on the machines in the Florence Exposition, see 95.
22. See A. Poggi, "Le opere immortali di Leonardo e di Galileo alla Mostra Nazionale di Storia delle Scienze," *La Nazione*, 7 May 1929; D. Brogi, "La macchina volante di Leonardo ricostruita alla Mostra della Scienza," *Il Giornale d'Italia*, 26 June 1929; I. Del Giudice, "La ricostruzione della macchina volante di Leonardo," *Unità Cattolica*, 28 July 1929.
23. R. Giacomelli, "Progetti vinciani di macchine volanti all'Esposizione Aeronautica di Milano," *L'Aerotecnica* 14 (1934): 8–9 (offprint).
24. "La sala di Bologna alla Mostra della Scienza," *Unità Cattolica*, 7 August 1929.
25. Metron, "Un Museo Industriale Italiano," *Corriere della Sera*, 15 September 1931.
26. On this argument, see M. Cagnetta, *Antichisti e Impero fascista* (Bari: Dedalo, 1979).
27. B. Mussolini, "La nuova Roma," in Mussolini, *Opera Omnia*, vol. XXII (Florence: La Fenice, 1957), 48.
28. A. Corsini, "Firenze e la storia delle scienze," *Atti della Società Colombaria di Firenze dell'anno 1925–1926* (Florence: 1927), 5 (offprint).
29. "La chiusura della Mostra Nazionale di Storia della Scienza," *La Nazione*, 12 November 1929.

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CHAPTER 5

History of the CNR Artifacts Collection

From the Century of Progress Exposition in Chicago to the Museum of Science and Technology in Milan

Claudio Giorgione
Curator

Leonardo da Vinci National Museum of Science and Technology
Milan, Italy

This chapter focuses on an interesting example of the circulation of artifacts at an international level as part of the Italian government's cultural propaganda strategy during its Fascist regime. In 1933, a large group of objects, mostly replicas and scale models, had been created in Italy by the National Research Council (CNR) to be displayed at the Century of Progress International Exposition, or the Chicago World's Fair.[1] These artifacts later became part of the collections of two museums: the Museum of Science and Industry, Chicago (MSI), which opened in 1933 together with the fair, and the Museo Nazionale della Scienza e della Tecnica (MNST, now the Museo Nazionale della Scienza e della Tecnologia [Leonardo da Vinci National Museum of Science and Technology]) in Milan, which opened 20 years later, in 1953.

"Science Finds, Industry Applies, Man Conforms": The Century of Progress World's Fair and the Hall of Science

The 1933 Chicago World's Fair celebrated the city's 100 years of development 40 years after the city held the World's Columbian Exhibition of 1893, 400 years after Christopher Columbus arrived in the "New World." For this reason, the main idea behind the 1933 fair's organization was to highlight the idea of progress, especially in the fields of science and technology, expressing the belief that progress rode on the swell of technological innovation and could improve daily life and generate optimism for an "economically depressed population."[2] This message was even reflected through the use of a colorful, futuristic, and streamlined architecture, definitively abandoning the Beaux-Arts style.

Settled along the lakefront, the Century of Progress would be a "new exposition for a new era," with both temporary pavilions and already familiar institutions like the Field Museum of Natural History, the Adler Planetarium, and the Rosenwald Industrial Museum (now the MSI). The architectural commission for building the fair site chose a modernist style to better communicate the idea of progress. It is interesting to note that the fair's largest building was the Hall of Science, designed by architect Paul Philippe Cret. Approached by walking along the Avenue of Flags, it served as the centerpiece of the entire site. The style of Cret's building was very modern, with the main architectural lines emphasized by neon lights forming abstract patterns. New materials were used in the building, such as asbestos board and plywood for walls and a variety of metals like aluminum and nickel for decorative elements. Exteriors and interiors were covered with brilliant colors—orange, blue, white, a touch of red—inviting people to feel joy.

The organization of the exhibitions at the Hall of Science was established under an advisory committee for the National Research Council. The committee recommended a chronological order for the exhibits to explain major discoveries in three scientific fields: physical sciences, biological sciences, and earth sciences. Generally, the exhibits were related more to science fundamentals than to science applications. When entering the Hall of Science, the first thing visitors would see was the huge *Tree of Knowledge* mural by artist John Warner Norton. Geometrical in style, the tree had the names of basic sciences as roots, radiating upward into 14 applied sciences for limbs. The motto on the mural—"Science finds. Industry applies. Man conforms."—was explained in the fair guidebook:

> Science discovers, genius invents, industry applies, and man adapts himself to, or is molded by, new things. Science, patient and painstaking, digs into the ground, reaches up to the stars, takes from the water and the air, and industry accepts its findings, then fashions and weaves, and fabricates and manipulates them to the usages of man. Man uses, and it affects his environment, changes his whole habit of thought and of living. Individuals, groups, entire races of men fall into step with the slow or swift movement of the march of science and industry.[3]

The great Hall of Science showcased different exhibits, including a bathysphere as well as a life-size transparent model of a man and specimens of human embryos. The various exhibits were arranged with the help of many American museums and cultural institutions.[4] In those years, U.S. museums were experiencing a lively surge of changes and implementations: in Chicago, the Field Museum of Natural History, founded in 1893 with the Columbian World's Fair, moved to its new building in the Park District in 1921.[5] The John G. Shedd Aquarium and the Adler Planetarium opened in the same area in 1930. The Buffalo Museum of Science, one of the most important U.S. contributors of artifacts to the Hall of Science, opened in 1931.

Many institutions from other nations also joined in contributing to the enrichment of the displays, particularly by loaning artifacts. Instead of being a national pavilion, the Hall of Science was created as an international project, gathering all the most important contributions, from the United States and abroad toward the development of medicine and the basic sciences, including chemistry, physics, biology, and geology. The Italian government was one of the most important contributors at many levels, but at the beginning its involvement was anything but certain.[6]

Italy at the Century of Progress

The story of Italy's participation at the Century of Progress World's Fair is very closely related with that of a museum that was opening in Chicago during the same period, the MSI. The facts about the museum's involvement are still being studied, but the recent discovery of a large group of documents in the Archivio Storico della Farnesina (Italian Ministry of Foreign Affairs archives), which collects files from embassies and consulates, gives a new outlook on the facts. A vast store of letters and reports exchanged between the general consul in Chicago, Giuseppe Castruccio,[7] the Italian Embassy in Washington, D.C., the ministries of Education and of Foreign Affairs in Rome, and the MSI help reconstruct the story of Italy's involvement. In fact, Castruccio was to play a very important role in the story, being the main contributor to Italy's successful participation at the world's fair.

On 20 November 1930, Waldemar Kaempffert, director of the MSI,[8] wrote to Giacomo De Martino, the Italian ambassador in Washington, D.C., informing him about the works for the constitution of the museum, which "will explain the technological results of the application of science to industry, trace the development of the mechanical devices which have contributed so greatly to industrial advancement, and finally, show the effects which all these things, in their numerous ramifications, have and have had upon society as a whole." After explaining the organization of the future museum, Keampffert wrote:

> While Italy has always received due credit for her great contribution to music, art, and literature, we find that there seems to be a widespread impression that her efforts have been restricted entirely to these activities, and that her accomplishments in the fields of science and invention are practically none. Of her great part in the "Industrial Revolution" very little is known. . . . We could enumerate these misconceptions almost indefinitely![9]

The Chicago museum invited the Italian government to take part in the establishment of the collections, highlighting the importance of the opportunity:

> In our attempt to present a true picture of Italy's part in world progress, through the medium of our exhibitions at the Museum of Science and Industry, we would sincerely

> appreciate the cooperation and support of the Italian Government, thus assuring not only the perfection of the exhibit material, but enabling us to obtain important objects, or replicas of them, which we shall otherwise be forced to omit. Though our contacts with prominent Italians here in Chicago we have been led to infer that Premier Mussolini would, if aware of our project and purpose, welcome the opportunity to assist us in obtaining the Italian displays which are so necessary to our sequences.

The letter contains an interesting list of 36 artifacts chosen by the MSI as a representation of "Italy's important contribution to man's technical achievement." These items traced innovation of technology through the centuries, from a reproduction of a Roman flour mill, models of Leonardo da Vinci's engineering works, and replicas of works by Galileo and Torricelli to high-voltage Pirelli cables and an Isotta-Fraschini gasoline engine.

This request for cooperation represented a great opportunity for Italy's Fascist government to achieve some measure of credibility and acceptance in the United States, already quite hostile toward Mussolini's totalitarianism. The significance of this offer was perfectly understood by the consul Castruccio, who wrote a letter to the ambassador confirming the importance of the new Chicago museum and urging support for Italy's participation in its organization: "Italian contribution in the fields of science, inventions and industry have been rewarded with the most dark ingratitude and the most shameful ignorance. We have the opportunity to claim the rights of our great scientists who died in poverty after having enriched the entire Universe, particularly Antonio Meucci, inventor of the telephone." The ministries of Foreign Affairs and of National Education were both involved in the decision, but for a long time, Chicago received no answer. The main problem centered on the financial aspects of the collaboration: the Italian government had never before officially participated in a cultural propaganda project in the United States and, up to that point, there had been no plans for a presence with an official Italian pavilion at the Century of Progress World's Fair. On 9 July 1931, a worried Castruccio wrote the ambassador insisting on the importance of Italy's participation:

> I'm talking about the Italian participation in the Basic Sciences Museum, pointing out that the Chicago Fair will offer a great development to this branch, not in a national sense, but displaying the machines chronologically, [with their] scientific theories which contributed to the progress. It's about sending the replicas of the most important artifacts here, from Galileo, the Accademia del Cimento, Torricelli, Leonardo da Vinci etc., to be included in the exhibition. . . . These replicas, after being displayed for five months at the Fair, can be donated to the Museum of Science and Industry, as the Reale Accademia d'Italia [Royal Academy of Italy] already knows. It's clear that we can achieve two important goals with the same expenses.

Two other letters soon followed, one dated 13 July 1931 and the other 16 July 1931, which insisted on the singular importance of this opportunity. Castruccio suggested involving the newly constituted Italian National Research Council (Consiglio Nazionale delle Ricerche, or CNR), which had, among other aims, the political mission of promoting the role of Italian science abroad. Its president at that time was Guglielmo Marconi.

It is interesting that the consul continued insisting, even though he had been informed that the Italian government had already decided not to participate in Chicago's Century of Progress fair. A first sign of the change of mind in the government arrived on 8 September 1931, with a letter sent by the Ministry of Foreign Affairs to the Ministry of National Education, remarking, "we now have the opportunity to claim the Italian-ness of many scientific discoveries, so many of which have been successfully usurped by foreigners."

On 27 October 1931, the Italian ambassador at Washington, D.C., wrote a letter to the minister for National Education, Giuliano Balbino, urging a decision for Italy's participation in the History of Science exhibition at the world's fair science pavilion, as a sign of solidifying its established cooperation with the MSI. At that time, the museum was still under construction and not yet open to the public, but plans were underway for the future exhibition galleries, which needed a strategy for the acquisition of their collections.

There was then a lull in letters and documents until 9 March 1932,[10] when consul Castruccio again wrote to the ambassador, trying once more to bring attention to the problem that Italian participation in the fair was still unconfirmed. The message to the Italian Ministry of Foreign Affairs was clear: it should commission the Royal Academy of Italy to select a scientific committee to draw up a list of artifacts to be displayed in Chicago, indicating authors, dates, and accompanying illustrations. Oddly, the displaying of original artifacts was not considered a necessity, and the construction of replicas and copies had been considered since the beginning. Castruccio's report also had an attached list, drafted by Henry Crew, a professor of physics at Northwestern University[11] and scientific director of the future Division of Basic Sciences at the exhibition, which is interesting in that it gives an idea of the American "wish list":

Replica of a balance taken from Pompeii; now located in great Museum of Naples. Probably also medical instruments in this museum.

Any apparatus of Galileo's that may be lent by the Tribuna at Florence.

A thermometer from the Florentine Academy 1657–1667.

One of Volta's cells—from Pavia or Como. To be exhibited with Daniells and Weston to form a sequence.

Early thermopile of Melloni: possibly in Naples or Vesuvius laboratory. The beginning of the study of radiant heat.

Replica of Pacinotti's electromagnetic machine—Nuova Cimento—3 Maggio 1865.

Model of Larderello—Prince Ginori-Conti. Dimensions preferably not to exceed 12 feet in length.

Some important piece of apparatus devised by Professor Righi the adviser of Marconi; to be obtained from the University of Bologna.

- A vacuum tube prepared by Profesor Lo Surdo illustrating the splitting of spectral lines in an electric field; to be exhibited alongside the Zeeman effect, and to be viewed through a spectroscope.
- Either a replica or the original of the capstan taken from the boat recently raised from Lake Nemi, now preserved in the Museum at Genzano di Roma.
- Some apparatus or wall-sheet prepared by Professor Corbino at the University of Rome to illustrate the "Corbino effect."

An interesting manuscript note, presumably written by Castruccio, appears at the end of the list: "Complete claim to Antonio Meucci,[12] inventor of the telephone, and many other claims to be identified by the R. Accademia di Scienze Italiana."[13]

This thought-provoking list reveals the point of view of an American scientific institution regarding highlights in the history of science in Italy. The first theme in the list related to science and technology in the Roman civilization, then passed directly to the birth of modern science in the seventeenth century with Galileo and the Accademia del Cimento in Florence. Alessandro Volta, Antonio Pacinotti, and Augusto Righi represented the eighteenth and nineteenth centuries. Crew's idea was to compare some of these artifacts with similar ones coming from other countries in a very different way from the autarchic spirit that was to affect the creation of these artifacts in CNR workshops.

Finally, the CNR confirmed to the Ministry of Foreign Affairs its willingness to direct the setup of the Italian exhibition, collecting originals and preparing models and replicas, as documented in a letter signed by Guglielmo Marconi on 23 March 1932. The cost of the operation was estimated at 1 million lire, to be given to the CNR by the Italian government. The CNR started collecting a large group of artifacts, models, and replicas, in multiple copies; one of the series was intended for donation to the Chicago Museum.

Various Italian institutions became involved in the projects. The Museo di Storia della Scienza, inaugurated in 1930 in Florence thanks to the efforts of Prince Ginori Conti and physician and historian of medicine Andrea Corsini, was one of the most important contributors. Giulio Cipriani, the museum's curator, arranged for 28 replicas from the museum's most important exhibits. [14] The Museo dell'Arma del Genio was another important institution that the CNR involved in creating the various ancient military architecture models, such as the Aspendos aqueduct and the reconstructions of the sieges of Alesia and Avaricum.

The aim of the CNR project, by order of Mussolini, was to collect all the existing documentation about the history of science and technology in Italy to prove its supremacy in all the scientific disciplines. So, together with the artifacts, a huge archive of documents, books, leaflets, and photographs was created as supporting material, not only for preparing the contents of the Italian exhibits in Chicago but also with the intention of becoming a permanent documentation center. The director of this *Documentario* archive was chemist Giulio Provenzal, who was also president of the Italian Institute for the History of Chemistry.[15] In the introductory summary for his essay

The Scientific Primacy of Italians, he wrote: "The scientific primacy of Italians is characterized by the amount of scientific and technical achievements; from the number of great scientists in every branch of knowledge; from the unrivaled greatness of Cristopher Columbus, Leonardo da Vinci, Galileo Galilei, and also of Alessandro Volta and Marconi."[16]

The CNR agreed to the idea of displaying the collection at the science exhibition at the world's fair, to be given later to the MSI for permanent display. Professor Enrico Bompiani[17] was appointed official curator of the Italian exhibition in the Hall of Science, largely because in that period he was visiting professor at University of Chicago.

At this point, our story merges with the work of the engineer Guido Ucelli, who was founding a national industrial museum in Milan. As president of Riva e Calzoni Company,[18] a producer of turbines, pumps, and other mechanical components, Ucelli had already been involved with the organization of the Italian Exhibition of History of Science in Chicago by arranging the donation of three artifacts by Riva (including models of the turbines installed at the Niagara Falls hydroelectric power plant in 1899; Figure 1) and also with the exhibition of artifacts in connection with the recovery of the Roman ships from Lake Nemi in collaboration with the Ministry of the Navy (Figure 2).[19] Ucelli was involved in an official collaboration with the CNR for the Century

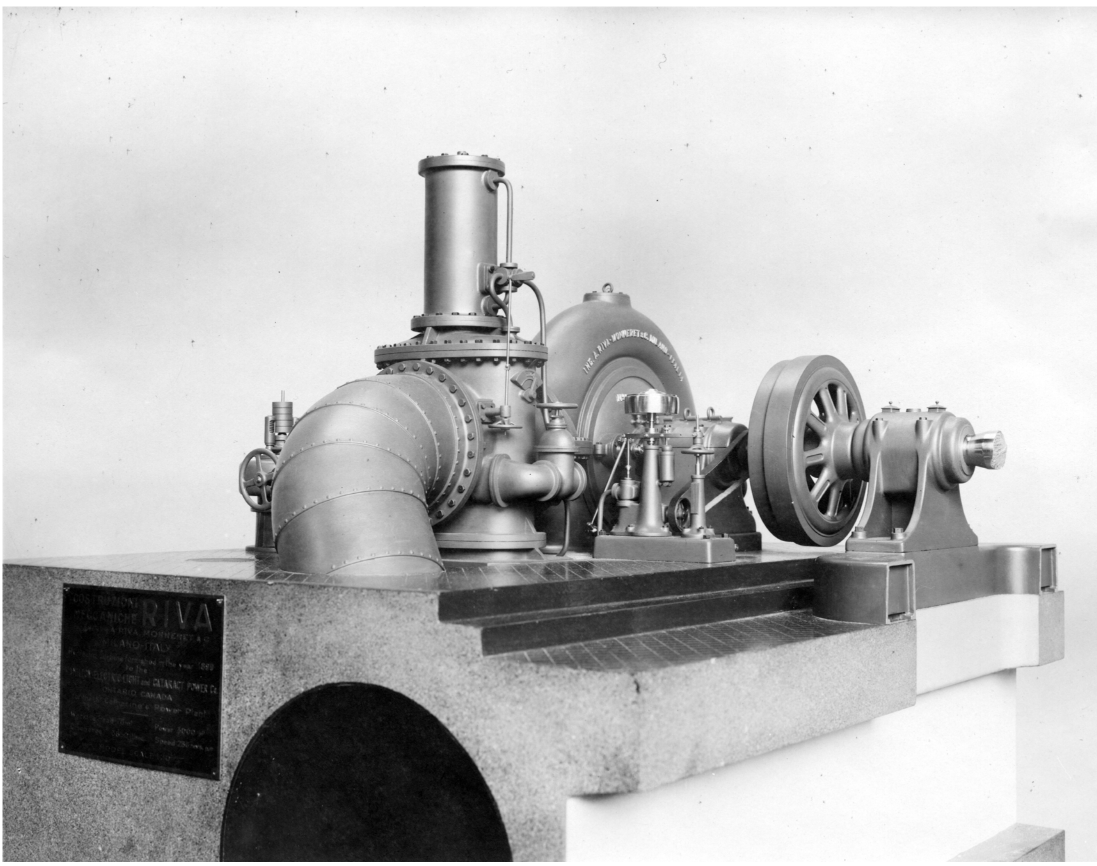

Figure 1. Model of Riva hydraulic turbine at Niagara Falls. © Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

Figure 2. Models of a Roman ship recovered from Lake Nemi and Roman architectural models displayed in Rome before the artifacts were displayed at the science exhibition at the 1933 Chicago World's Fair. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

of Progress World's Fair after a visit to the CNR secretary, Professor Giovanni Magrini, on 2 February 1932. The official invitation for Riva's participation was sent directly by Guglielmo Marconi in a letter dating 14 October 1932.

Before leaving for the United States, the artifacts were gathered and displayed in a building in Rome (at Via Crescenzio, 19), where they received official visits by King Vittorio Emanuele III and members of the government on 21 March 1933 (Figure 3). On this occasion an official film clip by the Istituto Luce was released, the only video documentation of these artifacts from the 1930s.[20]

Now that Italy's participation at the exhibition in the Hall of Science was confirmed, concerns about costs and expenses once more stymied the idea of a national pavilion. A preliminary pavilion design by the architect Fortunato Jerace was presented but not accepted. Then, just a few months before the beginning of the fair, a building design by the architect Adalberto Libera finally was approved.[21] The pavilion was designed to resemble a giant airplane, in celebration of Italo Balbo's transatlantic flight, which ended at the Century of Progress site in 1933. The front of the building sported a design that resembled the bundled fasces, the ancient symbol of the Roman Republic adopted by Fascism. Senator Ludovico Spada Potenziani, governor of the city of Rome, was appointed general commissary of Italy at the Chicago World's Fair.

Figure 3. The Consiglio Nazionale delle Ricerche artifacts displayed in Rome before leaving for the 1933 Chicago World's Fair. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

The CNR artifacts after the Chicago World's Fair

A very important document found in the MNST archives is crucial to identifying the list of artifacts to be given to the MSI: the "Report on Assignment of Exhibits Illustrating Italian Contributions to Science and Industry Presented by the Government of Italy" dated 16 July 1933 and signed by the Italian representative and Director Otto Kreusser. The document presents a summary of the exhibit sequences planned for the entire museum: (1) Fundamental Sciences; (2) Geology and Mineral Industries; (3) Agriculture, Textiles, and Forestry; (4) Power; (5) Road Transportation; (6) Rail Transportation; (7) Water Transportation; (8) Air Transportation; (9) Printing and Communication; (10) Architecture and Public Works. This sequence was followed by the catalog of Italian artifacts: 352 items, including physical objects and didactic charts, covering the entire course of Italian history, starting from plaster casts and models of the ancient Terramare civilization to a model of the contemporary SS *Rex* ocean liner, built in 1931. All periods were taken into consideration, with particular focus on the Roman civilization (construction and engineering), the late Middle Ages (crafts and labor-saving machines), the Renaissance (Leonardo da Vinci), the seventeenth century (Galileo and the Accademia del Cimento) (Figures 4, 5, and 6), and eighteenth- and nineteenth-century scientists (Figure 7), and, of course, the contemporary achievements of Fascist Italy. The document ends with a list of suggestions of future possibilities for collaboration in getting other exhibits from Italy. As was very clearly pointed out by this important list, the Italian CNR researchers wanted to describe a complete history of Italian science and technology; when it was not possible to use an artifact (whether replica or model) to describe a specific topic, a series of well-detailed "charts"—panels with iconography and text—were created as part of the list, treating them just like the actual objects. In fact, this is very well evidenced in the *Documentario* archive, where many folders are numbered with direct reference to the list of items in the Chicago exhibition, corresponding to an object or panel.

Returning to the MSI, we know that during the world's fair, at least one Italian artifact was already being displayed in the newly opened galleries: a Fiat motor is described in the catalog of the opening exhibition entitled *From Cave-Man to Engineer*, which, at best, represented the

Figure 4. Galilean inclined plane (replica; original at the Museo Galileo, Florence), 1932–1933. © 2018 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

Figure 5. Odometer by Accademia del Cimento (replica), Giulio Cipriani and Florentine workshop, 1932–1933. © 2018 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

Figure 6. Thermometer by Accademia del Cimento (replica; original at Museo Galileo, Florence), 1932–1933. © 2018 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

Figure 7. Death mask of Lazzaro Spallanzani (replica; original at Musei Civici, Reggio Emilia, Spallazani collection), 1932–1933. © 2013 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

idea of progress at the center of the fair.[22] With the closing of the second edition of the fair in the autumn of 1934, the CNR artifacts finally were moved, to the museum as planned.[23]

From the outset, the CNR had envisioned building four different series of the collection of artifacts to be given not only to the MSI, but also to the Deutsches Museum in Munich, the London's Science Museum, and the new National Museum of Technology and Industry in Milan planned by Guido Ucelli. In the end, however, only two or three samples of each artifact were created, and just the first collection, the one sent to Chicago, was complete. In the following years, the CNR developed the idea of the *Documentario*, which was curated by Giulio Provenzal and inaugurated on 20 November 1937 by Benito Mussolini as a permanent exhibition at the institution's headquarters in Rome.[24] This second group of artifact replicas was completed, and some of them were later displayed at the *Mostra di Leonardo da Vinci e delle Invenzioni Italiane* (the *Leonardo da Vinci and the Italian Inventions* exhibition) held at the Palazzo dell'Arte in Milan from May to October 1939, with the inventions part being curated by the CNR. The Sala delle Celebrazioni (Celebrations Hall), which was very well described in the fair's official guidebook, displayed many replicas, such as Galileo's telescopes and inclined plane, along with modern devices, including Marconi's detectors.[25] A topographical list found in the MNST archives reveals that during World War II the artifacts were stored in Rome: the majority were stored by Istituto Nazionale di Elettroacustica, while a part remained in the CNR's storage, and some even in Provenzal's office.[26]

Gathering the CNR Artifacts at the New Museum in Milan

After World War II, the development of the MSI and its galleries changed throughout the years. We know from a report[27] by the Italian engineer Silvio Levi and sent to Guido Ucelli, founder and president of the MNST in Milan, that in the early 1950s many of the Chicago museum's exhibits had already been taken off display and stored. From the same report, we know that the Milan museum was exploring the possibility of bringing these artifacts, or at least a selection of them, back to Italy. This museum opened officially in February 1953 with a grand exhibition celebrating the fifth centenary of Leonardo da Vinci's birth.

A letter from the Italian Embassy in Washington, D.C., to the CNR in Rome dated 26 October 1951[28] gives a very clear idea of the reasons why the most of the CNR artifacts (except for a few models of ships and airplanes) were no longer on display in the Chicago museum's galleries, but instead packed into 147 crates in storage. The museum confirmed that there was no viable chance for them to be returned to display: they were old-fashioned, of no further interest for museum visitors, and no longer conformed with new exhibition guidelines. The rhetoric of Italian achievements that had guided the creation and assembly of the artifacts in from 1932 to 1933 was clearly obsolete, even embarrassing, in Chicago. There was no sense any more in displaying the collection based on the autarchic spirit that animated it during the 1933 Chicago World's Fair. Currently, we do not know precisely which artifacts remained in the MSI, but surely the selection was quite limited, favoring artifacts with a certain importance from the point of view of the Chicago institution's agenda at that time, such as those related to telecommunications and Marconi's work on radio transmission. During my visit to the Chicago museum in 2006, I examined some replicas of Marconi's inventions in the historical galleries, constructed by the CNR for the Chicago World's Fair: a vertical aerial capacity plate and ebonite suspension insulators (Cat. no. 33.423) and a replica of the Righi transmitter and parabolic reflector (Cat. no. 33.428.1-2), both described as gifts from the Century of Progress.[29]

In Italy between the late 1940s and early 1950s, Ucelli was working on the new museum of science and the development of its collections and exhibition galleries. If these former CNR artifacts at the MSI were considered to have no further use or relevance owing to that museum's exhibition policies, a new course had been plotted for these objects in Milan. In Ucelli's conception, the collection could be very useful in documenting the history of science and technology up to the nineteenth century, and accordingly, his efforts in gathering historical objects focused on the industrial period, starting particularly with the Italian Unification in 1861. For this reason, he established a very close collaboration with the CNR,[30] which not only promoted the influx of artifacts, but also favored the CNR's entry as a financial contributor[31] to the museum, inaugurating the beginning of a joint cultural agenda even before the museum's official opening.

The CNR artifacts arrived at the Milan museum in three separate shipments, the first from Rome and the last from Chicago. The first 56 crates were shipped on 3 June 1947.[32] The second group was assigned to the museum only on 19 June 1950.[33] In those years, the museum was still under construction at the former Monastery of San Vittore so the material was stored at first by the Riva Company, used by Ucelli as a temporary address for the museum. The artifacts were shipped by the Gondrand Shipping Company, filling up two entire train wagons and arriving in Milan on 12 July 1950. Each artifact coming from Rome was identified with an inventory number, using a system later abandoned. The *Documentario* archive was shipped in December of the same year. Finally, a letter by the president of the CNR to Guido Ucelli dated 8 April 1952 authorized Professor Balint to commence operations for bringing the neglected artifacts back from Chicago to Milan in a third shipment.[34]

In the Milan collections, a replica of a given CNR artifact might appear in more than one exhibit. My conclusion in such instances is that one came from Chicago, and the other or others from the CNR in Rome. In one of Ucelli's first letters starting negotiations with the CNR for assignment of the artifacts stored in Rome, they are defined "duplicates," with the first selection sent to Chicago being considered "originals."[35] In many cases, one of the copies is in a noticeably worse state of conservation than the other.

On 1 October 1952, an inventory conducted of the CNR artifacts already stored in the Milan museum produced a list of 136 items without any chronological order. The actual number of objects in the list, is more than 136, however, because many of them have two or three copies. Many of the artifacts are described as "badly damaged" or have elements missing:[36] for example, the pantelegraph by Giovanni Caselli is recorded at position 47 with three copies (47a, 47b, 47c), the first being in good condition and the following two having parts broken or missing.[37] The artifacts shipped from Chicago to Milan therefore were already registered, and perhaps could be identified among the items showing most damage, resulting from being neglected while stored in the MSI, and then being shipped overseas from the United States. It is clear that both Ucelli and his staff had at that time no direct memory of the Chicago 1933 exposition, and none of them had participated directly with the CNR in the creation of the artifacts. Only Ucelli had a role, which was limited to the Riva models and the Roman ships from Lake Nemi. This made identification of the hundreds of objects and didactic panels a daunting task. A report on the subject dating 1 October 1952 describes these difficulties.[38] Many artifacts were damaged and some of them were completely broken, such as the replica of the glass thermometer from the Accademia del Cimento, or the huge plaster model of the harbor of ancient Rome that was designed by the architect Ghismondi and made up of ten blocks—all damaged. The majority of the panels and photographs were cut or torn. Some artifacts could be identified without problem, but many doubts remained in the identification of others. Some key objects were missing, such as the replica of the Amici microscope. The museum staff wished to receive more documents and photographs of the objects when on display in Chicago. The report also states that in the inventory of the CNR material, many elements such as supports for display cases and for panels were present but incomplete and without connection to the objects—and thus of limited usefulness for a future display. A selection of artifacts related to navigation (mostly models of ships) was given on long-term loan to the Civico Museo Navale Didattico (City Naval Museum), which was transferred in 1952 from the Castello Sforzesco to the same building as the museum.[39]

How did the museum use the CNR artifacts in the development of its exhibition galleries? During the aforementioned 1952 inventory and identification of artifacts, the Milan museum, not yet officially opened, was involved in preparations for the Leonardo da Vinci exhibition celebrating the fifth centenary of his birth. An extensive series of models was prepared, designed, and built based on interpretations of his drawings, with significant involvement of the Italian army, which studied, designed, and built most of the models.[40] In order to integrate the objects into the exhibition, there was the idea of using some of the CNR items. These artifacts and panels referred directly to Leonardo da Vinci's studies such as the models of navigable canal locks or the maps of the Pontine Marshes, or they were designed to make technological comparisons, especially in the area of Roman engineering, as with the models of the aqueduct at Aspendos, and of a Roman road. They also provided broader views on other aspects of Renaissance science, such as the model of Fabrizio d'Acquapendente's anatomical theater in Padua (Figure 8).[41] This interesting

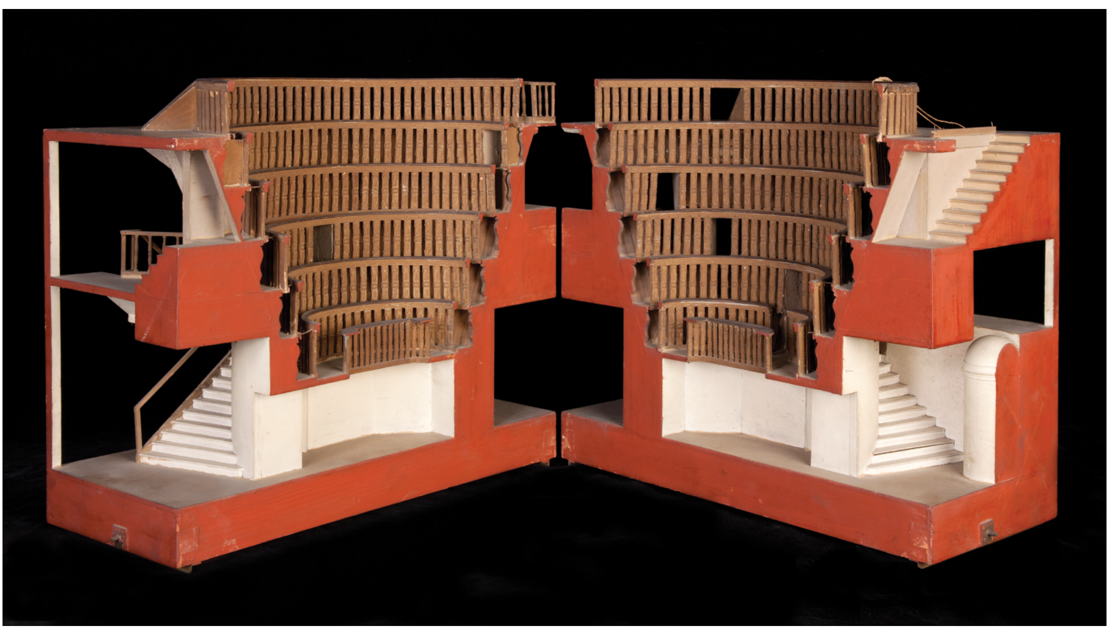

Figure 8. Model of Fabrizio d'Acquapendente's Anatomic Theatre, 1932–1933. © 2013 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

concept of using the artifacts to recreate the cultural background around Leonardo, however, never materialized, and the Leonardo exhibition was to come to life using only the models of his machines and related iconographic materials.[42]

What did happen starting in 1952 was that the artifacts began to progressively lose their identity as being connected with the Century of Progress exposition, their historical background, and, moreover, the *Documentario* archive. During the years that followed, a selection of objects was used to set up the museum's galleries, ranging from Telecommunications[43] to Physics and Transports. Later, the artifacts were registered in the museum's general inventory as being from the CNR as a general provenance but with no other historical references (Figure 9). All the other

Figure 9. Consiglio Nazionale delle Ricerche inventory plate. © 2013 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

Figure 10. Model of Alesia siege Roman fortifications according to *De Bello Gallico* by Julius Caesar, Museo del Genio Militare, 1932–1933. © 2013 Alessandro Nassiri. Leonardo da Vinci National Museum of Science and Technology (CC BY-SA 4.0).

artifacts, such as the plaster casts of works of arts, the models of works of Roman architecture, and many others were put into storage and never used or displayed (Figure 10). They received no inventory number and were transformed into "ghost" artifacts, with no meaning or importance for the development of the museum in the decades to follow, much as happened to them previously in Chicago.

Only at the beginning of the twenty-first century, along with the project of reordering the contents of the museum storehouses, did these artifacts begin to be reconsidered, registered, and studied, and in some cases even, to receive conservative treatment. A very important step in this "renaissance" was the project of reordering the museum and the CNR archives in the early 2010s, allowing for a new start in historical research on the provenance of the objects. A complete inventory and inspection of the objects in the collection is still awaiting a general research project, but certainly the CNR artifacts are now in line for a positive future. Many of them, among the most neglected in the last decades and never displayed, will be part of the monumental project of the new Leonardo da Vinci Galleries, to be carried out for 2019 in celebration of the fifth centenary of his death, and finally bringing to fruition the 1952 idea of showcasing them.

Studying this interesting episode in depth has made it possible not only to reconstruct the history and provenance of these artifacts but also to highlight some interesting issues. The first is the close relationship between politics and culture in the Fascist government's propaganda strategy and the role of diplomacy in creating connections among the Italian Ministries of Foreign Affairs and National Education, the Chicago Museum, and the World's Fair Organization. The second is the way in which this collection of artifacts was created: as a way to enrich a U.S.

museum collection and to populate a future Italian national museum of science and industry. The latter is the common direction in which scientific museums were moving, inspiring each other, starting from the first institutions of that kind, the Science Museum in London and the Deutsches Museum in Munich. Within this framework, the birth of the MSI and the MNST in Milan were strongly linked, in having resulted from the same inspiration in the 1930s, when the first was opened and the second conceived. At the same time, after only 20 years, their destinies began to diverge: while the first was already transforming, rejecting a collection deemed old-fashioned and irrelevant, the second was just opening, embracing the idea of showcasing the collection for the development of its exhibits.

Notes

1. The Century of Progress World's Fair has been broadly studied in these last decades and its bibliography is extensive. Among the most recent contributions, and for complete bibliography, see C. R. Ganz, *The 1933 Chicago World's Fair: Century of Progress* (Urbana: University of Illinois Press, 2008) and L. D. Schrenk, *Building a Century of Progress: The Architecture of Chicago's 1933–34 World's Fair* (Minneapolis-London: University of Minnesota Press, 2007). For official archival materials about the Chicago World's Fair see *A Century of Progress Records, 1927–1952*, conserved in the Special Collections and University Archives Department, University of Illinois at Chicago Library.
2. Ganz, *The 1933 Chicago World's Fair*, 1–5.
3. *Official Guide: Book of the Fair* (Chicago: published by A Century of Progress Administration Building, 1933), 11.
4. *Official Handbook in the Division of the Basic Sciences: Hall of Science* (Chicago: Century of Progress, 1934). Among the U.S. museums, institutions, and societies that helped compile the exhibits in the Hall of Science: Buffalo Museum of Science, University of California, Harvard University, Columbia University, American College of Surgeons, U.S. Navy, Westinghouse. Among foreign institutions: Wellcome Research Institution, London; Pasteur Institute, Paris; the Robert Koch Institute, Berlin.
5. See K. A. Rader and V. E. M. Cain, *Life on Display: Revolutionizing U.S. Museums of Science and Natural History in the Twentieth Century* (Chicago: The University of Chicago Press, 2014).
6. A large series of documents as well as leaflets, guidebooks, and other material about the Century of Progress World's Fair can be found in the archives of the Museo Nazionale della Scienza e della Tecnologia (MNST), *Fondo Musei*, Musei Americani, 1929–1976; *Fondo Museo*, Mostre ed Esposizioni.
7. Giuseppe Castruccio (11 September 1887–3 June 1985, Genova). When young, he played for the Genoa Soccer team. He graduated in chemistry in 1910 and for a short period was assistant professor of chemistry and physics at Genova University. During World War I, he enrolled in aeronautics and became an airship pilot. In 1917, he saved the M-10 Airship during a bombing operation and received a gold medal for military valor. In 1926, he left aeronautics, entering the Ministry of Foreign Affairs. While he was a consul in Chicago from 1928 to 1935, he went to Sao Paulo, Brazil, and during World War II, he was a consul in Istanbul and Thessaloniki. During the Chicago World's Fair, he was also mainly responsible for the Italo Balbo Italian Formation Flight from Rome to Chicago.
8. The Museum of Science and Industry, Chicago (MSI) was founded by businessman and philanthropist Julius Rosenwald, and for many years it was referred to as the "Rosenwald Industrial Museum" even though it never had an official dedication as such. The building hosting the new museum was the Palace of Fine Arts, designed for the Columbian Exhibition of 1893. The MSI opened together with the Century of Progress World's Fair in 1933, one year after the death of Julius Rosenwald. For an interesting overview of the museum's vision before its opening, see W. Kaempffert, "The Museum of Science and Industry founded by Julius Rosenwald: An Institution to Reveal the Technical Ascent of Man," *The Scientific Monthly*, June 1929.
9. Kaempffert's letters are mentioned in the Archivio Storico Diplomatico della Farnesina, Rome, Affari Politici 1931–1945, folder 2.
10. This second group of documents is in the Archivio Storico Diplomatico della Farnesina, Rome, Affari Politici 1931–1945, folder 7.
11. Henry Crew (4 June 1859–17 February 1953) was an American physicist and astronomer born in Richmond, Ohio. He graduated in physics from Princeton University in 1882. In 1883, he traveled overseas for a semester to study physics in Berlin. Three years later he was awarded a Ph.D. in physics with a thesis on *Doppler Determination of the Rotation Period of the Sun for Various Heliocentric Latitudes*. In 1892, he was awarded the position of professor of physics at Northwestern University, which he accepted. He would remain at that post until he retired 41 years later in 1933. In 1930, he was granted leave from Northwestern to accept an appointment at the Century of Progress International Exposition staged in Chicago, where he was chief of the Division of Basic Sciences.
12. Castruccio, in a later report, referred to Antonio Meucci as a "victim of Bell."
13. The Accademia Nazionale delle Scienze, detta dei XL, was founded in 1782 by the 40 most-distinguished members of the Italian scientific society, including Alessandro Volta, Lazzaro Spallanzani, and Ludovico Lagrange. In 1875 the society headquarters moved from Modena to Rome. In Fascist Italy, the academy was subjected to the "Revision of Statutes and Regulations of the Cultural Institutions" imposed by the regime. In fact, it was brought under the supervision of the Ministry of National Education.

14. On the birth of the Museo di Storia della Scienza and its role in the preparation of the CNR artifacts, see M. Beretta, "Andrea Corsini and the Creation of the Museum of the History of Science in Florence (1930–1961)," in *Scientific Instruments on Display*, ed. S. Ackermann, R.L. Kremer, and M. Miniati (Leiden: Brill, 2014), 1–36. As Beretta remarks, the replicas made and sent to Chicago included: telescopes, a thermoscope, and a verge escapement mechanism constructed by Galileo; a barometer by Torricelli; a hygrometer devised by Ferdinando II; an odometer and several thermometers by the Accademia del Cimento (see Figures 4, 5, and 6); Nobili's galvanometer; a telescope lens by Torricelli; a model of Bregans's double lens; the apparatus devised by Macedonio Melloni for studying infrared rays; Giovanni Amici's direct vision prism and microscope objectives; Barsanti and Matteucci's engine prototype.
15. The *Documentario* archive remained in the CNR headquarters in Rome until December 1950, when it was donated to the MNST in Milan. The archive contains 1,700 folders ordered by subject and 1,200 folders ordered by author. The story of the *Documentario* and its connections with the establishment of the MNST in Milan have been recently studied by R. Reali, *Materiali dell'Archivio Museo della Scienza: Appunti* (typewritten article in the MNST Library) and E. Canadelli, "Le macchine dell''ingegnere umanista'. Il progetto museale di Guido Ucelli tra Fascismo e Dopoguerra," *Physis* 51, no. 1–2 (2016): 93–104. On the same theme see also G. Paoloni, R. Reali, and L. Ronzon, eds., *I "primati" della scienza. Documentare ed esporre scienza e tecnica tra fascismo e dopoguerra* (Milan: Hoepli, 2018).
16. G. Provenzal, *Il primato scientifico degli italiani* (Rome: Società Italiana per il progresso delle scienze, 1938).
17. Enrico Bompiani (12 February 1889–22 September 1975, Rome) was an Italian mathematician. He studied at Sapienza University with Guido Castelnuovo, where he received his Ph.D. in geometry. He taught in many Italian universities, mainly at Sapienza in Rome. He was also visiting professor at Chicago University from 1930 to 1934. From 1926 to 1959 he was in the advisory board for the CNR committee for physics and mathematics.
18. For the life of Guido Ucelli (born 25 August 1885 in Piacenza, died 23 August 1964 in Milan), his role in the cultural life during the Fascist regime, the recovery of the Roman ships from Lake Nemi, and the founding of the MNST in Milan, see *Guido Ucelli di Nemi: industriale, umanista, innovatore* (Milan: Hoepli, 2011) and Canadelli, "Le macchine dell''ingegnere umanista.'"
19. Guido Ucelli's involvement in the Century of Progress exposition is documented starting from June 1931 (MNST archive, Museo Industriale, Esposizioni, Esposizione di Chicago 1933, box 18). Materials about the Riva contribution to the Chicago World's Fair can be also found in MNST archive, *Musei*, Chicago Museum of Science and Industry, Esposizione 1933, Partecipazione Riva. Ucelli also acted as intermediary in collecting artifacts from other companies to be displayed in Chicago, such as Ansaldo Genova. However, he never visited the fair.
20. Giornale Luce B0236 03/1933 "A Roma S. M. il Re visita la Mostra dei Cimeli che l'Italia invierà alla esposizione mondiale di Chicago. Dall'arte delle fortificazioni alla meccanica della cartografia alla navigazione aerea. L'Italia può mostrare il suo costante primato nel campo delle scienze," Archivio Luce, https://patrimonio.archivioluce.com/luce-web/detail/IL5000009423/2/a-roma-s-m-re-visita-mostra-cimeli-che-l-italia-inviera-alla-esposizione-mondiale-chicago-dall-arte-fortificazioni-alla-meccanica.html?startPage=0&jsonVal={%22jsonVal%22:{%22query%22:[%22cimeli%20chicago%22],%22fieldDate%22:%22dataNormal%22,%22_perPage%22:20}} (accessed 25 May 2017).
21. In fact, due to lack of time, the pavilion worked only as a center for promoting tourism, with a restaurant inside.
22. W. Kaempffert, *From Cave-Man to Engineer: The Museum of Science and Industry founded by Julius Rosenwald. An Institution to Reveal the Technical Ascent of Man* (Chicago: 1933), 67.
23. It would be interesting to research whether the Chicago museum had relationships with other countries and foreign cultural institutions for the acquisition of artifacts at the beginning of its life. At the current state of studies, the CNR artifacts were the only collection acquired by the museum from a foreign institution, thanks to the Century of Progress World's Fair.
24. The exhibition was displayed in eight rooms, with the following themes: (1) Mathematics, Astronomy, Navigation, Exploration, and Geography; (2) Physics and Chemistry; (3) Natural Sciences and Reclamation; (4) Public Works and Engineering; [sic] (6) War; (7) Italian Navy; and (8) Aeronautics and Aviation. See G. Provenzal, *Il documentario dei primati scientifici e tecnici italiani* (Rome: Società Italiana per il Progresso delle Scienze, 1938).
25. *Mostra di Leonardo e delle Invenzioni. Guida Ufficiale della Mostra delle Invenzioni* (Milan: 1939), 11–19. This exhibition is currently under study for future publication.
26. MNST archive, *Museo Industriale*, Esposizioni, Materiali Ex Documentario CNR, box 17: "Elenco del materiale del 'Documentario' esistente nel magazzino dell'Istituto Nazionale di Elettroacustica trasportato dai magazzini del CNR."
27. MNST archive, *Musei*, Chicago, various publications.
28. MNST archive, Corrispondenza, I Serie, Consiglio Nazionale delle Ricerche (1), box 18. In the previous letter written on 6 March 1951 by the CNR to the cultural attaché of the Italian Embassy, we read: "After the closure of the Fair, all the material was allocated to the Chicago Museum, where is still stored nowadays, neglected and ignored, waiting for a future destination."
29. While writing this article, I tried to contact the Museum of Science and Industry curators and received no answer.
30. The first reference to Guido Ucelli's desire to use the CNR artifacts as part of the objects to be displayed in the Milan museum is found in a letter written on 9 July 1946, in MNST archive, Corrispondenza, I Serie, Consiglio Nazionale delle Ricerche (1), box 18.
31. For the first years of life of the museum, the CNR participated also in the costs of maintenance with an annual fund of £8,500,000 (Italian lire).
32. A list of the first 56 crates with inventory numbers was already prepared on 3 June 1946: "Elenco delle casse spedite al Museo della Tecnica di Milano e relative numeri d'inventario segnati sulle casse stesse," in MNST archive, *Museo Industriale*, Esposizioni, Materiali Ex Documentario CNR, box 17.
33. From the MNST archive, *Museo Industriale*, Esposizioni, Materiali Ex Documentario CNR, box 17, we know that the artifacts, together with some panels, were packed in 67 crates: "Elenco del materiale, ex documentario, contenuto in 67 casse, destinato al Museo della Tecnica di Milano." I think this list was prepared in Rome before shipping. According to the list, every crate contained many artifacts, some even more than 10, with no chronological or typological order.

34. All the documents about the arrival of the *Documentario* artifacts and archive are in MNST archive, Corrispondenza, I Serie, Consiglio Nazionale delle Ricerche (1), box 18.
35. MNST archive, Corrispondenza, I Serie, Consiglio Nazionale delle Ricerche (1), box 18.
36. *Elenco di prima ricognizione del materiale proveniente dall'ex documentario C.N.R. 1933 e giacente presso il Museo*, in MNST archive, Depositi, Materiali in deposito permanente, box 1.
37. The conservation problems of the pantelegraph artifacts influenced their future use. The one in good condition was displayed in the new telecommunications gallery, while the other two were kept in storage; their conservation status, even today, is very precarious.
38. In MNST archive, *Museo Industriale*, Esposizioni, Materiali Ex Documentario CNR, folder 17.
39. The two museums, MNST and Museo Civico Navale, shared the same building until their collections were united in 2000.
40. For the story of the collection of Leonardo models, see C. Giorgione, "The Birth of a Collection in Milan: from the Leonardo Exhibition of 1939 to the Opening of the National Museum of Science and Technology in 1953," *Science Museum Journal* 4 (2015), http://dx.doi.org/10.15180/150404.
41. The list of materials is in the MNST archive, Corrispondenza, I Serie, Consiglio Nazionale delle Ricerche (1), box 18.
42. This idea will now be realized, with the new Leonardo da Vinci Galleries scheduled to be completed in 2019, when many of the CNR artifacts not seen during the last 80 years will finally be displayed.
43. In the list of artifacts to be displayed in the new Marconi Room and Telecommunication Galleries in 1956, the 1933 CNR artifacts were already confused with the ones coming from the *Elettra* ship and given on temporary loan by the CNR, only in the same year.

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CHAPTER 6

Astronomy between Solemnity and Spectacle

The Adler Planetarium and the Century of Progress Exposition in Chicago (1933–1934)

Pedro M. P. Raposo
Curator and Director of Collections
Adler Planetarium
Chicago, Illinois, USA

In the evening of 27 May 1933, a crowd of 30,000 gathered in a field known today as the natural area Northerly Island in Chicago to attend the official ceremonies of the opening of A Century of Progress International Exposition. The crowd stood in an open-air court in front of the Hall of Science, one of the main buildings at the world's fair. Those who did not find a place in the busy court could hear the proceedings through speakers scattered throughout the fairgrounds, and those unable to come to the fair still had the chance to follow the festivities being broadcast on radio.

A concert by the Chicago Symphony Orchestra, featuring a 2,500-voice choir and the famous baritone Lawrence Tibbett as a soloist, was followed by a series of speeches. The speakers were the prominent businessman and head of Century of Progress, Rufus C. Dawes (1867–1940), and the astronomers Edwin B. Frost (1866–1935) and Philip Fox (1878–1944). Frost was a former director of the University of Chicago's Yerkes Observatory in Williams Bay, Wisconsin; Fox was the director of the nearby Adler Planetarium and Astronomical Museum, which had opened to the public three years before and now featured as a major attraction in Century of Progress.

Next was a spectacular stunt that connected earth and sky. An illuminated panel above the rostrum showed the location of four astronomical observatories: Yerkes Observatory of the

University of Chicago in Williams Bay, Wisconsin; Harvard College Observatory in Cambridge, Massachusetts; Allegheny Observatory of the University of Pittsburgh; and University of Illinois Observatory in Urbana. Philip Fox took the lead. After each observatory was pronounced ready, the respective mark was encircled on the map. Then a star appeared in the center of a flaming circle. Finally, a switch was thrown, triggering a searchlight at the top of the Hall of Science. The white beam started to move slowly from one building to another. Upon being touched by the beam, each building burst into a colorful display of light.

If this was not spectacular enough, the electric current that triggered the show had originated in space, more specifically in the star Arcturus, one of the brightest and easiest to identity in the spring sky from Chicago's latitude. Its light had been captured at Yerkes Observatory (the other three observatories served as backups) with a photoelectric cell attached to its 40-inch refracting telescope. The resulting electric signal was then relayed to the grounds of Century of Progress via the telegraph wires.[1] At the time, Arcturus was reckoned to be 40 light-years away, meaning that the light used to illuminate Century of Progress had left the star when Chicago was hosting its first world's fair, the Columbian Exposition of 1893.

Century of Progress was probably the most "astronomical" of all world fairs. Not only did it open with a major astronomical trick, but it also showcased the first modern planetarium in America, which was fashioned as a full-fledged astronomical museum. The Adler Planetarium and Astronomical Museum (later the Adler Planetarium and Astronomy Museum, and today the Adler Planetarium), named after the businessman and benefactor Max Adler (1866–1952), had opened to the public on 12 May 1930. Besides hosting the first planetarium projector in America (a Zeiss Mark II), it also sported a magnificent collection of historical scientific instruments known as the Mensing Collection.

The Mensing Collection has traditionally been seen as fancy appendage to what would otherwise be considered just a venue for scientific shows. The original name, Adler Planetarium and Astronomical Museum might have contributed to that perception. The first volume of the catalog series of the planetarium's collections states that "in 1930, when the Adler Planetarium opened to the public, its facilities included an astronomical museum."[2] But Philip Fox actually wanted the institution to be regarded as comprehensive museum of astronomy. He clearly stated in a guide of the planetarium that "though this Chicago institution bears a double name and is commonly referred to as the Planetarium, it is in reality an Astronomical Museum of which the Planetarium instrument is the principal exhibit."[3]

It has been suggested that the purchase of the Mensing Collection could have been motivated by a warning from a Northwestern University librarian that the planetarium might become a venue for "canned astronomy"—that is, a sort of astronomical cinema for entertainment rather than proper scientific education.[4] Another account highlights the element of emulation. In his youth, Philip Fox spent one year studying at the University of Berlin and the Potsdam Observatory, developing a great respect for German culture and science. More than two decades later, after visiting the Mathematisch-Physikalischer Salon in Dresden and seeing the splendid collection of scientific instruments there, he would have felt the desire to see something similar in Chicago.[5] Fox did write that the Mensing Collection was comparable to the "gemlike collection" at Dresden, but he also referred to the collections of the Ashmolean Museum in Oxford (now in the Museum of the History of Science), the Science Museum in London, the Conservatoire des arts et métiers in Paris, and the Deutsches Museum in Munich.[6]

It is not likely that the cultural concerns expressed by a librarian, no matter how learned and prominent, would per se lead Fox into persuading Max Adler to provide additional funds for acquiring the Mensing Collection. And it is also clear that, even if the Dresden collection held a special fascination for Fox, he sought inspiration from a wider roll of European museums. Rather than an afterthought or a simple instance of direct emulation, the acquisition of the Mensing Collection should better be regarded as use of an exceptional opportunity for fully realizing the concept of the new planetarium as a proper museum—an idea that seems to have evolved gradually between Fox and Adler.

In fact, Max Adler's original intention was to sponsor the installation of a Zeiss projector at the Museum of Science and Industry (MSI), which started to be planned in Chicago in 1926 under the patronage of Adler's brother-in-law, businessman Julius Rosenwald (1862–1932). Successive delays in turning the old Palace of Fine Arts of the Columbian Exposition into the premises of the new science museum led Max Adler to look for other possibilities. The decision to locate the planetarium in Northerly Island, close to the Field Museum and the Shedd Aquarium, gave Adler the chance to inscribe his name on an entire innovative cultural institution and gave director-to-be Philip Fox some leeway to shape it into a proper astronomical museum. Most important, while developing the plans for the planetarium, both Adler and Fox knew that a major world's fair was to take place in that very same area, an aspect that has generally been overlooked in accounts of the early history of the planetarium.

The early affirmation of the Adler Planetarium and Astronomical Museum should not be reduced to the antagonism of cultural credibility versus entertainment. Adler, and especially Fox, actively sought a compromise between the solemnity of a science museum with a valuable collection and the fair atmosphere of spectacle and entertainment of Century of Progress—a major event in Chicago history that they had helped organize. Also, the acquisition of the Mensing Collection, and more generally Philip Fox's concept for the Adler Planetarium and Astronomical Museum, might have been influenced by the preparation of Century of Progress, which provided an outstanding opportunity to showcase America's first modern planetarium in local, national, and even international contexts.

An Astronomical Museum in Chicago

The Adler Planetarium and Astronomical Museum (Figure 1) opened to the public on 12 May 1930, to coincide with the birthday of its benefactor, Max Adler. It was the very first time that a projection planetarium was put to work on a regular basis in America.

Figure 1. The Adler Planetarium in its early days, c 1930. Adler Planetarium archives.

The modern projection planetarium resulted essentially from the convergence of two streams of modeling, visualization, and communication technologies in astronomy: the production of mechanical models to replicate celestial motions,[7] and the communication of astronomical concepts and ideas with the aid of optical devices such as the Eidouranion (transparent orrery) and the magic lantern (image projector).[8] The concept of projecting the celestial bodies and their motions on a dome was put forward by Walter Bauersfeld (1879–1959) of the German optical firm Zeiss. It was a response to a request from Oskar von Miller (1855–1934), the director of the Deutsches Museum in Munich, who wished to realize the concept a hollow sphere capable of demonstrating celestial motions to an audience sitting inside it. The first planetarium projector started to be constructed in 1919. In 1924, after some test performances, it was placed inside a 9-meter dome at the Deutsches Museum and put to use on a regular schedule of demonstrations.[9] The first projector, known as Zeiss Mark I, was never mass-produced, but an improved version, Zeiss Mark II, soon started to be sold to many emerging planetaria in Europe and the United States.

By the time the Adler Planetarium and Astronomical Museum opened to the public in Chicago, some fifteen planetaria had been established in Europe.[10] Only six other planetaria would be founded in the United States until World War II.[11] The idea of giving a planetarium to the city of Chicago came from the wife of Adler's German teacher of violin in Berlin, Suzanne Joachim.

Trained as a musician, Adler became a vice president and general manager at Sears, Roebuck and Co. after he married the sister of the company's chief executive officer and the patron of MSI, Julius Rosenwald.

The MSI was significantly inspired by the Deutsches Museum and, thus, seemed to be a natural host for a Zeiss projector. But this plan proved difficult to implement, so Adler redirected his energy to place the new planetarium next to the Field Museum and the Shedd Aquarium, which opened to the public roughly two weeks after the planetarium. His proposal was accepted in June 1928, with Adler donating an initial $500,000.[12] In the words of Philip Fox, the three museums formed a "trinity: the heavens above, the Earth beneath, and the waters under the Earth."[13]

The original planetarium building was designed by architect Ernst Grunsfeld (1897–1970), a cousin of Max Adler. The building, which garnered Grunsfeld an award, was shaped as a dodecagon and topped by a copper dome, inside of which sat another dome made of several pieces of canvas supported by a frame. It was onto this internal dome that the sky was projected. In the middle of the room stood the Zeiss Mark II projector (Figure 2).

The noteworthy art deco appearance of the building is enhanced by the external walls of gneiss and by 12 bronze zodiacal signs by the sculptor Alfonso Iannelli (1888–1965), which

Figure 2. The Adler Planetarium's Zeiss Mark II projector in its original settings. Adler Planetarium archives.

are placed along the building's corners, thus representing the apparent annual path of the sun through the celestial sphere.[14] Iannelli also designed a set of sculptures depicting the planets, and a plaque presenting the three-fold vision of Max Adler for the planetarium: it would help advance science, make astronomical knowledge accessible to everyone, and serve as a reminder that everything is interconnected under the heavens. The order of the heavens thus served as a metaphor for social order and peaceful coexistence of different social groups, a message of increasing significance as the effects of the Great Depression became more visible.

Similar to other U.S. planetarium sponsors such as Charles Hayden (1870–1937) and Henry Buhl (1848–1927), Adler had not shown any particular interest in astronomy prior to the undertaking. The actual scope and content of the new planetarium-museum was conceived mainly to by Philip Fox (Figure 3), a professor of astronomy and director of the Northwestern University's Dearborn Observatory by the time he agreed to become the planetarium's first director. Fox travelled to Europe in the summer of 1929 in order to visit its principal museums and planetaria. Apparently by then he had become interested in antique scientific instruments and his vision for the Chicago planetarium as a full-fledged museum of astronomy effectively started to gain shape.

As far as the demonstrations with the Zeiss Mark II projector are concerned, it seems that Fox's experience as a professor of astronomy provided the main orientation. He structured the

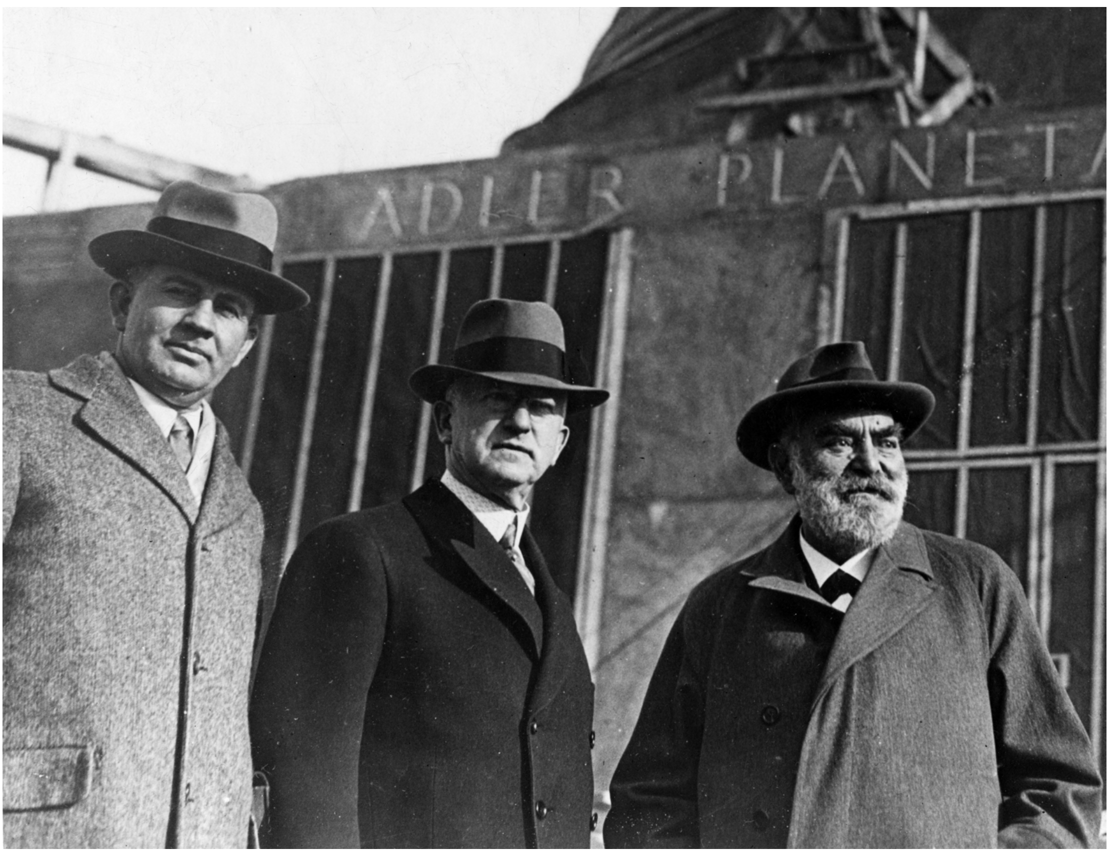

Figure 3. Philip Fox (left), who conceived much of the original content of the Adler Planetarium, with benefactor Max Adler. Adler Planetarium archives.

program of regular demonstrations as series of 12 topics, one for each month, with some of the themes bearing a direct connection with the respective time of year.[15] The lectures were independent of one another and meant to be accessible to the general public. Those who returned systematically and followed the 12 demonstrations would have attended a sort of introductory course to astronomy. This practice would become common in U.S. planetaria.[16]

The Chicago planetarium held demonstrations daily, with at least two demonstrations each day.[17] The lecturer guided the audience using an optical pointer that projected the image of an arrow onto the dome. The Zeiss Mark II instrument had also come with a new feature to show variable stars, and received some additional accessories to reproduce eclipses, meteor showers, and aurorae. There was also an auxiliary projector for lantern slides. The connection to the local milieu was emphasized by the addition of a silhouette with Chicago's skyline.

All demonstrations included a description of the instrument involved. Standing in the middle of the dome with its intriguing profile, the Zeiss Mark II projector constituted an attraction in itself. It was a feat of mechanics and projection technology in association with astronomical science. And it is important to bear in mind that, at the time, the device was a novelty, especially in the United States. This is certainly the reason why Fox described it in minute detail in a presentation of the Adler Planetarium and Astronomical Museum published in *Popular Astronomy* in 1932.[18]

Planetarium visitors were also presented with a number of displays intended to provide a fuller picture of the historical advancement of astronomy and its contemporary developments. The Mensing Collection was a major feature in these displays (Figure 4). Around September 1929, Fox became aware of a collection for sale by Dutch antiques dealer Anton W. M. Mensing.

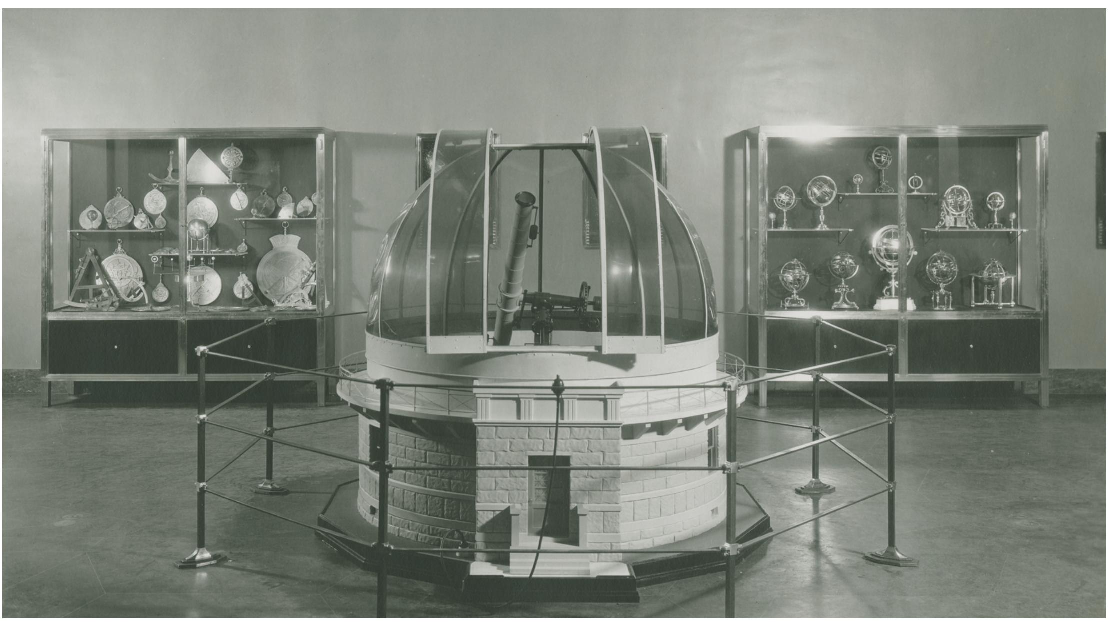

Figure 4. Observatory model and historical scientific instruments on display at the Adler Planetarium, c. 1932. Adler Planetarium archives.

The collection included remarkable examples of astronomical and mathematical instruments dating from the late-fifteenth to the late-eighteenth century. The acquisition of the Mensing Collection by the planetarium was agreed upon by late December. In January 1930, Fox travelled to Europe again to examine the collection and complete the transaction. The instruments (a total of 553, in 498 lots) arrived in Chicago two months later, just in time to be put on display at the new planetarium.[19]

Fox's assistant, astronomer Maude Bennot (1892–1982), coordinated the displays of historical instruments, which included items from the Mensing Collection and some noteworthy additions, such as a telescope made by William Herschel (the discoverer of Uranus) that was a gift from the Astronomer Royal of England. The historical displays consisted mostly of cabinets showing instruments more or less organized by type and function. They were concentrated in the planetarium's upper floor, in the halls surrounding the dome. In the same area, visitors could also find astronomical photographs in the form of transparencies. The transparencies included some of the best photographs of solar system and deep-sky objects from well-equipped U.S. observatories (Yerkes, Mount Wilson, Lowell, Lick, Harvard, University of Michigan, and Dearborn at Northwestern University). Images from the observatories of Greenwich (United Kingdom) and Meudon (France) were eventually added. Additional exhibits in the upper floor included a model of an observatory dome with a telescope, based on the U.S. Naval Observatory, and a model of the Mount Wilson Observatory, by then one of the most advanced astrophysical observatories in the world.

Exhibits on the planetarium's ground floor were focused mainly on modern astronomy. The most striking artifact on display was the Dearborn refractor, an 18.6-inch-aperture telescope built in the early 1860s that held the record for the largest telescope in the world for roughly a decade. Initially set up at the Old University of Chicago in Douglas Park then relocated to the Dearborn Observatory at Northwestern University, the instrument—or more precisely its original mount and tube—ended up in the Adler Planetarium and Astronomical Museum.[20]

It was part of a number of exhibits highlighting the contributions of Chicago's institutions and scientists to contemporary astronomy, which also included the mounting and tube of a telescope used by Sherburne W. Burnham (1838–1921) in his double-star observations, and medals celebrating the work of Edward Emerson Barnard (1857–1923). In the same area, visitors could also learn how time was found from star observations, as explained in a display featuring a transit circle on loan from the Harvard Observatory.

The public responded well to the new museum, which featured a machine capable of bringing the heavens indoors. The museum's attendance during its first year was 731,108 people; the million visitor mark was surpassed on the 479th day of operation. The average daily attendance for its first two years was 1,704.[21] Even taking into account that many visitors may have come back regularly to follow the annual lecture cycle, these numbers are remarkable, particularly as the early activity of the planetarium coincided with the onset of the Great Depression and accessing its somewhat far-off premises could be challenging. This would change dramatically with the inclusion of the planetarium in the Century of Progress exposition, which not only brought millions of visitors to the area, but also conveyed a message of hope to a Depression-ridden America.

"Science Finds, Industry Applies, Man Conforms"

In 1927, the industrialist Rufus Dawes became president of the Board of Trustees of the newly chartered "Chicago Second World's Fair Centennial Celebration committee." Century of Progress was the second world's fair hosted in Chicago, after the Columbian Exposition of 1893. The Columbian Exposition was held on the South Side of Chicago (near the present campus of the University of Chicago) from 1 May to 30 October 1893. Its overarching theme was the 400th anniversary of Columbus's journey to the New World, but above all it showcased and celebrated the economic and industrial growth of the United States during the nineteenth century.[22]

While the Columbian Exposition focused on the past, sporting an impressive array of neoclassical buildings that earned the fair the nickname "the White City," Century of Progress was more forward looking. It was originally meant to celebrate the centenary of Chicago's incorporation as a town in 1833. The leading astronomer George E. Hale (1868–1938), former director of the Yerkes and Mount Wilson observatories and a prominent figure in the U.S. National Research Council, suggested focusing the fair on the services of science during the past 100 years.[23] Above all, Century of Progress was to showcase the marvels of a brilliant future powered by science and technology in alliance with industry. The spirit of the exposition was summed up by the motto "Science Finds, Industry Applies, Man Conforms."[24]

Similar to other North American fairs of the Depression era,[25] Century of Progress became a cultural icon of America's hopes and futures. European and British world's fairs tended to stress the development of empire; U.S. fairs were more focused on science, technology, and the modern corporation as the key to a better future.[26]

Century of Progress was initially held from May through November 1933; due to high demand, it reopened for a second season between May and October 1934. Its main building was the aforementioned Hall of Science. Like most of the principal buildings at the exposition, it was a modernist structure with practically no windows, relying on artificial lighting. Light and color were, in fact, two essential elements in Century of Progress, reinforcing its message of hope and techno-scientific optimism in times of economic crisis (Figure 5).

The Hall of Science was decorated with allegorical sculptures of mythic figures representing concepts such as energy and light. Before entering the building, visitors coming through the main entry encountered a large sculpture named *Man Combating Ignorance*, which featured a heroic figure slaying a serpent (Figure 6).[27] Inside the Hall of Science, a number of exhibits and demonstrations highlighted the unit of mathematics, physics, chemistry, biology, and geology. Medical exhibits were also included.[28]Astronomical exhibits were noticeably scant, consisting solely of a model of Galileo's telescope, a few transparencies of a spiral nebula taken with the Mount Wilson reflector, and two movies: *A Motion Picture Journey to the Moon*, and *The Solar*

Figure 5. A display of light and color around the Electrical Building (with exhibits celebrating electricity and its commercial applications) at the 1933 A Century of Progress Exposition. From *A Century of Progress Official Guide*, Adler Planetarium library.

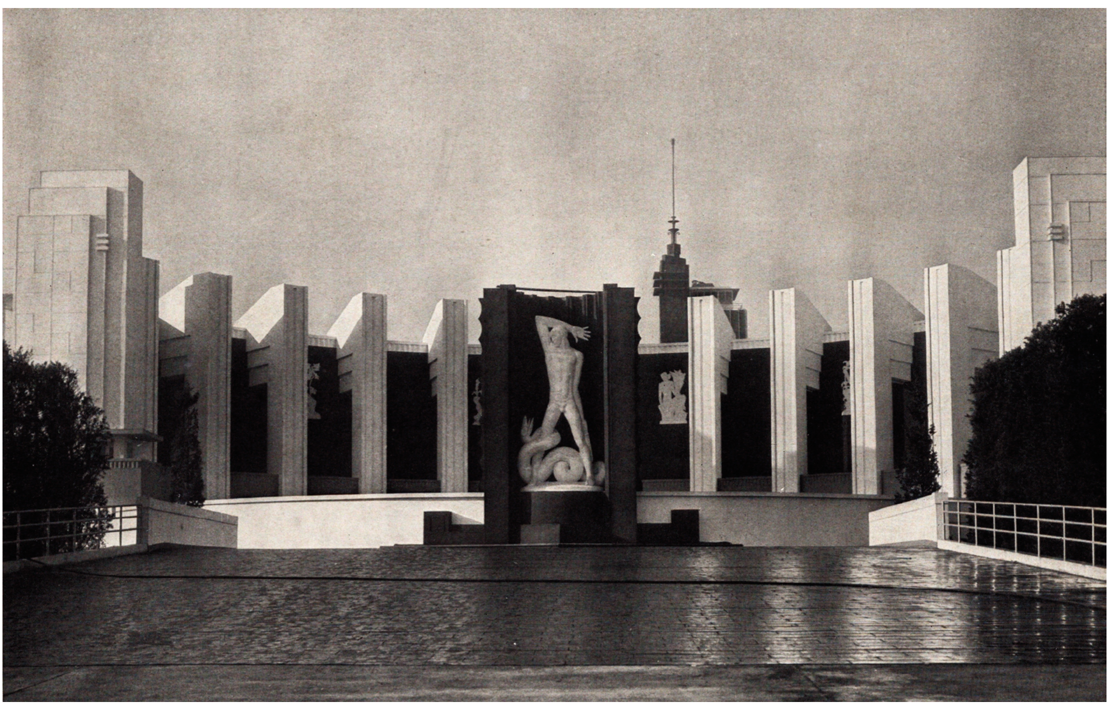

Figure 6. The north side of the Hall of Science at the 1933 Century of Progress Exposition. From *The Official Pictures of A Century of Progress Exposition*, Adler Planetarium library.

Eclipse of August 31, 1932.[29] Not much more on astronomy was needed as Century of Progress counted on the Adler Planetarium and Astronomical Museum on its grounds to fulfill that need.

The decision to include the planetarium in the fair was made around the same time the Mensing Collection was purchased. Meeting on 14 December 1929, the Subcommittee on Astronomy of the National Research Council's Science Advisory Committee of the Chicago Century of Progress voted the planetarium, then still under construction, would be the focal point for astronomy at the exposition.[30] The idea had likely been in the air for a long time. Max Adler was a member of the Board of Trustees of Century of Progress, and the aforementioned subcommittee included the astronomers Edwin Frost and Forest R. Moulton, who played important roles in the fair: Frost suggested the idea of the Arcturus trick, and Moulton, as the chairman of the subcommittee served as manager of concessions. It is interesting to note that a list of exhibits for the Adler Planetarium and Astronomical Museum presented by Fox during that meeting contained a reference to the possible acquisition of the Mensing Collection. The prospect of showcasing it in a major world's fair might even have helped Fox convince Max Adler to fund the purchase (for which Fox sought a budget of $50,000) in addition to Adler's initial gift of $500,000.

Astronomy had been featured in world's fairs since the first major event of the kind: the exhibits of the Crystal Palace Exhibition of 1851 in London included a large telescope and other instruments for observation and celestial navigation.[31] The Columbian Exposition of 1893 had sported a working observatory and a timekeeping station run by the U.S. Naval Observatory. However, the astronomical highlight was the mounting and tube of the great 40-inch refracting telescope bound to the Yerkes Observatory—the very same telescope used to illuminate Century of Progress four decades later.

Electric Eye on the Sky: The Arcturus Stunt

Plans to turn on the lights of Century of Progress in some spectacular way had been under discussion at least from 1929. In the same meeting where the inclusion of the planetarium in Century of Progress was approved, the Subcommittee on Astronomy also decided to contribute some "stupendous spectacle" involving an arrangement of electric lamps that would be successively lighted by control devices used in advertising signs.[32] It was only in the fall of 1931 that Edwin Frost suggested to Philip Fox that a symbolic connection between the Columbian and Century of Progress fairs could be attained by capturing the light from Arcturus at Yerkes with the 40-inch refractor and a photoelectric cell (Figure 7).[33]

Initially seen as just components for other devices, photoelectric cells had become a research topic of their own during the 1920s. In the following decades, so-called "electric eyes" came into vogue to open doors and count customers. By the early 1930s, firms such as the General Electric Company (GE) were fostering demonstrations and publicity campaigns focused on these devices.[34] Astronomers had been using photoelectric devices for a few decades in a subfield called photoelectric photometry, the quantitative study of the brightness of stars by measuring

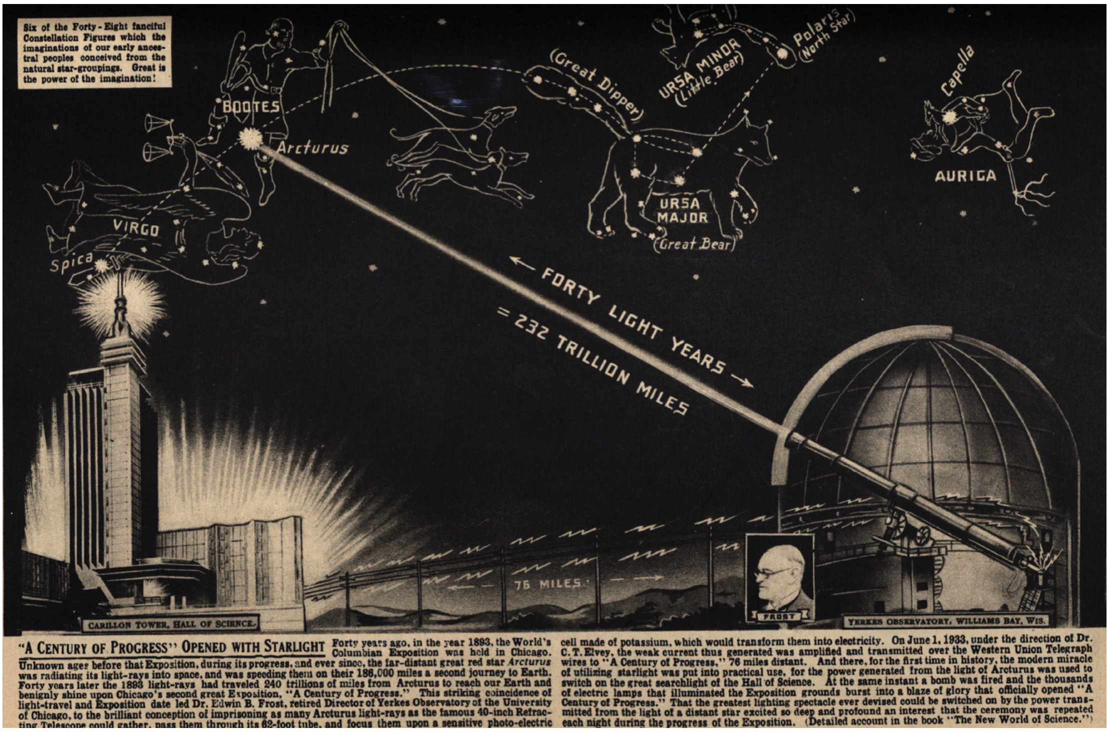

Figure 7. The Arcturus stunt at the Adler Planetarium, illustrated in Norton Wagner's *Unveiling the Universe*, 1936. Adler Planetarium library.

the weak electric currents generated by their light. Photoelectric photometry was much more accurate than the old visual photometry, in which the astronomer compared the brightness of an observed star with a standard artificial star.[35]

The Arcturus trick was not the only show in Century of Progress involving photoelectric devices. An exhibit at the Westinghouse building, for example, featured a bank-teller window with a $20 bill resting on it. Visitors were invited to grab the bill, only to see a gate descending between their hands and the bill before they could reach it. The gate was activated by a photoelectric cell.[36]

The teller-window trick was an automatic setup, but there were several performers leading the same sorts of techno-scientific tricks in Century of Progress. All of this echoed the growing importance of showmanship in presenting businesses before an audience perceived as passive and simpleminded. Corporate research laboratories sought to display miracles and wonders instead of conveying dull scientific explanations. In the late nineteenth century, performers akin to Promethean figures subjugating the whole of nature conducted electrical tricks; now that electricity had been domesticated, the stage magician occupied the place formerly held by those "wizards."[37]

Magical tricks associated with techno-scientific wonders played an important role in Century of Progress. For example, GE hired a magician to perform in its exhibit, the "House of Magic." Demonstrations intended to convey GE's research in a spectacular manner ran every day.[38] The Arcturus operation was fashioned to extol astronomy and astrophysics along the same lines —not to serve any commercial purpose but rather to show that the science of the heavens and its practitioners were by no means detached from earthly affairs.

Edwin Frost coordinated the operations on the technical front while Philip Fox conducted most of the negotiations. In 1929, Joel Stebbins (1878–1966), a professor of astronomy at the University of Wisconsin-Madison and a leading expert in photoelectric photometry, had assembled a photoelectric apparatus to be used with the 40-inch refractor at Yerkes Observatory.[39] Stebbins had also trained a graduate student named Christian T. Elvey (1899–1970). Elvey, who became an assistant at Yerkes, was entrusted with the practical operations at the observatory on the evening of the Century of Progress grand opening.

Before the great astrophysical “fiat lux” on 27 May 1933, Frost used his speech to extol the spin-off value of astronomy as exemplified by the photoelectric cell and Fox provided a brief explanation of telescopes and “electric eyes.”[40] Dull technicalities were to be addressed parsimoniously; the show had to proceed to its most anticipated moment. The crowd rejoiced with the Arcturus show, which proved so successful that it was allegedly repeated every evening. Arrangements were made with the Elgin National Watch Factory (about 35 miles west of Chicago) so that its small observatory could be used to capture the light of Arcturus. Similar performances involving cosmic rays and radio signals from a supernova would be used to open the world’s fairs in New York in 1939 and Seattle in 1962, respectively.[41]

It is difficult to imagine the Arcturus trick being repeated successfully every single night during the fair. Maybe the activation of the panel with the observatories and the large star with the ensuing light show compensated for any astronomical shortcomings on the technical side. In any case, fairgoers could not see whether starlight was actually being collected with a telescope and a photoelectric cell in some far-off observatory; they just had to trust the scientists and enjoy the show.[42] And for those willing to delve more seriously into this science that probed the far-off recesses of space and lighted fairs with stars, the Adler Planetarium and Astronomical Museum was just a brief walk away.

Heavenly Amusements and Mundane Attractions: The Planetarium in the Exposition

Century of Progress was not only a great opportunity to showcase the Adler Planetarium and Astronomical Museum to millions of visitors from across the United States and from abroad, it was also an equally good motive for making the planetarium more accessible and appealing. In September 1933, Fox presented the first official guide of the planetarium, which was based on material previously published in *Popular Astronomy*.[43] Fox remarks in the guide that “until 1933 the approach to the building was none too inviting. The way to the island led across the lagoon by a temporary wooden bridge, which in rough weather might be swept by waves, and then a bleak third of a mile on a dirt and cinder road or path.”[44] A new bridge and landscaping would change this situation. The area in front of the planetarium was also embellished with a terrazzo fountain sporting 12 colorful mosaics, one for each month of the year.

Inside the planetarium, the projection dome received a new sound system that made it possible to play music before and during the presentations and to amplify the voice of the lecturer. An air-conditioning system was also installed in the dome, and in the second season of Century of Progress in 1934, hearing-aid devices were adapted to some of the chairs.

The Adler Planetarium was a paid attraction[45] in a wide array of amusements spanning the whole spectrum of taste, from the bawdier to the loftier. Some sought to boast technological promise in a spectacular way, such as the Sky Ride: a transport bridge between two towers gave visitors a chance to ride a "rocket car" above the lagoon from one tower to the other. A celebration of the future of transportation, the Sky Ride constituted a key attraction in the fair and was often featured in its promotional materials. But it failed to become its most recognizable icon. That honor—even if against the will of Century of Progress leaders—fell to the fan-and-bubble dancer Sally Rand (1904–1979), whose performances defied the prevailing moral conventions as much as they enhanced the feeling of hope and optimism that Century of Progress conveyed during the Depression.

Century of Progress was the era's greatest escape, and the fact that it coincided with the repeal of Prohibition contributed not only to the financial success of the fair's Midway, but also to the prevailing atmosphere of enjoyment.[46] Nobler offerings such as the Hall of Science and the Adler Planetarium shared the same grounds with the cafes of the Midway (Figure 8), the performances of Sally Rand and her imitators, and questionable displays of human beings—some

Figure 8. West side of the Century of Progress Midway. From James Weber Lin, Kaufmann & Fabry Co., *The Official Pictures of a Century of Progress Exposition*, 1933, Adler Planetarium library.

intended as scientific (for example, the Infant Incubators, with its 25 premature babies), others outright bawdier (such as the Midget Village and freak shows).

Amid all this varied competition, the Adler Planetarium and Astronomical Museum fared very well. Up to 20 demonstrations with the Zeiss II projector were offered every day.[47] Demand proved so high that the initial presentations of one hour were eventually shortened to 40 minutes.[48] They centered on showcasing the capabilities of the Zeiss Mark II projector. The official guide of the exposition conveyed a dramatic description of what visitors could expect: "The light is dimmed. The ceiling becomes a blue sky, sparkling with millions of stars seeming so close and so real that you can reach up and touch them."[49] According to the guide, visitors would also learn how the projector showed the location of the Pole Star or any celestial body at a particular date and time, decades or centuries hence, or at some time in the past: "You can look back into the past and see the heavens as they appeared when Christ walked on Earth or when Galileo studied the stars with the first telescope."[50]

Before and after demonstrations, visitors could also explore the surrounding halls and the exhibit rooms downstairs. The Century of Progress guide highlighted "the wonderful collection of instruments which men of science in centuries past have used."[51] Adding to the displays already described, some new exhibits in the lower floor highlighted the practical utility of astronomy. These included a diorama replicating the bridge of a ship with the instruments for navigation and communication, and a booth with geodetic instruments. Contemporary astronomical practice was further illustrated by a booth presenting different types of spectra and photographic materials and devices used in astronomical research, which included a blink comparator (a device to examine images of the same area of the sky taken at different times) and copies of the plates in which Clyde Tombaugh found Pluto using an identical apparatus.

Yet in a world exhibit focused on the alliance between science and industry, it was also important to show that the science of the heavens—which provided the basis for timekeeping, cartography, and navigation—had not necessarily lost its connection with mundane affairs simply because it was increasingly focused on probing the depths of outer space. Thus, in accordance with the general theme of the exposition, the connection between astronomy and industry was emphasized with displays by the Spencer Lens, Bausch and Lomb, and Carl Zeiss firms of optical components in various stages of manufacture.[52]

The roll of exhibits at the Adler Planetarium and Astronomical Museum during Century of Progress was completed with an interactive display illustrating how the Arcturus stunt worked. A telescope with a photoelectric cell provided by GE was directed toward an artificial star. When a button was pushed, a metal disk resting before the objective was drawn aside, letting the light be captured by a photoelectric apparatus. The electric current that was generated turned on the lights behind a silhouette of Chicago. Examples of photoelectric cells manufactured by R. J. Cashman and W. S. Huxford of the Physical Laboratory of Northwestern University, and an amplifying tube by GE complemented the display. The astronomical side of Century of Progress was thus brought full circle.

Conclusion

When the second season of Century of Progress closed on 31 October 1934, 39 million visitors had walked through the fairgrounds. In the midst of the Great Depression, the fair returned a profit, improved the image of Chicago, and boosted the local economy. During the first 100 days of the Exposition, 550,000 visitors attended the demonstrations at the Adler Planetarium and Astronomical Museum. Daily attendance in the last of half of August during the first season of the exposition averaged more than 10,000.[53] By 1937, a total cumulative attendance of 3,405,864 was recorded.[54] The planetarium's share of the revenues was later used to form a trust with which its collections were expanded.[55] Significantly, the impact of events such as Century of Progress went beyond those who actually visited them. Together with the fair's own publicity, news reports, radio broadcasts, and a wide array of memorabilia contributed to make it known and to spread its message of hope among a much wider audience.[56]

For a novel and somewhat unusual establishment such as the Adler Planetarium and Astronomical Museum, there could have been no better opportunity for a wide-reaching promotion than the fair, as the institution carved its identity and message through several tensions in its exhibits: the past, present, and future; local or international; and utilitarian versus fundamental sciences. The Mensing Collection and the other historical artifacts provided for a big picture of astronomy evolving through the centuries, while the transparencies and displays depicting the modern astronomical observatory evinced a science in fast progress, delving into the very depths of outer space. On the one hand, the planetarium's building provided Chicago with an astronomical landmark, and displays about accomplished astronomers such as Barnard and Burnham appealed to local pride. On the other hand, the varied provenances of the historical artifacts and the images from European observatories underlined the universal character of astronomy. If the modern content on display overall conveyed an idea of scientific pursuits detached from immediate societal and economical concerns, the planetarium's involvement in the Arcturus show that extolled the photoelectric cell and the exhibits by vendors of optical material emphasized an ongoing connection between astronomy and earthly affairs, whereas the antique timekeeping, surveying, and navigational instruments on display emphasized ages past.

More challenging was achieving the right balance between spectacle and the solemnity associated with a credible museum. This balance was a matter of compromise rather than a straightforward choice between the two. By focusing on the Zeiss projector itself, as a technology of spectacle, rather than on the astronomical content it projected, and by partaking in the Arcturus stunt, Philip Fox managed to confer an astronomical "tone" on Century of Progress while showing that the museum he led told the story of a science that continued to connect the heavens and

Earth. A certain dose of spectacle and sheer entertainment was undoubtedly convenient, even to those who pursued loftier scientific and cultural undertakings, and it is tempting to think of our astronomers engaging in occasional escapades at the Century of Progress Midway.

Notes

1. R. J. Havlik, "A Fair Use of Arcturus: A Sugyzy of Scholars and the Lighting of the Chicago Century of Progress Exposition, 1933–1934," *Journal of Astronomical History and Heritage* 9 (2006): 99–108.
2. R. Webster and M. Webster, *Western Astrolabes* (Chicago: Adler Planetarium and Astronomy Museum, 1998), xi.
3. P. Fox, *Adler Planetarium and Astronomical Museum: An Account of the Optical Planetarium and a Brief Guide to the Museum* (Chicago: The Lakeside Press, 1933).
4. L. Taub, "'Canned Astronomy' versus Cultural Credibility: The Acquisition of the Mensing Collection by the Adler Planetarium," *Journal for the History of Collections* 7 (2005): 243–250. The librarian was Theodore Wesley Koch; the reference to "canned astronomy" relates to an article by Albert Ingalls (the leader of the Amateur Telescope Movement) published in *Scientific American*, in which Ingalls describes the optical planetarium as one of the best movies he had seen.
5. M. Korey, "Transatlantic Inspiration: The Mathematisch-Physikalischer Salon in Dresden and the Founding of the Adler Planetarium in Chicago," in *Engaging the Heavens: Inspiration of Astromomical Phenomena*, ed. M. Bolt and S. Case (Astronomical Society of the Pacific, 2012), 161–167.
6. P. Fox, "Adler Planetarium and Astronomical Museum," *Popular Astronomy* 40 (1932): 320–350, cf. p. 323.
7. See H. C. King and J. R. Millburn, *Geared to the Stars: The Evolution of Planetariums, Orreries, and Astronomical Clocks* (Toronto: University of Toronto Press, 1978).
8. See, for example, H.-F. Huang, "When Urania Meets Terpsichore: A Theatrical Turn for Astronomy Lectures in Early Nineteenth-Century," *History of Science* 54 (2016): 45–70; K. B. Staubermann, "Making Stars: Projection Culture in Nineteenth-century German Astronomy," *British Journal for the History of Science* 34 (2001): 439–451.
9. C. Bigg, "The View from Here, There and Nowhere? Situating the Observer in the Planetarium and in the Solar System," *Early Popular Visual Culture* 15 (2017): 204–226; King and Millburn, *Geared to the Stars*, 341–368.
10. J. D. Marché II, *Theaters of Time and Space: American Planetaria, 1930–1970* (New Brunswick: Rutgers University Press, 2005), 20.
11 Marché II, *Theaters of Time and Space*, 26.
12. Marché II, *Theaters of Time and Space*, 30.
13. P. Fox, *Adler Planetarium and Astronomical Museum: An Account of the Optical Planetarium and a Brief Guide to the Museum*, 4th ed., (Chicago: 1937), 6.
14. Fox's intention was to arrange the zodiacal signs from an external perspective that is, as they would normally be represented on a celestial globe, but the works were already well advanced when he realized that this other arrangement had been adopted.
15. The themes of the full annual series of demonstrations were the following: January, Winter Constellations; February, Time and Place; March, The Calendar; April, The Moon and its Motions, Eclipses; May, The Way of the Planets; June, The Midnight Sun, the Heavens at the North Pole; July, Summer Constellations; August, The Southern Sky, The Southern Cross; September, The Great Recessional Cycle; October, The Seasons, the Annual Journey of the Sun; November, Objects of Special Interest in the Sky; December, Architecture of the Heavens. Fox, "Adler Planetarium and Astronomical Museum" (1932): 124–155.
16. Marché II, *Theaters of Time and Space*, 69.
17. The usual schedule was each week day one session at 11:00 a.m. and one session at 3:00 p.m.; on Thursdays and Fridays there was an additional evening session at 8:00 p.m. Schoolchildren were admitted for free every morning. In Sunday afternoons there were sessions at 2:30 p.m. and 3:30 p.m.
18. Fox, "Adler Planetarium and Astronomical Museum" (1932): 124–155; 320–350; 532–549; 613–622.
19. For details on the acquisition of the Mensing Collection, see the article by Liba Taub cited in note 4.
20. On the history of this telescope, see M. Bolt, *Telescopes: Through the Looking Glass* (Chicago: Adler Planetarium, 2009), 222.
21. Fox, *Adler Planetarium and Astronomical Museum* (1937), 63.
22. C. M. Rosenberg, *America at the Fair: Chicago's 1893 World's Columbian Exposition* (Charleston, South Carolina: Arcadia Publishing, 2008), viii–xi.
23. L. R. Lohr, *Fair Management: The Story of a Century of Progress Exposition* (Chicago: The Cuneo Press, 1952).
24. Century of Progress, *Official Guide: Book of the Fair* (Chicago: Century of Progress, 1933).
25. Pacific Exposition, San Diego, California, 1935–1936; Cleveland Great Lakes and International Exposition, 1937; New York's Fair, 1939–1940.
26. R. W. Rydell, *World of Fairs: The Century-of-Progress Expositions* (Chicago and London: The University of Chicago Press, 1993), 10.
27. F. Nadis, *Wonder Shows: Performing Science, Magic, and Religion in America* (New Brunswick: Rutgers University Press, 2005), 189.

28. Havlik, "A Fair Use of Arcturus," 102.
29. Havlik, "A Fair Use of Arcturus," 102.
30. The meeting took place on 14 December 1929, and was attended by Max Adler, Philip Fox, Edwin Frost (then director of Yerkes Observatory), R. H. Baker (University of Illinois), William D. Macmillan (University of Chicago), and F. R. Moulton (who served as chairman). F. R. Moulton, "Report of the Committee on Astronomy, National Research Council Science Advisory Committee of the Chicago Century of Progress, 1933," 28 December 1929, Adler Planetarium archives, Adler Planetarium Institutional Records Series XIV, Century of Progress, box 1, folder 2.
31. D. Brodherson, "Eye on the Sky. From Astronomy to Astronautics at World's Fairs and Theme Parks," in *2001: Building for Space Travel*, ed. J. Zukowsky (Chicago: Harvey N. Abrams Publishers, Art Institute of Chicago, 2001).
32. F. R. Moulton, "Report of the Committee on Astronomy, National Research Council Science Advisory Committee of the Chicago Century of Progress, 1933," 28 December 1929, Adler Planetarium archives, Adler Planetarium Institutional Records Series XIV, Century of Progress, box 1, folder 2.
33. Havlik, "A Fair Use of Arcturus," 104.
34. S. F. Johnston, *A History of Light and Color Measurement. Science in the Shadows* (Bristol: CRC Press, 2011), 211.
35. On the history of photoelectric photometry, see D. S. Liebl and C. Fluke, "Investigations of the Interstellar Medium at Washburn Observatory, 1930–58," *Journal of Astronomical History and Heritage* 7 (2004): 85–94.
36. Nadis, *Wonder Shows*, 190.
37. Nadis, *Wonder Shows*, 189.
38. Nadis, *Wonder Shows*, 190.
39. D. E. Osterbrock, *Yerkes Observatory, 1892–1950: The Birth, Near Death, and Resurrection of a Scientific Research Institution* (Chicago: University of Chicago Press, 1997), 137.
40. Osterbrock, *Yerkes Observatory*, 138.
41. Havlik, "A Fair Use of Arcturus," 107.
42. The Arcturus story has been, in fact, the subject of doubt, and even mockery. For example, when addressing the subject, the historian of Yerkes Observatory, Donald E. Osterbrock, did not hesitate to remark that "perhaps it was just cloudy there [in Williams Bay] but Elvey shone a light up on the dome" (Osterbrock, *Yerkes Observatory*, 138). An online account makes reference to the possibility of light from Arcturus having been collected with a telescope set up in the balcony of the Hall of Science (https://www.universetoday.com/100799/the-curious-and-confounding-story-of-how-arcturus-electrified-chicago/, 11 June 2017).
43. Fox, P. "Adler Planetarium and Astronomical Museum." *Popular Astronomy* 40 (1932): 320–350.
44. Fox, *Adler Planetarium and Astronomical Museum* (1933), 62.
45. Admission to the Planetarium was $0.25. General admission to the fair was $0.50.
46. Cheryl R. Ganz, *The 1933 Chicago World's Fair*: *A Century of Progress*" (Urbana, Chicago, Springfield: University of Illinois Press, 2012), 13.
47. Century of Progress, *Official Guide*, 43.
48. Fox, *Adler Planetarium and Astronomical Museum* (1937), 26.
49. Century of Progress, *Official Guide*, 43.
50. Century of Progress, *Official Guide*, 43.
51. Century of Progress, *Official Guide*, 43.
52. Fox, *Adler Planetarium and Astronomical Museum* (1933), 60.
53. Fox, *Adler Planetarium and Astronomical Museum* (1933), 62.
54. Fox, *Adler Planetarium and Astronomical Museum* (1937), 63.
55. Webster and Webster, *Western Astrolabes*, xi.
56. Rydell, *World of Fairs.*

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CHAPTER 7

Built in Thoughts Rather than Stone

The Palais de la découverte and the 1937 Paris International Exposition

Andrée Bergeron
Associate Professor
Universcience and Centre Alexandre Koyré
Paris, France

Charlotte Bigg
Permanent Research Fellow
Centre Alexandre Koyré, Centre National de la Recherche Scientifique
Paris, France

What was a museum of "living science"—*la science vivante*—in 1937? The Palais de la découverte in Paris is commonly considered to be a precursor of modern science centers, inspiring their characteristic hands-on displays and emphasis on contemporary science. There have, however, been remarkably few in-depth studies of the Palais, and these were published in the 1980s and early 1990s and have focused on other dimensions, such as the Palais's role in promoting the institutionalization of public scientific research in France or its place in the elaboration of an ambitious cultural policy by the left-wing political government of the mid-1930s, the Popular Front.[1]

In this chapter we take a look at the claims made by the founders of the Palais de la découverte, showing how these claims were realized in practice and contextualizing them within the broader aims of the 1937 Paris International Exposition of Arts and Technology in Modern Life. We seek to contribute to the history of the relations between exhibitions and museums in the twentieth century and related issues, such as the place of artifacts in science exhibits and the aims followed by science exhibitions and museums organizers in the interwar.

The Palais occupies an interesting and paradoxical position in the history of science exhibitions and museums. Like many science museums, the Palais originated with an exposition, the

1937 Paris International Exposition, though its founders believed from the start that it should become a permanent institution. Unlike, for instance, the Science Museum set up with objects left over from the 1851 Crystal Palace Exhibition in London, the Palais was imagined from the start as a museum of living science, devoid of collections, and dedicated to modern science: a permanent exhibition, so to speak. Realizing those plans, however, was beyond its founders' hopes: the Palais is still housed in the ill-suited Grand Palais, a Beaux-Arts style monument built for the Paris 1900 exposition, a "temporary" arrangement that endures 80 years later.

Apparent contradictions involved in the conception of the Palais de la découverte can be understood within the broader history of museums and their transformation in response to the multiplication of exhibitions in the late nineteenth century.[2] Simultaneously, as a major highlight of the 1937 exposition, the Palais took part in an important way in the transformation of universal expositions from displays of technological progress to representations of ideological struggles to define modernity and the future of international relations.[3]

France in the 1930s was confronted with the major political crises of the late Third Republic. When exhibition planning began at the end of 1933, the political climate was tense, which was evident in the antiparliamentary demonstrations organized by the extreme-right *ligues* that killed 15 people and injured 1,500 in February 1934. The 1937 Paris International Exposition was prepared during the great strikes that preceded the rise to power of the Popular Front; Léon Blum's government resigned during the exhibition.

Perceived as a showcase of Popular Front ideology, the exhibition was in part dedicated to the *expression de la pensée* (expression of thought). The 1937 exposition was organized in "groups," themselves divided into several "classes." One whole group of 14 was dedicated to the "Expression of Thought," coordinated by the man who would later become the first director of the Palais de la découverte, André Léveillé. The "Expression of Thought" section was intended to promote the peaceful advancement of knowledge as a means of promoting better understanding between nations. Deliberately focused on the work of the mind rather than on technology, it promoted the cultural and social importance of intellectual labor while more immediately remedying unemployment by engaging artists and scientists to work on the exhibition.[4]

In the first part of the chapter, we examine the astronomy section of the Palais as a way of documenting the practical realization of the overall aims of the exhibition organizers. Our concern is to show how—through specific objects and techniques—thought was put on display. In considering this question, we examine the layered meanings and ambiguities of the notion of living science and how it can be analyzed in its contemporary context rather than from the narrow, retrospective lens of the development of the science center. We highlight the tensions present in the display of historical vs. modern science, and of contemporary vs. spectacular science. The major influence of the Chicago Century of Progress exhibition of 1933–1934 on the Palais is stressed, particularly the decision to put scientists in charge of the exhibits, the emphasis on modern science and spectacular displays, and on creating powerful, emotional experiences.

In the second part, we take a detour and visit the Musée de la littérature (Museum of Literature) at the 1937 International Exposition as a further means of showing that the Palais de la découverte was not unique in its museological choices. We find that many of the aims and methods of the Palais and the Musée de la littérature coincided, expressing the overall strategy of the Group I organizers to showcase intellectual labor in action as part of a broader social, economic, and political program.

Living Science at the Palais de la découverte and the Chicago Model

Eighty years after the Palais's founding, exhibiting *la science en train de se faire* (science in the making) remains a central objective of the institution. Today, the motto *un chercheur, une manip* (one scientist, one experiment) is associated with the live demonstration of experiments in niches set up within exhibition spaces. Its origin is to be found in the rhetoric of its founders, their frequent reference to living science and to the spectacular nature of the exhibits.

This rhetoric fitted squarely with the stated aim to dedicate part of the 1937 exposition to the "Expression of Thought," to be conveyed in the most vivid manner possible. While existing museums such as London's Science Museum or Munich's Deutsches Museum were not explicit sources of inspiration for the Palais organizers (though some objects on display were on loan from these institutions), previous exhibitions were carefully studied by the French organizers. With respect to the display of scientific thought, the inspiration can without doubt be traced to the Hall of Science at Chicago's Century of Progress world's fair of 1933–1934.

The Palais representatives wrote in a long, typescript report on previous international exhibitions that Chicago had been "a great lesson" and "a triumph." Never, they argued, "had pure science been given so much attention, so much financial support and such formidable means." Thereby, "the organizers were able to produce an attractive, lively scientific presentation that met with considerable success."[5] The report stated,

> The Hall of Science was organised according to the different sciences. . . . For each field, the most qualified, the most advanced scientist was designated and put in charge of the programme. Once this programme had been established and approved, men trained in publicity and spectacular displays were recruited and asked to create "shows" together with the scientists. The results of this collaboration were extraordinary. In each category, only the essential aspects were presented, the most audacious means of publicity were employed to "touch" the public with the loftiest scientific purposes.[6]

Talks lasting 20 minutes followed by demonstrations were regularly offered to visitors. The French visitors were deeply impressed by the exhibits: there were no showcases, only artifacts in motion. "Dynamic models" were everywhere, and "in biology, members of the public could carry out many experiments on their own bodies."[7] "By pressing an electric button, turning a lever, the circulation of blood can be studied, the action of the heart valves, the variation in pulse, the motions of the diaphragm. Visitors will not be told 'do not touch.' Instead they will be invited to take part in experiments on the human body in order to be educated and to have conveyed to them the value of preserving their health."[8]

All these "lessons" were applied in the Palais de la découverte, conceived from the start as an "anti-museum," an "exhibition of living science" that was nonetheless to become permanent.[9] Devoid of collections, it was meant to showcase contemporary "living" science rather than its history, which would have turned it into an "inert museum."[10] Promoted as an "innovative" museum, it featured film screenings, live lectures by scientists, interactive displays, and demonstrations.[11] Even when visitors could not grasp the science, they were said to have felt "boundless emotion before the 'grandiose spectacle' offered to them . . . whose pure beauty will not escape them."[12]

The Astronomy Section

A close look at the exhibits themselves helps to convey a better sense of how the expression of thought was put on display, and how it could shape visitors' experience. Sidestepping the better-studied physics section devised by the Palais's most prominent figure, Jean Perrin, and usually taken to be representative of the Palais as a whole, we focus here on the astronomy section (Figure 1).

The archives of the Palais, now kept at the Pierrefitte site of the French National Archives, document the exhibits and their creation through different type of documents: protocols of successive meetings; lists of artifacts with prices and suppliers; texts by the section organizers (proposals, subsequent reports); press clippings reporting on the sections after they opened to the public; and visual materials, including photographs and brochures about each section, which were sold at the time at the library of the Palais.

Pure Science

Pure science was a major focus at the Palais. Mimicking the Chicago Hall of Science, the Palais was organized along disciplinary lines, with each section being further divided into more specialized rooms. In the astronomy section, the first two rooms introduced mathematics, leading to separate spaces dedicated to different kinds of astronomical objects: the stellar universe, the moon, the sun, the planets, and comets. In keeping with the overall aims of the 1937 exposition and the Chicago model, "pure science" was emphasized, with technology presented as an outcome of pure thought. For this reason, practical aspects of observatory work, such as navigation or timekeeping, were largely left out.

The Chicago mode of organization was also adopted. Eminent scientists assisted by junior scientists were put in charge of each disciplinary section. For the astronomy section, the most prominent astronomer of the country was recruited: Ernest Esclangon (1876–1954), director of the Paris and Meudon observatories. Esclangon played a remarkably active role in putting together the exhibit with two assistants, Robert Lencement and Jacques Camus.

Figure 1. Entrance and staircase leading to the astronomy section of the Palais de la découverte in 1937. © Universcience/Pytlik

Pure science was put forward in the exhibition as an inherently international—if not internationalist—undertaking. The 1937 exposition's regulations expressly stated that "the presentation (of scientific discoveries) is necessarily established in an international manner."[13] In this spirit, the astronomy section proudly put forward the internationality of astronomy and of the exhibit. Its report listed, at length, the 18 national and 44 international institutions and individuals who had contributed to the section.[14] It proposed that commemorative medals or diplomas be awarded to more than 30 foreign personalities and learned societies, a particularly large number compared to other sections. The archives of the Palais contain several boxes filled with correspondence with foreign astronomers and instrument manufacturers, including the German firm Carl Zeiss, that supplied many photographic reproductions, artifacts, and suggestions for the section.[15]

The astronomy section at the Palais de la découverte in 1937 was a characteristic display of interwar internationalism as put forward in universal expositions and by many scientists since the nineteenth century. But this internationalism took on a new, pacifist flavor in the context of the international tensions of the late 1930s.[16] In the Palais, scientific and political internationalism converged, considered two sides of the same coin by such central founding figures of the Palais as Jean Perrin, Emile Borel, and André Léveillé.

Living Science as Modern Science

The Palais was put forward as a museum of *la science vivante* (living science). To its organizers, this phrase signified above all modern science, contemporary thought rather than history: "To remain in the spirit of the Palais, which is not a museum, the historical dimension was omitted, except for a few rare reminders where this proved necessary."[17] After the opening of the Palais, this idea became a matter of debate, when criticisms were made in the press arguing that the astronomy on display was closer to that practiced in 1900 than in 1937. In any case, all participants agreed that modern science, not its history, should be on display.

According to the astronomy section organizers, 90 percent of astronomy artifacts on display were of recent origin. A comparison of the room dedicated to the sun at the Palais de la découverte in 1937 (Figure 2) with the astronomy section at the Deutsches Museum in its initial, temporary quarters (Figure 3) testifies to their contrasting museological attitudes. While in Munich mainly astronomical instruments were on display, in Paris large photographs and planetary models stole the show.[18] The Deutsches Museum had been opened in 1903 to celebrate the "masterworks of science and technology." The presentation of historical artifacts and narratives was part and parcel of this enterprise to promote the new engineering professions and technology within the culturally prestigious institution of the museum rather than within industrial and commercial exhibitions.[19] In contrast, the Palais de la découverte promoted the display of contemporary, "pure" science. Architecture and design helped convey the particular brand of modernity promoted by its founders. While the instruments blended smoothly with the historical building and fittings of the Deutsches Museum in its initial quarters, in the Palais the Beaux-Art stucco decorations were hidden behind white casings that stood for an alliance of aesthetic modernism and progressive politics.[20] An ahistorical and placeless character was thereby conferred on the science on display at the Palais, reminiscent of the standardized laboratory architecture that in the twentieth century contributed to promoting a generic science detached from its immediate surroundings.[21] Thus the Palais could appear both as a "cathedral for science," as cultural historian Pascal Ory put it, and as a "white cube," asserting a universal artistic and scientific modernism.

Figure 2. Room dedicated to the sun at the Palais de la découverte in 1937. The images shown were provided by the Paris and Meudon observatories and showcase solar research. © Universcience/P. O'Doyé

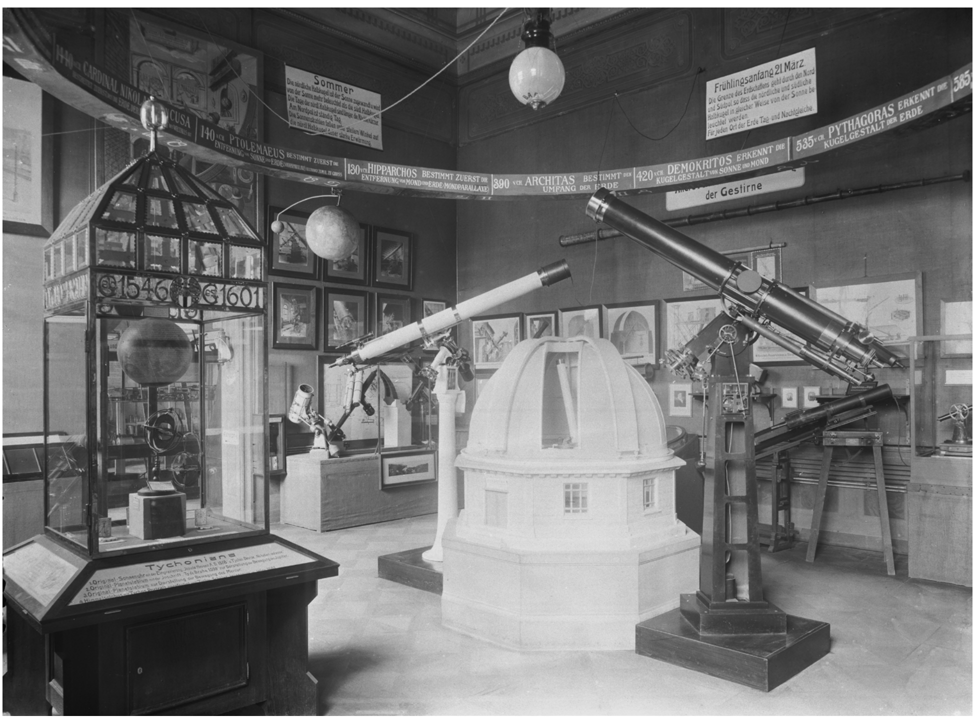

Figure 3. The astronomy section at the Deutsches Museum in its initial, temporary quarters at the old national museum, in 1906. Photo nr. 33083. © Deutsches Museum, München

These lofty internationalist and universalist claims did not prevent local and national ambitions from shaping the astronomy exhibit. Esclangon was quite open about this, writing that the section aimed to encourage the knowledge and study of astronomy in France, where he felt it was particularly neglected. He also hoped to gain public support for the construction of a new high-altitude observatory on the model of the U.S. mountain observatories, a project he had nourished since 1929.[22] The Palais's astronomy section involved all the important French astronomers, but it could not entirely cover up the conflicts that erupted in the 1930s between Henri Mineur and Esclangon. Mineur, an astronomer of the Paris Observatory critical of its research program, was supported by Perrin, then under secretary of state for scientific research, in the creation of an "office of astrophysical research" independent from the observatory but to be established on observatory grounds.[23]

The astronomy section was leveraged in the running conflicts among contemporary astronomers about the perceived decline of French astronomy compared to the astronomical achievements of other countries, particularly the United States. Mineur and Esclangon offered different solutions to this perceived problem, and therein probably lies one of the reasons Mineur claimed that the astronomy section coordinated by Esclangon was backward and old-fashioned. The Paris Observatory's director was regularly portrayed by his detractors as representing a scientific conservatism that was damaging French astronomy.[24] In the astronomy section of the Palais, debates about the future of French "modern" astronomy were also played out.

Science for Life

La science vivante could also mean "science for life." The Palais exhibits were to be about "living science," not only in the sense of not being old, "dead" science but also of science developed for the benefit of humanity and society. In a rare and revealing passage, the exhibition organizers pointed out that "we might then believe that all the tools of Intellectual Cooperation would be put to the service of works of happiness and no longer to works of misery, destruction and death."[25] The need to advertise the social, intellectual, aesthetic, and even spiritual benefits of science addressed the doubts raised by the wartime uses of physics and especially chemistry. In the face of mounting international tensions, the exhibition organizers emphasized its potential role in remedying economic, social, and cultural woes. Astronomy had for obvious reasons been less compromised during the war. The stated mission of the astronomy section of Palais was to elevate the mind and make it sensible to the vastness and diversity of the universe.[26]

Lively, Mobile, Spectacular Science

La science vivante also meant lively, mobile, spectacular science. Here also the parallels with the Century of Progress world's fair are striking. The Adler planetarium, opened in 1930, was a major focal point of the fair, as Pedro Raposo shows in this volume. French visitors praised the "wonderful planetarium" and its associated exhibit:

> Beyond the apparatus, an atmosphere was created. Visitors entered a long, darkened gallery, on the floor was a thick carpet, silence reigned. On each side of the gallery glass positives displayed cloud formations, nebulae and many different aspects of the sky, of the planets and the atmosphere. The visitors then entered the planetarium room itself, in full darkness, total silence was required. The acoustics of the room had been studied to avoid the spread of sound. A very soft, specially-composed music created a supernatural atmosphere and gave a kind of otherworldly vertigo to the spectators. Every day, conferences on astronomy took place.[27]

The 1937 exposition also featured a planetarium specially constructed for the event and the first one of its type in France, though it remained distinct from the Palais. Set up on the *parc des attractions* (entertainment grounds) at a distance from the Palais, the planetarium was dismissed by the organizers of the astronomy section as fulfilling purely pedagogical functions. (After the International Exposition closed, the planetarium was dismantled and stored in the cellar of the Conservatoire national des arts et métiers, and then subsequently integrated into the Palais in 1952, on Léveillé's request.)

How could astronomy be made "living," especially without a planetarium? Experiments could not be easily reproduced within the Palais. Moving great instruments from observatories to the exposition was inconceivable, since they could never be properly set up for observations to take place. Large instruments were in any case too few to be dispensed with for the duration of the exposition. (At one point the whole idea of a live astronomy exhibit in the Palais was abandoned in favor of a trip to the Paris Observatory; special buses would have carted visitors back and forth between the two locations.) Direct observation made in addition little sense when most astronomical phenomena were invisible to the eye: "One should add that spirals, nebulae, and star clusters whose beautiful images the spectators can contemplate, are only revealed to us by means of photography. Thus, these same visitors would be very disappointed if they were shown, even with a powerful instrument, these objects whose visual appearance is very poor. Most of them, which may seem very detailed and of large dimensions, are totally invisible in the telescope ocular."[28]

Substitutes had to be found: small telescopes were set up in the gardens around the Palais for observers to peek through when the weather allowed. Mock telescopes inside the Palais offered a reconstituted observation of different astronomical objects. A device was constructed that enabled the live projection of the solar surface on a large screen. Large-scale models of the moon were built (Figure 4) and an impressive mobile orrery was hung above the great staircase leading to the astronomy section—though technical difficulties meant it was not actually in motion most of the time. Most important, and reminiscent of the Chicago astronomy exhibit inside the Adler Planetarium, was the vivid presence of large photographic reproductions, some of them backlit, of interesting and beautiful astronomical phenomena.[29]

Presenting instrumental techniques and theories of astronomy (particularly difficult to render as exhibits) posed additional challenges. In facing the general problem of making perceptible

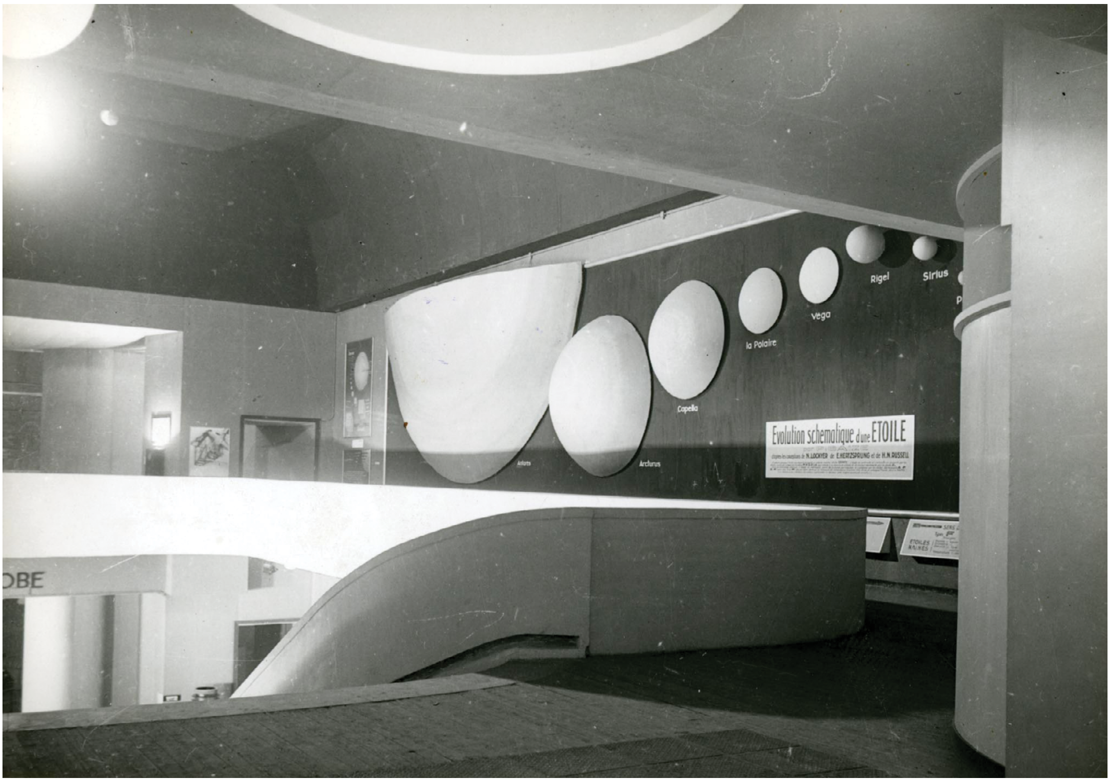

Figure 4. Model of stellar evolution at the astronomy section of the Palais de la découverte in 1937. © Palais de la découverte/P. O'Doyé

the Expression of Thought, the Group I organizers put forward cinema as a privileged means to this end: "Cinema will be everywhere in the exhibition. Not one class will avoid resorting to projections. This class will be linked to all the others. Cinema will help complement scientific presentations. In many cases a cinematographic projection will be more moving than a presentation through a model. A film library would be desirable."[30]

La science vivante here meant live presentations through lectures, or lively presentations by means of film. This approach picked up on the contemporary pedagogical thrust to encourage visual and film-based teaching, as demonstrated in the 1920 report of the "French Extra-parliamentary Commission in charge of studying the means of generalizing the application of the cinematograph in the different branches of teaching":

> The show solicits the attention of the pupils, especially those whose imagination is lazy. The memories they retain of a moving image are sharper and persist longer. An admirable auxiliary to the teacher, whose teaching it enlivens, the cinematograph reduces the verbalism that dilutes and weakens ideas: it puts before the eye the living synthesis of beings and things. . . . To see is practically to know. . . . It does not simply supply a quick view of movement and action; it slows it down, decomposes it, and thereby becomes a marvelous instrument of demonstration and analysis . . . When the direct observation of reality is

> not possible, cinematographic projections replace it. They are the precious document, the authentic witness account that confirms the teacher's lesson.[31]

At the Palais a special room was equipped for lectures and projections that attracted 70,000 visitors over three and a half months (2.5 million people visited the Palais de la découverte during the whole time of the exposition). The pioneering science film maker Jean Painlevé was put in charge of this program, and many innovative films were produced for the Palais, in particular the remarkable films on mathematics produced by André de Sainte-Laguë. Different types of films were proposed in the astronomy section: projections showing changes in the appearance of the solar system taken at the Meudon observatory, films of solar flares recorded by Bernard Lyot at the Pic du Midi observatory during the summer of 1937, and films explaining different astronomical theories. A series of live conferences was also offered in the lecture hall, along with documentary and fiction films, including Painlevé's *Voyage dans le Ciel*.[32]

"The Expression of Thought" at the 1937 Exhibition

The Palais de la découverte is usually seen as occupying a singular position in the contemporary landscape of science museums. To present "living science," as the museum's creators chose to do, seems to have constituted a *novum*, as were, allegedly, the manner in which they did so: using spectacular displays, motion, and laboratory experiments.

The undeniable inspiration provided by the Chicago Hall of Science already helps relativize this view. The Palais instead appears as part of a new line of exhibitions of "pure thought" that appealed to the "most audacious means of publicity [in order] to 'touch' the public with the loftiest scientific purposes."[33] Through the Chicago Century of Progress exposition, the Palais connected to a broader movement that had emerged in the United States during the interwar period, which criticized old-fashioned science exhibits and advocated the presentation of fundamental science using "dynamic" displays. The devices in motion that had been a staple of exhibitions were endowed in the United States at this time with pedagogical legitimacy as forms of "tactile education."[34] But this trend also had its roots in European museums, with the Deutsches Museum serving as a major inspiration for Julius Rosenwald's Chicago Museum of Science and Industry, which opened for the 1933 fair, and possibly for Max Adler, founder of the planetarium and Rosenwald's brother-in-law. The Deutsches Museum was indeed not just a museum of technology but also of science, and university scientists, as in Chicago and Paris later on, were initially in charge of the acquisition policy.[35] Promoting the connections between technology, engineering, and science had positioned the Deutsches Museum very differently from contemporary social museums and exhibitions that were focused on workers, hygiene, and industrial safety.[36] With respect to the displays, the emphasis on the pedagogical mission of the Deutsches Museum resulted in a policy to produce accessible, playful, and "instructive and stimulating displays," helping to popularize technology and make it accessible—in contrast to what museum founder Oskar von Miller qualified as the "dead museums" of Paris and London (an incidental reminder that the rhetorical trope of innovation has a tradition of its own).[37] The Palais de la découverte was thus hardly unique in the contemporary landscape of science exhibitions and museums. Situating the Palais de la découverte within the broader context of the 1937 Paris International Exposition further suggests that it was not unique within the 1937 exposition either. It was, in fact, representative of the very particular spirit that guided Group I.

> But the first agent of all these transformations conceived, desired, and accomplished by man escapes exhibition. In an exhibition, it is everywhere present through its effects; but absent everywhere by its very nature. The original power of transformation, the spirit, only reveals itself through the order or the disorder that it introduces in the world of sensible objects. The scheme hatched by the organizers of the 1937 exhibition therefore constituted a great and paradoxical novelty: to give a face to this invisible principle, the spirit itself, and to bring before visitors' eyes invention herself, next to invented objects, and what can be glimpsed or suspected of creation beyond what it creates.[38]

The "great and paradoxical novelty" put forward by Paul Valéry,[39] who was in charge of Group I, was the dedication of a significant section of the exposition to a subject that was a priori difficult to exhibit: the activity of the mind, or in the exhibition's terminology, the expression of thought. The group was assigned the task of making creation visible, on a wide spectrum represented by the seven classes that composed it:

1st class: Scientific discoveries in their applications
2nd class: Literary events, libraries
3rd class: Museums and exhibitions
4th class: Theatrical events
5th class: Musical and choreographic events
6th class: Cinematographic events
7th class: Congresses, lectures

In the context of a universal exposition, putting thought on display appeared both as a novelty and as an unprecedented challenge. The idea went back to the very early stages of the project, when in February 1932 François Isidore Tournan, a radical-socialist senator, proposed to the French senate to modify the original plan of an international exhibition of decorative and industrial arts. The coming exhibition appeared to him a means of promoting peace:

> The whole world is prey to an unprecedented economic crisis that awakens bellicose passions in all quarters and fosters the fear of a new cataclysm. In the midst of exacerbated nationalisms and the competition between material interests, how can the respect for human life be guaranteed if not by maintaining the international order? However, even the best-meaning and most skilled diplomats cannot alone, as can be seen in these troubled times, resist to popular momentum, to this call of the abysses that a great German writer wrote

about. The masses themselves must be enlightened, moved, won over to peace by means of momentous events. [40]

For these reasons, Tournan proposed to broaden the scope of the exhibition to include an international exhibition of "civilization (science, literature, the arts and the essential industries connected to them)" with the aim of promoting intellectual cooperation.[41] This proposal was subsequently combined with another one, put forward by socialist deputy Eugène Fiancette, to organize an exhibition of working and peasant life.[42]

One year later, in February 1933, another radical deputy, Aimé Berthod, a member of the intellectual workers' defense group at the Chamber of Deputies, became the general commissioner of the future international exhibition. Berthod in turn put André Léveillé, at the time one of the vice presidents of the Confederation of Intellectual Workers (Confédération des Travailleurs Intellectuels, CTI), in charge of the part devoted to intellectual cooperation.[43] Under this heading, Léveillé proposed to set up "three groups on the manifestation of thought": "expression," "training," and "diffusion."[44] Berthod adopted this classification, as did his successor Edmond Labbé (1868–1944), when the latter took over as the International Exposition's general commissioner in July 1934.

Jean Perrin is usually credited with being the main initiator of the Palais de la découverte. It is worth insisting on the fact, however, that the first proposal explicitly included a class dedicated to science as early as 1933, even before Perrin joined the project.[45] The idea of "reserving a place for science" in an exposition in part dedicated to thought very much fit with the conceptions of the promoters of intellectual cooperation and labor. The CTI constituted a federation of intellectual workers without distinction, and for this reason its representative André Léveillé proposed to reserve "a large place for Science and Human Progress" in the form of a "Palace of the Elements" that belonged from the outset to the Expression of Thought group. This proposal, upheld by the successive exhibition leaders, was the basis on which Henry de Jouvenel (another CTI member), when he was put in charge of Group I, organized a lunchtime meeting in November 1934 bringing together eminent scientists, including Jean Perrin. It was on this occasion that Perrin, starting from and deconstructing Léveillé's original proposal, set forth the outline for the Palais de la découverte.[46]

Members of the CTI and individuals close to the French Commission of Intellectual Cooperation were very visible, and they led Group I and many of its different classes.[47] This fit their shared conviction about living intellectual creation in all fields. Two objectives guided them. First, they sought to support both human thought's creations and intellectual cooperation as factors of progress and peace. Second, they pragmatically saw the exposition as an immediate means of improving the practical conditions of intellectual work, particularly affected by the economic crisis. In the short run, they hoped that the exposition would give work and commissions to many intellectual workers. In this respect, the exposition was very much in keeping with the initiatives of the CTI, which had long promoted the idea of a major program of public works in response to the crisis.[48] This would lead to long-term benefits, in the sense that promoting these activities could be seen as a first step toward the establishment of bodies that would improve the practice of intellectual work and the social conditions of these workers. Jean Perrin realized this objective when he made the Palais a key feature in his promotion of the organization of French research, leading to the establishment of the national research organization, the Centre National de la Recherche Scientifique in 1939.[49]

Exhibiting Thought: One Challenge and Converging Solutions

Exhibiting thought was seen to constitute a major challenge. As Paul Valéry noted, if "things" had been chosen, there would have been no need to invent products or beings to offer for display; however,

> imagine one ventured, in other areas of an exhibition, to make space for the immediate creations of the mind, and to attempt to lay before the eyes the spectacle of the loftiest intellectual effort, and soon you will have before you the obligation to first imagine *the visible devices that will best suggest essentially invisible labors*.[50]

Most of the Group I classes faced this problem, though not all with the same intensity. The physical and natural sciences seemed less disadvantaged in this respect since they could rely on apparatuses and experiments, and "in these fields intellectual labor always yields **acts** that produce phenomena that it has foreseen or prescribed."[51] Valéry continued:

> Can a representation of the labor of the mind be conceived, that would not give room to Mathematics or Literature? Here the problem or the paradox of showing what exists only through and in the mind appears and becomes obvious. It proved necessary on the one hand to search for the visible productions of geometers' calculations and mediations and to find therein the elements for an exhibition that, as I hope, will prove surprising enough and even captivating for many visitors; on the other hand, we will strive to make even the labor of the writer appear and become materially observable.[52]

It is noteworthy that Paul Valéry did not draw a distinction between scientific and other activities, but rather between what could be relatively easily "exhibited" and what first required solving a fundamental problem. Music, the visual arts, and theater could be made visible or audible. It was even their primary function, as was that of the many experimental sciences that relied on tangible reality (objects, instruments, reproducible actions). The fundamental challenge of how to "put before the eyes what exists only through the mind and in the mind," was, however, the same for literature and for mathematics. It was inconceivable for Valéry that either would be excluded from "the representation of the labor of the mind."

The Palais was therefore far from being unique in seeking to "make space for the immediate creations of the mind and attempt to put before the eyes the spectacle of the loftiest intellectual effort." This was the overall goal of Group I, and the Palais represented merely the materialization of this project with regards to the natural sciences. The expression "immediate creation of the mind" should be here understood in two senses. First, it should be understood as designating *thought at work*, which for the sciences corresponded to the idea of discovery as it was put forward by Perrin. Second, this expression emphasized *recent creations*, as opposed to a conservatory of the productions accumulated throughout time, a notion close to the "living science" put forward at the Palais.

The objectives followed by the Palais organizers, the problems they faced, and the museological choices they ultimately made were thus not unique. They were part of the wider strategy developed within Group I. This was not necessarily a deliberate decision; rather it reflected a common way of thinking at the time and in the circles to which the exposition organizers belonged.

One way of understanding these common choices is to focus on another project developed within Group I that was often compared to the Palais: the Museum of Literature (Figure 5).[53] The museum belonged to the second class (literary events, libraries), eventually located in a 300-square-meter space in the west wing of the Palais de Chaillot. It was elaborated under the direction of Julien Cain, then director of the National Library and a personal friend of Léon Blum.[54] Paul Valéry claimed that "this small exhibition of letters is an experiment that until today has never been imagined nor realized." Cain recalled that Alfred Picard, the general commissioner of the Universal Exposition of 1900 had stated that "literature does not figure and cannot figure in the program of exhibitions."[55]

Figure 5. The Literature Museum in 1937, general view. From *Ebauches et premiers éléments pour un musée de la littérature* (Paris: Denoël, 1938).

Yet this was exactly the ambition of the museum of literature: to exhibit literature, and in particular literary creation, the labor of the writer as it took place rather than its outcome. Museums already existed for printed works, as Georges Duhamel, a member of the Class 2, pointed out—they were called libraries.[56] Neither books nor their history, the process of their material production, should be on display but rather what "one might call their prehistory: the interior labor whose outcome is the book."[57]

The museological choices made by the museum's founders are known to us mainly through the volume that serves as its catalog,[58] since the museum was dismantled when the International Exposition closed—even though the volume's title and its founders' claims make clear that the museum was conceived as a first step towards a more ambitious and durable institution. It is on the basis of this document that the museum can be analyzed and compared with the Palais de la découverte.

What was the museum fundamentally about? Julien Clain argued that its role was emphatically not to bring together works, iconography, or original documents concerning one writer or one movement such as naturalism or symbolism. This was the remit of an institution such as the National Library, to satisfy the public's taste for rarity and the needs of erudites.

> Our ambition has been altogether another one. We have attempted an explanation, always concrete, of literary matter. We know well that we will never penetrate the secret of creation: it would be foolish to pretend so, and besides, quite pointless. However, we could hope to show literary labor, the very traces that the writer's effort have left, from the first notes thrown on paper up to the manuscript on which the book will be composed: the very steps by which the creative will struggles with its object, a play of substitutions, overlays, epuration.[59]

The parallels with the Palais are patent. Just as the founders of the Palais wished to put forward "living science" and left to others (the Conservatoire national des arts et métiers) the task of exhibiting the sciences of the past and technical objects,[60] the Museum of Literature focused on the "creative will" of the writer, leaving to libraries the task of exhibiting the learned approaches to literature and their heritage. But how could this "creative will struggling with its object" be put on display, if it was "foolish to pretend" penetrating "the very secret of creation?" The makers of the Museum of Literature took a bold and unprecedented decision to systematically rely on writers' manuscripts.[61]

As anthropologist of writing Claire Bustarret has pointed out, original manuscripts were not put forward as "treasures" but rather as witnesses of a practice, the "document of an act" of writing. The exhibition made visible a diversity of such writing acts.[62] The writer's manuscript was to the museum of literature what experiment was to the Palais de la découverte: the museological keystone of a project whose objective was to display creation at work. In the museum of literature, writing was put forward as an "act liable to be dramatized"[63] in the exhibition via the recurrent use of photographic enlargements of autograph pages. The effect could be

Figure 6. The Literature Museum in 1937, entrance and manuscript section. From *Ebauches et premiers éléments pour un musée de la littérature* (Paris: Denoël, 1938).

particularly spectacular, as in the section on "the manuscript" (Figure 6), which made good use of the difficult space of the great entrance staircase of the museum. The tiny figure that can be distinguished under the central hanging gives some indication of the monumental size of the photographic display. This deliberate choice of spectacular monumentality was also at the heart of the Palais' museological choices: witness the impressive Van de Graaf electrostatic generator positioned in the *hall d'Antin* at the museum entrance (Figure 7). The generator had been elevated on a 4-meter-high platform for effect.[64] According to the director of the New York Museum of Science and Industry, Robert P. Shaw, this made it the "most impressive exhibit in the whole exposition."[65]

Photography was not the only "modern" technology the museum of literature's founders planned on using. In order to convey "the dynamic speech of the author, his gestures, in other words, motion, . . . why not rely for these lofty purposes on the machines created by thought itself: cinema and records?" Though the small scale of the project, in terms both of available funding and space, probably prevented their use, its inceptors imagined these technologies would find their place at a later stage, when the museum was established on a permanent basis: "Why not film the authors and record their explanations? In the thoughtful shadows of the library, the dead would present themselves in discrete and luminous tableaux; in the motions of the library, the living would show themselves and speak to each other, their voices and gestures commenting their works: would this not be a means of truly exhibiting their thought, making it visible, audible and permanent?"[66]

Figure 7. The van de Graaf electrostatic generator at the entrance of the Palais de la découverte. © Musée Curie, collection of the Association Curie et Joliot-Curie.

Despite differences in size and resources, there were many similarities in the museological choices made at the Palais de la découverte and at the Museum of Literature, two classes of the 1937 International Exposition Group I that chose the medium of exhibition.[67] The emphasis on spectacular displays, the preference for "modern means" of representation, and especially the focus on showing the act of creation through its materialization (experiments for the sciences, the autograph manuscript for literature) were deliberately promoted in these two groups to show creation at work.

Conclusion

In keeping with the modern pedagogical emphasis on experience, and much inspired by the combination of spectacularity and pure science at the 1933 Chicago World's Fair, the Palais organizers, as the example of the astronomy section shows, sought to develop an innovative "antimuseum" of "science in the making," of live, lively, and living science, in order to encourage scientific vocations and to promote the public funding of scientific research. Situating the Palais within the context of the 1937 Paris International Exposition and its emphasis on the "expression of thought," however, does more than connect the Palais simply with the introduction of innovative displays in science museums. It shows the Palais to partake in a wider project to promote both intellectual work and workers in society at large, and it shows the idea of *thought* as a factor of social and economic progress, a means to promote reason and understanding between peoples.

A comparison between the Palais and the Museum of Literature, two realizations of an exhibition of which it had been claimed that "it was built in thought rather than stone,"[68] shows that the museological solutions developed to put thought on display were not specific to science. Recalling also that the Deutsches Museum was closely patterned on Nürnberg's Germanic National Museum—which honored monuments of German history, art, and literature—there might be a broader lesson to learn about the need to consider specific modes of displaying and promoting science in their wider museological and cultural contexts. This comparison also raises another question: do "interactive displays," of which the Palais is often credited to have been a precursor, really best characterize the Palais in 1937? Indeed, the use of interactive devices in museums and exhibitions predates the Palais.[69] Contemporaries found in any case that the Palais's originality lay less in its interactive displays than in its offer of experiments actuated by demonstrators: "In analyzing the technique of display, one might characterize this exhibition as a presentation by attendants giving lecture demonstration. There was a large number of visitor-operated, automatically operating, and static exhibits, together with other types of display. But, in the main, the job was done by attendants."[70]

The Palais founders resorted to demonstrators and experiments in order to display the *act of scientific discovery*, since, as Paul Valéry wrote, "in these fields, intellectual work always leads to acts that produce phenomena that it has predicted or prescribed."[71] Article 3 of the regulations of the first class makes sense in this light:

Art. 3: The fundamental discoveries that have broadened Man's mind (discoveries in astronomy or mathematics) as they secured his increasing domination on matter (discoveries in physics and chemistry) and improved his physiological safety (discoveries in biology) will be repeated in a spectacular manner and with modern resources in order to produce a living exhibit, as far as possible. Demonstrators will supply the required explanations (using sychronated photographic disks and cinematographic films).[72]

This was to be done by demonstrators who acted out the experiments while explaining them. "Fundamental discoveries" could be "repeated in a spectacular manner." Through its devices and demonstrators, the Palais thus sought to regularly stage reenactments of discovery. Pascal Ory has noted that religious metaphors pervade Perrin's speeches about the Palais de la découverte, even claiming that "his faith in science is truly religious in nature."[73] In this light, the reenactment of discovery by demonstrators might perhaps be considered as a "Perrinian" version of the Eucharist, making the Palais "a living organism of the communion between scientists who create science and the people that aspire to it."[74]

Notes

This article in part draws from an earlier publication: A. Bergeron and C. Bigg, "D'ombres et de lumières. L'Exposition de 1937 et les premières années du Palais de la découverte au prisme du transnational," *Revue Germanique Internationale* 21 (2015): 187–206. We are grateful to the editors of that journal and of the special issue for permission to reuse parts of this publication.

1. J. Eidelman, *La Création du Palais de la découverte: Professionnalisation de la recherche et culture scientifique dans l'entre-deux guerres* (Ph.D. diss., Université Paris V, Paris, 1988); P. Ory, *La belle illusion: Culture et politique sous le signe du Front Populaire (1935–1938)* (Paris: Plon, 1994). B. Bensaude-Vincent, "Popular Science and Politics in Interwar France," *Science in Context* 26 (2013): 459–471.
2. R. W. Rydell, "World Fairs and Museums," in *A Companion to Museum Studies*, ed. S. Macdonald (Chichester: Wiley-Blackwell, 2011), 135–151; T. Bennett, *The Birth of the Museum: History, Theory, Politics* (London: Routledge, 1995); A. Te Heesen, *Theorien des Museums zur Einführung* (Hamburg: Junius Verlag, 2012).
3. R. H. Kargon, K. Fiss, M. Low, and A. P. Molella, *World's Fairs on the Eve of War: Science, Technology and Modernity, 1937–1942* (Pittsburgh: University of Pittsburgh Press, 2015), 2.
4. E. Labbé, *Exposition internationale des arts et techniques dans la vie moderne, 1937: Rapport général* (Paris: Imprimerie nationale, 1938–40), vol. 5, xii.
5. Archives Nationales, Pierrefitte-sur-Seine, France (henceforth AN), file 19900512-1, *Chicago* (unsigned typescript, file "Exposition internationale Chicago 1934": n.d.), 1.
6. AN 19900512-1, *Chicago*, 1. All translations are ours.
7. AN 19900512-1, *Chicago*, 3. A similar device was developed in the original biology section at the Palais that proved particularly popular (Labbé, *Exposition internationale*).
8. AN 19900512-1, *Chicago*, 5.
9. At the end of the Exhibition, Léveillé campaigned for maintaining the Palais, arguing that "Altogether the Palais de la découverte was presented by Jean Perrin as fulfilling for science a function similar to the Louvre for art: whereas the latter elevated the masses to the joys of art, the former fostered their scientific education." AN 19900512-3, "Le Palais de la découverte," *Conférence prononcée par M. Léveillé, secrétaire général du Palais de la Découverte à la réunion du vendredi 19 novembre 1937 de la société d'économie industrielle et commerciale, 5.*
10. AN 19900512-3, "Le Palais de la découverte," *Conférence prononcée par M. Léveillé*, 6.
11. J. Perrin, "Préface," in Exposition Internationale: *Le Palais de la découverte, Paris, 1937* (Paris: L'Emancipatrice, 1937), 6.
12. AN 19900512-3, "Le Palais de la découverte," *Conférence prononcée par M. Léveillé*, 7.
13. AN 19900512-1, *Classe I: Découverte Scientifiques: Règlement de la classe* (unsigned typescript , file "Group I, classe I, 1935–37," n.d.), 2.
14. AN 19900512-3, Robert Lencement, *Section d'astronomie* (typescript, file Rapports des sections, 1937, n.d.), 13.
15. AN 19900512-4.
16. P.-G. Forest and B. Schroeder-Gudehus, "L'internationalisme et les Expositions Universelles dans les années trente," in *Masses et culture de masse dans les années 30*, ed. Régine Robin (Paris: Les éditions ouvrières, 1991), 205–224.
17. AN 19900512-3, Lencement, *Section d'astronomie*, 7.

18. F. Fuchs, "Der Aufbau der Astronomie im Deutschen Museum (1905–1925)," *Deutsches Museum Abhandlungen und Berichte* 1 (1955).
19. H. Trischler and W. Füßl, eds., *Geschichte des Deutschen Museums: Akteure, Artefakte, Ausstellungen* (Munich: Prestel, 2003); W. Füßl, *Oskar von Miller (1855–1934)* (Munich: Beck, 2005).
20. P. Ory, "Une 'cathédrale pour les temps nouveaux?' le Palais de la découverte (1934–1940)," in *Masses et culture de masse dans les années 30*, ed. Régine Robin (Paris: Les éditions ouvrières, 1991), 180–204, esp. 191–197.
21. T. Gieryn, "Laboratory Design for Post-Fordist Science," *Isis* 99 (2008): 796–802, on 798. See also R. E. Kohler, *Landscapes and Labscapes: Exploring the Lab–Field Border in Biology* (Chicago: University of Chicago Press, 2002), 6–11.
22. AN 19900512-3, Lencement, *Section d'astronomie*, 1–3.
23. H. Mineur, "Le Service de recherches d'astrophysique," *L'Humanité*, 4 May 1937, 4.
24. A. Saint-Martin, L'Office et le téléscope: Une sociologie historique de l'astronomie française, 1900–1940 (Ph.D. diss., Université Paris-Sorbonne, Paris, 2008), 414–456.
25. AN 19900512-1, *Conclusions générales* (unsigned typescript, n.d.), file Préparation de l'exposition universelle de 1937, 36.
26. AN 19900512-3, Note préliminaire de Mr. J. Perrin (unsigned, unpaginated typescript, n.d., file "Astronomie").
27. AN 19900512-1, *Chicago*, 3.
28. AN 19900512-3, Lencement, *Section d'astronomie*, 10.
29. AN 19900512-3, Lencement, *Section d'astronomie* , 6, 11-13.
30. AN 19900512-1, *Chicago*, 33.
31. *Rapport Général de la Commission extra-parlementaire chargée d'étudier les moyens de généraliser l'application du cinématographe dans les différentes branches de l'enseignement* (Paris: Imprimerie nationale, 1920), 4.
32. AN 19900512-3, *Rapport sur l'activité de la section de "Cinéma" du Palais de la découverte pendant la durée de l'Exposition internationale de Paris 1937* (unsigned typescript, n.d.), 5. See also Florence Riou, "Le cinéma à l'Exposition internationale de 1937: un média au service de la recherche scientifique," *1895* 58 (2009): 39–55.
33. AN 19900512-1, *Chicago*, 1.
34. K. A. Rader and V. E. M. Cain, *Life on Display: Revolutionizing U.S. Museums of Science and Natural History in the Twentieth Century* (Chicago: University of Chicago Press, 2014), 99–101.
35. Füßl, "Gründung und Aufbau 1903–1925," in *Geschichte des Deutschen Museums*, ed. H. Trischler and W. Füßl, p. 82.
36. W. Weber, "Vorgeschichte und Voraussetzungen der Museumsgründung," in *Geschichte des Deutschen Museums*, ed. H. Trischler and W. Füßl, p. 56.
37. Füßl, "Gründung und Aufbau 1903–1925," in *Geschichte des Deutschen Museums*, ed. H. Trischler and W. Füßl, pp. 69, 82.
38. P. Valéry, Preface to J. Cain, *Ebauches et premiers éléments pour un musée de la littérature* (Paris: Denoël, 1938), iv–v.
39. After Henry de Jouvenel died in 1935, Paul Valéry was chosen to succeed him as president of the group.
40. Séance du 25 février 1932 au Sénat, Journal Officiel de la République Française. Débats parlementaires (1932).
41. Senator Tournan's proposal came at a moment when the central organs of intellectual cooperation, and especially the executive organ of the Organization of Intellectual Cooperation (OIC), were resolving an internal crisis with the nomination of a new director, Henri Bonnet. To promote intellectual cooperation for a radical senator signified promoting an instrument of peace in the face of the menace of war, but it also helped promote French influence abroad, especially through an organization that in its French branches was peopled by radicals and kindred spirits. On the OIC, see J.-J. Renoliet, *L'UNESCO oubliée: la Société des Nations et la coopération intellectuelle (1919–1946)* (Paris: Publications de la Sorbonne, 1999).
42. Décret relatif à la création à Paris d'une exposition générale internationale (arts décoratifs et industriels modernes, vie ouvrière et paysanne, coopération intellectuelle), *Journal Officiel de la République Française. Lois et décrets,* 17 January 1933, 491.
43. In France, the interests of the supporters of intellectual cooperation met those of another, related group, the members of the Confédération des Travailleurs Intellectuels (Confederation of Intellectual Workers, CTI). Founded in 1920 by personalities from the arts, the sciences, and letters, including Henry de Jouvenel and Emile Borel (Jean Perrin later joined it), the CTI revolved around the idea of the "intellectual worker." Its definition of intellectual work was broad and pragmatic, recognizing as an intellectual worker "any person whose social function is characterized by its recourse to intelligence," such as artists, scientists, technicians, lawyers, and architects. One of its main objectives was the promotion of "intellectual work" and the improvement of working conditions. On the CTI, see Alain Chatriot, "La lutte contre le 'chômage' intellectuel: l'action de la Confédération des Travailleurs Intellectuels (CTI) face à la crise des années trente," *Le mouvement social* 214 (January–March 2006): 77–91.
44. AN 19900512-7, letter from A. Léveillé to Docteur Renaudeaux, n.d.
45. AN 19900512-7, letter from A. Léveillé to Léon Binet, 17 August 1937. Note that during a lecture given to the *Centre d'étude des problèmes humains* in 1939, Léveillé recounted that "The general commissioner M. Berthod decided to merge the three projects into one single exhibition and this is how, one evening, an artist whose mind was surely ill-formed, voiced the idea that an exhibition giving a place to thought should reserve a space for science. This proposal met with a formidable majority against it, and it was only thanks to the support of the director of the International Institute of Intellectual Cooperation, of the director of the Pedagogical Museum, and the great authority of M. François Carnot that a minority of three voices could impose its will to a majority of 30 voices. This is how, overturning the forms of classification established by the International Bureau of Commissions, a place for the sciences was secured at the 1937 exhibition." AN 19900512-86, Allocutions de Léveillé-1939, Letter from P. Aube to A. Léveillé, 11 July 1939, 7.

46. AN 19900512-3, "Le Palais de la découverte," Conférence prononcée par M. Léveillé.
47. AN F12-12303 , Projets et arrêtés de nomination aux comités de groupe et de classe.
48. In fact, the additional funds allocated by the State in 1936 were taken from the budget destined for infrastructure works (Ory, *La belle illusion,* 603).
49. See Eidelman, *La Création du Palais*.
50. P. Valéry, "Un problème d'exposition," *Paris 1937, Revue mensuelle de l'exposition*, reprinted in *Œuvres*, Vol. 2, 1150–1156 (Paris: Gallimard, 1960). Quotations translated; emphasis added.
51. Valéry, "Un problème d'exposition," 1151. Emphasis in original.
52. Valéry, "Un problème d'exposition,"1151.
53. G. Rageot, "Le Palais des lettres et du livre doit être sauvé aussi," *Paris-Soir*, 30 january 1938.
54. See C. Nicault, "Julien Cain (1887–1974)," in "Les bibliothèques, grands équipements en sciences humaines et sociales, l'exemple de la BnF," ed. V. Tesnière. La revue pour l'histoire du CNRS 12 (2005). http://histoire-cnrs.revues.org/1330 (accessed 21 February 2017).
55. Cain, *Ebauches*, x.
56. G. Duhamel, "Pour un musée de la littérature," *Marianne*, 20 octobre 1937.
57. P. Valéry, Preface to Cain, *Ebauches*, v.
58. Cain, Ebauches.
59. Cain, Ebauches, x.
60. According to Perrin, the Palais de la découverte would be "a modern museum of science, one in the style of the Luxembourg Museum compared to which the Conservatoire national des arts et métiers would be a Louvre, that is, a museum of the past," cited by Jacqueline Eidelman, "The Cathedral of French Science. The Early Years of the Palais de la Découverte," in *Expository Science: Forms and Functions of Popularisation*, ed. T. Shinn and R. Whitley (Dordrecht: Reidel, 1985), 201.
61. The Museum of Literature was the first exhibition of writers' manuscripts. See C. Bustarret, "Quand l'écriture vive devient patrimoine: Les manuscrits d'écrivains à l'Exposition de 1937," in *La (r)évolution des musées d'art*, ed. A. Gob and R. Montpetit, *Culture & Musées* 16 (2010): 159–176.
62. Claire Bustarret listed these, on the basis of the exhibition catalog: "Learning to write and practicing versification, annotating books or taking notes on a theme, scribbling a few lines on a makeshift medium or a favorite notebook, documenting oneself, drawing a sketch or a diagram, gathering papers on a working table, outline using a pencil or put down a first draught, composing through successive versions, or preparing an outline, developing a poem or an episode, crossing out to correct or erase, adding notes in the margins or on additional pages, inserting new passages, copying and reworking a clean or typed version, revising a text published in a periodical, taking into account editorial constraints or confronting censorship, abandoning or returning to a manuscript after several years, correcting posters and proofs, preparing one or several editions, neglecting or taking care of one's draughts, 'cleaning up' after finishing one piece of work, ordering it for posterity or for future purposes, safeguarding, transmitting, destroying or reusing one's manuscripts, engaging in correspondence, signing, writing a testament, . . . " Bustarret, "Quand l'écriture," 164.
63. Bustarret, "Quand l'écriture," 160.
64. P. Molinié and S. Boudia, "Exhibiting Sparks of Big Science to the Public: Electrostatics, Atomic Machines and Experience of Paris Palais de la découverte," *IEEE Transactions on Dielectrics and Electrical Insulation* 16 (2009): 751–757. See also Musée Curie, collection of L'association Curie et Joliot-Curie (https://musee.curie.fr/public/acjc).
65. R. P. Shaw, *Report on Studies of Palace of Discovery, Paris International Exposition, Museums of Science and Industry and other Exhibitions in Europe*, 7, Rockefeller Archive Centrer, RG 1.1, series 200, box 262, folder 3119. The authors are grateful to Jaume Sastre-Juan for allowing access to this document.
66. G. Rageot, "Comment exposer la pensée?" *Le Figaro littéraire*, 12 June 1937.
67. A comparison with class 3, "Museums and exhibitions," is not easy because the latter was focused on exhibitions themselves. The other classes were dedicated either to congresses or to live performance (theater, music, dance, cinema). See Labbé, *Exposition internationale*, vol. 5, 3–69.
68. Labbé, *Exposition internationale*, vol. 5, xix.
69. Jaume Sastre-Juan has studied their use at the New York Museum of Science and Industry (NYMSI) at about the same time and has shown in his study of interactive displays that these could serve very different, even opposed, ideological purposes. J. Sastre-Juan, Un laboratori de divulgació tecnològica: El New York Museum of Science and Industry i la política de la museïtzació de la tecnologia als Estats Units (1912–1951) (Ph.D. diss., Universitat Autònoma de Barcelona, Barcelona, 2013). The NYMSI was the Palais's first international partner. It participated in the realization of the exhibition that the Carnegie Institution of Washington presented at the Palais in 1938, just after the Palais reopened after the exhibition ended.
70. Shaw, *Report on studies of Palace of Discovery*, 16.
71. Valéry, "Un problème d'exposition." Emphasis in original.
72. AN 19900512-1, Règlement de la classe 1, n.d.
73. Ory, "Une 'cathédrale pour les temps nouveaux,'" 183.
74. J. Perrin, "Discours prononcé lors de la Réception à l'Hôtel de Ville des Membres du Congrès du Palais de la Découverte," *Bulletin municipal officiel de la Ville de Paris, LVIIe année,* no. 28, 4 February 1938, 843.

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CHAPTER 8

Science versus Technology

The Exhibition of Universal Science in E42 Rome and the Museum of Science and Technology in Milan

Elena Canadelli
Assistant Professor in History of Science
Department of Historical and Geographic Sciences and the Ancient World, University of Padua
Italy

The Esposizione Universale di Roma (EUR, Universal Exposition of Rome), the 1942 world's fair of Rome commonly known as "E42," is pivotal to understanding the great interest in science and technology exhibitions and museums that spread throughout Italy during the 1930s. Despite its cancellation, E42 represents a fundamental piece of a more complex puzzle: the use and interpretation of science and its history during the Fascist regime, against the background of the international museological debate of the time. As expressed in the exposition's subtitle, "Olympiad of Civilization," it endeavored to be a sound cultural enterprise that had originated within a spirit of internationalism among nations[1] as well as a monumental celebration of the imperial ambitions of Mussolini. As stated in the 2015 book *World's Fairs on the Eve of War*, E42 tried to introduce "a brilliant fusion of the past and the scientific future," a "blend of modernity and tradition,"[2] even in the monumental architecture of its edifices. Thus, the Fascist regime planned an entire new suburban district in Rome, with monuments and buildings designed to last and host permanent museums after the closure of the world exhibition—a fairly unusual decision for this kind of temporary mass event. EUR gave shape to the "paradoxes of Fascist modernism,"[3] blending together the patriotic celebration of a glorious past of ancient Rome with a successful science- and technology-based present and future.

Indeed in E42, science and its applications were intended to be shown as part of human culture and civilization, and they played a crucial role. Scientific artifacts would have been displayed in many of the planned exhibits (Figure 1), starting from the ambitious Exhibition of Universal Science, which would later have been transformed into a permanent science museum hosted in the Italian capital city. Science and technology were also to be featured in exhibits that dealt with other historical topics, including the Exhibition on Italian Civilization and the Exhibition on Roman Civilization. Both were in line with the great number of more or less politicized temporary exhibitions organized in Italy during the 1930s about Italian achievements and records (*primati*) in science, technology, and industry. The Exhibition on Italian Civilization (Figure 2) should have included some focus on scholars such as Leonardo, Galileo, Cesalpino, and Realdo Colombo to represent Italian science in the history of civilization in connection with art, philosophy, and literature of a certain period.[4] In the Exhibition on Roman Civilization, some sections were to be dedicated to the history of Roman civil and military engineering as well as to science and medicine, similar to what was actually seen in the majestic Mostra Augustea della Romanità exhibition in Rome from 1937 to 1938. Many of the E42 exhibitions, including the Exhibition on Popular Italian Traditions, which eventually opened in 1956 in the EUR site, should have become permanent museums. Though the Museum of Italian Civilization and the Science Museum in Rome were never realized, the Museum of Roman Civilization opened at the EUR site after the Second World War, in 1955. The redundancy of many scientific topics among these exhibits is striking, even more so when one realizes that an entire section of E42 would have been devoted to the field of industry and science applications in relation to autarky.[5] In actuality, one wonders how the organizers of the Universal Exposition of Rome would have managed the coexistence of all these exhibitions in terms of the artifacts on display.

The E42 planning committee involved many Italian academics and politicians, from Senator Vittorio Cini, the general director of the fair, to Giuseppe Bottai, the influential minister of national education from November 1936 to February 1943, governor of Rome, and one of the Fascist party's chief ideologues. Bottai in particular is a key figure in understanding Italian debates during the 1930s about how to disseminate science and scientific education and how to protect Italian cultural heritage. In the same years that E42 was being planned, from approximately 1936 until 1943, Bottai organized an exhibition on technical education in the present and the past that was displayed in Rome from 1936 to 1937; established the Day of Technology in 1940; and introduced the important law for the preservation of Italian cultural–historical heritage named *Tutela delle cose d'interesse artistico o storico*, which passed in 1939 but did not include protections for historical scientific instruments.[6] As minister of national education, Bottai was also deeply involved in the realization and support of the main rival project to the Exhibition of Universal Science, the Museo Nazionale della Scienza e della Tecnica Leonardo da Vinci (Leonardo da Vinci National Museum of Science and Technology). The museum was ultimately established in Milan under the auspices of Guido Ucelli, an influential engineer working as general manager at Riva, a renowned factory assembling turbines and water pumps in Milan.[7]

Figure 1. A new Rome arises. In the E42 general plan, the science exhibition is at the bottom left, colored green. Courtesy of Archivio Centrale dello Stato, Rome, EUR, Photographic Archive.

Figure 2. The Palace of the Italian Civilization under construction around 1940. Its words welcomed Italians as a "people of poets, artists, heroes, saints, thinkers, scientists, sailors, and migrants." Courtesy of Central Archives of the State, Rome, EUR, Photographic Archive.

Almost the entire Italian scientific community was called to cooperate in the extensive project of the Exhibition of Universal Science; the committee included scientists—mostly professors at major Italian universities and fellows at prestigious Italian scientific academies—but not historians of science, as clearly emphasized by the Italian scholar Paolo Galluzzi.[8] Even though the exhibition and the science museum it was to produce have never been realized, it is possible to retrace the general plans for the exhibition thanks to the extraordinary number of EUR documents and reports preserved at the Central State Archive in Rome. Formally established at the end of 1937, the committee was composed of 19 members, including, as president, Francesco Giordani, a chemist at the University of Naples, and, as vice president, Sabato Visco, a physiologist at the University of Rome. It also included the industrialist Ucelli.[9] In order to plan the exhibition, nine subcommittees were created to address physics, electromagnetic waves, mathematics, chemistry, biology, geology, astronomy, geography, and technical applications in construction. Many of the scientists involved—including astronomer Giorgio Abetti, physiologist Filippo Bottazzi, and physicist Antonino Lo Surdo—were to be present at the Exhibition on Italian Civilization. Others, such as Ucelli, were to be at the exhibitions on electrical industries or land reclamation. Scientists aimed to organize an educational enterprise, a "living" visual and material handbook of the history of basic sciences—as well as their discoveries, phenomena, and laws—through selected artifacts and exhibits. These were to include mostly models, replicas, dioramas, photographs, diagrams, film footage, and reproductions of instruments. This approach was much like that of other temporary exhibitions of this kind, such as the aforementioned Mostra Augustea della Romanità, which consisted mainly of casts of statues and reliefs; large-scale dioramas of Roman engineering; realistic models of bridges, buildings, catapults and siege engines; reproductions of surgical instruments; and large-scale models of astronomical instruments. In addition, for the first time in Italy, scientists had the opportunity to publicly demonstrate scientific laws in front of the general audience in the halls of an exhibition.

To understand the choices made by the committee, it is important to emphasize that the planning of E42 perfectly overlapped the realization of relevant national and international fairs that focused on different aspects and histories of science and technology, especially the Exposition Internationale des Arts et Techniques dans la Vie Moderne in Paris in 1937 and the New York World's Fair in 1939, each of which offered a different model that could be followed or ignored by the Italian committee in terms of topics, organization, style of exhibits, and scientific artifacts on display. Paris emphasized the scientific thought examined in this volume by Bergeron and Bigg, while the New York World's Fair, themed the "World of Tomorrow," was basically perceived as a commercial.[10] As clearly demonstrated by several detailed EUR reports preserved in the central state archives in Rome, the organizers of E42 looked at what was happening abroad: at the visits of different Italian delegates not only to Paris and New York, but also to the Brussels International Exhibition of 1935; the Glasgow Empire Exhibition of 1938; and the San Francisco World's Fair, the International Water Exhibition in Liège, and the Switzerland National Exhibition in Zürich, all held in 1939.[11] In the reports are not only the carefully described practical arrangements and overall organization of the exhibitions, but also the impressions aroused in the visitors by each fairs' pavilions and exhibits. This shows the close relationships and influences among these popular international mega events. Furthermore, it is necessary to consider that, during the planning of E42, many temporary exhibitions organized throughout Italy—which were more or less politicized by the Fascist regime—covered topics somehow related to the history of science, technology, and industry. This set a standard and a precedent for other exhibitions, from Leonardo da Vinci and the Italian Inventions that opened in Milan in 1939 to the autarkic Exhibition of Italian Minerals held in Rome during 1938 to 1939.[12] These ideological exhibitions were intended for the general public and offered opportunities to gather artifacts and other materials that could be used later to establish or expand collections for permanent museums. However, at the same time the very idea of museums was being questioned.

It is impossible to understand the overall concept of the Exhibition on Universal Science and the intention to transform it into a permanent institution without analyzing this project in the context of the lively Italian and international scenes during this time. On the one hand, E42 was a response to the attempts of establishing in Italy, as in other Western countries, a national science and technology museum, which did not exist until then. On the other hand, it had the ambition to offer an alternative to the models existing at the time, such as the Deutsches Museum in Munich and the brand-new Palais de la découverte in Paris. Although it is basically a history of failures, since E42 was never realized due to the Second World War, this case study provides an in-depth understanding of the relationships between national and international exhibitions and permanent science museums during the interwar period, and outlines the many-sided Italian debate, which after many years finally led to the foundation in 1953 of a national museum of science and technology, albeit in Milan rather than in Rome. This debate involved different communities, ranging from scientists and engineers to historians of science and industrialists, which for some years acted in parallel and represented different demands. During the 1930s, the discussion in Italy could be seen as a miniature version of a wider and differentiated debate happening abroad regarding the fate of science museums, the public use of scientific artifacts in the context of nationalistic narratives focused on identity and *primati*, and the introduction of new kinds of interactive and manufactured exhibits to display science and its history to a general audience.

The Quest for the "Living Museum" and the Italian Exhibition Mania

The Exhibition on Universal Science acted in the Italian panorama as a turning point in an ongoing debate regarding the foundation of an Italian national science and technology museum and the very idea of a "museum" as a living institution. When plans for the exhibition and the science museum of Rome began, the debate already had been taking place since at least the end of the 1920s. The E42 stimulated discussion among different antagonists while at the same time responded to the need for new and more effective exhibits to disseminate science.

In the Italian context, a prominent role had been played by the Institute and Museum of History of Science, which had been established in Florence in 1930, one year after the pioneering National Exhibition of the History of Science (see Barreca, this volume). The museum was engaged in the preservation, protection, and study of the Italian scientific heritage. In Rome, on the occasion of the Italian participation in the Century of Progress International Exposition, a world's fair held in Chicago from 1933 to 1934, the National Council of Research (CNR) started the *Documentario dei primati scientifici italiani* (Italian scientific achievements documentary) project. Led by chemist Giulio Provenzal, who was also involved in the E42, the project was composed of artifacts and documents and focused on the recovery and glorification of Italian scientific achievements.[13] Meanwhile, Ucelli—supported by a strong community of engineers and industrialists—sought to establish in Milan a museum of labor, industry, and engineering to advance the technical education of general audiences and to document the history of technology. These efforts in Florence, Rome, and Milan all held the same goals: science dissemination, historical research, public education, heritage preservation, and celebration of the Italian scientific tradition. Sometimes, in the absence of sufficient resources, these objectives were intentionally confused—for "opportunistic reasons"—even though they were the expressions of distinct communities driven by different motives. The Institute and Museum of the History of Science in Florence, for example, responded to different kinds of needs compared to the museum in Milan, even though the protagonists preferred to emphasize similarities over differences in order to gain the support of the authorities.[14] The same happened with the two museums in Milan and Rome, which had their identities adjusted or swapped to fit different needs. For example, the museum in Rome was considered a museum of industry when the E42 committee wanted the support of Confindustria (the Confederation of the Italian Industry)[15] as opposed to a museum of basic science, a label used by the committee when it wanted to differentiate the museum in Rome from that of Milan.

The foundation of an Italian national science museum was already an issue before the strong impetus resulting from the Florentine exhibition in 1929 and the Chicago World's Fair in 1933. On 1 January 1928, in a message to Guglielmo Marconi, the well-known physicist and inventor who had just become president of the recently reformed CNR, Mussolini's personal commitment to the creation of "living museums where progresses of science, technology, and industry" was made clear. He wrote, "A country does not spend effort in vain in these works of progress."[16] Mussolini believed that his country should have a museum intended for science education and dissemination in a time of political and economic autarky promoted by its regime. The press immediately emphasized that "models and machines in museums should not only be proudly displayed or simply evoke the memory of a glorious past,"[17] but instead had to teach and entertain, stimulating the interest of young generations and driving the working class toward science and technology. The realization of the museum soon became one of the objectives of the CNR, the same institution involved in the creation of the *Documentario* project, displayed in 1937 in the CNR's new building in Rome. In June 1928, the secretary Giovanni Magrini contacted several European museums, including the Science Museum of London, to gather information to establish an institution of this kind in Rome, but in the end Marconi preferred to support the initiative led by Ucelli and the municipality of Milan.[18]

It is likely that the message of Mussolini was the result of a previous debate regarding, on the one hand, the history of science and, on the other hand, technical education. In the former case, many science historians had been asking for a national museum as a solution to the fragmentation and preservation of historical and scientific heritage on Italian territory. For example, Aldo Mieli closed his 1921 report on the Deutsches Museum wondering, "Why don't we join efforts and try to build a great institution, able if not to outdo, at least to equal the new museums in Munich, Paris, London and Washington?"[19] Mieli sought to establish in Rome a leading institution for the study of the history of science, with the support of the influential philosopher and minister of public education Giovanni Gentile. Also in Rome, science historian and mathematician Federigo Enriques had established the National Institute for the History of Physics and Mathematics in 1923. In Florence in 1927, the Institute and Museum of the History of Science had been founded thanks to the efforts of the Group for the Preservation of Italian Scientific Heritage, which included physicist Antonio Garbasso, physician Andrea Corsini, and senator Piero Ginori Conti.

In the latter case—technical education—in 1926, the engineer Giuseppe Belluzzo, at the time minister of national economy and very close to Mussolini, wrote his article entitled "*Scienza* *e tecnica per l'avvenire economico dell'Italia fascista*." He underlined the educational objectives of displaying machines in action, turbines, engines, and cannons such as those seen at the Deutsches Museum, and the importance of science and industry museums for the formation of an "industrial conscience of the people."[20] Belluzzo recalled his tour of the European scientific museums in 1905 and the unsuccessful proposal to establish such a museum in Milan following the Universal Exhibition in 1906. The article closed with the request to install a permanent pavilion of physics, chemistry, and their industrial applications in the industrial city of Milan, an idea later successfully developed by Ucelli, one of Belluzzo's friends and most brilliant disciples at the Polytechnic University of Milan.

Following Mussolini's 1928 message, the debate intensified during the 1930s, which had significant consequences on the planning of E42 Exhibition of Universal Science. Many scholars spoke of needing "living museums," both in terms of renovating existing museums and founding new and more instructive ones. The use of the adjective "living" referred mostly to ways of engaging visitors through more effective and amusing displays, such as dioramas or functioning models accentuated by sound and film. In 1930, Francesco Mauro, an engineer and keen mineralogist who was active in Milan and very close to Ucelli, published a report concerning his visit to some American museums, including the American Museum of Natural History in New York and the Field Museum of Natural History in Chicago. Comparing Italy to the United States, he pointed out that the main aim of a public museum should be the education of the people through dynamic exhibits rather than being "*musei chilometrici* [very large museums], of a total frigidity in winter and summer, good only to humiliate the soles of the feet."[21] For example, the dioramas of the African Hall of the American Natural History Museum or the comparison of mineral samples and industrial products in the Field Museum impressed visitors more than the many specimens and instruments displayed without any interpretation in an endless sequence of shelves or glass cases. Showing processes and comparing phenomena was thus considered more effective and instructive than having visitors merely looking at objects, even if the artifacts were of great relevance. As in the United States, Italy had to put an end to the fixed pair "museum and dust"[22] that was favored by many Italian scholars of the time. These included biologist Gustavo Brunelli, who emphasized the role of dioramas for natural history museums, and zoologist Giovanni Battista Trener, director of the Natural History Museum of the Tridentine Venice that was established in Trento in 1930, who stressed the importance of a museum being "alive" as a center of promotion of scientific research and education. In favor of creating an Italian National Museum of Natural History (which was never realized),[23] Trener discussed the use of the word "museum" to describe his newborn institution, since many in Italy considered it a "compromised" and "dusty" term. In terms of science and technology museums, Ucelli also wondered about and discussed with ministers and Mussolini himself what to call the nascent museum in order to transmit an idea of dynamism and liveliness: "Polytechnic Institution," "Center of Documentation and Propaganda for the History of Technology," and "Polytechnic Documentary of Science, Arts and Industries," were all considered, but in 1943, he finally opted for "museum." And in particular, in opposition to the E42 project that focused on basic science, he chose to call it "Museum of Technology and Industry."

At the same time, temporary exhibitions organized in Italy during the 1930s influenced the style, design, and topics of scientific and technological artifacts to be displayed in public—whether they were originals or, more often, replicas and models. I am referring to mass events organized in different Italian cities under the auspices of the regime, such as the Mostra dell'Aeronautica Italiana, inaugurated in 1934 in Milan in the Palazzo dell'Arte, or to the aforementioned Mostra Augustea della Romanità. In many of these exhibitions, the achievements of fascist Italy were connected to the idea of a glorious scientific past in order to highlight the successful autarkic politics promoted by fascism. A symbol of this trend was the imposing Mostra di Leonardo da Vinci e delle Invenzioni Italiane (Exhibition on Leonardo da Vinci and the Italian Inventions), which opened during the organization of E42. It comprised two exhibits that celebrated the genius of one of the most famous Italian artists and scientists in connection with Italian scientific tradition and the achievements of the regime in the fields of science, invention, and industrial applications. Some of the most relevant Italian industries of the time participated in the event: the Officine Galileo for optics, Pirelli for chemistry, Fiat for the automobile industry, in addition to universities and the ministries of the army, navy, and air force. As stated in the event brochure, the two exhibits "are not two distinct things, but a whole organic project ideally connected through the centuries: the common purpose is to provide perfect and up-to-date documentation of the advances made by science and technology from the sixteenth century to the present."[24] In addition, Gerolamo Oldofredi, general director of the executive committee of the Exhibition on Italian Inventions, declared that Galileo memorabilia, Galvani's notebook, Volta's battery, Pacinotti's ring, Meucci's telephone, and Marconi's transmitters should be seen in continuity with the work of Leonardo in presenting the Italian contribution to human civilization.[25] Many exhibitions devoted to Italian self-sufficiency in industry and economy included a historical focus. This included the Mostra Nazionale delle Bonifiche, which opened in Rome in 1932 and had a section devoted to Leonardo and the Exhibition of Italian minerals, which was held in Rome from 1938 to 1939. The latter featured a section called *Research and Inventions* that was headed by the CNR and offered a retrospective on the history of the use of minerals and the mining industry since the Etruscans, including dioramas, machines, and instruments of miners; a relief of a furnace; and original manuscripts of engineer and politician Quintino Sella, metallurgist Vannoccio Biringuccio, and physician Andrea Cesalpino.[26] Again and again, historical and current research were connected in one exhibition, in one narrative.

A Palais de la Découverte in Rome, a Deutsches Museum in Milan?

In the Italian multilayered debate on whether living museums were needed to disseminate science, the Exhibition on Universal Science had to stress its individuality in comparison to exhibitions and museums in Florence and Milan and the *Documentario* project in Rome. It was designed as a gallery of scientific principles, a review of the history of scientific thought from ancient civilizations to the present day. It was not intended to become a museum of original instruments, like Florence, or a museum of technical and industrial devices, like Milan, but rather mostly a museum of manufactured exhibits concerning the universal history of scientific discovery looked at through the history and development of disciplines until the present state of the art.

On an international level, the brand-new Palais de la découverte (see Bergeron and Bigg, this volume) in Paris, inaugurated during the 1937 Exposition Internationale, had a great influence on E42 in terms of exhibits and contents. In Milan, Ucelli led an opposing project inspired by the Deutsches Museum in Munich. The German museum was aimed at educating and disseminating technical and industrial knowledge as well as documenting and studying the so-called progresses of technology and production. At the time, the Deutsches Museum was among the best-known museums of this kind in Italy, to the extent that the architects of E42 also looked first at its exhibitions.[27] As Ucelli wrote in 1941, these museums "must not only be of interest to scholars, they have also to make clear and understandable to the masses, to the community, the ideals of science, the general problems of the availability and processing of raw materials, the specific problems of agriculture and industry, the real problems of production and organization; they have to celebrate the nobility of work, facilitating professional guidance; they also have to give the maximum possible technical culture to the people to promote progress and individual self-development."[28] From the very beginning of the planning of E42, the parallel attempts of Rome and Milan developed in mutual and constant dialogue and in opposition to each other, giving voice to different protagonists and demands existing at the time in Italy in the field of museum practice. Both projects were trying to interpret and respond to Mussolini's mandate. The correspondence between Ucelli and Vittorio Cini, the general director of E42, started in October 1936, when Ucelli asked to be involved in the project. He wanted to deal with the technical section, following "in a livelier way" the examples of the museums in Munich, London, Chicago, Vienna, and Paris, which he had personally paid visits to since the early 1930s.[29]

Before planning for E42 began, the pursuit of establishing a science museum already involved both Milan and Rome. Ucelli's attempts dated back to 1930, when he chaired a commission the municipality of Milan had appointed to realize a Museum of Art and Industry. In February 1931, he gained the support of Marconi, with whom Ucelli collaborated on the occasion of Italy's participation in the Chicago World's Fair. In June 1933, Ucelli informed the municipality that the secretary of the CNR, Giovanni Magrini, while giving priority to Milan, was evaluating various options: "1) the creation in Rome of a museum of science and industry; 2) the creation of two distinct museums, one of science in Rome or in Florence, the other of industry in Milan; and 3) the creation of a national museum and of several regional industrial museums in different cities of Italy in order to document and display typical regional productions."[30] One year later, the situation had not changed much, as pointed out by Ucelli: "In recent times, various hostilities have arisen in the directorate of the CNR against the project of the museum of Milan, since several members view this as an opportunity to found the new institution in Rome. It would seem, however, that Marconi and Magrini together with others want to entrust Milan with the industrial museum, leaving to Rome the museum of science (which in the past others had wanted to be established in Florence)."[31]

With the start of the work for E42 and the death of Marconi, the negotiation for the science and industry museum was taken over by Bottai, who as the minister of national education presided over both initiatives. With Florence slowly leaving the national scene, the debate narrowed to choosing between Milan and Rome, with both sides negotiating behind the scenes. In 1936, Ucelli, in association with the engineer Mauro and the architects Enrico A. Griffini, Piero Portaluppi, and Giovanni Sacchi, proposed creating a polytechnic institution (Figure 3) to be built in close proximity to the Polytechnic University of Milan and designed not as a center of "dead documentation but of living and 'speaking' instruments, capable of an effective propulsive action (machines in movement, films, phonographs)."[32] On 29 December of the same year, a copy of the project was given by Ucelli to Cini in order to coordinate the two initiatives, while at the same time Bottai, the main supporter of the E42 science exhibition, stated that an influential group still wanted to establish the museum in the capital and not in Milan. At this stage, Ucelli's project had not been realized due to economic difficulties, which left room for E42— so much so that during a meeting with Mussolini on 15 July 1937, Ucelli asked and obtained permission to proceed with his plan only after assuring Mussolini that his project would not interfere with the Exhibition on Universal Science. Cini gave the same assurances on various occasions.[33] Therefore, E42 had the effect of accelerating the negotiations led by Ucelli, who aimed at gaining the support of the government for the museum, particularly once Milan hosted the successful Exhibition on Leonardo da Vinci and the Italian Inventions in 1939. Ucelli saw this exhibition as an opportunity to assemble the first nucleus of collections of the nascent museum.

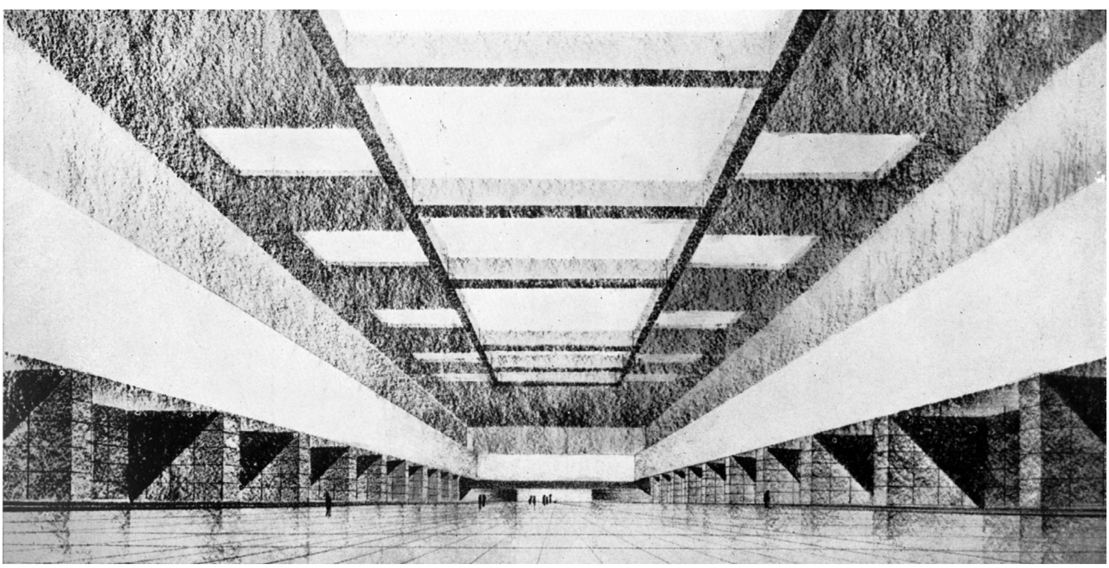

Figure 3. A sketch of the great gallery of machines designed for the polytechnic institution in Milan. From Mauro, Griffini, Portaluppi, Sacchi, and Ucelli, *Schema di progetto per una istituzione politecnica in Milano*, 1936. Courtesy of Leonardo da Vinci National Museum of Science and Technology, Library.

Inasmuch as Ucelli looked for the most part at the Deutsches Museum for inspiration, the concept behind the Exhibition on Universal Science remained vague for a while. Ucelli was involved in both projects (formally from 16 May 1939); in 1938, he had expressed his opinion to Cini on the design of the Exhibition of Universal Science. His idea resembled the CNR's *Documentario* project in that it stressed the relevance of Italian scientific tradition:

> I think that a universal science exhibition in the E42 should necessarily largely repeat, albeit improving on them, the programs of the Chicago, Paris, New York world fairs, not to mention the achievements of the museums of Monaco and London. In my opinion, a universal documentation is hardly likely to have the character of novelty and originality, while, on the other hand, in an international context it would be impossible to give particular importance to the scientific contribution of Italy. For all these reasons, I would like to recommend an exhibition of the Italian genius to make known and to celebrate the contribution made by Italy in all fields of science and technology to progress and civilization.[34]

In answering him, Cini reminded him that this idea was precisely the core of another E42 initiative, the Exhibition on Italian Civilization. They had to plan something else. In October 1937, the minister of popular culture, Dino Edoardo Alfieri, had already suggested to Cini to aim at something similar to that of the Palais de la découverte, even though "this glorification of Research and Discovery should be something more and better in Italy, and above all it should be realized with other intentions: it should be a synthesis of our current scientific knowledge, with the demonstration of all the ways they have opened to technology and to modern civilization, realized by making a great effort to bring it to the understanding of the masses. Not a didactic museum, but a living parade of our conquests, shown to our people."[35] Bottai—who in those days was working at the Exhibition of Scientific Education in Rome—had his own ideas of what the exhibition should be. He thought it should be a museum of science, technology, and pedagogy, the "representation of human labor and the triumphs of genius, . . . showing the role of technology in society and of school in the education of new generations."[36] His idea more closely resembled Ucelli's project than the scheme later prepared by the organizers of E42.

The objectives and design of the Exhibition on Universal Science remained confused until the committee vice president, Sabato Visco, published the planning outline of the exposition in March 1939. His report was pivotal to understanding the overall framework of the exhibits, even if it lacked practical instructions for the distribution of space or the coordination of the works of the subcommittees. Comparison with foreign museums played a central role in defining the shape of the Italian initiative. Visco was not thinking in terms of an exhibition focused on technical applications of science, as in the Deutsches Museum or in the Science Museum of London. Instead, he was oriented toward the new Palais de la découverte, where scientific laws were demonstrated in front of the visitor. The experience of the Palais was well known in Italy. For example, it was reviewed in the CNR's journal *La Ricerca Scientifica* by Edoardo Lombardi, who had personally visited the exhibition. In his article he focused on the beauty and originality of some of the exhibits: "In many sections, the organizers wanted the public to experiment with their own hands by pressing buttons, maneuvering flyers according to the instructions written on special tables. Other demonstrations, instead, followed one another cyclically and automatically, repeating at intervals throughout the day, often associated with phonographically recorded explanations."[37] Nevertheless, according to Visco, Paris lacked the provision of a synthetic and universal vision of science, emphasizing entertainment more than education. It resembled too much "a fair where more or less interesting demonstrations are made, arousing the curiosity of the audience without contributing to its education."[38] On the contrary, the encyclopedic exhibition of Rome sought to explain how humankind has deciphered nature throughout the centuries, claiming the importance of basic science and the role played by scientists in a regime that preferred applied scientists and engineers. This is not surprising considering that the organizers were almost entirely scientists rather than engineers or technicians, as was the case in Milan. On the one hand, the topics of the Florence Museum and E42 were similar in that both were related to the history of science; on the other hand, the exhibits were completely different, as Florence preserved and displayed relevant original items, such as the microscope of Giambattista Amici or the instruments of the Accademia del Cimento, and not replicas and models.[39] Moreover, in Rome the main goal was displaying scientific enterprise and discovery rather than history.

Visco was aware of the ongoing debate regarding science and natural history museums in Italy and abroad. Therefore, as Mauro pointed out some years before pleasing the visitors as well as educating them in a sort of "edutainment" ante litteram was important. "It is not enough for the documentation to be clear and understandable," argued Visco in his planning outline of the Exhibition of Universal Science. "The visitor should not be bored, because boredom causes tiredness, distracting attention and eventually leads to the visitor going through the exhibition without paying attention, obtaining nothing more than a chaotic memory of incomprehensible instruments, complicated machines, and inexplicable applications." Scientists had to work together with technicians, artists, decorators, electricians, and sculptors to achieve a satisfying result, which was a "living" and "dynamic" exhibition where the presence of an object had to be immediately understandable to the general public. Emotionless and outdated heaps of machines, instruments, and documents on shelves and in glass showcases should be completely avoided. On the contrary, Visco wrote, "light games, working models, lighting schemes, animated projections, working devices, [and] 'living' reproductions of animal organisms" awakened the visitor's attention and were thus recommended. In particular, he added, the exhibition "should avoid the abuse of photographs and photomontages that should only be reserved for very large reproductions of manuscripts, book pages, or panoramic backgrounds. If they are unavoidable, they could be used as subsidiary means from time to time, even if it must be noted that they are generally unsuitable for a science exhibition."[40] In his opinion, the exhibition on Leonardo in Milan was, as he wrote in a letter to Cini, "burdened with several rooms that claimed to reproduce the environments in which Leonardo lived and worked, with many halls overloaded with books, paintings, busts, and other objects."[41]

Cini confirmed that the Exhibition on Universal Science should be an Italian interpretation of the Palais de la découverte and of the scientific departments of the Deutsches Museum. Furthermore, the engineer Giovanni Gallarati, in charge of editing the final draft of the project, agreed with Visco that the exposition should be something new compared to the Deutsches Museum and the Palais de la découverte. Gallarati stated that whereas "the Germans have realized an impressive encyclopedia for didactics and science dissemination," and "Jean Perrin and his collaborators have organized what they called a 'Louvre of Science,'" the two models appeared insufficient: "Anachronistic and outdated is the celebration of Science, devoid of any light and poetry, seen only as a valued and feared means for the conquest of wealth, fortune and power." On the contrary, E42 sought to display a summary of the history of scientific thought depicted as a cultural enterprise of human spirit in its more significant moments. Indeed, according to Gallarati, science represented first of all an "artistic and religious enterprise," an unselfish observation of nature.[42] If New York 1939 World's Fair had been dedicated to the "world of tomorrow," for Gallarati, E42 should focus on the "past of tomorrow," on how science developed throughout the centuries and on the truths of the past that had been revealed as mistakes in the present.

Oscillating between Milan and Rome and between Paris and Munich, the debate over the Italian museum of science and technology began gathering momentum in 1941. The relationship between Ucelli and the E42 committee became more tense. One of the reasons was the disappointment of the Confindustria, the General Confederation of Italian Industry, which in 1939 had funded the construction of the Science Palace at EUR with the intent to establish a national museum of industry and technology instead of an institution dedicated to theoretical science. In 1942 the annoyance of Confindustria's president, Balella, came to the surface, as shown in the correspondence exchanged between November and December 1942 among Ucelli, Cini, and Balella. The latter did not believe in Cini's reassurance that the two ongoing projects of Milan and Rome would not overlap.[43] In a letter of 7 July 1942, Cini remarked on the differences between the two initiatives in terms of objective and concept: On the one hand Milan had "a national profile and completely didactic and technical-industrial aims." On the other hand Rome had an "international and universal profile, with historic, scientific and cultural characteristics."[44] Technology was then considered a national matter, whereas science was interpreted as a universal enterprise. Nevertheless, as claimed by historian of science Geert Somsen, stressing universal science was always part of the propaganda strategy of the Fascist regime; likewise the rhetoric on Italian science and culture displayed at E42 Exhibition of Italian Civilization. Thus, displaying the spiritual and universal side of science contributed from a different perspective to promoting to the world the fascist conception of civilization and world order.[45]

As a matter of fact, despite the complaints of Giordani, the president of the committee of the Exhibition of Universal Science, Bottai attended an official meeting in Milan in June 1942 to support the project sketched out by Ucelli in December 1941. With the approval of Bottai and Mussolini, the foundation named National Museum of Technology and Industry came to life between October and November.[46] Before Mussolini's fall in July 1943, this gave Ucelli a considerable advantage in the frenetic negotiations that involved ministers like Bottai, the organizers of E42, and a new protagonist—the permanent pavilion of technology constructed at the Mostra d'Oltremare, a fair established in Naples in 1940. In December, the committee of the Exhibition of Universal Science asked for a clarification,[47] and on 12 January 1943 a commission headed by Giordani was appointed to coordinate and balance the three projects, showing how complex and multilayered the situation was because E42 had not yet been officially cancelled. In Ucelli's vision, the Exhibition of Universal Science and the pavilion of Naples would be two appendages of the national museum of Milan, with the focus on pure science in Rome, and on science and technology as related to import and export in Naples in the colonies. But the other groups involved had different plans.

Moreover, dividing science and technology was not a simple matter. A technology museum should in any case respond to a synthetic vision: "Documentation of technology cannot exclude documentation of science because technology is nothing more than science's application. The continuous technical developments, which will be the core of the living museum proposed by il Duce, will descend from future applications of scientific research and inventions."[48] In some notes, Ucelli complained that Giordani sought to demonstrate that most of the topics pertained to science rather than technology. In Giordani's view, even the study of the human factor in production had to be considered in connection with topics such as physiology, biology, the study of human fatigue, professional education, and organization of production—pertaining to science more than to technology and industry.[49] In the meeting of 22 January 1943, even civil engineering projects such as irrigation were claimed as pertaining to science, which Ucelli denounced. On 4 March of the same year, Bottai invited Ucelli to pursue his project, ignoring Giordani whom he disregarded as a "Neapolitan."[50] Most likely, at that point Ucelli's project seemed more concrete and achievable to Bottai.

Eventually, the project of the Exhibition of Universal Science was abandoned due to the fall of the Fascist regime, whereas the efforts of Ucelli survived these dramatic events. Soon after the war, during the first general conference of the International Council of Museums (ICOM) held in Paris from 28 June to 3 July 1948, the international community of science museums still discussed the challenges of "dividing science from technology, concluding that it was necessary to leave the choice to single institutions of each country according to their specific characteristics." Ucelli explained, "It can be estimated that at the Science Museum in London two-thirds is devoted to technology and one-third to science: For example, in some areas like electricity, weights and measures, the supremacy of science is clear; however, it would be almost impossible to have exhibitions of pure science or pure technology, considering their interdependence."[51] In 1946 Ucelli resumed his activities until in 1953, when the Leonardo da Vinci National Museum of Science and Technology, which featured displays that resembled the interactive exhibits of the Deutsches Museum, opened its doors in Milan (Figure 4). From 1946 to 1952 Ucelli attempted to acquire the preparatory materials produced by the commission of both the Exhibition of Universal Science and the Exhibition of Italian Civilization, as at that

Figure 4. During the 1950s, some of the exhibits at the Museum of Science and Technology in Milan encouraged interaction. Courtesy of Leonardo da Vinci National Museum of Science and Technology, Photographic Archive.

point the museum had to include technology as well as science,[52] but his attempt failed and the documents remained in Rome.

The Exhibition of Universal Science: A Visual Encyclopedia for the History of Science

In the ideal division of tasks between Milan and Rome, Ucelli took advantage of the delay of E42. The nine subcommissions—composed of around 230 university professors from all over Italy—worked primarily between 1939 and 1940 to follow Visco's outline, and in the end produced 124 reports that needed to be summarized in one final document. According to archival materials, only the subcommittees on mathematics, astronomy, physics, geophysics, and meteorology became a final draft, even though the information at our disposal is sometimes contradictory. On 29 October 1941, Cini complained with Giordani about the serious delays of the committee: "I asked, I insisted, I begged . . . and still I have received nothing!"[53] Cini had promised to deliver the final program to Bottai by October and to Mussolini by December. Because both Visco and Giordani were unable to systematically deal with the job, despite their repeated promises, Cini asked them to find at least "a diligent even though mediocre person"[54] in charge of producing a summary from the reports. Likely, the engineer Giovanni Gallarati was chosen to be the author of what ended up being an incomplete scheme for the first part of the exhibition, as based on the notes of Visco and Giordani. The project followed a chronological order up to the birth of so-called "modern science," continuing with the chronological development of each discipline.

The organizing committee released an anonymous draft in February 1943 that followed Gallarati's recommendations: divide the exposition into 13 halls, each covering a particular topic, which ranged broadly from archaeological excavations of Ur to works of Galileo. Then followed other reports about some of these topics: geodesy would be subdivided into 10 halls; geography had only brief information; chemistry was organized into 21 halls; geology and mineralogy had only four halls and very few details; and astronomy was organized in 15 halls according to subjects such as the stars, the planets, or the moon. In the draft, next to the description of the contents, the anonymous author also indicated what and how objects should be displayed. Most of the exhibits featured replicas, functioning models, portraits, casts, and duplicates accompanied by maps, charts, drawings, diagrams, schemes, films, mottos written on the walls, and practical demonstrations. For each exhibit, committee members had to fill in preprinted forms, specifying: (1) the observation, discovery, invention under examination; (2) name of the scientist being featured and subsequent discoveries; (3) the scientific law on which the discovery was based; (4) the instruments related to the observation, discovery or invention and exhibits required to display them; (5) how the phenomenon could be explained to the public, such as through diagrams or films; (6) the museums or universities that preserve the objects; (7) producers, funds, and estimated time required for construction; and (8) other related documentation. For example, to explain the circulation of blood, exhibitors could show film of cardiac arrest, brought about by nerve stimulation activated by the Weber brothers. According to its organizers, E42 should have had its own workshop equipped with carpentry, glassmaking tools, and chemical supplies, where the assembly and repair of instruments could take place during the world's fair.

Architects Luigi Brusa, Gino Cancelotti, Eugenio Montuori, and Alfredo Scalpelli were in charge of the realization of the Palace of Science, which was to host the Universal Exposition of Science, on the right side of the Piazza Imperiale, in front of the ethnographical Exhibition on Popular Italian Traditions. They designed a monumental palace divided into two buildings, which were to be connected by a bridge (Figures 5, 6).[55] Giordani laid out a floor-by-floor scheme, as the main aim of the exhibition was "leading the visitor, through a logical thread, to the gradual knowledge of the contribution of scientific thinking to modern civilization."[56] At the main building's basement level there were to be exhibits on geology, mineralogy, and speleology. The ground floor would have documented origins of scientific thinking up to the time of Leonardo. Following a visitor's path from right to left, the first floor would have opened the path to the modern physical sciences with Galileo, while medicine and biology would have been displayed on the second floor. The ground floor in the second building would host a conference hall and a library. Another small pavilion was to be devoted to astronomy.

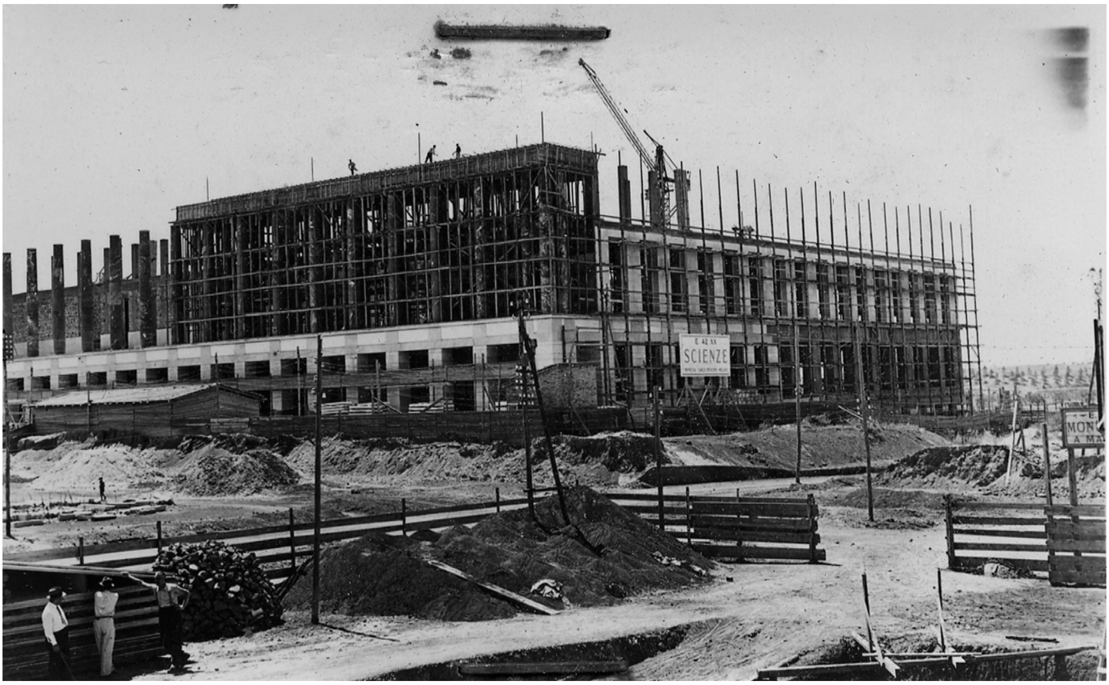

Figure 5. The Palace of Science under construction, 18 July 1940. Courtesy of Central Archives of the State, Rome, EUR, Photographic Archive.

Figure 6. A view of Piazza Imperiale from the Palace of Italian Civilization in January 1942. Courtesy of Central Archives of the State, Rome, EUR, Photographic Archive.

The plan for decorating the Palace of Science was extensive, aimed at conveying the glorious idea that scientific discovery is a tool of progress in human civilization. Artist and commissioner Cipriano Efisio Oppo was in charge of choosing artists, to whom Visco had to provide examples of scientific iconography. The plan included the mosaic *Le professioni e le arti* by Fortunato Depero on the external wall, paintings by Valerio Fraschetti about the school of Galileo and the technical applications of science in the entrance hall, stained-glass windows depicting scenes from the development of astronomy by Giulio Rosso (Figure 7), and inlaid flooring with decorations representing science by Mario Tozzi (Figure 8).[57] Only a few of these decorations were actually completed before the war interrupted.

In searching for a balance between entertainment and education, show and culture, how did scientists interpret and give shape to the suggestions made by Visco and Giordani? The answers were disparate depending on personal tastes and interests of each scientist—a fact that made it even harder to plan a coherent project for the exhibition. Even if not all the participants could visit the Palais de la découverte in person, its extensive catalog was circulated among the organizers and served as a crucial source for academic professors who became museum curators. The chain of command was strict. For the subsection of animal ecology, for example, the biologist Umberto D'Ancona had to send his proposal to zoologist Alessandro Ghigi, responsible for the ecological commission, who had to transmit them for approval to Visco, head of the biological commission. D'Ancona suggested the use of dioramas as in natural history museums, marine animals made with blown glass, photos of marine environments, and several film clips. Even though on 22 January 1940, Ghigi informed D'Ancona that the supervisors "do not want dioramas, neither charts, nor models, but devices, footages, and diagrams, Visco eventually agreed to the creation of a small number of dioramas that could be exhibited as relaxing areas for the visitor."[58] On the other hand to a biologist like D'Ancona, some exhibits seemed too "frivolous and more suitable for a fair than for a didactic science exhibition designed to become a permanent museum."[59] If D'Ancona asked for scientific accuracy, Visco complained about the extent of the drafts, which too closely resembled a biology textbook than an outline of the main achievements and discoveries in biology.

In the subcommittees' reports regarding recent scientific fields, the focus was more on the present state of the art and on explanations of scientific laws than on history. For instance, in the oceanography section the main objective was to explain phenomena like tides; in the genetics halls the aim was explanation of hereditary laws. Next to artifacts and interactive exhibits, scientists would be on stage, demonstrating their own science and performing phenomena in front of the visitors, like in the Palais de la découverte. Felice De Carli, a chemist of the University of Bologna, referred explicitly to the catalog of the Palais, suggesting that the exhibition should include "the work of an experimenter explaining the phenomenon that the experience wants to reproduce as well as the meaning of it. This can be done at certain hours of the day and can be supplemented by movies and cartoons."[60]

In the subcommittee on chemistry, Giovanni Malquori, the head of the Institute of Pharmaceutical Chemistry of the University of Naples, imagined an exhibition that made the sequence

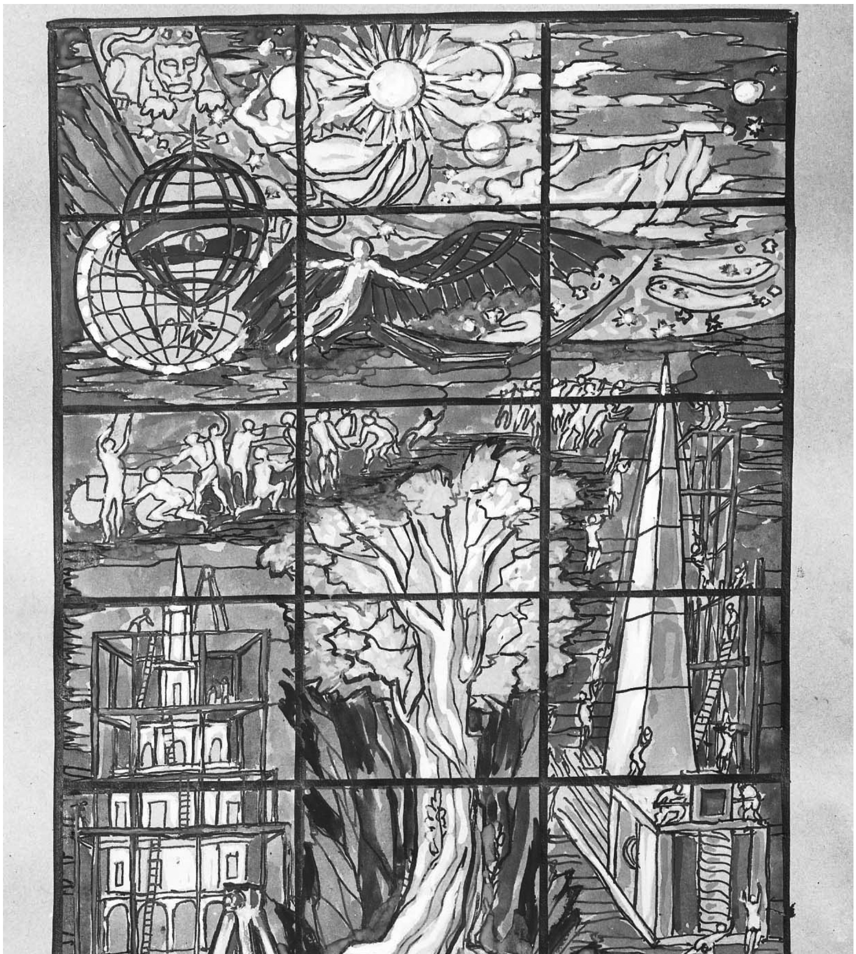

Figure 7. Sketch of stained-glass window with scientific motifs by Giulio Rosso for the Palace of Science vestibule. Courtesy of Central Archives of the State, Rome, EUR, Photographic Archive.

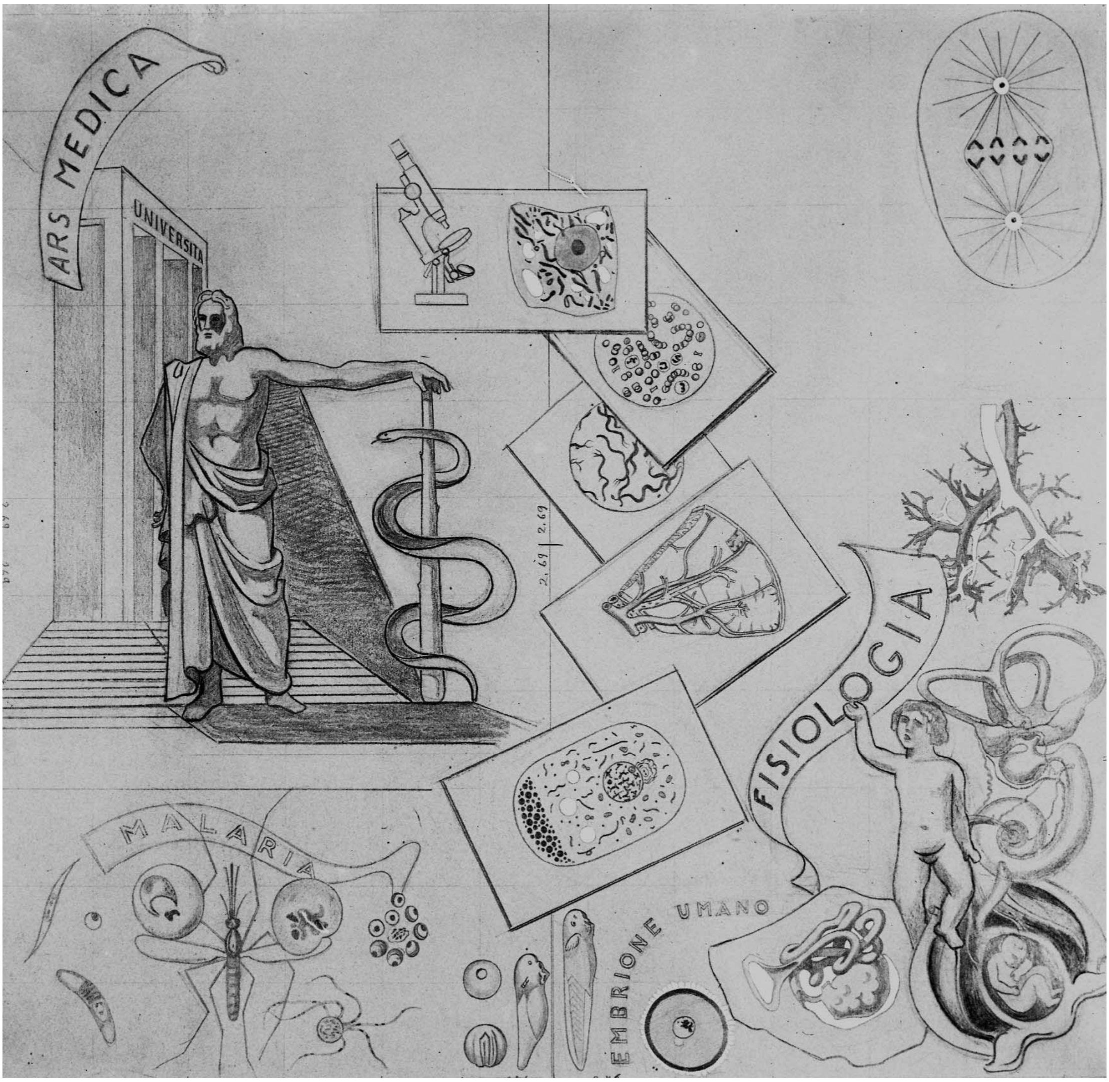

Figure 8. Sketch *Ars medica* and *Physiology* by Mario Tozzi for the floor of the central hall of the Palace of Science. Courtesy of Central Archives of the State, Rome, EUR, Photographic Archive.

and evolution of chemical knowledge as evident as possible. As he wrote to Provenzal, the aim of the exhibition "is not to make a museum like the Deutsches Museum, but to display the evolution of scientific thought in broad terms."[61] Following these suggestions, Provenzal planned a total of six halls that would cover the history of science from the time of pre-Roman and Roman Antiquity, passing through alchemy, to the chemistry of Lavoisier. In the entrance hall devoted to Greek and Latin philosophy, he invoked the collaboration of artists in order to give an "artistic representation of fundamental concepts: for example, in the upper spheres should be inserted a huge quantity of atoms of various sizes and with special forms in accordance to the vision of Lucretius; an illumination given by a sun, a moon, and a Saturn; and a ray of light that illuminates the atmospheric dust."[62] He also mentioned a copy of an Etruscan furnace, statues, portraits, instruments, a reconstruction of an alchemical laboratory, and Lavoisier's laboratory; for which he suggested using students as guides. The final draft of the chemical section of the Exhibition of Universal Science increased to 28 halls.

Conclusion

The widespread debate around E42 sheds light on what a scientific or technical museum would have been like during the Fascist regime, including what artifacts would have been chosen and how they would have been displayed to the public. It also places the Italy of the interwar period into a broader international debate about museums and universal exhibitions. It would be impossible to understand the Exhibition of Universal Science without taking into consideration the museum project of Ucelli, or vice versa.[63] With regard to the Italian debate about the need for living museums of science and technology, during the 1930s in Italy there was not just one museum that strove to become national but at least three: the Institute and Museum for the History of Science in Florence, the National Museum of Science and Technology in Milan, and the never-realized science museum in Rome. They represented three different ideas of museums and three distinct research communities: historians of science, engineers, and scientists, respectively. The E42 had the effect of accelerating an ongoing debate. Despite its failure, the Universal Exposition of Science did give birth to a permanent museum in Milan—the National Museum of Science and Technology—though that museum was the exposition's rival.

Notes

1. On E42, science, and internationalism, see also G. Somsen, "Science, Fascism, and Foreign Policy: The Exhibition "Scienza Universale" at the 1942 Rome World's Fair," *Isis* 108 (2017): 769–791.
2. R. H. Kargon, K. Fiss, M. Low, and A. P. Molella, *World's Fairs on the Eve of War: Science Technology and Modernity, 1937–1942* (Pittsburgh: University of Pittsburgh Press, 2015), 136, 125.
3. Kargon et al., *World's Fairs on the Eve of War*, 111. On EUR, see also chapters 7 and 8 of A. Kallis, *The Third Rome, 1922–1943: The Making of the Fascist Capital* (New York: Palgrave Macmillan, 2014) and V. Vidotto, ed., *Esposizione Universale di Roma: Una Città Nuova dal Fascismo agli Anni '60* (Rome: De Luca Editori d'Arte, 2015).
4. See E. Garin, "La civiltà italiana nell'Esposizione del 1942," in *E42: Utopia e scenario del regime*, vol. I, *Ideologia e programma dell'Olimpiade delle Civiltà*, ed. T. Gregory and A. Tartaro (Venice: Marsilio, 1987), 3–16 and appendix, 118–120. The exhibition also focused on minor Italian scholars and scientists.
5. V. Castronovo, "La città italiana dell'economia corporativa," in *E42: Utopia e scenario del regime*, vol. I, 17–25.
6. For an overview on the Italian legislation over historical scientific heritage see E. Canadelli, "I musei scientifici," in *Storia d'Italia*, *Annali 26*, *Scienze e cultura dell'Italia unita*, eds. F. Cassata and C. Pogliano (Turin: Einaudi, 2011), 867–893.
7. During its history the museum had many names. From its inauguration in 1953 to 2000, the Italian name was Museo Nazionale della Scienza e della Tecnica Leonardo da Vinci di Milano, and then "Tecnica" changed to"Tecnologia." The English translation used is Leonardo da Vinci National Museum of Science and Technology. See *Guido Ucelli di Nemi: Industriale, umanista, innovatore* (Milan: Hoepli, 2011) and E. Canadelli, "Le macchine dell''ingegnere umanista': il progetto museale di Guido Ucelli tra Fascismo e Dopoguerra," *Physis* 51, 1–2 (2016): 93–104.
8. Galluzzi, "La storia della scienza nell'E42," in *E42: Utopia e scenario del regime*, vol. I, 53–69.
9. For the other members of the committee, see Galluzzi, "La storia della scienza nell'E42," 58.
10. In the Italian journal *Sapere*, several articles on New York have been published: A. Podestà, "Il 'mondo di domani' New York: Esposizione 1939," July 1938: 8–10; G. Lo Duca, "'New York World's Fair 1939' critica di una esposizione," December 1939: 488–490; and the interview with the president of the exhibition, Grover Whalen, November 1939: 342–343.
11. See the reports in Archivio Centrale dello Stato, Rome (hereafter, ACS), Ente Autonomo Esposizione Universale di Roma-E42 (hereafter, EUR), Servizi organizzazione mostre (hereafter, SOM), box 126, folder 687, on Paris 1937, folder 694, on Glasgow, folder 696, on New York and San Francisco; box 127, folder 696, on New York; box 129, folder 700, on Zurich and Liegi; box 129, folder 696, on New York, with a list of all the ongoing exhibitions worldwide in August 1938; box 128, on New York; box 130, folder 711, on Bruxelles 1935, Paris 1937, New York and Zurich; box 130, folder 705, on Portuguese centenary celebrations of 1939 and 1940. See also E. Godoli, "L'E42 e le esposizioni universali," in *E42: Utopia e scenario del regime*, vol. II, *Urbanistica, architettura, arte e decorazione*, 147–155.

12. A. Russo, *Il fascismo in mostra* (Rome: Editori Riuniti, 1999). See also J. Schnapp, *Staging Fascism: 18 BL and the Theater of Masses for Masses* (Stanford, Calif.: Stanford University Press, 1996).
13. See G. Provenzal, *Il Documentario dei primati scientifici e tecnici italiani*, offprint *Atti SISP 1938* (Rome: Scuola Tipografica Pio X, 1939); *Il Consiglio Nazionale delle Ricerche nella sua nuova sede* (Rome: Società Italiana Arti Grafiche, 1937), 45–46.
14. G. Baroncelli and M. Bucciantini, "Per una storia delle istituzioni storico-scientifiche in Italia: L'Istituto e Museo di storia della scienza di Firenze," *Nuncius* 5 (1990): 5–52.
15. See ACS, EUR, SOM, box 1011, folder 970 and Archivio Storico del Museo Nazionale della Scienza e della Tecnica, Milan (hereafter, MNST Archive). On the 16 July 1942 the general manager Balella attached to his letter to Cini a letter from Volpi dated 12 July 1939, where Volpi had written: "The science palace should contain the achievements of science applied to industry and will then be transformed, with subsequent developments and refinements, into a museum of industry, in an institution that is similar to the ones existing in some of the largest industrial countries."
16. *Il Consiglio nazionale delle ricerche: Compiti e organizzazione* (Venice: Officine grafiche Carlo Ferrari, 1929), 5. Canadelli, "I musei scientifici," 884.
17. "Notiziario," *La scuola superiore* 3 (1928): 32.
18. See ACS, Cnr, Presidenza Marconi, box 11, folder *Musei tecnici e scientifici stranieri*.
19. A. Mieli, "Il Deutsches Museum," *Archivio di storia della scienza* 3 (1921): 189. See also Canadelli, "I musei scientifici," 879–884; Barreca, this volume; and M. Beretta, "Andrea Corsini and the Creation of the Museum of the History of Science in Florence (1930–1961)," in *Scientific Instruments on Display*, ed. S. Ackermann, R. L. Kremer, and M. Miniati (Leiden: Brill, 2014), 1–36.
20. G. Belluzzo, "Scienza e tecnica per l'avvenire economico dell'Italia fascista," *Rassegna Italiana* 102 (1926): 727.
21. F. Mauro, "Per un museo naturalistico dell'Africa orientale italiana," *Natura* 29 (1938): 26. See also F. Mauro, "L'organizzazione dei musei di storia naturale, l'educazione del popolo ed il progresso della scienza," *Natura* 21 (1930): 130–156.
22. G. B. Trener, "L'organizzazione scientifica dello Stato moderno," *Atti della Società italiana per il progresso delle scienze (SISP),* 19a Assembly, 1 (September 1930): 844. For the debate on the "living museum" in the United States, see K. A. Rader and V. E. M. Cain, *Life on Display: Revolutionizing U.S. Museums of Science & Natural History in the Twentieth Century* (Chicago: University of Chicago Press, 2014).
23. E. Canadelli, "Il museo nazionale italiano di storia naturale: Storia di un'idea," *Rendiconti Accademia Nazionale delle Scienze detta dei XL Memorie di Scienze Fisiche e Naturali 132* 38 (2015): 121–154.
24. "La Mostra delle 'Invenzioni Italiane'," in *Mostra di Leonardo da Vinci e delle invenzioni italiane*, Palazzo dell'Arte, Milan, 9 Maggio–30 Settembre 1939, 10, http://www.museoscienza.org/voci-della-scienza/documento.asp?doc=113#document_open (accessed 10 May 2017).
25. G. Oldofredi, "Spirito e connotati della rassegna," in *Catalogo ufficiale della mostra delle invenzioni* (Milan: Palazzo dell'Arte, 1939), 26.
26. PNF, *L'autarchia del minerale italiano: Guida della mostra* (Rome: [1938]), 81–86.
27. See the detailed report of 10 June 1938 by the architect Marcello Piacentini on the Deutsches Museum, in ACS, EUR, Servizi architettura, parchi e giardini (hereafter, SAPG), box 905, folder 7888.
28. G. Ucelli, *Il Museo industriale di Milano*, 10 December 1941, preserved in the library of the National Museum of Science and Technology (MNST) in Milan.
29. ACS, EUR, SOM, box 1011, folder 970, letter of 19 October 1936.
30. MNST Archive, *Museo industriale*, Corrispondenza, box 13, Ucelli to Nicodemi, 8 June 1933.
31. MNST Archive, *Museo industriale*, Corrispondenza, box 13, Ucelli to Nicodemi, 29 March 1934.
32. F. Mauro, E. A. Griffini, P. Portaluppi, G. Sacchi, and G. Ucelli, *Schema di progetto per una istituzione politecnica in Milano* (Milan: [s.n.], 1936), no page.
33. ACS, EUR, SOM, box 1011, folder 970, letter from Cini to Ucelli. See also letter from Ucelli to Cini, 12 October 1939.
34. ACS, EUR, SOM, box 86, folder 412, 2 February 1938.
35. ACS, EUR, SOM, box 1009, folder 9770, 11 October 1937 and the answer of Cini of the 22 October.
36. "Città della scienza," in *E42: Utopia e scenario del regime*, vol. I, 106.
37. In *Ricerca scientifica* (March 1938): 253–254.
38. S. Visco, *La mostra della scienza universale*, 22 March 1939, in EUR, SOM, box 1007, folder 9770.
39. See the article by S. Timpanaro senior, in *Ambrosiano*, 2 March 1934.
40. Visco, *La mostra della scienza universale*.
41. ACS, EUR, SOM, box 1010, folder 9770, letter of Visco to Cini, 14 August 1939.
42. ACS, EUR, SOM, box 1011, folder 9770.
43. See ACS, EUR, SOM, box 1011, folder 970. See also Somsen, "Science, Fascism, and Foreign Policy," 786–790.
44. ACS, EUR, SOM, box 1011, folder 970, letter of Cini to Balella, 7 July 1942.
45. Somsen, "Science, Fascism, and Foreign Policy," 778–781.
46. MNST Archive, *Museo industriale*, Corrispondenza, box 11. During the meeting of 13 November, Mussolini, probably unaware of the entire discussion, suggested also including science, but Ucelli answered that "in the museum, science would have been displayed only in its basic principles."

47. ACS, EUR, SOM, box 1011, folder 970, 16 December 1942, a document entitled *La mostra della scienza all'EUR e il Museo nazionale della tecnica di Milano*. See also the preparatory notes for the meeting dated 11 January 1943.
48. MNST Archive, *Museo industriale*, Esposizioni, box 21, "La Mostra della Scienza all'EUR e il Museo Nazionale della Tecnica di Milano" [12 January 1943].
49. MNST Archive, *Museo industriale*, Esposizioni, box 21, post 22 January 1942.
50. MNST Archive, *Museo industriale*, Corrispondenza, box 11, folder Ministero educazione nazionale.
51. MNST Archive, *ICOM*, Strumenti scientifici, box 3, Report by Ucelli, 12 July 1948.
52. ACS, EUR, SOM, box 86, folder 412. From 1946 to 1952, Ucelli sought to obtain all the preparatory materials, but he failed.
53. ACS, EUR, SOM, box 1007, folder 9770, 29 October 1941.
54. ACS, EUR, SOM, box 1007, folder 9770, 29 October 1941.
55. ACS, EUR, SAPG, box 905, folder 7888, Brusa, Cancellotti, Montuori, Scalpelli, "Relazione". As examples of scientific exhibitions, they mentioned the Palais de la découverte and the technical exhibitions at Circo Massimo in Rome.
56. Mentioned in ACS, EUR, SOM, box 1011, folder 9770, "Mostra della scienza."
57. In *E42: Utopia e scenario del regime*, vol. II, 404, and also 402–418. For the correspondence between Oppo and some of the artists, see also ACS, EUR, Servizi Artistici, box 920, folder 8170 (Rosso); box 921, folder 8179 (Felice Casorati); box 933, folder 8589 (Depero).
58. Accademia Galileiana, Padova, *Archivio D'Ancona*, "Manoscritti vari 1938–1949," box 30, folder 9, Esposizione '42, 22 January 1940.
59. Accademia Galileiana, Padova, Archivio D'Ancona, "Manoscritti vari 1938–1949," box 30, folder 9, Esposizione '42, 28 gennaio 1940.
60. MNST Archive, *Raccolta documentaria dei primati scientifici italiani–CNR*, Esposizione E42 Relazioni diverse, De Carli to Giordani, 5 January 1940.
61. MNST Archive, *Raccolta documentaria dei primati scientifici italiani–CNR*, Esposizione E42 Relazioni diverse.
62. MNST Archive, *Raccolta documentaria dei primati scientifici italiani–CNR*, Esposizione E42 Relazioni diverse.
63. Somsen asks in his article "Why did the 'spiritual' conception of the science exhibit prevail? How was it that Italian industry, with all its financial power and the entire tradition of world's fairs on its side, lost out to an academic focus on ideas and on science as an intellectual pursuit?" ("Science, Fascism, and Foreign Policy," p. 790). In addressing this, I think we should look at the Italian politics on scientific museums as a whole. The most convincing explanation could be in fact that in the creation of the museum in Milan, Ucelli had the support of most of the Italian industrial community as well as that of Bottai. To avoid duplicate contents, Rome had to choose another path.

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Postwar Exhibitions:
What Is the Role of Artifacts?

CHAPTER 9

North American World's Fairs and the Reinvention of the Science Museum in the 1960s

Arne Schirrmacher
Department of History
Humboldt University
Berlin, Germany

While it is an established fact that world's fairs played a key role in the establishment of science museums during the nineteenth century, this perspective is largely absent during the twentieth century, especially the postwar period. However, this is more due to a lack of interest in the history and impact of world's fairs during the twentieth century than to a lost connection between the popular forms of science and technology displayed at fairs and those in museums. In order to uncover these connections, I focus in this chapter on two diametrically opposed reinventions of what usually is called a "science museum"—both of which occurred in the United States in the 1960s—and try to place them into the context of the North American world's fairs of that decade.

The Smithsonian Institution's Museum of History and Technology in Washington, D.C., revived the traditional museum of historical artifacts, in which the objects are meticulously and systematically arranged into one visiting tour. However, in its conception as a museum of history *and* technology (rather than *of*), objects of science and technology were meant to be contextualized within a larger historical narrative. Along the museum's trajectory—which involved its renaming to the National Museum of American History—it was ultimately drawn into the "science wars" of the 1990s, thereby pushing its way to the fore of museum discussions.[1]

The Exploratorium in San Francisco, in contrast, did not develop as a place where historical artifacts could be found, despite following "a rationale for a science museum."[2] Rather, it was seen as the model for what is now widely identified as a "science center"—a place for hands-on experiences of scientific phenomena, a playground of exploration with few, if any, rules or tour recommendations, and as site where science and art can connect, however loosely.[3] Whether it was intentional or not, as those involved would say, the "science center" became an ideal presentation of science that could be politically instrumentalized while easily evading tedious problems of social implications, the environment, or military application. In this way, science centers opened a window for a more uplifting "public understanding of science"—to use an old phrase that had been remobilized in the 1980s—foregoing more critical approaches.[4]

I argue that the apparently contradictory developments of the "science museum" as an institution can be understood only within the context of the history of world's fairs in North America at that time. After the rather late, postwar resumption of the world's fair model in Brussels in 1958, the expos in Seattle (1962), New York (1964–1965) and Montreal (1967) not only defined the state of the art of display in this field, but also shaped visitor expectations toward permanent science and technology display in museums through ambitious exhibits.

I proceed in four steps: After a short introduction into the postwar setting, during which few new museums or large fairs were erected before 1958, I first focus on the immense efforts undertaken for the U.S. Science Exhibit of the 1962 Seattle expo, and demonstrate how it anticipated display concepts now associated firmly with later institutions. Second, I discuss the rather awkward simultaneity of the 1964 New York World's Fair, whose Hall of Science was transformed into a permanent institution, and the opening of the Smithsonian Museum of History and Technology in Washington, D.C., which marked the positive ending to a long struggle to establish such a museum in the U.S. capital. While the former was dominated by big corporations, the latter pursued a much more historical and academic approach. Third, I address the developments between 1964 and 1969, sketching the prehistory of the Exploratorium and its "rationale" and relating it to the contemporaneous 1967 International and Universal Exposition, or Expo 67, in Montreal.[5] Last, I put into perspective the Exploratorium and its initial program, which—though soon dismissed—had more likeness to the display approaches in museums and world's fairs. This section concludes with reflections on how the history of a long-term development of interactive exhibits differs from the rather local and audience-dependent reinventions of different kinds of science museums.

Bringing the World's Fair Model into the Atomic and Space Age

It is widely held that world expositions were a phenomenon of the nineteenth century, culminating in the Paris fairs in 1889 or 1900 (the fairs in Chicago and St. Louis were other notable events in 1893 and 1904, respectively) and extending until World War I. However, there have been two renaissance periods of this type of spectacle that have not been given the same historical attention so far: the first was in the 1930s, particularly on the eve of the Second World War, and the second took place in the 1960s, during the period of time referred to as the Space Age. After plans for an international exposition in Tokyo in 1940 and Rome's "E42" in 1942 were canceled, it would take until 1958 for a postwar world's fair to take place in Brussels.[6]

While the war took a toll on some of the leading science museums hit by bombs, such as those in Munich and Paris, or blighted by years of neglect, like that in London, the demand for scientific heritage in Europe survived virtually unscathed. As the special *Diesel* exhibit at the Deutsches Museum in 1947 showed, presented even before the museum was reopened in 1948, the idea of the science museum was very much alive.[7] This was confirmed again with the London Science Museum's exhibit on *Chemical Progress* in the same year.[8] While Italy could boast the opening of a new museum in 1953, the Leonardo da Vinci National Museum of Science and Technology in Milan had a concept that was more compatible with plans from the 1930s and 1940s.[9] In the United States, the New York Museum of Science and Industry had excelled with its interactive and "progressive" exhibits, but these were supplanted first by industrial and, during the war, by military displays. Thus, wrecked by war and war ideology, the museum died quietly in 1951.[10]

Science exhibits became a key part of events to raise the spirit of nations. For example, the 1951 Festival of Britain, which—like the British Empire Exhibition of 1924—used the model of a world's fair, but adapted it to serve the self-assurance of empire and nation, respectively.[11] The festival became a "golden opportunity" because it brought a new building for the Science Museum, which served as the key place to promote the atomic theme of the fair.[12] Similarly, the All-Union Agricultural Exhibition, which had been reopened in Moscow in 1954, was rebranded as an industrial exhibition two years later and became the Exhibition of the Achievements of the People's Economy in 1959.[13] The world's fair model had been adapted once again, only this time for the Soviet world. Clearly, the exhibition raised the spirits of the Soviet peoples, but its Pavilion of Atomic Energy in particular also had the effect of sparking international competition in Atomic Age exhibits. Most popular among the artifacts was a working 100-kW nuclear reactor of swimming-pool type, which was demonstrated to the visitors from 1956 on.[14]

When the United States wanted to counter this idea for the promotion of nuclear energy at the Brussels Expo 58 with a U.S. reactor, it displayed a dwarf copy with the feeble power of 1 watt in a section of the International Hall of Science that was accessible only to qualified scientists and hence visited by a very small fraction of fairgoers. (Originally it had been planned to power the entire event with the first Belgian 11.5-MW nuclear plant to be built on the fairgrounds, but a worried King Baudouin in his nearby palace ultimately nixed the idea.)[15]

The United States also had underperformed in other areas in competition with its Cold War rival at the time of the Khrushchev Thaw. Newspaper reports and historians' judgments on the American performance at the Expo 58 appear rather mixed. They cite as detrimental factors the long struggles against underfunding, an aura of complacency, an exhibit conceived by the MIT on *Unfinished Work*—which was supposed to present the problem-solving capabilities of American democracy, but at the same time acknowledged the social problems of race and urban blight—and even the use of the U.S. presence for espionage activities. In any case, it was difficult for the Americans to counter the hard-selling approach of the Soviets. Like most western countries, the United States was still playing the tune of the peaceful atom and the advantages of democracy, while the Soviet pavilion combined a monumental Lenin with *Sputnik* I and II, including their notorious *beep-beep-beep*. Taken together with a model of a future solar-powered space station, the Soviet exhibits significantly shifted the field of competition and at the same time drew attention to new sorts of artifacts: satellites, rockets, and space modules.[16] There had been no time to counteract the *Sputnik* shock at the Brussels Expo, but something had to be done to reclaim U.S. scientific preeminence.

The United States Science Exhibit at the Seattle World's Fair 1962

In mid-October 1957, a few days after the Soviets launched the first *Sputnik*, the Josiah Macy Jr. Foundation's Frank Fremont-Smith, Chief of the Office of Science at U.S. Department of Defense Orr Reynolds, and Associate Director of the National Science Foundation James Mitchell met in Washington, D.C., and agreed that something such as an international science fair was badly needed to demonstrate the many areas in which U.S. science was preeminent and awaken the American public to the significance of the general scientific effort and the importance of supporting it.[17] This was the starting point for a world's fair that put science—"rather than its massive technology"—at the center like no other before or after.[18] The *Sputnik*-induced project was discussed in wider and wider scientific circles, and eventually more than 300 scientists collaborated with the U.S. Department of Commerce on a U.S. Science Exhibit, for which the federal government appropriated about $10 million. Only several months after planning had started, it became apparent that the opportunity of Seattle's thematically rather unfocused and delayed bid for a world's fair could be seized, and so the U.S. Science Exhibit along with the Space Needle became the core attractions of the 1962 world's fair.[19]

For Seattle—the city of Boeing Corporation, a leading airplane and rocketry company that was now also supporting the international event with $2 million—the Expo stimulated city modernization, brought in cultural institutions, and diversified Seattle's commercial range beyond aerospace. However, neither the initial theme of the "World of Century 21," a typical future-oriented display of technological prowess, nor the "World of Commerce and Industry," the more traditional trade show part, let alone the "Worlds" of entertainment or art, defined the expo of 1962. Rather it was the "World of Science," which was visited by more than 6 million people, or 70% of all those entering the fairground.[20]

The "storyline" of the Science Exhibit was conceived to be "a radical departure from all science and technology exhibits in the past." Already its size of six acres, housed in five huge buildings, "not only dwarfed similar exhibits in other fairs, but there are relatively few museums in the world with this much space devoted to science," let alone "contemporary science." In contrast to other exhibits and museums, a novel approach had been adopted: As "an adventure of the mind" and "man's effort to understand the universe," it needed to be more than a pleasing compilation of interesting objects. In any case, it had to be neither "a glamorization of science," nor "a parade ground for products" for industry, thus alluding to criticism, which had been raised towards the largely corporate-driven expos in Chicago and New York in the 1930s. Now it was an "effort to display the innate beauty and joy of science rather than its complex discoveries," as in this way it could become "the most powerful and important social force in the world."[21]

As *Science* reported after the fair, the approach had worked: "[P]lanners of the United States science exhibit risked a display that was essentially science without technology, and they appear to have made a popular success of it," which was all the more remarkable because in Brussels "some of the exhibits had gone over the heads of the fairgoers."[22] The latter, however, was a euphemism; in the report of a science adviser to the U.S. secretary of state, the exhibit was described more devastatingly as "too technical for any but the most highly trained scientists."[23] Seattle's U.S. Science Exhibit should do better, for one by providing a carefully crafted storyline unfolded in six areas, which I will only briefly sketch out. Another decisive element of the exhibit's success, upon which I will focus in more detail, were its artefacts and "edufacts"—that is, non-authentic and non-historical objects, which elucidate scientific phenomena often in a hands-on way.

In Area 1 (Figure 1) the visitor first saw a 13-minute state-of-the-art immersive film presentation that was created by Charles and Ray Eames and portrayed the scientist at work, claiming that "a laboratory can be anywhere that a scientist is drawn to look." Thus, it stressed a general human interest and faculty, while in the end summarizing that "[S]cience is essentially an artistic or philosophical enterprise carried on for its own sake. In this it is more akin to play than work." And this play was meant to solve "a system of interlocking puzzles," assuming they are solvable and fair.[24] Area 2 was mainly historical and arranged in such a way that the visitor followed a defined path. It started with a large section on false perceptions of the senses of sight, hearing, and touch. For example, "Touching concentric loops of warm and cool pipe convey a burning sensation" (Figure 2, on the left). The section then turned to the techniques of precision measurement and subsequently opened a museum-like display of artifacts, mostly historical replicas and some loans from the Smithsonian Institution that dealt with electromagnetism, atomic-molecular research, genetics, and astronomy. By combining historical objects with three-dimensional scale models and a number of panels and charts, the exhibit emulated—or rather updated—contemporary forms of display, such as those found in the major science museums. However, there were only a few "audience-operable devices," such as an exhibit demonstrating the charge-to-mass ratio of electrons.[25] More than an update of the contemporary planetarium shows was the Boeing-sponsored Space Age planetarium, or *Spacarium*, which simultaneously beamed 750 "passengers" into outer space. With the help of astronomers and space scientists, "the production as true a representation as possible of the stars, planets and other astral phenomena" was attempted in Area 3.[26]

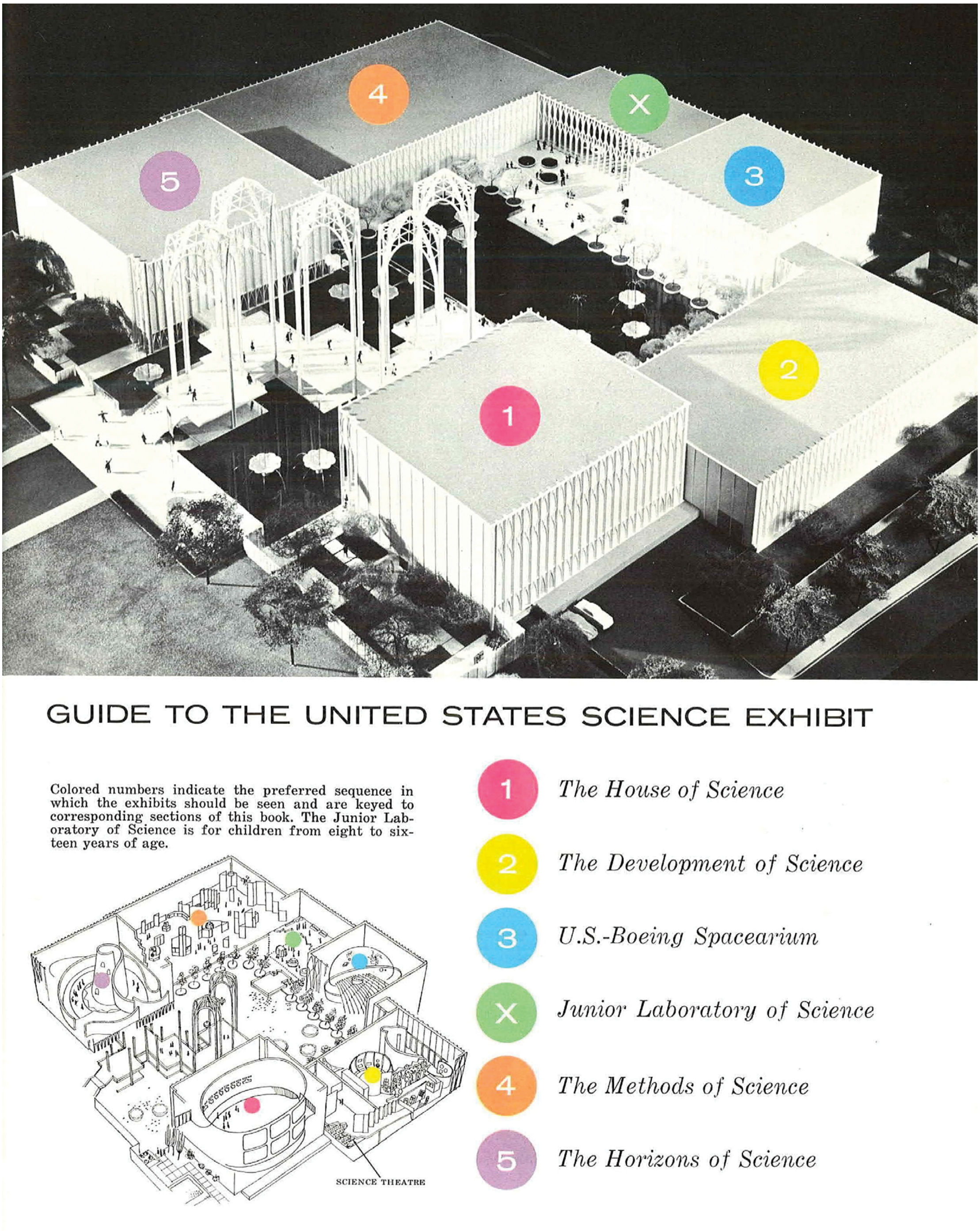


Figure 1. U.S. Science Exhibit at the Seattle World's Fair 1962, bird's-eye view of a plan of the site and interior of the buildings. From U.S. Department of Commerce, ed. *Souvenir Guide Book: United States Science Exhibit. World's Fair in Seattle 1962* (Seattle: Craftsman Press, 1962), 7.

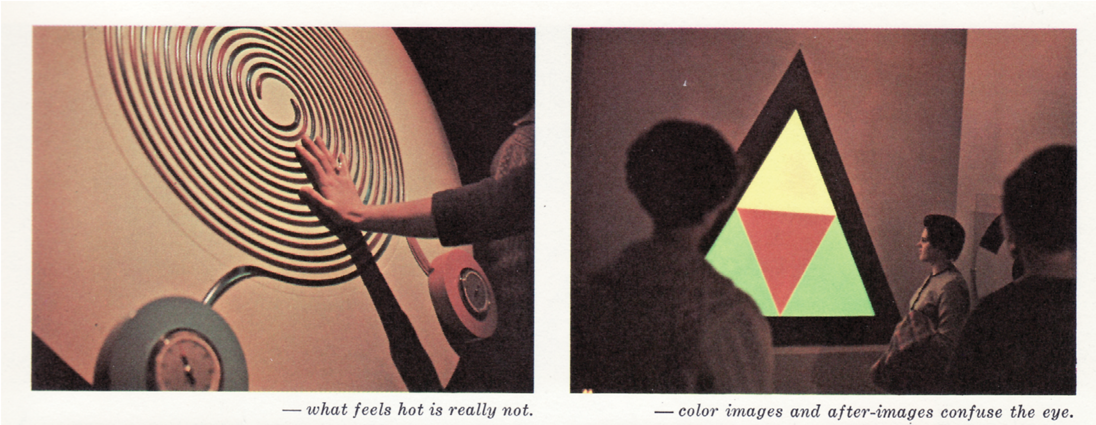


Figure 2. Hands-on and visual perception exhibits in Area 2 of the U.S. Science Exhibit. On the left, a "touch-deception exhibit" with a double spiral of hot and cold tubes, and on the right a color projection that demonstrates the fallibility of human vision. From U.S. Department of Commerce, ed., *Souvenir Guide Book: United States Science Exhibit. World's Fair in Seattle 1962* (Seattle: Craftsman Press, 1962), 13.

Returning from both the future and history, Area 4 on "the methods of science" aimed to show the visitor "how scientists do their work" and to present 27 supposedly "random samples of present day research which is still going on," each of them addressing a question that would provide the exhibit's main headings. Doing good science was all about asking the right question, "one that goes to the heart of the problem—and can be answered with the tools and information at the scientist's disposal." The planners stopped short of presenting current research, but they hired 40 carefully selected, scientifically trained and attractive young women as "science demonstrators," who were dressed in uniforms and consistently styled. Their assignment was to explain, for example, a working satellite-tracking station or topics such as atomic structure or nuclear energy to a large crowd of visitors without entering into politically laden terrain: The satellite exhibit was simply determining the exact shape of the earth, while atomic and crystal structures were unrelated to negative uses, as was the production of energy by nuclear fusion and photoelectric cells. Further demonstrations from the life and behavioral sciences included the process of preparing tissue for examination under the electron microscope, how pigeons learn to peck according to the colors and patterns presented to them, and the filial imprinting of chickens. A special part of the building was reserved for The Modern Laboratory, where standard lab techniques were demonstrated "live," including the handling of radioactive cobalt-60 to inhibit bread mold; the stimulation of horseshoe crabs' optical nerves, which could then be monitored on an oscilloscope; or the operation of a Soxhlet extractor to isolate special ingredients from plants. In this modern look-the-scientist-over-the-shoulder laboratory, some gifted female demonstrators engaged in individual research that "bordered on original work."[27]

This approach to exhibiting scientific work and the real materiality of the lab with an attractive and placid (female) face may be traced back to the Palais de la découverte in Paris, which introduced the demonstration of scientific practice into the museum in the 1930s. Even more spectacular than this part of the exhibit, however, was likely Area X, also named Junior

Laboratory of Science, which can be understood as the postwar version of the London Science Museum's Children's Gallery, which also opened in the 1930s.

While initial plans for a children's area were dismissed at an early stage, they were revived in spring of 1961, leaving just 10 months available for the realization of what became probably the first participatory and hands-on science center. Somewhat ironic for an exhibit that in all other aspects apparently eschewed every link with war and destruction, the children's area was housed in the fallout shelter previously required by the Office for Civil Defense. Just as Area 4 presented the methods of science with 27 general quests for knowledge and demonstrators taught visitors about modern research, the Junior Lab had 27 audience-participation exhibits that invited visitors to individually "observe and draw conclusions," since here one "should *learn* but not be *taught*." Initially, this approach of knowledge acquisition was meant for adults as well, as "science can be learned . . . from climbing trees, blowing soap bubbles, or *doing* things." The Junior Lab planned for the 8- to 16-year-olds was, in fact, so popular with adults that children hardly made it to the buttons and handles of the interactive exhibits; after two weeks all adults except the teachers were banned. However, an attentive observer may have sensed the opportunity that such a place would offer to a broader audience, or as the final report—in which the costs, use, and effectiveness of the exhibits were meticulously recorded (Figure 3)—put it: "While it may not have educated the children to the extent first hoped for, the Junior Laboratory of Science demonstrated that the potential for exhibits of this kind is almost limitless. It showed what is possible and pointed new paths."[28]

The finale for all Science Exhibit visitors was Area 5, a multimedia apotheosis about the universality of science and its kinship with art. Conveyed through a darkened room by a moving floor, the visitors were presented a highly immersive "best-of" experience composed of film, dioramas, models, images, and so forth from other parts of the exhibit. These were often mysteriously arranged behind louvres and combined with a voice coming from above, which predicted new discoveries, longer life for all, control of nature, moon rockets, and reactors everywhere, but most important of all, "the delight of knowing the common laws that govern things." Like art, science explores the essence of things and connects with the humanities and philosophy.[29]

In this way, the entire U.S. Science Exhibit stressed the universality of science and almost completely omitted the reference to scientific rivalry and technological competition so obvious in the fields of nuclear threats and space exploration. Only after visitors had left the peaceful "World of Science," could they proceed to "NASA's first major attempt to tell graphically the story of the United States' space program." Located two blocks away from the Science Exhibit, the NASA exhibit featured "models and mock-ups" of satellites successfully launched, and of rockets in miniature, and included John Glenn's Mercury capsule, *Friendship 7,* used during the first American space orbit, which as the guide mentioned, had been succeeded a few months earlier by Shepard's first American but suborbital flight. However, the attempt to celebrate the Space Age as an age of exploring new frontiers and developing new technologies for a better life, without dealing with the ongoing space race between the Soviet Union and the United States, was put to a test.

JUNIOR LABORATORY OF SCIENCE

Summary of Cost, Use, and Effectiveness of Exhibits

		Original cost	6-month maintenance	Time in operation	Popularity at any instant	Educational effect
		Dollars	*Estimated dollars*	*Estimated percent*	*Estimated percent*	*Estimated percent*
1	Linear Accelerator	10, 303	450	95	4. 0	40
2	Hartl Disk	5, 184	40	100	1. 3	100
3	Low Friction Carts	10, 000	510	15	0. 0	50
4	Pinball Scattering	9, 000	570	70	8. 6	60
5	Weight on Other Worlds	11, 417	275	60	2. 8	30
6	Bernoulli Effect	6, 800	525	95	2. 3	50
7	How a Telescope Works	13, 388	150	95	4. 0	60
8	Measuring Distances in Space	11, 131	730	65	4. 5	60
9	Crystal Growth	4, 294	505	95	1. 6	90
10	Microscopes	8, 952	555	85	5. 6	90
11	Pond Water Micro-organisms	2, 196	650	85	0. 0	80
12	Gyroscope Effect	4, 474	200	70	11. 8	70
13	Audio-Visual Stethoscope	15. 132	515	50	3. 7	90
14	Electromagnetism	4, 800	82	95	2. 4	50
15	Probability Checkerboard	5, 216	50	100	5. 0	40
16	Electrolysis of Water	3, 093	140	85	1. 3	80
17	Paper Chromatography	10, 000	100	80	3. 4	80
18	Photosynthesis	2, 640	30	30	1. 5	20
19	Ant Colonies	15, 820	690	100	3. 7	60
20	Gravity Well	42, 000	710	70	11. 0	70
21	Speech Stopper	8, 500	300	95	4. 8	40
22	Vacuum Phenomena	10, 100	400	50	3. 4	90
23	Peep Shows	7, 415	600	35	5. 4	60
24	Ripple Tanks	20, 788	560	70	4. 2	90
25	Electric Fish	4, 566	550	20	0. 6	30
26	How We Hear	8, 500	250	95	2. 7	80
27	Rain Forest Mural	2, 800	10	100	0. 0	40

Figure 3. List of the 27 hands-on exhibits at the Junior Laboratory of Science at the 1962 Seattle World's Fair. Each exhibit was evaluated in regard to building and maintenance costs as well as availability, popularity, and educational effect. From U.S. Department of Commerce, ed. *United States Science Exhibit. Seattle World's Fair. Final Report*. (Washington, D.C.: U.S. Department of Commerce, 1962), 41.

A public relations crisis occurred when Russian cosmonauts visited the NASA exhibit with much press fanfare, while the American organizers were still waiting for Glenn and Werner von Braun to meet the challenge of human spaceflight.[30]

When the U.S. Science Exhibit, along with the entire world's fair, was closed on 21 October, the Science Center opened the next day. It heeded the University of Washington's proposal, developed during the fair, that it should not be a "hold-over attraction" but a "National Living Science Center." Some parts of the U. S. Science Exhibit would remain open through 1963, but thereafter objects were gathered in one building devoted to "learning equipment" for students. Rather than becoming a national institution, the outlook was more that of a regional science education institution, mainly addressing schools. In a way, it was the first "science center," since its education coordinator Dixy Lee Ray argued that rather than a museum, it should be a place to "amuse, beguile, stimulate, inspire, inform," mainly the regional residents or students, about the "essence as well as the aims and methods of science." This was, however, achieved in a modest way, and after a few years of constant struggle for survival, the museum became more traditional.[31] The Pacific Science Center did not become a "Smithsonian of the Northwest," but rather fell somewhat under the radar of national and international discussions about new science museums. Instead of capitalizing on the novel approach of the Junior Laboratory of Science, it turned to exhibits from NASA's space program and focused in particular on the history and environment of the Puget Sound region, including a reproduction of a Native American village and public lectures about environmental pollution.[32]

Washington and New York, 1964

According to *Science*, Seattle's world's fair had become "both the ideal and the standard for science exhibits," but New Yorkers had to "try a different tack" for their presentation of science and technology at the 1964–1965 New York World's Fair. From the outset, its Hall of Science was to become a permanent museum to fill a gap that other projects had just started to tackle. However, the reuse of Flushing Meadows, the site of the 1939–1940 world's fair, led to critical speculation whether "anything more than a trade show for science-based exhibitors" would emerge.[33] In fact, both the Hall of Science and the U.S. Space Park were located in one corner of the Transportation Area, while the others were occupied by a journey from prehistory to Space Age (created by Ford with the help of Walt Disney); General Motors's *Futurama II*, in which visitors looked at the world by driving through the city of the future (thus updating a similar 1939 *Futurama I*, which depicted its concept of a city and highway landscape from 1960); and the *Auto Thrill Show*. In this way, large corporations presented their visions of the future use of science and technology to visitors, who were strapped into moving seats or cars that would ensure that carefully prepared immersive shows as *The Miracle of Life* or *Magic Skyway* could not be sidestepped.[34]

Like a quarter of a century before, a strong commercial orientation and consumer culture of entertainment characterized the New York fair, which had a much larger visitor reservoir and a less important role for the city than its precursor on the West Coast. As for science, however, New York could in no way compete with the Seattle exhibit, as it lacked both federal funds and a universal attitude. As the Hall of Science was meant to make clear, science has made the "highest form of a *free* society" possible in the United States; "in the great war of ideas . . . our greatest defensive weapons are not atomic and hydrogen bombs but the mind of man functioning in an environment of intellectual and spiritual freedom." Wasn't it primarily "scientists from the free western democracies" who made the fundamental discoveries? Evoking the linear model, wherein basic scientific research would almost automatically lead to rich technical applications, the fair's top science adviser, William L. Laurence, connected pure scientific work, modern technological might, and political spin into one line of reasoning perfectly fitting the commercial nature of the entire event.[35] Consequently, when a preliminary report on the post-fair use was composed in January 1965, the main part of the future museum was a Hall of Discoveries and

Inventions that included engineering, communication, transportation, and space technology as "physical sciences"—thereby omitting most of the fundamental sciences—and "life sciences," mostly understood as addressing medical questions.

From the review of exhibits to be kept in the Hall of Science after the fair, it suffices to name a few by their sponsors: Martin Marietta Corporation (*Rendezvous in Space* and *National Orbital Space Station*), Abbott Laboratories (*The Chemical Man*), Upjohn Company (*The Brain in Action*) and others had exhibits in the Hall of Science during the fair; these were then supplemented with exhibits from Bell Laboratories, Eastman Kodak, General Electric, Ford, General Motors, and more from other pavilions. For children, there was also a play area on the list: the Atomic Energy Commission's *Atomsville U.S.A* which had allowed children to simulate the discovery of uranium on a world map by means of hidden buttons, manipulate radioactive material with mechanical hands, use Geiger counters, or handle a reactor while their parents observed them via closed-circuit television. (The adults also could find out more about "the science of survival" at the Office for Civilian Defense Exhibit, which, however, was not retained).[36]

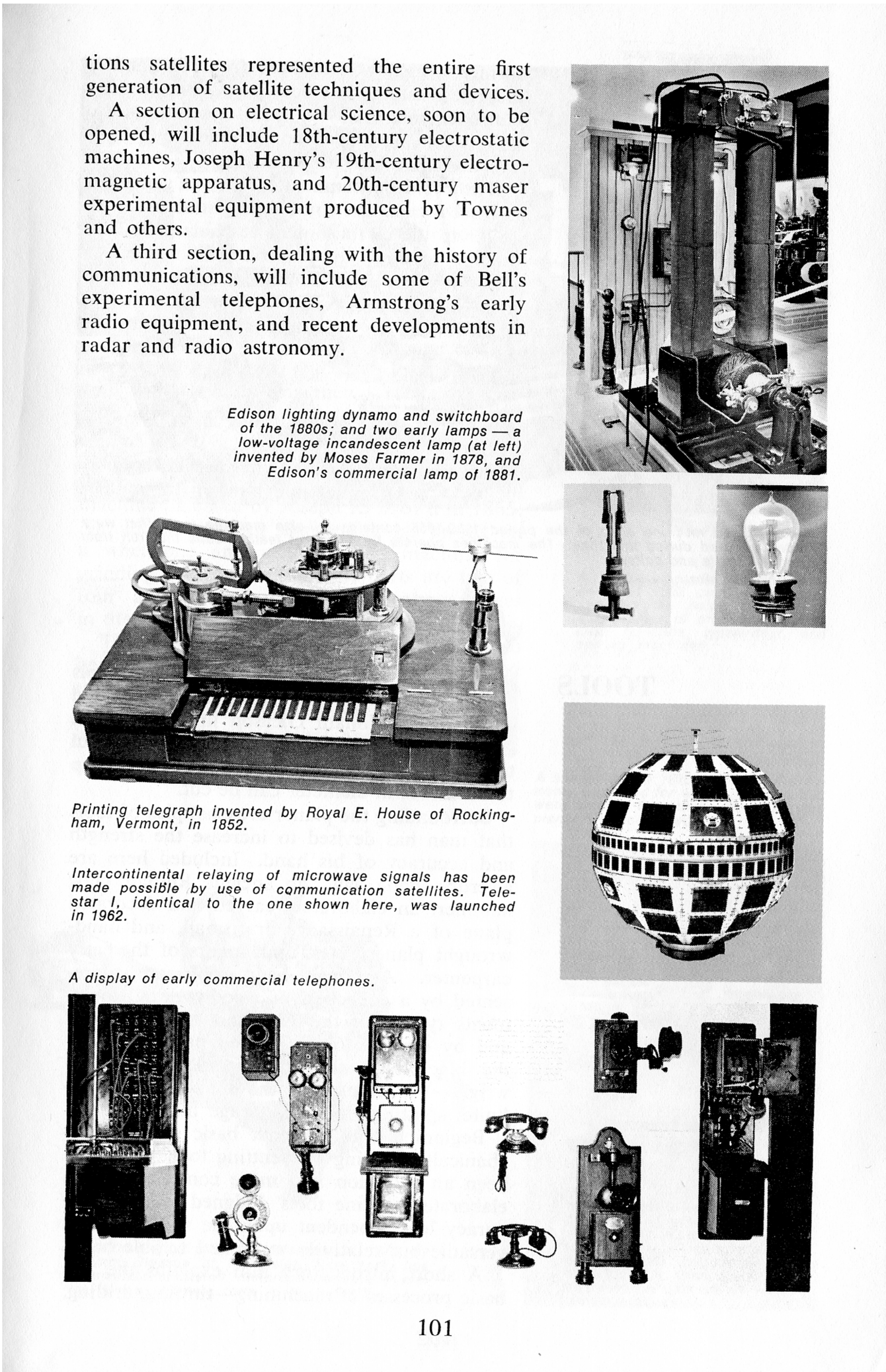
The term "science center" was occasionally used by planners and administrators for what was eventually to become the permanent New York Hall of Science after the fair ended in the fall of 1965. However, this apparently pointed to the status the organizers of the Hall of Science hoped it would attain, namely that of the Lincoln Center, Metropolitan Museum, or National Museum of Natural History.[37] No reference was made to the Pacific Science Center or the Smithsonian Museum of History and Technology (MHT), which opened its doors in January 1964. The new museum in Washington, D.C., was similar to New York's Hall of Science in terms of its modern architecture, but the presentation inside could hardly have been more different.[38] While the expo created an immersive and captivating experience with spectacular renderings of the *Futurama*, sci-fi underwater cities or space capsules, visitors in the MHT mostly could not tell whether they were in a museum of technology from the beginning of the century or in postwar America. If not for a few contemporary objects such as a satellite or a fusion reactor, he or she probably would not have seen much difference (Figure 4). After a long history of collecting artifacts dating back to the 1880s and some unsuccessfull attempts to create a dedicated technology museum in the 1920s and 1940s the new galleries continued to tell the story of technological progress in connection to American civilization by featuring period settings that focused heavily on agriculture, the railroad, and oil machinery.

Having been appropriated by Congress in 1955, the MHT was a hybrid from the onset, "for under one roof it combines the history and technology of a nation," which was symbolized by the Foucault pendulum swinging in front of the Star-Spangled Banner, an icon of the American nation. For the press, the MHT characterized itself as "an exposition illustrating the cultural and technological development of our nation," and according to its research agenda, it was part of a new Smithsonian Institution that "aspired to nothing less than the reinvention . . . as a great university."[39] In any case, it is hard to see in what way the new Washington, D.C., museum and the New York Hall of Science interacted. Although it was claimed on the occasion of the fiftieth anniversary of the MHT that both institutions served a patriotic agenda and that New York's *Futurama* and the like "challenged MHT's new staff of designers to create equally exciting historical displays," such displays did not make it into the "illustrated tour" that was published in 1968 (see Figure 4).[40]

Diverging Paths of Science Museums

The history of science and technology display at world's fairs and the efforts to establish new museums of science were closely linked, but not in a simple way. The immense momentum of the U.S. Science Exhibit had not pushed the Pacific Science Center to the front of the discussions on science display or museum development, nor did the hundreds of scientists involved in the preparations transfer its approach, or "tack," to other projects. While the Smithsonian had its secretary, Leonard Carmichael, on the Seattle planning board and provided a number of historical exhibits for the fair—which one of its designers, Robert B. Widder, judged "[o]ne of the finest displays ever conceived"—reports on the fair and post-fair Hall of Science do not mention any use of the "nation's attic," the undisputed repository of cultural as well as scientific and technological heritage in America.[41] Whether or not the designers at MHT took up the challenge from New York, the underlying commercial and showman nature had no place in the Smithsonian Institution. While it was suggested that the permanent exhibit in New York should have actors playing great scientists and inventors—"demonstrating each major discovery or invention made by them, [so this] would make such presentations not only highly instructive, but highly dramatic and entertaining as well"[42]—in Seattle, the general and everyday practices of science were on display. In Washington, D.C., however, it was not only the history of the nation that should be included, but also the manifestation of a new and confident history of science, which defined the approach. In 1954, Robert P. Multhauf was the first academically trained historian of science to join the Smithsonian. He recruited a number of others with the goal of "making the MHT one of the centers of history of science and technology in the United States." The editing of the journals *Isis* and *Technology and Culture* and the opening of the Smithsonian Institution Archives in 1967 propelled the museum to the crest of a new wave of social and cultural history of science and technology with a rich production of eminent scholars. The 28 curators of the new museum were "historians," not "educators," and the aim was to create a "research atmosphere." The MHT's planners did not consult with those of the New York Hall of Science but instead traveled in droves to Europe, in particular to Munich.[43]

The great differences in the representation of the nature, uses and, in particular, artifacts of science explain why New York's approach to the world's fair would not resonate well with that of the museum in the capital, where collecting, traditional documentary research, and new social and cultural history corresponded to a rather serious and substantial presentation of scientific heritage, aiming more at the educated and interested than at those to be educated and interested. Eventually, the Smithsonian's approach proved to be more viable, since efforts to transform the New York Hall of Science into a permanent institution in 1966 were judged to be



tions satellites represented the entire first generation of satellite techniques and devices.

A section on electrical science, soon to be opened, will include 18th-century electrostatic machines, Joseph Henry's 19th-century electromagnetic apparatus, and 20th-century maser experimental equipment produced by Townes and others.

A third section, dealing with the history of communications, will include some of Bell's experimental telephones, Armstrong's early radio equipment, and recent developments in radar and radio astronomy.

Edison lighting dynamo and switchboard of the 1880s; and two early lamps — a low-voltage incandescent lamp (at left) invented by Moses Farmer in 1878, and Edison's commercial lamp of 1881.

Printing telegraph invented by Royal E. House of Rockingham, Vermont, in 1852.

Intercontinental relaying of microwave signals has been made possible by use of communication satellites. Telestar I, identical to the one shown here, was launched in 1962.

A display of early commercial telephones.

101

Figure 4. Page 101 from the electricity section of the catalog *Exhibits in the Museum of History and Technology*, which shows the wide variety of artifacts that were displayed at this Smithsonian museum. From National Museum of History and Technology, ed., *Exhibits in the Museum of History and Technology: An Illustrated Tour* (Washington, D.C.: Smithsonian Institution Press, 1968), 101.

"a tired version" of the fair, "unworkable," and "an acoustical nightmare," and in the 1970s "got stuck in the Flashing Meadows mud."[44] Although it took until the 1990s for the MHT to open its own "Hands-on Science Center" and to hear the "call of stories,"[45] it was nevertheless the Smithsonian Institution that set the course for the future of the science center as we know and historicize it today. This is true at least under the premise that it was the Exploratorium that became the key engine of the science center movement and that its driver was Frank Oppenheimer, J. Robert's experimental brother.

Toward a New "Rationale" for the Science Museum

After a decade of being blacklisted by Joseph McCarthy, Frank Oppenheimer returned to academia in 1957 as an educator in the West, first to high schools, where his students soon won prizes at regional science fairs, and then to the University of Colorado. There he developed the idea of making experiments available to lower-division physics students much in the same way books were accessible in a library.[46] While there is no evidence directly linking Seattle's 1962 World's Fair to Oppenheimer's hands-on educational interests when he taught in Colorado, it appears that, in addition to his 1965 Guggenheim fellowship—which took him to Europe, where he studied its science museums—it was the Smithsonian Institution's Conference on Museums and Education at the University of Vermont in August 1966 that was the decisive step toward what he would later term a new "rationale" for a science museum.[47]

Initially scheduled to talk about school curriculum reform, Oppenheimer in fact expanded on "The Role of Science Museums" and was one of the most active discussants of the conference. This conference laid the foundation for his "Proposal for a Palace of Science and Art" in San Francisco, which was drafted in July 1967 and published a year later as "A Rationale for a Science Museum."[48] With the aim of creating a model for a science museum in medium-sized cities, he referred to his own experiences with the university's demonstration laboratory and the regional science fairs in Colorado, as well as the elaborate demonstrations at the Palais de la découverte, which were its hallmark. He recalled what he had seen during his Guggenheim year abroad: boys who were searching for push-buttons in the Science Museum's coal mine in London and the hands-on teacher training courses of the Deutsches Museum. Considering these examples, Oppenheimer first suggested, among other things, that science demonstration should become a profession and that personnel would be needed to "continually" redesign apparatus, not only in order to withstand wear and tear but also "on the basis of the museum experience." Then, however, he went on with a general critique of the push-button exhibits and other too-constrained display techniques. After observing the random button-pushing by children and adults alike, who often walked away without observing the full demonstration, he recognized the problems: lack of observer control, lack of stimulation during the demonstration process, and poor textual explanation. He wrote, "It is almost impossible to learn how anything works unless one can repeat each step in its operation at will; furthermore, it is usually necessary to make small changes which impair its operation. . . . detailed control of apparatus does not necessarily preclude remote control, although wherever possible it is more instructive to hold and manipulate the items directly in one's hand."[49]

While these were some key elements of the Exploratorium model, Oppenheimer's approach was still firmly rooted in "terms of the traditional science museum but a little more out in the open."[50] However, things became less traditional in the lecture "Gawk or Think?" by Michael V. Butler, especially during the discussions. As a physics curator and teacher of the Cranbrook Educational Community in Michigan, Butler was involved in the creation and evaluation of the 1962 U.S. Science Exhibit and was now discussing an object-based approach inspired by Seattle's Junior Laboratory, which made it appear as the stellar example of successful museum learning.[51] Even "busloads of tough city tenth graders" did not wreck the exhibit against all odds; rather "[a]fter ten or fifteen minutes of bedlam, the noise dropped off and the people began to concentrate . . . the children had just found the satisfaction that goes with learning." Like Oppenheimer before, he argued that such new science exhibits need a machine shop for designing and redesigning, but he went on to stress a more emotional and sensory approach: museum exhibits should "involve handling, hearing, or smelling as well as seeing; that involves puzzlement, with its inevitable consequence: thinking."[52]

Oppenheimer presented himself as "a non-museum person" who had realized how "terribly important" museums are as they "lay before one all the things that people take or have taken seriously" and that are not "fake." He also advocated for the complementary role of museums and schools that have to narrow things down. In the discussion following Oppenheimer's presentation, Albert Parr, the renowned director of natural history museums at Yale and in New York pointed out the inconsistency: "a science museum will achieve its most 'authentic,' scientifically exact effects with exhibits which are . . . 90 percent fake" because the idea or effect "prevails over the object." Parr also tried to escape the question of (historical) artifacts and whether they are already "the message" by claiming that the art museum is about objects and the science museum about ideas, for it presents the principles of nature. The editor of the conference volume, however, praised Oppenheimer for his plea not to divide art and science; what "both art and science do is to teach one to beware of one's surroundings . . . to pay attention to things that one has learned to ignore," what the stars in the sky or even complementary descriptions of reality in physics can be. Playing the card of atomic—or rather quantum—physics, which revolutionized the understanding of reality, and criticizing the narrow discussion of this topic in schools and curriculum reform projects, Oppenheimer suggested that both art, such as poetry or music, and science offer ways to understand aspects of the world "far away from the tactile, ordinary experience."[53]

Despite inconsistencies, Oppenheimer's views apparently dominated the whole discussion, with Albert Parr initially taking on the task of advocacy and reconciliation, then later criticism: "Too many museums are scared of finding out how wrong they have been." As frustrating as the different approaches of educators, researchers, and curators towards museum practice and education in often underfunded institutions may have been, it is surprising that out of the seven participants from the Smithsonian (of a total of around 40), no one appeared in the documentation of the discussions. Charles Blitzer, the Smithsonian's new director of education, had organized the conference; Secretary S. Dillon Ripley provided the introduction; the eminent Frank Tayler, who served all his life for the Smithsonian and eventually became founding director of the MHT, had chaired a session; and others were panelists for the discussion of individual presentations. Over the six days of the conference, however, there must have been much undocumented exchange, which gave Oppenheimer the opportunity for the first time to interact with seasoned museum professionals like Parr, Taylor, or Alma Wittlin, and to discuss current projects such as the "self-instruction demonstration exhibits" developed for the Lawrence Hall of Science at University of California, Berkeley, with Hans Weltin.[54] The Lawrence Hall of Science was initially conceived as a museum, but when it opened in 1968, it was more of a center for curriculum study and a teaching laboratory and thus did not seize the opportunity to establish itself as a science center.[55]

After the conference three notable things happened: Blitzer from the Smithsonian invited Oppenheimer to help plan a Mid-America Center in Arkansas, an offer which he declined; Oppenheimer's attempt to join the staff of the Lawrence Hall of Science was turned down; and his own concept for a Palace of Arts and Science in San Francisco went far beyond what he had presented in Vermont.[56] Parr wrote Oppenheimer that his new proposal for a "museum of science and technology" was "excellent" and suggested publishing its first sections in *The Curator*. Oppenheimer did so under the title "A Rationale for a Science Museum," which became a charter of science centers in 1968 and has been cited hundreds of times since.[57]

Key to the proposal became something that Oppenheimer remembered emerging "when the perception theme occurred to me." One may wonder about different sources for his insight to focus on the human senses and the very processes of perception as a good basis for a novel kind of science museum.[58] The topic of perception and sensory experience was raised by Michael Butler at the conference in Vermont but was not deepened; it was also present to a certain extent in some perception exhibits at Seattle's world fair (see Figures 2 and 3). Furthermore, the approach of teaching science through perception and play was also present at Expo 67 in Montreal—though not as a part of the U.S. pavilion, which dramatically showcased the American space program in a translucent Buckminster Fuller sphere, but this was displayed in a small gallery of the German Pavilion.[59]

The Exploratorium Revolution in Perspective

At Expo 67, Hugo Kükelhaus, a carpenter, educator, and a kind of natural philosopher, presented a selection of objects for Germany that allowed visitors to experience the laws of nature through play. With the support of chemist Otto Hahn and help from the central workshop of the Max Planck Society for the Advancement of Science, Kükelhaus had " . . . designed a collection of 32 devices, which demonstrate important phenomena of motion, the principles of the lever and of falling bodies, oscillations, flow patterns in water and smoke, the laws of sound, the conditions of perception like seeing, hearing, smelling in such a way that a child can handle them in bodily play."[60] His Strudelgerät (Figure 5), a machine that produces a vortex in water, may be a good

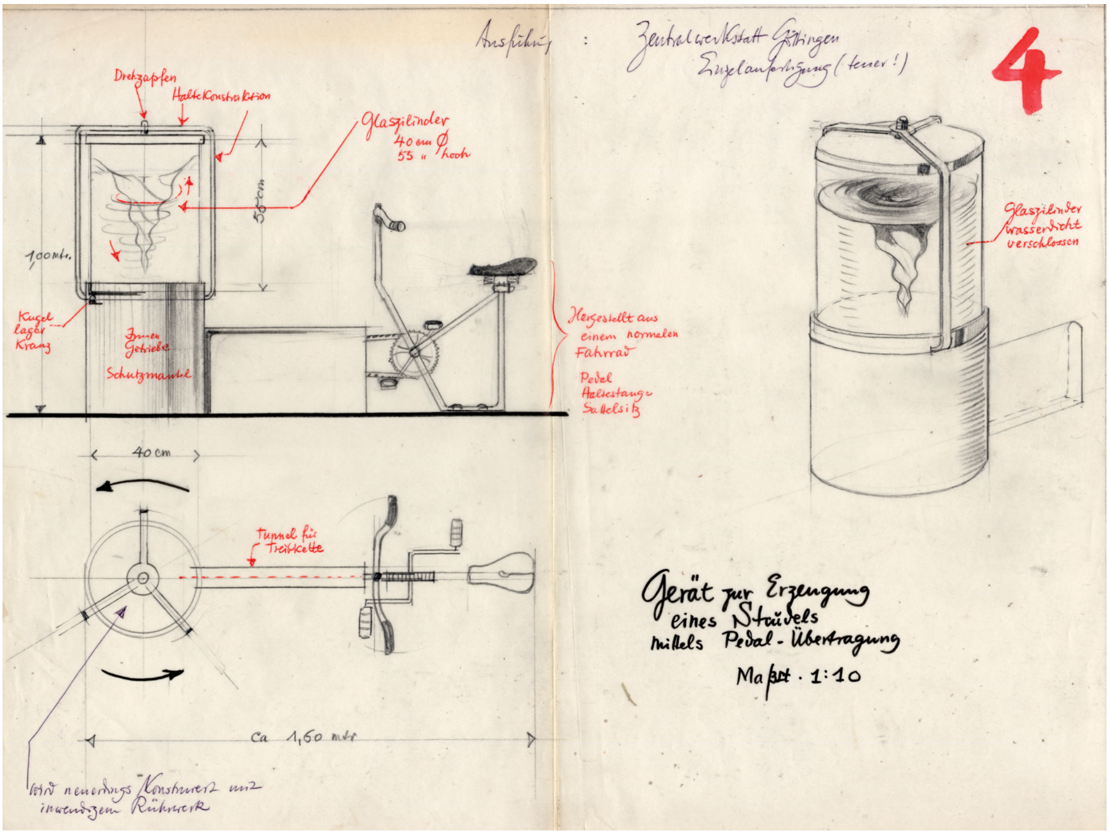


Figure 5. Plans drawn by Hugo Kükelhaus for a "Strudelgerät," or water vortex machine, displayed at Montreal's Expo 67 and for the custom-made building by the Göttingen Zentralwerkstatt of the Max Planck Society. Hugo Kükelhaus Papers, Stadtarchiv Soest. Courtesy of Barbara Vogel-Kükelhaus.

example that satisfies all requirements Butler, Oppenheimer, and others had put forward for educative science exhibits; it may even have conceptually outshone later "vortex machines" in the Exploratorium. It is reported that, as in Seattle, "also and especially adults felt invited" to operate the objects, though most of the gear did not withstand the crush of users.[61]

Those interested in Kükelhaus have tried to describe him as a trailblazer for the science center, but a direct connection to Oppenheimer has not yet been established.[62] What appears to be a puzzle, I would argue, is more of a deception due to a singular perspective—like some of the optical illusions that entertain us in science centers. To this end, and to conclude this discussion on the interrelationship of world's fairs and museum history in the 1960s, I suggest that the history and evolution of display techniques should be neither reduced nor too narrowly related to successful institutional development, which is often labeled by main protagonists and too often judged only in hindsight.

Two observations appear particular revealing. First, by using the rich visual material available from the 1962 U.S. Science Exhibit, one can easily illustrate all the essential display innovations for which the Exploratorium stands: from phenomena of color, tactile sensations (see Figure 2), and optical delusions to animal behavior (with horseshoe crabs in Seattle and grasshoppers in

San Francisco). Similarly, some of Kükelhaus's examples of *naturkundliches Spiel-Werk* (natural historic playthings) for Expo 67 can be rediscovered later in the Palace for Art and Science, as the Exploratorium was called initially. Clearly, the main fields of playful science were already identified, and many display techniques were not completely new.

Second, the Exploratorium of 1969 was intended to be a kind of museum, and initially it was also realized in much more of a traditional museum mode than its later archetypical science center nature would suggest. The *San Francisco Chronicle* reported in May 1969 that "SF 'Exploratorium' Gets Big League Help" and that NASA had just decided to make it "the permanent home for a major series of Space Agency exhibits" with "dozens of full-scale models, mock-ups and working examples of satellites and rockets." In addition, the "historic Smithsonian Institution in Washington, world-famed as a museum of technology . . . [had] agreed to ship out a large group of permanent exhibits."[63] Three months later the paper reported that "California's oldest glider" as well as "a diorama and bone castings of a prehistoric animal" would also be on display.[64] All this appears to be in line with a 1968 document on "The Initial Program for the Palace of Arts and Science." The Exploratorium was to be opened at the same time as the moon landing, which would be projected on large screens and complemented by "detailed charts and information about the mission." Space and accelerator exhibits, which represent the largest and smallest domains of the universe, were to "form the heart of the initial program." As Oppenheimer's concept documents explained, in general, the "museum" should present both "demonstrations" and "historical displays." In this way, the early Exploratorium was not what most people may think it was in view of its later archetypical status. For Oppenheimer the initial program meant an intermediary step "not necessarily based on the envisaged rationale," which called for "developing demonstrations that elucidate the mechanisms of human perception." Time and funds were needed to achieve this; hence, in a way, the visitors were attracted by the first exhibits but they were also misled about the project.[65]

It might look like the Exploratorium was on a way to becoming the "Smithsonian of the West," uniting the American science museum, as epitomized by the Museum of History and Technology, with the participatory, hands-on innovations of the U.S. Science Exhibit of the 1962 world's fair, but it was not. Clearly, a detailed and multifaceted early history of the Exploratorium, which involved a number of negotiation processes between multiple institutions and actors on the demarcation of the (visitor and funding) terrain as well as several conceptual adjustments, still needed to be written. For example, the temporary exhibit *Cybernetic Serendipity*, which came to the United States from the London Institute for Contemporary Art in late 1969, had a great impact on the development of the Exploratorium with its exhibits that lived in some new realm between art and science and were supposed to allow the visitor to "push, pull, whistle, blow and yell at a gallery full of tame wonders which look as if they've come straight out of a Science Museum of the year 2000."[66]

However, concerning the general development of hands-on and participatory exhibits and its display techniques, which are nowadays closely associated with the science center, it was a question of choice and implementation rather than one of unprecedented invention or individual ingenuity. As Alison Griffiths has convincingly argued, the history of expository media is a "back to the (interactive) future"—meaning that a closer historical investigation shows that the interactive display technique emerged to large extent along with the science museum and concurrent world's fairs throughout the nineteenth century.[67] It is hence not surprising that standard exhibits of science centers, such as the Bernoulli blower, wave machines, the gyroscope, optical illusions, Chladni patterns, or silent bells in a vacuum, can be traced back to the *Exploratorium Cookbook* (a publication that explained how to build the interactive exhibits of the Exploratorium), to the major science museums in the first half of the century and further back to the early science exhibits for the bourgeois audiences in 1890s Berlin or 1830s London.[68]

From this wider perspective, it turns out that the reinvention of the science museum in the 1960s—including the Museum of History and Technology and the Exploratorium—cannot be reduced to the presence or absence of new display techniques or novel ways of contextualizing historical artifacts. Rather, this development must be explained as the deliberate mobilization of methods of visualization and narrative strategies that can be applied both to artifacts and "edufacts" and that have a track record in earlier museums, fairs, and shows.

Apart from the local conditions that determined visitor reservoirs, the single most important factor for the success of new science exhibits may have been to meet the demands and expectations of the audience. Here the interrelationship between world's fairs and museums likely becomes most crucial, as it was to a great extent the visits by multiple millions to the expos that defined visitor expectations, particularly for science and technology museums.

Acknowledgements

This work was made possible in a large part by grants, visiting research and teaching appointments as well as colloquium invitations from the following institutions: Deutsches Museum (Scholar-in-Residence Program), Center for Science, Technology, Medicine, & Society at University of California, Berkeley (Visiting Research Scholar), Humboldt-Universität zu Berlin (Visiting Professorship), and Department of History and Philosophy of Science, Cambridge.

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6. For example, A. C. T. Geppert, *Fleeting Cities: Imperial Expositions in Fin-de Siècle Europe* (New York: Palgrave Macmillan, 2010) concludes with a chapter on "Exhibition Fatigue, or the Rise and Fall of a Mass Medium," while R. W. Rydell, *World of Fairs: The Century-of-Progress Expositions* (Chicago: University of Chicago Press, 1993) highlights the significance of the 1930s world's fairs in the United States. Cf. R. H. Kargon, K. Fiss, M. Low, and A. P. Molella, *World's Fairs on the Eve of War: Science, Technology, and Modernity 1937–1942* (Pittsburgh: University of Pittsburgh Press, 2015), and L. Hollengreen, C. Pearce, R. Rouse, and B. Schweizer, eds., *Meet Me at the Fair: A World's Fair Reader* (Pittsburgh: ETC Press, 2014).
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14. S. D. Schmid, "Celebrating Tomorrow Today: The Peaceful Atom on Display in the Soviet Union," *Social Studies of Science* 36 (2006): 342–345.
15. B. Schroeder-Gudehus and D. Cloutier, "Popularizing Science and Technology during the Cold War: Brussels 1958," in *Fair Representations: World's Fairs and the Modern World*, eds. R. W. Rydell and N. Gwinn (Amsterdam: VU University Press, 1994), 165, 167, and 177f.
16. Rydell, *World of Fairs*, ch. 7, 193–212; Kargon, Fiss, Low, and Molella, *World's Fairs*, ch. 7, 138–148. For two 1959 exhibitions, of the U.S. in Moscow and the USSR in New York, resp., and the acknowledgement "each other's popular interest of the contents of the two pavilions in Brussels," at Expo 58 see C. S. Lewis, *The Red Stuff: A History of the Public and Material Culture of Early Human Spaceflight in the USSR* (Ph.D. diss., George Washington University, Washington, D.C., 2008), 202–207.
17. U.S. Department of Commerce, ed., *United States Science Exhibit: Seattle World's Fair. Final Report* (Washington, D.C.: United States. Department of Commerce, 1962), 3.
18. U.S. Department of Commerce, ed., *Souvenir Guide Book: United States Science Exhibit. World's Fair in Seattle 1962* (Seattle: Craftsman Press, 1962), 5.
19. U.S. Department of Commerce, *Final Report*, 3.
20. B. Cotter, *Seattle's 1962 World's Fair* (Charleston: Arcadia Publishing, 2015); P. Becker, A. J. Stein, and The History Link, *The Future Remembered: The 1962 Seattle World's Fair and Its Legacy* (Seattle: Seattle Center Foundation, 2011); U.S. Department of Commerce, *Final Report*, 49.
21. U.S. Department of Commerce, *Final Report*, 7.
22. J. Walsh, "Science Exhibits: At Seattle Fair, Federal Funds, Scientists Helped, New Yorkers Try a Different Track," *Science* 140 (1963): 960 and 961.
23. Trip report by Wallace R. Brode, July 1958, cited in Schroeder-Gudehus and Cloutier, "Popularizing," 168.
24. U.S. Department of Commerce, *Final Report*, 9. The puzzle-solving theme goes back to Thomas S. Kuhn, who was the primary consultant of the Eameses; see also his *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962), which was published slightly later.
25. *Official Guide Book. Seattle World's Fair, 1962* (Seattle: Acme Pubs., 1962), 10–14.
26. *Official Guide Book. Seattle World's Fair, 1962,* 15–17.
27. U.S. Department of Commerce, *Final Report*, 20 and 31.
28. U.S. Department of Commerce, *Final Report*, 36, 40, and 42 (table).
29. U.S. Department of Commerce, *Final Report*, 34.
30. On chronology and persons, see Cotter, *Seattle's 1962 World's Fair*, and Becker, Stein, and The History Link, *The Future Remembered.*
31. Cf. K. A. Rader and V. E. M. Cain. *Life on Display: Revolutionizing U.S. Museums of Science & Natural History in the Twentieth Century* (Chicago: University of Chicago Press, 2014), 198f.
32. E. Ellis, *Dixy Lee Ray, Marine Biology, and the Public Understanding of Science in the United States (1930–1970)* (Ph.D. diss., Oregon State University, Portland, 2005), 188f. (quotes) and 201ff.

33. Walsh, "Science Exhibits."
34. L. R. Samuel, *The End of Innocence: The 1964–65 New York World's Fair* (Syracuse: Syracuse University Press, 2007); R. W. Rydell, J. E. Findling, and K. D. Pelle, *Fair America: World Fairs in the United States* (Washington, D.C.: Smithsonian Institution Scholarly Press, 2000).
35. W. L. Laurence, "Consultant's Report," in *Post-Fair Expansion Hall of Science*, ed. New York World's Fair 1964–1965 Corporation (New York: World's Fair 1964–1965 Corporation, 1965), 25.
36. Universal Newsreel, *Atomsville U.S.A*, 1964 http://www.c-span.org/video/?322982-1/1964-universal-newsreel-atomsville-usa (accessed 4 May 2017); W. L. Laurence, *Science at the Fair* (New York: New York World's Fair 1964–1965 Corporation, 1964), 19f.
37. For example, in the preface by Paul Screvani in Laurence, *Science at the Fair*.
38. For the long history and prehistory of the MHT, see Post, *America's Past*.
39. Post, *America's Past*, 55 and 58.
40. Quote by Frank A. Taylor and for discussion on influences from New York's World's Fair, see National Museum of American History, "Making a Modern Museum," Web exhibit 2014, http://americanhistory.si.edu/documentsgallery/exhibitions/50th/ (accessed 4 May 2017); Museum of History and Technology, *Exhibits in the Museum of History and Technology*.
41. Other museum representatives were Bradford Washburn (Museum of Science, Boston) and Albert E. Parr (American Museum of Natural History, New York) on the Science Advisory Committee, U.S. Department of Commerce, *Final Report*, 62f., quote on 49.
42. Laurence, "Consultant's Report," 17.
43. P. M. Henson, "'Objects of Curious Research:' The History of Science and Technology at the Smithsonian," *Isis* (1999): S264ff.; B. Finn, "The Science Museum Today," *Technology and Culture* 6 (1965): 74–82; B. Finn, "Der Einfluss des Deutschen Museums auf die internationale Landschaft der Wissenschafts- und Technikmuseen," in *Geschichte des Deutschen Museums*, ed. W. Füßl and H. Trischler (Munich: Prestel, 2003), 403.
44. Samuel, *End of Innocence*, 193ff.
45. Henson "'Objects of Curious Research,'" S267, references, footnote 51.
46. NSF Proposal "Request for Funds for the Establishing a Student Participation Demonstration-Experiment Laboratory," 1 December 1961, Frank Oppenheimer Papers, Bancroft Library, Berkeley, MSS 98/136; F. Oppenheimer and M. Correll, "A Library of Experiments," *American Journal of Physics* 32 (1964): 220–225.
47. I cannot detail at this point further influences and persons like the Colorado colleague David Hawkins, physicist and philosopher interested in childhood learning, who suggested Oppenheimer for the Conference; F. Oppenheimer and C. Weiner, "Oral History Interview with Frank Oppenheimer, 1973 February 9 and May 21," http://www.aip.org/history-programs/niels-bohr-library/oral-histories/4807-1 (accessed 4 May 2017), 25.
48. Oppenheimer, "Proposal for a Palace of Science and Art," Exploratorium Records, Bancroft Library, University of California, Berkeley, MSS 87/148c, carton 5:1 (July 1967).
49. E. Larrabee, ed., *Museums and Education* (Washington, D.C.: Smithsonian Institution Press, 1968), 175.
50. Oppenheimer and Weiner, "Oral History Interview," 27.
51. Butler wrote a report on the Junior Science Laboratory, which appears to have been the basis for the *Final Report*.
52. Larrabee, *Museums and Education*, 187–188.
53. Larrabee, *Museums and Education*, 213–215.
54. H. White, H. Weltin, M. Gould, and R. Rice, "Quantitative Demonstration Exhibits and a New Low-Cost Physics Laboratory," *American Journal of Physics* 34 (1966): 660.
55. Initially conceived as a major science museum, the Lawrence Hall turned to curriculum development and teacher training. It also developed teaching machines. The interesting connections between Seattle's Junior Scientific Laboratory and the developing concept of the Lawrence Hall cannot be covered here. See H. E. White, "The Lawrence Hall of Science," *The Physics Teacher* 3 (1965): 256–262.
56. H. S. Hein, *The Exploratorium: The Museum as Laboratory* (Washington, D.C.: Smithsonian Institution Press, 1990), 15; Oppenheimer and Weiner, "Oral History Interview," 25; Oppenheimer, "Proposal for a Palace of Science and Art."
57. Albert Parr to Frank Oppenheimer, 2 Feb and 24 Mar 1968. Frank Oppenheimer Papers, Bancroft Library, University of California, Berkeley, Mss. 98/136, 1:36.
58. C. Weiner, "Oral History Interview," 27. At the beginning of 1967, perception exhibits were not yet a focus of Oppenheimer and were only mentioned in passing in a letter discussing exhibits and demonstrations for a future science museum, Frank Oppenheimer to Jerrold Zacharias, 6 Jan 1967, Bancroft Library Berkeley, Mss. 98/136, 1:36.
59. R. Kenneally and J. Sloan, eds., *Expo 67: Not Just a Souvenir* (Toronto: University of Toronto Press, 2010). Another, however, rather distant elaboration on the perception theme was due to Richard Gregory in Britain, who presented his view in the 1967 Royal Institution Christmas Lectures "The Intelligent Eye" broadcast on BBC, cp. A. Barry, "On Interactivity: Consumers, Citizens and Culture," in *Politics of Display: Museums, Science, Culture*, ed. S. Macdonald (London: Routledge, 1998), 89f.
60. H. Kükelhaus, "Über das Erleben von Naturgesetzen im Spiel," *Physikalische Blätter* 24 (1968): 25.
61. J. Münch, "Erfahrungsfeld zur Entfaltung der Sinne," in *Neue Ausstellungsgestaltung 1900–2000*, ed. A. Müller and F. Möhlmann (Stuttgart: av Edition, 2011), 160.
62. Hildegard Vieregg, for example, claims that the ideas of Kükelhaus directly led to the development of the Science Center, of which the Exploratorium was the first. Vieregg, *Museumswissenschaften. Eine Einführung* (UTB, 2006), 22.
63. D. Perlman, "S.F. 'Exploratorium' Gets Big League Help." *San Francisco Chronicle*, 16 May 1969.
64. *San Francisco Chronicle,* "'Exploratorium' Taking Shape," 25 August 1969.

65. F. Oppenheimer. "The Initial Program for the Palace of Arts and Science" ca. 1968, and "The Content of the Museum" 1968, BANC MSS 87/148c, 5:4 and 5:2, respectively. Because Oppenheimer's museum concept had changed significantly between 1966 and 1969, and the "perception theme" has not been seized upon from the beginning, I would like to stress not so much a coherent "vision" of Oppenheimer but rather follow the contingent developments and acknowledge the apparent inconsistencies that determined the Exploratorium's history. In this I differ to some extent from H. S. Hein, *Exploratorium,* and K. A. Rader, "Hands on Science Centers as Anticollections? The Origins and Implications of the Exploratorium Exhibits Model," in *Challenging Collections: Approaches to the Heritage of Recent Science and Technology*, ed. A. Boyle and J.-G. Hagmann (Washington, D.C.: Smithsonian Institution Scholarly Press, 2017), 198–213.

66. Publicity for the London exhibition, cited in M. Fernández, "Detached from HiStory: Jasia Reichardt and Cybernetic Serendipity," *Art Journal* 67, 3 (2008), 6–23, on 13. For a short discussion of the role of the exhibition for the Exploratorium from the perspective of media studies, see M. Henning, *Museums, Media and Cultural Theory* (Maidenhead: Open University Press, 2006), 87ff.

67. A. Griffiths, *Shivers Down Your Spine: Cinema, Museums, and the Immersive View* (New York: Columbia University Press, 2008), ch. 5, 159–194.

68. See, for example, R. Bruman, *Exploratorium Cookbook I: A Construction Manual for Exploratorium Exhibits* (San Francisco: Exploratorium, 1975); Deutsches Museum, ed., *Amtlicher Führer durch die Sammlungen* (München: Deutsches Museum, 1925); M. W. Meyer, *Illustrierter Leitfaden der Astronomie, Physik und Mikroskopie in Form eines Führers durch die Urania zu Berlin* (Berlin: Paetel 1892); R. Altick, *The Shows of London* (Cambridge: Belknap Press, 1978), ch. 27, 375–389.

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CHAPTER 10

The Rise, Fall, and Unexpected Rebirth of Russia's *Buran* Shuttle at the Exhibition of Economic Achievements, 1988–2014

Cathleen Lewis
Curator
National Air and Space Museum, Smithsonian Institution
Washington, D.C., USA

This is dual history of an exhibition location in Moscow and the Soviet Union's changing philosophies for displaying technological and space hardware there. The Vystavka dostizhenii narodnogo khoziaistva (Exhibition for [National] Economic Achievements, or VDNKh) began as a government cultural park in the early Stalin years and emerged to international fame in the early 1960s as the forum where various players in the USSR (Union of Soviet Socialist Republics, or Soviet Union) and post-Soviet Russia created narratives about their cultural and technological history. These narratives changed over time, depending on national policy and the units directing them. Through the years, administration of the park has fluctuated between the national, state or local government, or public educators. Each has placed a different emphasis on the public portrayal of the history of technology, ranging from the highly didactic to fully propagandistic. The current displays at VDNKh—including the featured placement of the ill-fated *Buran* shuttle—signal a radical departure from previous Russian narratives about their history of technology.

Public historical narratives were essential to Russian national identity, which, for 74 years in the twentieth century (1917–1991), directed that of the Soviet Union.[1] Russia remained the intellectual and cultural center of the Soviet Union, reflecting a centuries-long history in which the Russian capital stood at the center of a geographic and ideological empire.[2] The production of the idea of a nation consists of repeated "whole complex of beliefs, assumptions, habits, representations and practices."[3] And as these ingredients have changed over time, so has the Russian concept of nationhood. It has fallen to the capital-centric groups of elites to shape national identity around important symbolic events and ideas. They have refined that skill and passed their ideas down from one group to another during the last century.[4] The process has relied on repetition and reiteration, which is essential when there is a flagging faith in the political structure or a need to remind the country of its nationhood.[5]

The influence of Soviet-era monuments and public spaces in modern, twenty-first century Russian public memory has been dynamic, changing as Russians assess and reassess the Soviet experiment. The dynamism of the years since World War II have been especially agile, having to account for shifting appreciations of Stalin and the war. Once the Soviet Union collapsed, monuments and public spaces fell into three categories of reassessment: those that were co-opted, glorified and celebrated; those that remain contested; and those that are completely disavowed. The constant cycles of reinterpretation and reassessment have left few in a single category during the last 25 years. An analogous situation prevailed immediately after the 1917 Russian Revolution, when czarist and Orthodox sites were first tolerated, then reviled, and later tolerated once again. The unmistakable example of this situation is the public turbulence over the memory and memorialization and ambiguous feelings over the role that the party had played in World War II.[6] The internal and public debates over the scope and voice of a central war memorial stretch the opening of the monument out from the 1960s until three and a half years after the collapse of the Soviet Union.

The potential trap in classifying Soviet-era monuments according to their public acceptance over time is to misjudge the time horizon and misunderstand the complexity of the public discussion. Some perceived rejections could merely be a shuffling of the political deck only to re-emerge within a few years.[7] Unlike a selective unravelling of the Soviet nation, this process signified a healthy continuing reassessment of the past.[8] Therefore, unlike an exercise in "forging a national identity distinct from the Soviet Union and thus redefining itself as a nation rather than as the center of a territorial or ideological empire,"[9] the Russians have undergone a repeated exercise of examining, discarding, and re-examining components of the Soviet and czarist Russian identity to form a post-Soviet national culture.

The Soviet and Russian Exhibition for Economic Achievements (VDNKh) (Figure 1) is one place that, in recent decades, has undergone that process of reevaluation. This 600-acre shrine to the contemporary ethnic, economic, and technological drivers of the Soviet and Russian identity and economy has existed for more than 75 years in the north end of Moscow. Once considered an artifact of the Stalinist era, the 2014 rechristening of the Exhibition of Economic Achievements indicates that this exposition of culture, material goods, and technology has an indelible presence in the Russian psyche. The decision of Moscow Mayor Sergey Sobyanin to rededicate the park disproves the theory that an initial post-Soviet disavowal and abandonment of the park was permanent.[10] The VDNKh in Moscow was long recognized as a barometer of official Soviet pride in its agricultural, scientific, and technical accomplishments. It has existed since the prewar rule of

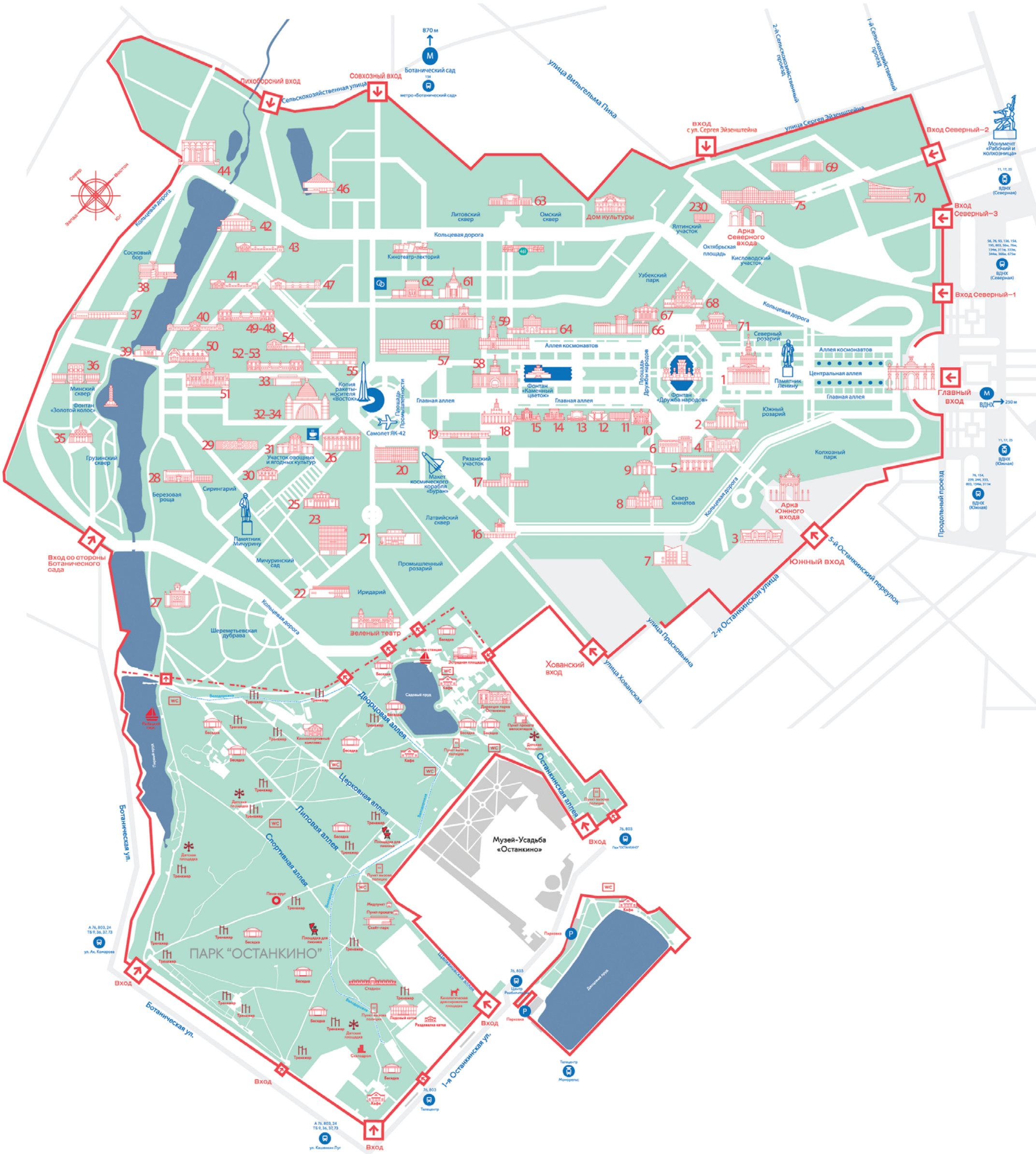

Figure 1. The layout of the Exhibition for Economic Achievements. The Kosmos pavilion is near the center, slightly to the left. Courtesy of the Government of Moscow, Russian Federation.

Stalin and has had various names that represented the relative emphasis of Soviet and Russian economic and planning achievements. Content and emphasis have changed over time, reflecting policies, successes, and regnant myths of the political systems that ruled the country. One monumental change took place in the 1960s: a *Vostok* rocket replaced a statue of Stalin outside of what had been known as the Mechanization of Agriculture pavilion. Although the placement of the launch vehicle pre-dated the official dedication of the site to space exploration, it did mark the gestation of what was to become the Kosmos pavilion.

The Kosmos pavilion, formally named as such in 1966, was a Soviet icon almost until the collapse of the Soviet Union. Ironically, as the excitement around and state support of the VDNKh began to dwindle in the late 1980s, the Soviet human spaceflight program seemed to show new life. February 1986 marked the launch of the main block of the space station Mir, the first modular space station that hosted 15 years of near-continuous human presence in Earth orbit. In November 1988, the Telegraph Agency of the Soviet Union (TASS) breathlessly announced the launch of the Soviet Union's space shuttle, the *Buran* (Snowstorm). Launched in automated mode without a crew, the *Buran* represented more than a decade of work within the Ministry of Defense to design a reusable space orbiter similar to the U.S. space shuttle. When local economic pressures and shifting administrative responsibilities brought foreign electronic and auto merchants to the grounds of the park, they took over the storied pavilion, pushing space artifacts to the side. In 1989, administration of the park was transferred from the Council on Exhibitions of the Soviet Academy of Sciences to the Moscow city government, and the park was renamed in 1989 to the All-Russia Exhibition Center (*Vsesoiuznyi vystavochnyi tsentr*, or VVTs), which it remained for more than a quarter-century. Stripped of the national mandate, the park quickly lost authority to sequester artifacts and other content resources for its exhibits. Gradually, most of the content of the Soviet and Russian economic park disappeared or fell into disrepair, and production facilities reclaimed legacy exhibits from their past.

The histories of VDNKh and the *Buran* have converged in the post-Soviet years. During the last 25 years a multitude of proposals for the future of the park have become known, including a seemingly fanciful proposal for a "Soviet Land" theme part that would at once poke fun at and wax nostalgic for the recent Soviet past. In 2014, when Sobyanin restored the park's original name, he also announced that the *Buran* structural test article OK-7M, which had once served as a restaurant in Gorky Park, was to be relocated to the exhibition. This action signaled a renewed importance of VDNKh as a showcase of Russian technology. This long, convergent history of the VDNKh and the *Buran* provides insight on the role and uses of technology in Soviet and Russian public life for the last 75 years. The technologies on exhibit have shifted from materially obscuring the present and being inspirational during the middle of the twentieth century, to illustrating a much more complex and fraught relationship with reality in the twenty-first century. Now at VDNKh, an unsuccessful technology has risen to the level of national icon, taking its place at the national fair of economic celebrations.

Evolution of an Iconic Space Exhibit: The Kosmos Pavilion

The 1960s witnessed the beginning of Soviet efforts to erect public commemorations of space exploration. Sergei Korolev, the talented manager of Soviet space activities, had lobbied for and successfully promoted a museum of spaceflight in Kaluga, Russia, the birthplace of Konstantin Tsiolkovsky, the legendary grandfather of Russian spaceflight. Korolev attended the groundbreaking for construction before his death in 1966, and in the following year, cosmonaut Yuri Gagarin led the dedication of the Konstantin E. Tsiolkovsky State Museum of the History of Cosmonautics. During that period, other space exhibits in the Soviet Union would begin to take hold. The VDNKh was becoming synonymous with space exhibits. At this site, the national tone and scope of space exhibitions were established. When a parallel and equally active program of exhibitions began outside the Soviet Union, those international exhibitions resembled the VDNKh. This relationship between the international and national faces of public exhibitions has grown from their intertwined origins.

Long before the VDNKh in Moscow was recognized as a barometer of official Soviet pride in its agricultural, scientific, and technical accomplishments, the Soviet Union made the first steps in translating its image from its exhibit at the 1937 Paris International Exposition to its domestic audience. The origin of VDNKh dates back to the Second Congress of the Kolkhoznik-Udarnik (farm and factory workers) that took place in Moscow in February 1935 and celebrated the union between farm and factory.[11] An exhibition first opened in 1939 named the Vsesoiuznaia selsko-khoziastvenaia vystavka (VSKhV, or All-Union Agricultural Exhibition), a celebration of Stalinist collectivization. Far from the city's center at the time, the exhibition grounds were established on the site of the Ostankino estate once owned by the Sheremetyevo family. Adjacent to the Soviet Academy of Sciences Botanical Gardens, the new exhibition offered an additional respite for Moscow inhabitants from the pressures of urban living. The overt purpose of the 1939 exhibition was to celebrate national achievements in agriculture.[12] The covert mission was to demonstrate that there was no famine in the country but rather only abundance resulting from collectivization and mechanization of agriculture. As a domestic forum, the exhibition park was successful in engaging the Soviet population in the accomplishments of the Stalinist state.[13] Coming to the park to reflect on things not available in their everyday lives, the Moscow public tacitly accepted the lies of abundance.[14] The architectural and artistic themes and architecture of the park dated to the high-Stalinist period (1945–1953), and featured exemplars of socialist realism and neoclassicism. After representing the Soviet Union at the Paris World Fair through 1937, Vera Mukhina's sculpture *Rabochi i kolkhoznitsa* (Worker and Woman Collective Farmer) marked the entrance to the park.[15] The park itself was an attempt to recreate the Soviet's 1937 exhibit for the domestic population.[16]

The original displays at the All-Union exhibition relied on the fact that agriculture dominated the Soviet economy. When the occasion demanded it, scientific exhibitions had their place, too. In 1938, a year before the official opening of VSKhV, the Soviet Arctic Exhibition celebrating recent accomplishments in the exploration and navigation of the North Pole.[17] It carried a motto attributed to Communist Party leader Sergei Kirov: "There is no land that Soviet power cannot transform for the good of mankind." This exhibition maintained the theme of agriculture and ethnographic displays. It was only after the post–World War II reconstruction of the exhibition halls at VSKhV that industrial accomplishments began to dominate the park, replacing the previous celebrations of agricultural accomplishments and folk culture.[18]

This prehistory of the location of spaceflight exhibits at VDNKh is significant because it demonstrates that the location has always played a role in displaying pivotal technologies in the

Soviet Union. The Kosmos pavilion's predecessor, the Mechanization of Agriculture pavilion at the exhibition, had a long design history. During the late 1930s, the architect Viacheslav Oltarzhevskii had designed a structure with four wings extending from the central axis of the exhibition under the shadow of Sergei Dmitrievich Merkurev's copper-clad statue of Stalin that stood at the exhibition's center. Construction of the original design never took place.[19] The final version of the pavilion was a simple, large, arched structure with open ends and enclosed alcoves facing across from each other at its midpoint. This design was convenient for installing the largest examples of agricultural machines, such as advanced combines, trackers, and aircraft. The building opened in 1939, with Merkurev's statue of Stalin towering in front of it.[20]

Reconceptualization of the Mechanization of Agriculture pavilion took place during much of the next two decades, overlapping with World War II and the death of Stalin. The exhibition's objects were evacuated to the Siberian city Cheliabinsk during the war. The All-Union Agricultural Exhibition (VSKhV) reopened in Moscow in August 1954.[21] This was the first permanent All-Union Agricultural exhibit, replacing the previous temporary ones in 1933 and 1939–1940.[22] In 1956, the *Vsesoiuznaia promyshlennaia vystavka* (VPV, All-Union Industrial Exhibition) opened on the same grounds.[23] The two exhibitions coexisted until yet another reorganization of the management of the exhibition occurred in the summer of 1959, when the VDNKh formally combined all exhibitions, including agriculture, construction, science, and industry into one centralized authority. The Ministries of Agriculture and Nationalities brought in the USSR Academy of Sciences and its Council on Exhibits to create new science exhibits inside the park.[24]

With this change in authority, the exhibition maintained a high level of authenticity, displaying working hardware. This time, instead of replicating the entire content of a previous world's fair, the exhibition replicated the general theme of industrial and scientific progress that had dominated the Soviet pavilion at the 1958 Brussels world's fair "Atomium," which had featured models of aircraft and cars that the Soviet public could not buy surrounding a heroic statue of Lenin. At the front of the pavilion stood full-scale models of *Sputniks* 1 and 2, which assured the public of a postwar technological future with the Soviet Union in the lead.[25] The themes of the 1959 Moscow exhibition continued this assurance of Soviet mastery of technology and production, but they were in greater detail and spread throughout the campus. For a few years, until 1962, the Physics pavilion of VDNKh maintained a working nuclear reactor on site for public display.[26]

Outside the mechanization pavilion that same year, the world's first successful jetliner—a Soviet Tupolev Tu-104 aircraft—took up residence.[27] Years later in 1965, the *Vostok* launch vehicle took the place left empty by the removal of the statue of Stalin (Figure 2).[28] The launch vehicle was genuine hardware that the military industry provided the Academy of Sciences for display. This was a simple and direct indication that a new icon had replaced the cult of personality. Space was the new focal point of the state. Where Stalin had stood in front of the mechanization of agriculture as a proud accomplishment of collectivization and industrialization, the *Vostok* rocket—the product of anonymous rocket engineers—now presided over the Soviet mastery of Cold War-era technology.

Figure 2. The Kosmos pavilion in 2005, when advertisers and merchants were given priority to the space. Photo by Alex Zelenko.

What had been a high-Stalinist monument did not officially become the Space pavilion (or, as was affectionately known in English, the Kosmos pavilion, as cosmos was a word that most Americans recognized) until 1966. However, displays of spaceflight first appeared at VDNKh in 1958, gradually edging out the tractors and combines and themes of agriculture and ethnic diversity. That year, models of the first three Soviet spacecrafts—*Sputnik*, *Sputnik* 2, and *Sputnik* 3—were displayed in the main entrance hall of VDNKh much as they had appeared in Brussels. The models moved into a 100-square foot exhibition in the Mechanization of Agriculture pavilion a year after their original appearance at VDNKh,[29] and they attracted a steady stream of visitors to the main exhibition hall.[30] In this case, the models were only replicas that provided little insight into the interior workings of the craft and their accompanying descriptions lacked detailed information about their missions. Nevertheless, they provided the first public exposure to anything remotely resembling the real objects. Western journalists and Muscovites were hungry to see the material evidence of the Soviet Union's accomplishments in space. One western journalist described the local interest in the display as a "steady stream of visitors."[31]

Soviet Narratives of Exhibiting Space at Home and Abroad

Throughout its history, VDNKh was never a museum with carefully curated collections. Although it did rely on science demonstrations, it never was a dedicated science museum. The outdoor structure lent an amusement-park flavor, but the themes contained within it were too serious for play. VDNKh had its own unique character of display and concealment. An illustrative example comes from the first time that a human spacecraft made its appearance there. Instead of revealing information about the history and technology of the first manned spaceflight, the Kosmos pavilion represented a carefully crafted effort to conceal aspects of the spaceflight program in the Soviet Union by camouflaging details about design and technical properties. The *New York Times* reporter who first wrote about the *Vostok* model interviewed the spacecraft designer, Konstantin Feoktistov, about the display and received only the most cursory description of the spacecraft from that knowledgeable engineer and cosmonaut. At the time of his interview with the *New York Times*, Feoktistov was known only as the flight engineer of the first *Voskhod*, a supposedly redesigned *Vostok* spacecraft that carried three men into orbit in October 1964 on the first multi-human mission. The reporter did not inquire about Feoktistov's role in the spacecraft design. In his memoirs, Feoktistov acknowledged that his flight on board the *Voskhod* was in fact a reward for redesigning the *Vostok* interior to accommodate three men.[32] In spite of his intimate knowledge of the spacecraft, Feoktistov said very little in his interview about the *Vostok* model on display. The engineer supplied only the most cursory technical specifications about the craft, limited to the gross weight and external dimensions, and he made no attempt to describe the operations of the spacecraft. His comments provided no basis for serious comparisons to the Mercury capsules that had previously been on display throughout the United States and the rest of the world.[33]

Another model of the *Vostok* soon appeared also at the 26th Salon International de L'Aéronautique et de l'Espace at Le Bourget Airport Paris Air Show in June 1965.[34] The Soviet portrayal of the craft was equally cagey. Gagarin accompanied the model and asserted that the *Vostok* and *Voskhod* crafts were "of entirely different design," a lie that the Soviet space establishment would perpetuate for another generation.[35] The *Vostok* at the Paris Air show served as a decoy, hinting to the world that great technical advances separated the displayed *Vostok* from the still-shrouded *Voskhod.* It would be almost a generation later that Soviet engineers would concede the identical designs of *Vostok* and *Voskhod*.[36] This had been a standard tone of VDNKh displays that reinforced the public culture of secrecy. Prior to that time drawings had included deliberately inaccurate representations of the spacecraft and how it functioned.[37] Deliberate trails of misinformation served to hide not one but many secrets about the first human spaceflights.

There was a significant technical secret about the *Vostok* that the Russians would not allow to become public, as this secret potentially threatened the Soviet Union's role as a generator of space firsts. *Vostok* was incapable of decelerating sufficiently to land a human inside. Gagarin had parachuted from his spacecraft at about 7,000 meters (20,000 feet). He had not really accomplished the first orbit of Earth as defined by the Fédèration Aéronautique Internationale (FAI), which required landing with one's spacecraft. The USSR's Chkalov Central Aero Club sent a telegram immediately after the landing to the FAI promising a detailed account of Gagarin's flight.[38] On 30 May 1961, the Chkalov Aero Club received its response to the report from the FAI:

"It is with great pleasure that we inform you that the FAI has confirmed that Yuri Alekseevich Gagarin has accomplished the world's first flight in space in the *Vostok* spacecraft."[39] The pristine representation of the *Vostok* in orbit that was placed on display at VDNKh did not betray the secret of the landing condition of the craft. A glimpse of the flown spacecraft would have revealed to the world its used ejection hatch, and the nearly shattered condition of Gagarin's *Vostok* would have revealed its fatal velocity at impact.

Changing Content and Context at the Pavilion

The installation of the *Vostok* model in summer 1965 began a content shift at Mechanization of Agriculture pavilion into Moscow's first permanent space exhibition.[40] Direct administrative control of the pavilion was under the USSR Academy of Sciences' Council on Exhibitions, which has internally directed the content of the scientific, industrial, agricultural, and ethnographic displays at the VDNKh since its rededication in 1959. The Kosmos pavilion did not devote the majority of its real estate to displays on Soviet accomplishments in human spaceflight, however. Only the rear, domed portion of the hall featured the activities of humans in space; the majority of the exhibits represented automated and robotic spaceflight projects through high quality, full-scale models of spacecraft, starting with the 1958 model of the *Sputnik* 3 satellite. These displays reflected the scientific and technical interests and expertise of the Academy of Sciences. The pavilion's visitors relied on paid staff to explain the displays, which provided little interpretation. The guides were busy with this activity, claiming to complete as many as 150 tours per day. This claim is somewhat doubtful, as it equates to 8–9 million visitors per year. This figure would break down to as many as 24,000 visitors making the pilgrimage to the pavilion each day—far more than the 10,000-square-meter facility could comfortably accommodate.[41]

As a form of Soviet-style recapitulation, another monument to the space program emerged near VDNKh in the Moscow skyline during the early 1960s. On the seventh anniversary of the launch of *Sputnik*, a 10-meter (350-foot), titanium-clad, stylized rocket and plume was erected just outside the entrance to the park to commemorate the "Conquerors of Space."[42] The titanium spire was as much a tribute to the revival of unadorned, modernist architecture as it was a tribute to the new Soviet Space Age. However, it was only one component of an architectural complex that served as a monument to the *Conquerors of Space*. In order to tie firmly the memories of revolutionary explosives experts to the contemporary activities of the engineers and technicians, the monument also included an alley lined with socialist realist tributes to the legends of Soviet rocketry and spaceflight. Sculptor Lev Kerbel, best known for his portrayals of Russian wartime suffering and Lenin,[43] created busts of Russian and Soviet scientists and engineers that lined the alley leading up to the spire.[44]

When *Conquerors of Space* was unveiled, the organizers promised that a museum would soon open at its spire's base.[45] This museum promised to replicate displays and stories previously shown at the K. E. Tsiolkovsky Museum in Kaluga. Almost 17 years later in 1981, the Memorial

Museum of Cosmonautics opened in an excavation underneath the spire.[46] If the Kosmos pavilion had been established to display models of Soviet spacecraft, the Memorial Museum was intended as an immersive experience. The museum contained a mixture of models, real artifacts, and artistic interpretations of spaceflight, and its main gallery had low ceilings and colorful lighting. In many ways, the museum appeared to be a place of worship, a church of spaceflight. The museum incorporated stained-glass windows and alters featuring images of Yuri Gagarin, and offered the visitors a ritualized experience culminating in a light show that flashed images of spaceflight to the soundtrack of popular music of the time.

Even while this public orchestration of spaceflight was going on, there was another type of space museum only available to those who worked inside the space industry. These museums rarely had outside visitors, usually foreign dignitaries and selected school groups. These isolated, private museums housed the remnants of the actual spacecraft and equipment that had flown or were designed to support human life in space. Each design bureau and enterprise jealously guarded its own collection of objects that represented the material legacy of its contribution to spaceflight. The resulting displays presented fragmented views of the space program. At the institution that rocket engineer Sergei Korolev had established were the remnants and components of rocket engines and spacecraft. A few miles away at the design and testing facility that developed spacesuits and other life-support equipment, a basement museum stored a complete collection of spacesuits dating from the first ones engineers had designed—those for dogs to wear during rocket experiment.[47]

The creation of these corporate museums resulted from the circumstances of the Soviet space program more than it reflected a deliberate attempt to isolate them from the public. The space program operated on a shoestring budget that did not permit secondary, backup hardware to be held in reserve. Engineers were using all hardware available to them to continue testing and refining their projects; recovered hardware was very valuable to them. After much of the flown hardware was lost to destructive post flight testing, what remained rarely left the factory of origin. Under the supervision of individuals who would collect and arrange the artifacts for the edification of his own colleagues, legacy displays developed. The purpose of these legacy display was both to reassure old-timers of their accomplishments and to educate new workers about the heritage of their missions.

It was not until the 1980s, under the last Soviet leader Mikhail Gorbachev, that these restricted museums incurred the obligation to promote visitation from the public. It is ironic that the same economic forces that drove the Kosmos pavilion to shut down simultaneously opened these closed museums to the public. At that time, the museums had to justify their existence through standards of accounting that no longer allowed manufacturing enterprises to support financially these pet projects solely for internal use. After the collapse of the Soviet Union, these museums took on the role of educational institutions and began measuring their outside visitation as an indication of public service.[48] Between the Kosmos pavilion and the private enterprise museums was a world of small museums that sprouted up during this period, each filling a specific demand from an audience or patron. For example, the display that ultimately became the Gagarin Spaceflight Training Center Museum in Star City (just outside of Moscow), had started in 1967 under the direction of Yuri Gagarin himself.[49] He initiated collecting as a repository for the gifts that cosmonauts received over the years from local and foreign admirers. He donated the first object to the museum's collection: a small, metal cast figure of a smelter (reflecting his early training as a smelter) that the people of Czechoslovakia had given him during his post flight tour.[50] The museum took on a somber and personal tone when Gagarin died in a training flight in 1968. At that time, the commandant of the Cosmonaut Corps, Nikolai Kamanin, decreed that everything associated with Gagarin at the center be gathered to form a memorial museum.[51] Kamanin oversaw the re-creation of Gagarin's office on the site of the museum in Star City and the official opening of the Gagarin Museum at the Spaceflight Training Center. This museum served more as a memorial than a museum, where objects were displayed with no context and minimal background information. In Gagarin's memorial office, the clock displayed the time when the cosmonaut died.

As other museums and memorials popped up in the Soviet Union, the Kosmos pavilion remained a world-renown icon of the space program, housing an idiosyncratic collection of displays and artifacts. In 1991, everything changed.[52] The expectation of the dissolution of the Soviet Union was growing throughout Russia. Politicians had begun to position themselves to take advantage of a collapsing empire. One approach was the active divestment from all-union resources and the redirection towards national—largely Russian—local resources. Moscow Mayor Yuri Luzhkov and Russian President Boris Yeltsin were willing participants in this shift from Soviet Union to Russian nationalism.[53] With just Yeltsin's signature, the exhibition lost its federal subsidy and the authoritative voice of the Academy of Sciences, and changed its name for a fourth time. In 1992, Boris Yeltsin reestablished the VDNKh as the *Vserossisskii vystavochnyi tsentr* (VVTs, or All-Russia Exhibition Center) leaving the existing management to fend for itself to secure funding. Its first response was to rent out the largest open spaces to commercial interests. In the early 1990s, a car dealership brushed aside the Academy of Sciences' displays of scientific satellites and began selling cars inside the pavilion.[54] Later, Asian electronics merchants installed and sold radios and televisions to Muscovites starved of consumer goods.[55] Finally, in 1998 RKK Energiia, the legacy organization of Sergei Korolev's OKB-1, reclaimed the human spaceflight hardware that remained housed among the electronics kiosks that had replaced the car dealership. RKK Energiia retained the collection for its formally private, corporate museum.[56] Even though the museum sat locked behind the steel gates of the formerly secret enterprise, Energiia began to encourage visitors, including school groups like the ones that used to visit the Kosmos pavilion 20 years earlier.[57] The Kosmos sign remained above the entrance of the pavilion, albeit on occasion hidden behind banners, as did the *Vostok* launch vehicle that had replaced the statue of Stalin. No one coordinated the demise of the Kosmos pavilion; it happened because of the deterioration of the USSR. It may have been fitting that the last displays in the building were sales kiosks of consumer electronics, the pivotal technology of the 1990s.

The *Buran*: A Spaceplane Once Shunned, Now Celebrated

Serious Soviet interest in a reusable space plane began in the 1950s at the dawn of the Space Age. After several incomplete design projects, the Soviets revived the effort in the 1980s in response to the U.S. announcement that it was creating space shuttles. At the time of the early U.S. space shuttle launches, the Soviets were testing an unmanned scale-model shuttle. Amid much speculation and after many delays, the Soviet Union launched its first full-scale reusable space shuttle, the *Buran*, on 15 November 1988. Although the *Buran* had been tested extensively in Earth's atmosphere with trained pilots in the cockpit, the maiden—and only—orbital launch was made without a pilot. The *Buran* was launched by the liquid-fueled Energiia launch vehicle, the largest among Soviet launch vehicles. Even without the strap-on solid booster rockets, it resembled the American shuttle quite closely. The *Buran* travelled two orbits of the Earth and landed uneventfully, heralded as a milestone in automated spaceflight.

The *Buran* resembled the shuttle far beyond the dictates of aerodynamics and represented what was supposed to become one of a fleet of shuttles that were under construction. The *Buran* became a flashpoint in the competition between the Defense Ministry's efforts to weaponize space and the scientific community's efforts to enhance Soviet international prestige through the scientific exploration of the solar system. However, due to the collapse of the Soviet Union, only two shuttles were manufactured and prepared for Earth orbit, and only a single unpiloted mission was flown before the program was cancelled. Yet, as true with many things, the Buran program was not entirely a military boondoggle. The program brought an economic boost to the town that supported the Kazakh launch facility, spurring a building boom in anticipation of Ministry of Defense forces and their families moving to the region. Today, those buildings remain empty and the population continues to dwindle. Although the *Buran* never flew again, the government waited to formally shutter the program until 1993. The *Buran* and two sister ships remained as material evidence of the Brezhnev/Ustinov endeavors in human spaceflight.

The *Buran* that made the 1988 flight was destroyed in a hangar collapse at the Baikonur Cosmodrome on 12 May 2002. Even today, discarded handling hardware and unused transport vehicles remain outside of the ill-fated assembly building, where there has been little or no visible attempt to repair the building (Figure 3). Its sister ship remained in storage at the Zhukovsky Air Force Base in Moscow and the Central Asian cosmodrome. The test vehicle that was most used during preparations for the 1988 mission and most seen at airshows and exhibits in Moscow, Europe, Australia, and Asia, now resides at the Technikmuseum in Speyer, Germany.[58] Other material test articles have been adapted to exhibition and other uses, including the test airframe that once provided the structure for a restaurant in Gorky Park in Moscow (Figure 4).

Beyond its technological uses, Buran had other, equally significant but hidden histories that endured well beyond the life of the shuttle. The program faced cancellation in 1993, but the

Figure 3. The *Buran* assembly building, which collapsed in 2002 with the carrier vehicle in the foreground to the left. Immediately to its left is the Soyuz assembly building. Photo by Cathleen Lewis.

continued persistence of its hardware encouraged a historical inertia that supported a mythology that prolonged the history of the program. This mythology was supported by the fact that there was not one, but many "Burans." There were the two flight-ready spacecraft—the flown *Buran* and a second, nearly complete and identical orbiter, called *Ptichka*. Following these were three incomplete versions of a second series of orbiting space planes, an atmospheric test unit, an analog to the American shuttle *Enterprise*, and a structural test vehicle. In addition, there were other pieces of structural hardware of typically incomplete and unrecognizable models. Although *Buran* was destroyed, the *idea* of the Buran did not die on that day in 2002. It persisted as a tourist attraction and an object of international interest. Another test vehicle remained at the Baikonur Cosmodrome as a tourist attraction at its public museum. (Figure 5). Boris Yeltsin presented models of the *Buran* spacecraft and Energiia launch vehicle to the Smithsonian Institution in June 1992 during a summit in Washington, D.C. In addition, in the spring and summer of 2014, the histories of VDNKh and *Buran* collided. On 14 May 2014, the mayor of Moscow announced that the structural test article that had been the attraction and restaurant in Gorky Park would move to the VDNKh. The move was complete by 21 July 2014 as part of a planned rejuvenation of the park, including a rededication of the Kosmos pavilion (Figure 6).[59] After a quarter-century, the *Buran* took its place alongside other Soviet accomplishments that had been celebrated.

Figure 4. The *Buran* test airframe at Gorky Park, Moscow, before its move to VDNKh. Photo by Cathleen Lewis.

Figure 5. An unflown *Buran* shuttle on display and the Baikonur Cosmodrome Museum in Kazakhstan. This incomplete airframe is open for visitors. Courtesy of the Government of Moscow, Russian Federation.

Figure 6. Russian President Vladimir Putin tours the newly reopened Kosmos pavilion on 12 April 2018. Courtesy of the Office of the President, Russian Federation.

Conclusions

There might be many justifications for placing the Gorky Park *Buran* into the place of honor in front of the former Kosmos pavilion. Three rationales that come to mind to explain why the Russians would display the *Buran*, a space technology failure, alongside the *Sputnik* launch vehicle, which launched the Soviet Union into the Space Age and the era of dominance in the space race. None is bullet proof, but each offers provocative ideas about what might be changing about the official history and the material culture of the Soviet space program in contemporary Russia.

Historians of space memorials face a challenging reality today. If the placement of the *Buran* at VDNKh is a signal as to how artifacts will be explored in the future, we can expect a style of display that will not merely be opaque but incomprehensible to other nations because it denies reality. One could acknowledge that the Soviet Union did indeed compete with the United States and make comparisons between these nation's displays in light of each nation's mission. Yet the display of the *Buran* denies the facts of a failed program: it places the Buran program at the same level as programs that succeeded or only partially failed. Such exhibitions are no longer tied to a real, fact-based history of technology that we have come to expect in western exhibitions.

The first rationale for such an exhibit to consider is that this move has been some sort of ironic juxtaposition of objects that might provoke new thinking about the past. In 1994 the Maryland Historical Society opened an exhibition called Mining the Museum.[60] In that show, an installation artist, Fred Wilson, culled the collections of an old, very revered historical society and created unexpected pairings of objects. One of his most noted pairings was the display of products of a Maryland silversmith alongside slave chains. The juxtaposition had the obvious motivation to make connections between the artisanship of the silversmiths, who created fine art pieces, and that of the metalworker who was devoted to keeping enslaved Africans in bonds. This explanation of the move of the *Buran* is a challenging idea, as it would signal a major departure from traditional Soviet and Russian technological displays. It is unreasonable to suspect that there has been a sudden and dramatic shift in official Russian sensibilities to encourage free and open exchange of ideas in the current domestic political climate.

A second explanation is that this display is a venture in creating a new science fiction for Russia. There is a very good argument to be made that much of the culture surrounding the heyday of Soviet human spaceflight was molded to hide certain realities while enhancing the promise of a golden future. This alternative proposes a combination of astrofuturism and astroculture.[61] The concept of creating new technological legends is nothing new in either American or Russian culture.[62] The fictionalized legends of John Henry, Aleksei Stakhanov, and Yuri Gagarin are prime examples. In each case, the legends are based on at least a kernel of truth. During the 1960s and 1970s, historians understood that the Soviet reality and use of artifacts was different from what we expected in the West. The use of models for the purposes of concealment and shadings of the truth were an offshoot of Soviet reality of the time. Soviet exhibition planners protected dominant myths about the Soviet space program by such means. But in each case, the use of artifacts and models was to partially conceal the truth, but not to deny a complete failure. Failures and abandoned programs, such as the Soviet plans to send humans to the moon and to create a human-tended outpost in space, remained concealed only to be revealed as the Soviet Union collapsed.

The third and most likely explanation is that it no longer matters within Russian discourse whether or not the *Buran* was a successful technology at all. As summarized in Masha Gessen's article on living in a post-truth society, Putin's Russia no longer demands a kernel of truth on which to build regnant myths.[63] While the acute nuances of technology have never been a feature at VDNKh, the exhibitions have always been straightforward exhortations of Soviet and Russian successes, even in the cases where the public histories have hidden flaws and shortcomings. Inside the Putin-controlled reality, there is no reason to debate the relative merits of the *Buran* versus the American shuttle. The only comparison to be made is that both sides had a reusable orbiter program and that now the remnants of each program are on display. It is not only a demonstration of what is reality in Putin's Russia but also, more importantly, of who is in charge in Russia. The power to rewrite reality is overwhelming because it assumes that there is no longer any opposition to contradict the new version of reality. The *Buran* at VDNKh is not only a testament to the spacecraft as a technology but also the power of the Russian state.

The exhibitions at VDNKh, its predecessors and successors, were never intended to present a static truth. The exhibition's origins sought to perpetuate myths about multinational egalitarianism that never existed in the Soviet Union. The parade of nations along the national pavilions presented an idealized and condescending view of the multinational state without mentioning the state policies that were eroding the cultures that the exhibition portrayed. Similarly, the agricultural exhibition demonstrated the myth of plenty during the times of famine. When the Stalinist mechanization pavilion was erected, it reinforced the official message of unrelenting progress through technology. This had been the rhetoric of Soviet nationhood. The current displays at the Kosmos pavilion indicate a return to an idea of nationhood that relies on previous Soviet mythology. All remnants of hardware from the heyday of Soviet space activities point to accomplishments, both real and imagined. These accomplishments exist outside of judgment of success or failure. In the words of Michael Billing, "protagonists were not fighting on behalf of god or a political ideology . . . but fighting for rightful nationhood."[64] The *Buran* stands in front of the Kosmos pavilion as a statement of Russian nationalism as it exists today, without the context of historical analysis.

Notes

1. B. Forest and J. Johnson, "Unraveling the Threads of History: Soviet-Era Monuments and Post-Soviet National Identity in Moscow," *Annals of the Association of American Geographers* 92, no. 3 (September 2002): 527.
2. It should be noted that the western world never recognized the postwar forcible incorporation of the three Baltic republics—Estonia, Latvia and Lithuania—into the Soviet Union.
3. M. Billing, *Banal Nationalism* (London: Sage Publishing, 1995), 6.
4. B. Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1993).
5. Billing, *Banal Nationalism*, 8.
6. A. Krylova, "Dancing on the Graves of the Dead: Building a World War II Memorial in Post-Soviet Russia," in *Memory and the Impact of Political Transformation in Public Space*, ed. D. J. Walkowitz and L. M. Knauer (Durham: Duke University Press, 2004), 83–102. Another example of an event that has been the victim of the churning cycles of historical interpretation and memory

is the martyrdom of Z. Kosmondem'ianskaia and A. M. Harris, "The Lives and Deaths of a Soviet Saint in the Post-Soviet Period: The Case of Zoia Kosmodem'ianskaia," *Canadian Slavonic Papers/Revue Canadienne des Slavistes* 53, no. 2/4 (June-September-December 2011): 273–304.

7. The major flaw in some of Forest and Johnson's arguments arises from the timing of their argument. Published in 2002, the authors researched and wrote the article during the time that Yuri Luzhkov was mayor of Moscow, prior to the administrative and municipal reforms that occurred after his resignation. It is also worth noting that their analysis of the long Soviet history of the Church of Christ the Savior is similarly truncated. They do not mention the role Russian Patriarch Aleksei played in the rise of the Russification of post-Soviet Russia. Forest and Johnson, "Unraveling the Threads of History," 530–536.
8. Forest and Johnson, "Unraveling the Threads of History," 339–340.
9. Forest and Johnson, "Unraveling the Threads of History," 524.
10. Forest and Johnson, "Unraveling the Threads of History," 535.
11. A. F. Zhukov, *Arkhitektura Vsesoiuznoi sel'skokhoziaistvennoi vystavki* (Moscow: Gosudarstvennoe izdatel'svo literature po stroiutel'stvy is arkhitekture, 1955), 1. S. Fitzpatrick, *Stalin's Peasants: Resistance and Survival in the Russian Village after Collectivization* (Oxford: Oxford University Press, 1996), xix. The first congress was held in 1933.
12. "Vsesoiuznaia sel'sko-khoiaistvennaia vystavka," http://www.bcxb1939.com/ (accessed 2 November 2016).
13. J. Gambrell, "The Wonder of the Soviet World," *The New York Review of Books*, 22 December 1994: 31.
14. Gambrell, "The Wonder of the Soviet World:" 31.15. K. A. Rusnock, "The Art of Soviet International Politics. Vera Mukhina's Worker and Collective Farm Woman in the 1937 Internationale Exposition," in *The Soviet Pavilion at the Exposition Internationale, Paris 1937*, ed. David C. Fisher, American Association for the Advancement of Slavic Studies (AAASS) National Convention, 17 November New Orleans, 2007. Rusnock has researched the engineering and construction of the Mukhina sculpture that topped the Soviet pavilion in Paris in 1937.
16. The one icon that the Soviet Union could not reproduce was the facing German pavilion in Paris. K. A. Rusnock, "The Art of Soviet International Politics."
17. J. McCannon, "Tabula Rasa in the North: The Soviet Arctic and Mythic Landscapes in Stalinist Popular Culture," in *The Lands of Stalinist: The Art and Ideology of Soviet Space*, ed. E. Dobrenko and E. Naiman (Seattle: University of Washington Press, 2003), 246.
18. Gambrell, "The Wonder of the Soviet World," 33.
19. Rumors over the reasons for the aborted design included claims of shoddy construction and the realization that the design resembled a swastika from an aerial perspective. Gambrell, "The Wonder of the Soviet World," 30. V. Paperny, *Architecture in the Age of Stalin: Culture Two*, trans. J. Hill and R. Barris (Cambridge: Cambridge University Press, 2002), 150–157.
20. I. Cheredina, "Na meste Stalina sostavili raketu" [They replaced the statue of Stalin with a rocket], *Ogonek*, 12–18 March 2007, online. The Merkurev statue of Stalin was one of three that the artist completed. The first was located in Erevan, capital of his country of his birth. The second was located at the entrance of the Moscow canal, and the third at VDNKh. Each copper-clad steel framed sculpture stood 49 meters tall. Entsiklopediia krugosvet. Universal'naia nauchno-populiarnaia onlain-etsiklopediia, "Merkurov, Sergei Dmitrievich" http://www.krugosvet.ru/enc/kultura_i_obrazovanie/izobrazitelnoe_iskusstvo/MERKUROV_SERGE_DMITRIEVICH.html (accessed 13 December 2016).
21. S. D. Schmid, "Celebrating Tomorrow Today: The Peaceful Atom on Display in the Soviet Union," *Social Studies in Science* 36, no. 3 (30 June 2006): 340.
22. Zhukov, *Arkhitektura Vsesoiuznoi sel'skokhoziaistvennoi vystavki*, 1.
23. Schmid, "Celebrating Tomorrow Today," 340.
24. The archivists of the State Archive for Science and Technology (RGANTD) in Samara have compiled a chronology of the Kosmos pavilion at VDNKh based on the collections at the Archives: O. S. Maksakova, "Iz istorii cozdaniia pavil'ona "kosmosa" na VDNKh SSSR," Glavnaia-Ispol'zovaniie-Stat'I informatsii. http://samara.rgantd.ru/activity/articles/6868/ (accessed 16 November 2016).
25. L. H. Siegelbaum, "Sputnik Goes to Brussels: The Exhibition of Soviet Technological Wonder," in *Soviet Space Culture: Cosmic Enthusiasm in Socialist Societies*, ed. E. Mauer, J. Richers, M. Ruthers, and C. Scheide (New York: Palgrave Macmillan, 2011), 170–187.
26. This was the second public display of a nuclear reactor. The first had been an American reactor in Geneva in 1955. Schmid, "Celebrating Tomorrow Today," 340 and 344.
27. https://en.wikipedia.org/wiki/Tupolev_Tu-104
28. Gambrell dates the removal of the Stalin statue to the early 1950s, but that date is unlikely. VDNKh reopened several times after World War II: in 1954, 1956, and finally in 1959. Khrushchev read his "Secret Speech" at the Twentieth Party Congress, calling for de-Stalinization in February 1956, and the declaration for removing Stalin from the Lenin Mausoleum did not pass until the Twenty-second Party Congress in October 1961. It is likely that the decision to remove the Stalin statue occurred during the renovations in the late 1950s. All evidence indicates that a Tupolev (Tu-104) passenger aircraft first replaced the Stalin statue in 1956. After renovations, the All-Union Agricultural Exhibition became the Exhibition of Economic Achievements in 1959. Gambrell, "The Wonder of the Soviet World," 33. B. E. Owens, *Taubman Khrushchev: The Man and His Era* (New York: W. W. Norton & Company, 2003), 513–515. A. M. Gurtiakov provides a brief synopsis of the negotiations over the creation and installation of the *Vostok* model in A. M. Gurtiakov, "Kak ustanavlivali raketu-nositel' 'vostok,'" *Gazeta national'nogo issledovatel'skogo tomskogo politekhnicheskogo universiteta*, no. 10 (3372), 23 May 2012. https://za-kadry.tpu.ru/article/3372/6966.htm (accessed 17 November 2016).
29. M. Childs, "Moscow Exhibits Stress Sputniks," *Washington Post and Times Herald*, 24 June 1958: A16.
30. Childs, "Moscow Exhibits Stress Sputniks," A16.

31. Childs, "Moscow Exhibits Stress Sputniks," A16.
32. K. Feoktistov, *Traektoriia zhizhi: mezhdu vchera i zavtra* [The trajectory of life: between yesterday and tomorrow] (Moscow: Vagrius, 2000), 141–142.
33. Feoktistov is identified as a cosmonaut, not as the chief designer of spacecraft in the interview. The information that he provided is either evident from visual inspection (diameter of the craft), or of general knowledge among the spaceflight community (orbited weight of the craft). "Vostok Model is Shown to Public in Moscow," 10.
34. "Vostok Revealed," *Spaceflight*, July 1965: 161.
35. "Vostok Revealed," 161. Feoktistov, *Traektoriia zhizhi*, 143–144.
36. Feoktistov, *Traektoriia zhizhi*, 143–144.
37. "Vostok Revealed," 161.
38. The FAI is the International World Air Sports Federation, also known as the International Aeronautics Federation, founded in 1905, which sets and documents all aviation and spaceflight records throughout the world. In order to comply with FAI mandates, the Soviet Union submitted fraudulently ambiguous paperwork to document Gagarin's flight as the first spaceflight. V. Mitroshenkov, *Zemliia pod nebom: khronika zhizni IUriia Gagarina*, izdanie vtoroe, dopolnennoe [The Earth under the skies: A chronicle of the life of Yuri Gagarin] (Moscow: Sovetskaia Rossiia, 1987), 185.
39. Mitroshenkov, *Zemliia pod nebom*, 203.
40. The director of the pavilion claimed in 1971 that it was Moscow's first permanent space exhibition. V. Bazykin, "Moscow's Permanent Space Exhibition," *Spaceflight* 3, no. 8 (August 1971): 295–297.
41. Mitroshenkov, *Zemliia pod nebom*, 296.
42. *New York Times,* 1964, "Soviet Space Monument Showing Rocket Unveiled," 13 October, 2.
43. N. Tumarkin, *The Living and the Dead: The Rise and Fall of World War II in Russia* (New York: Basic Books, 1994), 1–3; and "Lev Kerbel and His Time (to the 85th Anniversary of the Sculptor's Birth)," *Russian Culture Navigator*, 9 March 2005.
44. The apartment blocks in the region were commonly known as the Korolev houses by the end of the 1960s. B. E. Chertok, *Rakety i liudi: lunnaia gonka* [Rockets and people: The moon race] (Moscow: Mashinostroenie, 1999), 13.
45. G. S. Vetrov, "S. P. Korolev i razvitie muzeev po kosmonavtike," in *Trudy Xxxii Chtenii, Posviashennikh Razrabotke Nauchnogo Naslediiq I Razvitiiu Idei K. E. Tsiolkovskogo (Kaluga, 15–18 Sentiabria 1992 G.)* (Moscow: IIET RAN, 1994), 195.
46. Martovitskaia provides an explanation of the long wait for the Memorial Museum of Cosmonautics. The architects of the original monument had not planned for an excavation underneath its foundation, and it was not until 1969 that the Moscow City Council approved the petition for the new museum. A. Martovitskaia, "Muzei kosmonavtiki gotovitsia k rekonstruktsii" [Space museum prepared for reconstruction]. *Gazeta "Kultura"* no. 14 (7524), 13–16 April 2006; *Kultura Portal,* http://portal-kultura.ru/upload/iblock/35c/2006.04.13.pdf (accessed 15 February 2006).
47. My knowledge about the Zvezda museum comes from my research visit there to interview engineers about spacesuit development in 1996. Zvezda maintains a website page on its institutional history that includes photographs from its museum: OAO NPP "Zvezda," "Istoriia OAO NPP Zvezda," *OAO "NPP Zvezda"* 2006, http://www.zvezda-npp.ru/histor.html (accessed 29 October 2007).
48. Under Mikhail Gorbachev's leadership during the mid- to late 1980s, all enterprises, even in the military and government, maintained an accounting of all funds and generated income out of their operating budgets. Under the rubric of *khozraschet (khoziaistvennyi raschet*, self-financing), enterprises that had previously received generous government subsidies then turned to revenue-generating endeavors that included admission charges for tourists—especially foreign ones—and the sale of items in small shops. This type of revenue enhancement became an absolute necessity after the collapse of the Soviet Union in December 1991.
49. After a speech on his flight on 24 June 1961, Yuri Gagarin was asked about the center where the cosmonauts did all their training. He responded with the idea of creating a museum that would document their training and would be open for future generations to see: *Russkii gosudarsvennyi nauchno-issledovatel'skii ispytatel'nyi tsentr podgotovki kosmonavtov imeni Iu. A. Gagarina (RGNIITsPK imeni Iu. A. Gagarina)* [The Yuri Gagarin Russian state scientific research center for the testing and training of cosmonauts], 16 February 2007. http://www.gctc.ru/
50. http://www.gctc.ru/
51. N. Petrovich Kamanin, *Skrytyi kosmos. Kniga tret'ia: 1967–1968 gg* [Secret space. Book three: 1967–1968] (Moscow: Novosti Kosmonavtiki, 1999), 202.
52. State funding stopped in 1991 and in 1992 Yeltsin changed the name to the Vserossisskii vystavochnyi tsentr (All-Russia Exhibition Center, VVTs). Forest and Johnson, "Unraveling the Threads of History," 535.
53. Forest and Johnson, "Unraveling the Threads of History," 530.
54. J. Gambrell, "The Wonder of the Soviet World," *New York Review of Books*, 22 December 1994: 33. S. Leskov and I. Snegirev, "Sud nad VDNKh zakonchilsia [The Jury is in on VDNKh]," *Izvestiia*, 13 March 1997, no. 047: 1.
55. Leskov and Snegirev, "Sud nad VDNKh zakonchilsia" [The jury is in on VDNKh], 1.
56. The repossession of objects and exhibits from the Kosmos pavilion was not an orderly process. Within a few years, commentators were uncertain as to which objects returned to their origin of manufacture, which were sold at auction, and which remained on the premises at VDNKh/VVTs: B. Ustiugov, "Na VVTs nashli sputnik i partbilet Gagarin" [They found Sputnik and Gagarin's party card at the All-Russia Exhibition Center], *Izvestiia*, 16 June 2004, no. 105: 11 and 12.
57. Energiia now publicly advertises its museum for paid admission. The museum features Gagarin's original *Vostok* spacecraft, and Leonov's *Voskhod* spacecraft, among other hardware that previously only specialists could see. Also among the displays is the mockup of the Apollo-Soyuz Test Project that had resided at the Kosmos pavilion of VDNKh for more than twenty years. It has been my personal experience that access for a foreigner is difficult, requiring advance clearance through Energiia's security

office. S. P. Korolev Rocket and Space Corporation Energia, *Museum*, 26 October 2007 http://www.energia.ru/english/energia/history/museum/museum.html. T. Pirard, "The Space Museum at RKK Energia," *Spaceflight* 42 (June 2000): 247–253.

58. The Technik Museum Speyer has holdings not limited only to its *Buran* shuttle. It also holds flown Russian and Soviet spacesuits and both a Concorde and a Tu-144. Hans-Jürgen Schlicht, *Technik Museum Speyer* (Speyer: Auto & Technik Museen Sinsheim und Speyer, [n.d.]) and Heinz Elser, *Geschichte und Transport der russischen Ramfahre OK-GLI in das Technik Museum Speyer* [History and transportation of the Russian space shuttle OK-GLI to the Technik Museum Speyer] (Speyer: Technik Museum Speyer, 2008).

59. "Transportation of the shuttle to the VDNKh park," http://www.buran-energia.com/bourane-buran/bourane-modele-tva-transport.php (accessed 3 February 2016) and "VVTs v Moskve vozvrashcheno istoricheskoe nazvanie VDNKh," *Interfaks Rossiia* 17 (15 May 2014):16, www.interfax-russia.ru/Moscow/main.asp?id=500094 (accessed 3 February 2016).

60. L. G. Corrin, ed., *Mining the Museum: An Installation by Fred Wilson* (New York: The New Press, 1994).

61. These two terms are similar, but denote separate things. The former is the projection into the future. The latter is the re-examination of ideas on space. DeWitt Douglas Kilgore, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia: University of Pennsylvania Press, 2003). A. C. T. Geppert, "Rethinking the Space Age: Astroculture and Technoscience," *History and Technology* 28, no. 3 (2012): 219–223.

62. L. H. Siegelbaum, *Stakhanovism and the Politics of Productivity in the USSR* (Cambridge: Cambridge University Press, 1988) and S. R. Nelson, *Steel Drivin' Man: John Henry, the Untold Story of an American Legend* (Oxford: University Press, 2008).

63. M. Gessen, "The Putin Paradigm," *NYR Daily. The New York Review of Books*, 13 December 2016, http://www.nybooks.com/daily/2016/12/13/putin-paradigm-how-trump-will-rule/ (accessed 21 December 2016). She has summarized her assessment of Putin and his relationship to truth in her biography of Putin, *The Man Without a Face: The Unlikely Rise of Vladimir Putin* (Riverhead Books, 2013).

64. Billing, *Banal Nationalism*, 3.

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Russkii gosudarsvennyi nauchno-issledovatel'skii ispytatel'nyi tsentr podgotovki kosmonavtov imeni Iu. A. Gagarina (RGNIITsPK imeni Iu. A. Gagarina) [The Yuri Gagarin Russian state scientific research center for the testing and training of cosmonauts]. http://www.gctc.ru/ (accessed 16 February 2007).

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CHAPTER 11

National and International Expositions and the Origins of the National Apollo 11 Artifacts Collection

Allan A. Needell
Curator
National Air and Space Museum, Smithsonian Institution Washington, D.C., USA

In July 1969, while Michael Collins orbited the moon in the Apollo 11 command module *Columbia*, Neil Armstrong and Buzz Aldrin became the first human beings to set foot on another world. The command module—the only portion of the complex, three-part spacecraft to return to Earth—as well as the astronauts, a cargo of lunar samples, photographic film, and materials and equipment stowed in the spacecraft's lockers and cabinets were recovered by the U.S. Navy from the Pacific Ocean (Figure 1).

Following technical review and documentation, the National Aeronautics and Space Administration (NASA) selected several of the recovered items for public display, most notably internationally as part of a space exhibit within the United States pavilion at the 1970 World Exposition in Osaka, Japan, and domestically in a NASA-managed mobile exhibit sent to tour 50 U.S. state capital cities. Such international and national public and ceremonial displays are testimony to the perception by U.S. government officials that "real" space artifacts would have direct appeal and special significance to both international and American audiences. Display of the objects also complicated ongoing negotiations over ownership and control of such artifacts as well as what organization and what set of values should determine future access, care, and display.

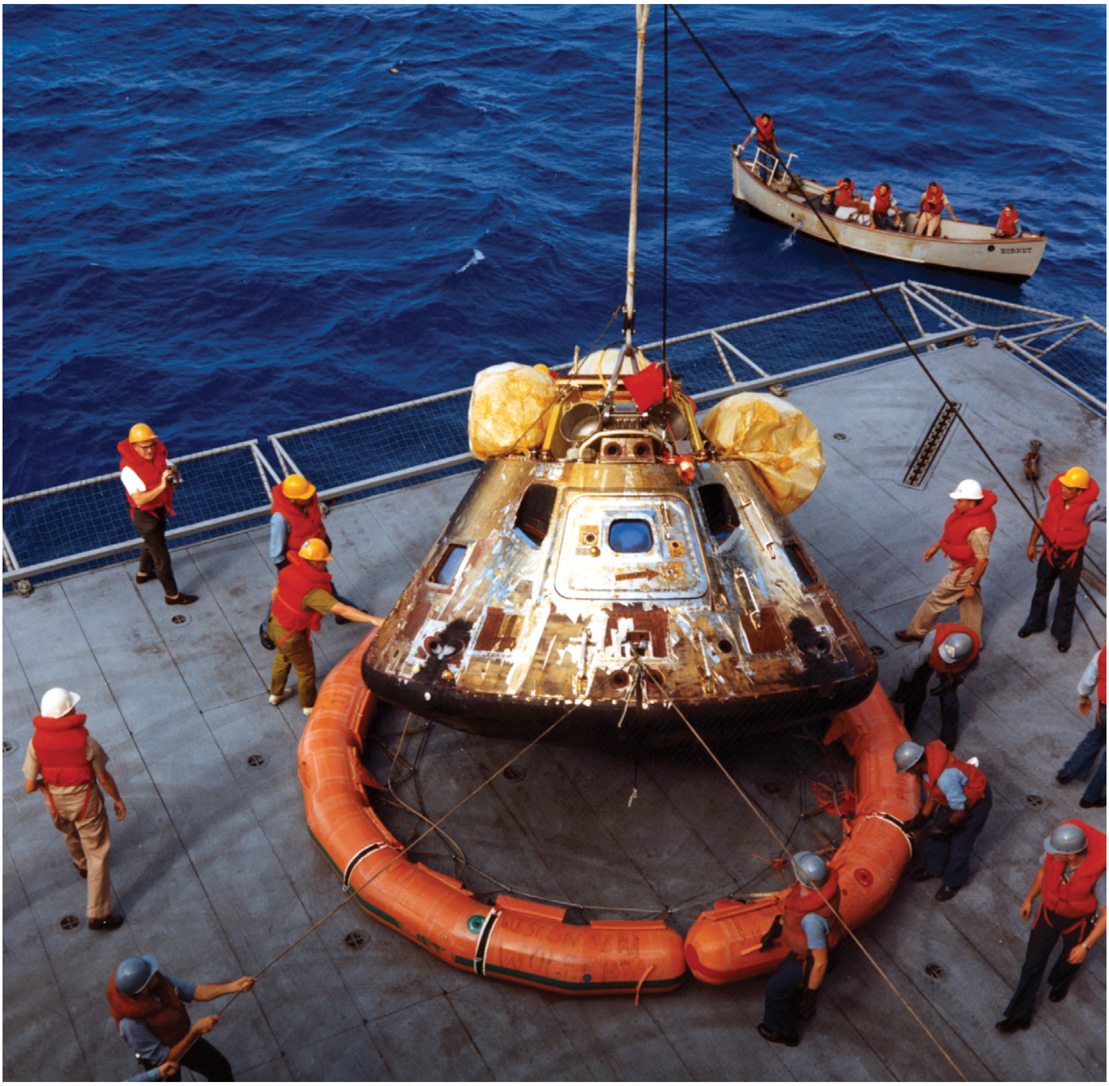

Figure 1. Apollo 11 spacecraft command module *Columbia*, hoisted aboard U.S.S. *Hornet* on 24 July 1969. NASA Photo ID: S69-21294.

The early history of these negotiations, and the influence of national and international expositions on their outcome and implementation, suggest contested and evolving perceptions about what afforded space artifacts "historic significance" as well as what institutional and professional resources such significance demanded.

Before Apollo

The potential for space program artifacts to support domestic and international public relations and propaganda efforts was recognized in the United States even before the creation of a civilian space agency in 1958. President Eisenhower had created the United States Information Agency (USIA) in 1953 to promote American interests abroad through various communications media, including exhibitions. Following the launch of *Sputnik* in 1957, the need for special public information guidelines—and the USIA's need for "space exhibit material" to counter Soviet touting of its own space accomplishments—was recognized. Publicizing American achievements in space became an important aspect of USIA exhibits and thus part of the ongoing Cold War competition for the hearts and minds of international audiences. NASA officials recognized the essential Cold War aspects and functions of the new agency and considered foreign relations and propaganda agencies of the United States as important constituents. Once NASA began to launch and recover animals, and then humans, from space, agency and U.S. State Department officials understood that flown spacecraft would be particularly useful as propaganda assets.[1]

From the beginning, domestic public relations were also important to the space agency.[2] Congressman and senators who had to vote on NASA budgets and programs were often quite anxious to have expert presentations made to their constituents and displays of the artifacts of spaceflight at local museums and other venues. As both sets of demands grew, NASA came under increasing internal pressure—pressure that placed escalating burdens, managerial and budgetary, upon the agency.

Enter Smithsonian

Long before the advent of spaceflight, the Smithsonian Institution was associated with aviation, first as a research institution and then as a venue for historic preservation and public display. During the 1930s a section within the Smithsonian National Museum's Division of Engineering and Technology displayed important aviation artifacts, including Charles Lindbergh's *Spirit of St. Louis*, in both the National Museum building (since renamed the Arts and Industries Building) and in the temporary World War I–era Aircraft Building (better known as the "tin shed") located behind Smithsonian's ornate headquarters "Castle" building (Figure 2).

The establishment of a National Air Museum (NAM) in 1946 as an organization, but at that time without a dedicated permanent building, was in anticipation of obtaining aviation artifacts from the military as it demobilized after World War II. Smithsonian curators associated with NAM mixed appreciation of patriotic and symbolic definitions of historical significance with a more narrowly focused fascination with technological and engineering developments.[3] For both reasons, with the advent of the Space Age a bit more than a decade later, curators and administrators at NAM pressed for the expansion of its subject matter to include collecting and display of artifacts related to spaceflight.[4]

In September 1959 (more than a year and a half before America would launch its first Project Mercury astronaut into space), Philip Hopkins, NAM director since October 1957, wrote to John Victory, special assistant to T. Keith Glennan, the first NASA administrator. "In building our collections," he wrote, "we must look ahead so I am taking this opportunity of making an official request for the transfer to the National Air Museum of the Mercury capsule as soon as possible after he [the astronaut] returns from his trip into space."[5] The response came from Administrator Glennan himself. Interestingly, Glennan introduced a rather stringent interpretation of what it was that would make a Mercury capsule "historic." "Your letter of September 21, . . . has been

Figure 2. View from Independence Avenue of the "tin shed" circa 1935. Smithsonian National Air and Space Museum (NASM 2003-6592).

forwarded to me. I assume," he replied, ". . . you mean that you wish for exhibition purposes the first Mercury capsule recovered after a successful *manned orbital flight*. . . . Your request will be kept in mind and in the meantime, let me assure you that your interest in the matter is appreciated. At this time, we are disposed to act favorably upon your request as soon as it may become practicable in the public interest to do so."[6]

Glennan's specification of an orbital mission rather than a lesser accomplishment, such as the preliminary suborbital "hop" that the Americans planned as the first crewed mission, suggests that he viewed orbiting the Earth as analogous to Lindbergh's 1927 solo Atlantic crossing, an event that exemplified historical significance. Glennan neither imagined nor anticipated the events that soon would afford the initial suborbital mission substantial national and geopolitical significance, if not status as a momentous historic first.[7]

At about the same time Glennan was responding to the NAM director, Smithsonian Secretary Leonard Carmichael was writing personally to Glennan offering decidedly less iconic Smithsonian artifacts to NASA as a means of establishing an appreciation within the new agency of its technical and institutional heritage. Carmichael proposed a small exhibition of aviation artifacts at the NASA Langley Research Center, a research facility inherited by the new agency from its predecessor, the National Advisory Committee for Aeronautics (NACA). The center, often referred to as "Langley," was named after the American aeronautical pioneer and third secretary of the Smithsonian Institution (1887–1906) Samuel Pierpont Langley. Smithsonian Secretary Carmichael (1953–1964) stated in his letter that "It would please us thus to record the relationship between the historic work of Secretary Langley [even though he had been *unsuccessful* in his attempt to demonstrate the possibility of controlled powered human flight] to that performed [by NASA] at the Langley Research Center." For Carmichael, what made the items historic was not the event represented but the inventive process that was illustrated.[8]

Several months later, Carmichael followed up his letter with another, but instead of offering items to display, he directly restated Hopkins' earlier statement about Smithsonian Institution's interest in formally becoming a repository for "historic" space artifacts. "My purpose in writing this letter," Secretary Carmichael avowed, "is to offer the services and facilities of the National Air Museum to the National Aeronautics and Space Administration for the collection, preservation and display of significant historic items in the field of your agency. Thus, can the historic accomplishments of your great organization be preserved and made available for the inspiration and education of the millions of visitors who annually come to the Smithsonian." The letter suggests that, for Carmichael, "historic" signified considerably more than propaganda value or iconic firsts. Instead, he expanded upon what he felt was the Smithsonian's mandate. "We consider that the development of aviation is the story of manmade flight. This is centered around flight vehicles, propulsion, aerodynamics, systems, and controls. Today, of course, the speed and the range of flight craft have been extended in a tremendous way, creating new uses and broadening the concepts of flight even beyond the Earth's atmosphere and gravitational influence." Carmichael indicated that the Smithsonian was planning to add the word *space* to the National Air Museum's title. He wanted Glennan to know that in his mind the NAM's mission was to document and tell—when possible, through artifacts—the "story" of man-made flight in and out of the Earth's atmosphere. The story was as much about how as about when and by whom.[9]

Glennan took this opportunity to reiterate that he accepted, at least in some sense, Carmichael's assertion that historic preservation of national accomplishments was the responsibility of the Smithsonian. "We will, of course be happy to work with you and we look forward to the completion of your Air Museum. In the interim we will expect to cooperate with you to ensure the proper preservation of our record and the carrying out of your full responsibility."[10]

The completion referred to by Glennan was of a new museum building on the National Mall, one then being actively promoted by the Smithsonian and within the U.S. Congress. His response, however, should neither be taken to mean that NASA slavishly prioritized the Smithsonian's interpretation of its mandate for historic preservation and storytelling over NASA's own mission requirements and interpretation of significance, nor that a precise understanding had been reached on criteria for selecting which of the items in NASA's possession were best suited to tell the story of human flight.

Eugene Emme, soon to be appointed the first NASA historian, was not at all enthusiastic about relinquishing responsibility for the preservation and display of historic artifacts. Responding to an earlier memo from the NASA public affairs office regarding NASA's own "museum" functions, Emme insisted that NASA itself had such responsibilities and that those responsibilities should be explicitly set forth in NASA's own "historical mission statement," which he was in the process of developing.[11]

Smithsonian's interests, like NASA's, extended beyond historic preservation to public education. During the short-term, the NAM director wrote to Eugene Emme in October 1960 seeking NASA's assistance in acquiring an accurate scale model of the planned Mercury spacecraft, possibly from the capsule's manufacturer. Such a model " . . . would make the most attractive, timely, and interesting display and we hope that NASA will be able to supply [one] . . . at the earliest possible time." Several months later, arrangements were made with the McDonnell Corporation, the manufacturer of the Mercury spacecraft, for the private company to donate a quarter-scale model for public display.[12]

That same month NASA began to put in place mechanisms to identify historic artifacts at its own facilities. As requested by the Smithsonian, these included physical items directly associated with specific events as well as items that might serve to document or illustrate details of the agency's technical accomplishments. The need to favorably respond to the many external requests from regional museums and educational institutions for recognizable display items also remained important.[13]

The Space Race Engaged

Significantly, 1960 was a presidential election year in the United States. Like many federal agencies, NASA followed the campaign closely in anticipation that its result might lead to added, or at least different, pressures on the organization. Little did its leaders imagine the extent to which that would prove true. Soon after the January 1961 inauguration of John Fitzgerald Kennedy, the new president championed human spaceflight and it assumed enormously enhanced importance as a symbol of national accomplishment. On 21 April 1961, Yuri Gagarin orbited the Earth in a Soviet Vostok spacecraft, thereby becoming the first human in space as well as the first human to orbit the Earth. On 25 May, Alan Shepard became the first American in space by completing the long-planned, 15-minute "hop" from the U.S. launch facility at Cape Canaveral, Florida, into the Atlantic Ocean. Shortly thereafter President Kennedy asked the U.S. Congress to support an urgent program (eventually named Apollo) that aimed at overtaking the Soviet Union in space accomplishments and set as its stated goal: "landing a man on the Moon and returning him safely to the Earth." The intense public interest generated by those events helped to bolster the Smithsonian's earlier request to acquire the first Mercury spacecraft to return an American astronaut from space. The mission, referred to by NASA as MR-3 (Mercury-Redstone 3), did not match the orbital accomplishment of the Soviet Union, yet it garnered a great deal of public attention. MR-3 marked United States' entrance into the human spaceflight business, even if it did not convincingly represent a Lindbergh-like "first."

Despite the Smithsonian Institution's request, NASA agreed to first permit the USIA to display astronaut Alan Shepard's spacecraft—one he named *Freedom* 7—in Europe following its recovery. Even though its accomplishment did not match that of the Gagarin spacecraft, USIA's interest in exhibiting *Freedom* 7, much as the Smithsonian's, suggests multiple considerations. Significantly, the artifact itself conveyed a desired emphasis on what National Air and Space Museum (NASM) curator Teasel Muir-Harmony has labeled "technocratic rationalism" over simple association with a specific personality or event. The belief was that the public display of actual hardware and equipment emphasized the openness and competence of American engineering, science, and management in contrast to Soviet secrecy on virtually all the technical details of the launch vehicle and spacecraft it used to beat the competition.[14]

Loan Versus Transfer

Smithsonian leadership appreciated the reasons for NASA's decision to send *Freedom* 7 to Europe, if not the stress the planned tour might place on the artifact. So, when informed of NASA's decision, NAM curator Ken Newland turned his attention to lobbying NASA and his own superiors to request the transfer of the spacecraft to the Smithsonian immediately following its return.[15] James Webb, President Kennedy's choice as the new NASA administrator, responded directly to Secretary Carmichael. "Your interest in obtaining the MR-3 (*Freedom* 7) capsule and Cmdr. Shepard's spacesuit for historical preservation and display in the Smithsonian is most understandable," he wrote. "We concur in the desirability of these important national historical artifacts being placed on display in the principal historical Museum of the nation's capital. When the capsule is returned from Europe in the latter part of June, it will be taken to the Langley Research Center for preparation for showing by the Smithsonian *on an indefinite loan basis*."[16] That summer *Freedom* 7 was displayed behind the Smithsonian Castle, in the Aircraft Building, just off the National Mall.

In February 1962, following John Glenn's successful three-orbit Mercury Atlas 6 (MA-6) flight, Smithsonian's Acting Secretary Remington Kellogg wrote to Administrator Webb requesting that Glenn's Mercury spacecraft, one he had named *Friendship* 7, also be made available to the Smithsonian "for preservation and display." Echoing the comments Glennan had made years before, Kellogg stated, "We consider this first manned orbital space vehicle to be of tremendous historical significance and of great inspirational and scientific value to our millions of visitors each year. It would be a fitting companion specimen to '*Freedom* 7.'"[17]

But, much as had occurred with Shepard's capsule, *Friendship* 7 was first assigned to the USIA. NASA agreed to allow the Air Force and USIA to send *Friendship* 7 on a "fourth orbit" of the Earth, a world tour to nearly 30 cities around the globe. Upon its return, it was displayed for several weeks within the U.S. pavilion at the 1962 world's fair in Seattle before it was provided to the Smithsonian.[18] In that way NASA was able to promote its own accomplishments while interest in those accomplishments was at its peak and assure continued public access afterward without additional agency expenditures.

Smithsonian curators were disappointed with the delay, having already made plans to augment their popular display of *Freedom* 7 with the spacecraft that carried the first American into orbit. This time they chose to voice their concerns explicitly, especially emphasizing the need for preservation. Hopkins cautioned the space agency and asked that extraordinary means be taken to protect the artifact prior to the time it might be displayed at the Smithsonian. "We can appreciate the educational and prestige value of such a tour," he wrote, but "may we respectfully offer a word of caution . . . concerning the management of the capsule while on tour. This spacecraft is an original, irreplaceable, priceless relic of history," Hopkins reminded Shelby Thompson, NASA's public affairs officer. "We classify it in the same category of historical significance as the Wright Brothers planes." The NAM director was especially concerned that the spacecraft be covered with a "clear plastic cover" to prevent the public from damaging it and, even more important, to restrict access to its internal instruments and components. He pointed out the "great hazard posed by 'souvenir hunters'" and noted that "great care should be exercised in properly guarding its security at all times." Indicative of the Smithsonian goal to become the capsule's permanent American home following its short-term exhibition commitment, Hopkins continued: "May I suggest that as further precaution you consider replacing many of the delicate instruments (clocks, cameras, etc.) with duplicate substitutes for the tour—sending the originals to us for safekeeping until the capsule comes to us for permanent display. We can then replace them and thus ensure its authenticity and the security of these parts against damage."[19]

The public affairs officer at NASA assigned to coordinate the *Friendship* 7 world tour (Figure 3), Hiden Cox, perhaps revealing some underlying annoyance that the Smithsonian felt that its concerns for authenticity applied only to when the artifact was displayed at the Smithsonian and not while on tour abroad or at another venue, immediately forwarded Philip Johnson's letter to Edward R. Murrow, who at that time was serving as USIA director. "The enclosed letter from Philip Hopkins at the Smithsonian," Cox wrote, "is self explanatory. We certainly endorse his view of the MA6 capsule as a priceless historical object requiring the very best of care. We know you are equally aware of the importance of the capsule, and this letter is forwarded simply as a matter of record, and to reinforce your own views on the subject."[20]

To be clear, Philip Hopkins was concerned not only with preservation and authenticity. He was also quite concerned with maintaining Washington, D.C., as a prime location for such popular public attractions. In May 1962, shortly after the exchange with NASA, Hopkins wrote to Smithsonian Secretary Carmichael pointing out the unsuitability of NASA's insistence that the Mercury spacecraft it provided be placed "on loan" rather than transferred. He wanted both *Freedom* 7 and *Friendship* 7 to be "transferred" to the Smithsonian. "I suggest further," he wrote, "that the transfers include the provision that the specimens are not to be exhibited other than in the Smithsonian Institution." His reasoning was that only this "would deter persistent 'would be' borrowers, who might learn of the 'loan' basis to us, from going back to NASA with their case. And it would provide us with the binding obligation (in addition to our sound policy reasons) to say 'no' to potential borrowers."[21]

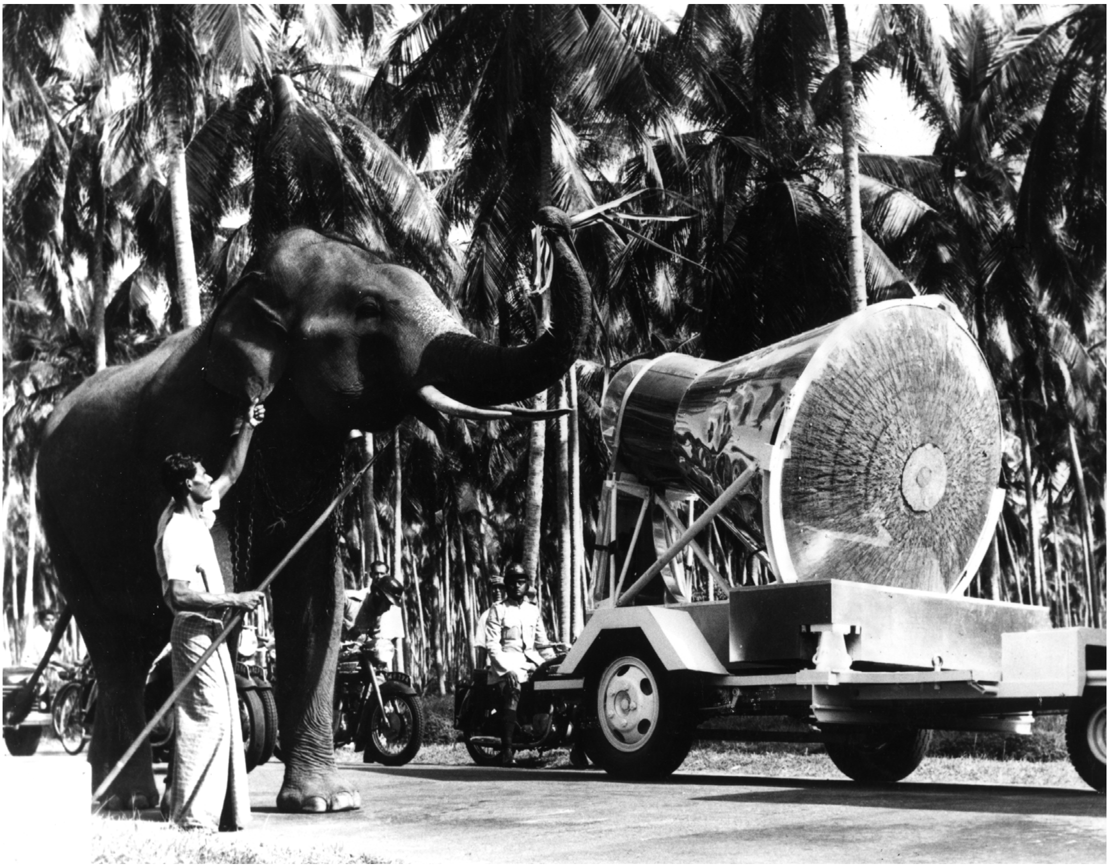

Figure 3. *Friendship* 7, with its plexiglass cover, in Sri Lanka July 1962. Smithsonian National Air and Space Museum (NASM 7B21889).

Several weeks following Hopkins's memo to Carmichael, internal NASA documents indicate that they had considered a Smithsonian request to "transfer" the two Mercury spacecraft and, at least at the time, that they rejected it. NASA Director of Spaceflight Programs Abe Silverstein received a policy recommendation on 22 June 1962 from the NASA General Counsel's office advocating that the loan policy be continued until "such time as it is clear that NASA has no further need for the spacecraft."[22]

Budgets, Missions, and the Establishment of a National Collection

It was the Apollo program that would alter the situation and resolve much of the conflict and ambiguity that plagued the early assignment of responsibility for the public display and historic preservation of spacecraft and other space artifacts. In February 1964, with the beginning of Gemini (the two-astronaut spacecraft program conceived as an intermediate step between the Mercury and Apollo programs) and progress developing equipment for the planned Apollo launches, the leadership in NASA began to discuss problems they faced responding to an increasing number of requests for the loan of spaceflight artifacts. "As a result of the large number of existing requests," wrote Deputy Director Hugh Dryden in a memo to Silverstein, "Mr. Webb and I have concluded that a committee be formed to develop a policy which would establish criteria for the final disposition of those items now on hand or which would become available in the future."[23]

The formation of the committee served as a catalyst for future action. As Julian Scheer, head of the NASA Public Relations Office and executive secretary of the artifacts committee, informed newly appointed NASA Assistant Deputy Administrator Willis Shapley, "there is a very large need for such a committee in NASA or, at least, a device such as this to handle the various questions of artifacts." He reported further that his office had established "an agency wide reporting system which enabled us to compile an inventory of all artifacts."[24] Eugene Emme had previously prepared a memo making a strong case that NASA itself had considerable interest in historic objects for display at its own centers and in the communities within which they operated. Emme stated that as a component of the development of a robust history program at NASA, his intention was to "prepare a proposal to the [NASA] artifacts committee for documenting the history of NASA and its predecessors with very select artifacts."[25] Emme, along with the leadership of NASA, believed the agency had been charged to "make history" and that therefore historical documentation was part of its mission. By the end of 1965, Webb agreed that Scheer should work with Jack Young of the NASA Office of Administration to develop specific procedures for the agency to follow with regard to the preservation and display of artifacts.[26]

Five months later, given the increasing expense of the Vietnamese conflict and increasingly difficult negotiations over its own annual budget, NASA was forced to look for places to reduce agency expenses. "Museum functions" were one possibility. In May, Webb addressed the issue in a memo to Scheer. On the question of whether NASA should set up its own museums at its various centers, he suggested discussing with the Smithsonian NAM Director Paul Johnson the possibility "of having all or most of our artifacts placed in the hands of the Smithsonian, with an obligation on the part of the Smithsonian to satisfy as best they can legitimate needs for the use of these artifacts for national or other historic or exhibition purposes." Webb sought advice on "the relative merits of doing the job ourselves" or whether they should rely on an external institution, "perhaps the Smithsonian," which would be required to "loan them back to NASA when necessary for certain periods of time."[27] "Museum functions" were distinguished, at least to some extent, from the agency's "historic mission" and the resources required to accomplish it.[28]

That it was the Smithsonian option that was decided upon became apparent when six months later Julian Scheer reported that "my office is currently identifying and locating artifacts such as Mercury and Gemini spacecraft which will make up the principal part of . . . [initial] transfers to the Smithsonian." He also reported that he was in the midst of preparing a formal "management instruction" outlining how NASA centers should continue to report the existence of artifacts deemed historic to the headquarters office of Public Affairs and the procedures they are developing for transferring them.[29]

The ultimate formal agreement, which came to be known as the NASA–NASM agreement, was signed by Paul Johnson for NASM, S. Dillon Ripley for the Smithsonian, and James Webb for NASA on 10 March 1967. It contains the following statements:

> WHEREAS [NASA-created artifacts] are unique specimens relating to the science and technology of aeronautics and astronautics, and of flight in the atmosphere and space, which may consist of aeronautical and astronautical objects including, but not limited to, aircraft, space launch vehicles, spacecraft (both manned and unmanned), subsystems of the above, such as rocket engines, pressure suits and personal equipment, instruments, significant recorded data, operating handbooks, drawings, photographs, motion picture film and related documents, sound tapes, training devices, simulators, and memorabilia; and
>
> WHEREAS the Smithsonian Institution is charged with the responsibility of memorializing the national development of aviation and space flight; to collect, preserve, and display aeronautical and space flight equipment of historical and educational interest and significance; to serve as a repository for scientific equipment and data pertaining to the development of aviation and space flight; and to provide educational material for the historical study of aviation and space flight. . . .
>
> . . . the National Aeronautics and Space Administration (hereafter called "NASA") and the Smithsonian Institution (hereafter called "Smithsonian") enter into this Agreement concerning the custody and management of those artifacts having such historical and educational or other value which have emerged and which will emerge from the aeronautical and space programs administered by NASA.[30]

As for the procedures, NASA agreed to transfer artifacts to the Smithsonian "after technical utility to NASA or other governmental agencies has been exhausted and post flight examination has been effected." The National Air and Space Museum agreed to "accept responsibility for the custody, protection, preservation, and display of such artifacts both in the Museum and upon loan to NASA Headquarters, NASA Field Centers, other Federal agencies, museums, and other appropriate organizations." Provision was made for a special NASA–NASM committee "to make curatorial decisions" and to assure "continuing liaison . . . between the Administrator of NASA or his designee and the Director, National Air and Space Museum or his designee." NASA maintained its right to consider short-term requirements of its own centers and other agencies of the federal government, but it largely relegated to the Smithsonian longer-term responsibility for historical preservation and interpretation.

The process of establishing the procedures for identifying, transferring, storing, and displaying historic space objects was complex and time-consuming. Establishing a program for receiving and executing loan agreements with external organizations taxed the still small NASM curatorial and administrative staffs. At the same time, and for the next several years, the financing and planning of the new museum building on the National Mall remained subjects of sometimes bitter disputes between supporters, Congress, and Smithsonian administration.

Money was scarce, largely due to military expenditures associated with the war in Vietnam, and museum advocates associated with aviation and the military feared the Smithsonian's priorities lay elsewhere.[31]

Nevertheless, responsibility at NASM for implementing the NASA–NASM agreement fell to Fredrick C. Durant, NASM's first assistant director for astronautics. The primary point of contact at NASA was Public Affairs Officer Brian Duff. Inventories of artifacts appropriate for transfer had to be assembled, and those currently in the possession of NASA centers or other museums (such as the North Carolina Museum of Life and Science and the Fort Worth Museum of Science and History) had to be placed under the terms of newly negotiated loan agreements.[32] In June 1967, Durant requested from Duff "your file of outstanding requests for exhibitor spacecraft and details of loan agreements made with USIA, etc. for spacecraft currently being exhibited." He added that "quite a number of requests have been arriving at this office."[33]

The intense interest in displaying the objects abroad and throughout the United States had a direct impact on the scope and content of NASM's collection. Most important, it encouraged NASM to accept far more objects than it could possibly display in Washington, D.C. The process of developing the criteria for designating objects as historic was, therefore, gradual and ongoing.[34]

Osaka Expo 1970, the 50-State Tour, and the Regularization of Artifact Transfers

In July 1968, USIA Director Leonard Marks informed Webb that the United States had accepted an offer to prepare one of three major exhibitions at an international world exposition planned for Osaka, Japan, in 1970 (the Soviet Union and Japan would prepare the other two). With the $10 million appropriation from Congress, USIA planners fantasized about possibly erecting an entire 365-foot-high Saturn V launch vehicle as part of its exhibit. Even though NASA was unable to even consider that possibility, following the successful missions of the three-man spacecraft *Apollo* 7 to orbit Earth that October and the dramatic Christmastime mission of the *Apollo 8* craft to orbit the moon, pressure only increased for the preparation of a spectacular display in Japan. In Marks's words, "The Osaka world exposition presents us with an unprecedented opportunity of showing the brilliant accomplishments of this country's manned space program to the people of Japan, Asia, and the world."[35]

The commitment to the Osaka '70 Expo had implications for the simultaneous attempt to regularize the NASA–NASM agreement. Jack Masey, the USIA exhibit designer who was acting as the State Department's Deputy Commissioner General for Planning and Design, requested that NASA provide the U.S. pavilion with the right to first refusal for the display in Japan of artifacts related to the U.S. space program. With respect to objects already transferred to the Smithsonian, Masey wrote to NASA: "We assume that requests for pre-Apollo space program hardware would be referred to the Smithsonian National Air and Space Museum." NASM and Smithsonian officials recognized that they were more than obliged to cooperate.

In Masey's view, one of the best alternatives to a complete Saturn V launch vehicle would be a display of an unflown—but flight-capable—lunar module, the spacecraft NASA officials hoped would soon land astronauts on the moon. Masey was aware that no flown lunar modules could be returned to Earth. Writing to a colleague as early as April 1969, Masey suggested that "U.S.I.A. should immediately investigate the possibilities of acquiring a *real* [unflown] LM [lunar module] with all of its wrappings for showing in Japan."[36]

As the first planned lunar landing approached in the summer of 1969, excitement over the inclusion of space artifacts at the U.S. pavilion in Osaka only increased. A primary interest was the possibility that the command module *Columbia* from Apollo 11 might become a centerpiece for the exposition in Japan. Although the Smithsonian was anxious to acquire *Columbia* to display in Washington, D.C., given its prior experience with *Friendship* 7, Secretary Ripley, at least, assumed that Japan's world's fair would be given priority.[37]

Several weeks after the successful return of the Apollo 11 astronauts from the moon, however, NASA informed Masey that the agency had decided to assign *Columbia* to a planned 50-state tour of U.S. state capitals, making its display at the Osaka Expo impossible. Tailored as a response to the intense pride and curiosity Americans expressed about the Apollo 11 accomplishment, the tour was labeled "from space to grassroots America" in a press kit provided to journalists. The command module, Neil Armstrong's lunar spacesuit, a small "moon rock," and a few small objects that had traveled to the moon were mounted in a specially configured mobile van. The tour began in Sacramento, California, in April 1970, and ended in Alaska in May 1971. More than 3 million Americans waited in long lines to personally witness the spacecraft and spacesuit that had enabled their countrymen to walk on the moon (Figure 4).[38]

Although disappointed, Masey recognized that the proposed plan was an attractive one for NASA. He was willing to accept the decision as long as a significant fraction of alternate items from an extremely long list could still be provided to the Osaka exhibition by either NASA or the Smithsonian.[39] In early September, Scheer wrote Masey, responding to his interest in obtaining a wide variety of flown items that returned to Earth on *Columbia*: "we are in the process of transferring on paper all of the Apollo 11 hardware," he explained "with the exception of certain 'visible' items, which we will be using here in this country on our State Capital Tour. We have, however, asked for and received assurance from the Smithsonian that they will provide USIA with the actual Apollo 11 flight hardware you requested for Expo '70. After the transfer, these items will remain at our Manned Spacecraft Center in Houston, where your people can assemble and ship them, along with other components, to Japan."[40]

Scheer also responded to Masey's request for a substitute command module and a lunar module for display in Japan. He suggested that *Apollo* 8's command module might be available from the Smithsonian. As for an unflown lunar module, Scheer was aware that none had yet been declared surplus to mission requirements and informed Masey that LM-2, a module whose scheduled flight had been canceled and had subsequently been used for ground testing, might shortly become available as a display item. Probably not a simple coincidence, a week later, Fred

Figure 4. Crowds around the mobile 50-state tour exhibition in Jefferson City, Missouri, in 1970. Gerald Massie Photograph Collections MS192_044_006, Missouri State Archives.

Durant prepared a letter to NASA requesting the transfer of LM-2 to the Smithsonian. As it turned out, one-half of LM-2 (the ascent stage) was mounted on top of a test version of the lower half for display in Japan. Upon its return, the complete LM-2 was reassembled by NASA and technicians from Grumman Corporation, its manufacturer, for transfer to NASM and display in the Smithsonian's Arts and Industries Building.[41]

At about the same time LM-2 disposition arrangements were being made, the Apollo 11 astronauts personally took part in their own triumphant world tour. The tour began in New York City with a tickertape parade and ended on 5 November at the White House. An overseas portion, dubbed the "Giant Leap" goodwill tour, began on 29 September with an entourage consisting of the astronauts and their wives together with NASA, U.S. State Department, USIA, and security personnel. The tour visited 24 cities in 23 countries, placing the astronauts in person or on local media in front of an estimated 100 million people.[42]

With the astronauts back in the United States, the items flown on Apollo 11 were formally "deemed excess to the technical needs of the center . . . and . . . available for immediate release to the Smithsonian Institute [*sic*]." Chuck Biggs, who had been assigned responsibility for artifact transfers at the manned spaceflight center in Houston, added that "immediate attention is necessary to allow various listed items to be utilized at Expo 70, Japan."[43] On 27 January 1970, a formal memorandum from NASA's public affairs officer, Wade St. Clair, transferred "all items, which have served the technical requirements of NASA, listed on the attached form . . . , to the Smithsonian."[44]

Four months after the astronauts returned from their world tour, NASA initiated the announced 50-state tour. When this tour was completed, NASA delivered *Columbia* to the Arts and Industries Building for display alongside LM-2, which Grumman technicians had mocked up to resemble LM-5, also known as *Eagle*, the lunar module that had taken Armstrong and Aldrin to the lunar surface. Beginning in December 1969, most of the remaining flown items were transferred in several batches.

Conclusion

When the National Air and Space Museum finally moved into its flagship building on the National Mall in 1976, *Columbia,* LM-2, and more than 250 additional Apollo artifacts were placed on display at central locations on the first floor or in a second-floor gallery entitled "Apollo to the Moon." Since then, NASM's Apollo collection has grown to include more than 3,600 artifacts.[45] NASM has established a robust loan program to NASA centers as well as public and private museums in virtually every U.S. state. The NASA–NASM artifacts committee continues to adjudicate occasional issues that arise with regard to NASA interests in artifacts that have been transferred to the Smithsonian or identified by the museum as appropriate for historic preservation.

Today, preservation, responding to requests from government agencies, and providing access to other museums is NASM's responsibility rather than NASA's. NASM is also responsible for defining what makes an artifact historic and worthy of the resources required for preservation, storage, display, or loan. The NASA–NASM agreement isolated such decisions, at least somewhat, from the demands placed by the original mission-oriented, technical organization and from government agencies that placed emphasis on furthering American national or geopolitical interests. Technical and political interests continued to matter, however; past and continuing requirements of NASA and government information agencies remain important considerations for NASM curators and other decision makers, although with significantly greater emphasis on preservation issues and on collecting examples of specific technical developments.

More complex issues involving the criteria for determining what items should be included in the Smithsonian collection have received attention in the years since the adoption of the NASA–NASM agreement. The NASM Division of Space History "Collections Rationale," a formal document that has been reviewed and revised periodically since at least 1991, recognizes that "increasingly the determination of objects' significance and appropriateness for the collection is based upon [further] judgments of how well they illustrate technological innovation, political and programmatic decisions, manufacturing techniques, organization and management schemes, and social and cultural resonances."[46]

The collection's foundation, however, remains those items selected in the 1960s and 1970s by NASA, the USIA, and the Smithsonian for display. The "Collections Rationale" in use at the time of the collection's establishment states that decision makers "placed greatest value on those objects flown in space or artifacts that remained as close to pristine as possible, objects that could provide visual details to that which visitors had seen, heard or read about in well-circulated media accounts." The current version, by comparison, states that, when NASM began collecting human spaceflight artifacts, "the primary objective was to collect those objects that were most suitable for exhibits dedicated to the who and what of recent human spaceflight exploits." The most prominent of those early exhibits were the 1970 world Expo in Osaka and the 50-state tour of Apollo 11's command module *Columbia*.

A need to augment such considerations, first with the desire to more closely document specific examples of technological innovation, and subsequently with considerations of social, cultural, and economic implications, is also expressed in the rationale. One approach has been to augment the collection with specific social and cultural artifacts (space toys, posters, memorabilia, collectables, and the like). Another has been to broaden the documentation and interpretation of the core items in the collection (in scholarly publications and exhibitions) to include technical, political, economic, social, and cultural contexts. Judgments and perspectives of historical significance expressed or implied by previous custodians along with changing ideas about what constitutes technological innovation and its implications have expanded and become fertile—if even sometimes controversial—areas for scholarly analysis.[47] Challenges remain, especially given that the fiftieth anniversary of the flight of Apollo 11 in 2019 is certain to generate a wide range of interest and attention, both similar to and quite different from the interest and attention of the 1970s.

Notes

1. For the elevation of communications as a central component of "political warfare" during the Cold War, see A. Needell, "'Truth is Our Weapon': Project TROY, Political Warfare, and Government-Academic Relations in the National Security State," *Diplomatic History* 17, no. 3 (Summer 1993): 399–420; Benno Nietzel, "Propaganda, Psychological Warfare and Communication Research in the USA and the Soviet Union During the Cold War," *History of the Human Sciences* 29, no. 4–5 (2016): 59–76. On the importance of space exhibitions after 1957, see minutes dated 16 October 1958 from the "5th Meeting, 15 October 1958, Operations Coordinating Board Working Group on Outer Space," documents relating to the space program, 1953–1962 (duplicate copies), box 1, DDE Library; Notes provided by Ron Doel.
2. D. Meerman Scott and R. Jurek, *Marketing the Moon: The Selling of the Apollo Lunar Program* (Cambridge, Massachusetts: MIT Press, 2014).
3. A. P. Molella, "The Museum That Might Have Been: The Smithsonian's National Museum of Engineering and Industry," *Technology and Culture* 32, no. 2, part 1 (1991): 237–263.
4. M. Neufeld and A. Spencer, eds., *The National Air and Space Museum an Autobiography* (Washington, D.C.: National Geographic, 2010), 203–204.
5. Philip Hopkins to John Victory, 21 September 1959, NASM Registrar accession file 001264, Washington D.C.
6. T. Keith Glennan to Philip Hopkins, 29 October 1959, NASM Registrar accession file 001264, Washington D.C. [emphasis added]
7. See below.
8. Leonard Carmichael to Glennan, 29 October 1959, Smithsonian Institution Archives, unit 50, box 258, folder NASA 1959. [emphasis and clarifications in square brackets added].
9. Carmichael to Glennan, 3 February 1960, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C. On Smithsonian curators' adherence to a "study series" collecting approach emphasizing "basic facts and accurate chronology," see Molella, "The Museum That Might Have Been," 245, n17.
10. Glennan to Carmichael, 12 February 1960, Smithsonian Institution Archives, unit 306, box 15, folder 9.
11. Eugene Emme to Shelby Thompson, Memorandum dated 30 August 1960, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C. On the origins and role of the NASA History Office see R. D. Launius, "NASA History and the Challenge of Keeping the Contemporary Past," *The Public Historian* 21, no. 3 (1999), 63–81.
12. Philip Hopkins to Eugene Emme, 21 October 1960, and Emme to Hopkins, 22 December 1960, NASM Registrar accession file 001264.

13. Shelby Thompson to Distribution, Memorandum, 17 October 1960, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
14. T. Muir-Harmony, "Selling Space Capsules, Moon Rocks, and America. Spaceflight in U.S. Public Diplomacy, 1961–1979," in *Reasserting America in the 1970s: U.S. Public Diplomacy and the Rebuilding of America's Image Abroad*, ed. H. Notaker, G. Scott-Smith and D. J. Snyder (Manchester, UK: Manchester University Press, 2016), 128.
15. Kenneth Newland to Eugene Emme, 7 June 1961, NASM Registrar accession file 001264.
16. James E. Webb to Leonard Carmichael, 22 June 1961, James E. Webb Papers, box 30, folder "Chronological File: February 1961 to July 1961," Harry S. Truman Library and Museum, Independence, Mo. [emphasis added].
17. Remington A. Kellogg to James E. Webb, 23 February 1962, NASM Registrar accession file 001794.
18. T. Muir Harmony, "*Friendship* 7's 'Fourth Orbit'," National Air and Space Museum, Smithsonian Institution, 16 February 2012, https://airandspace.si.edu/stories/editorial/friendship-7%E2%80%99s-%E2%80%98fourth-orbit%E2%80%99 (accessed 17 December 2016); Hiden Cox to James Webb, 13 March 1962, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
19. Philip Hopkins to Shelby Thompson, 10 April 1962, NASM Registrar accession file 001794.
20. Hiden Cox to Edward R. Murrow, 19 April 1962, copy in NASM Registrar accession file 001794.
21. Hopkins to Carmichael, 4 May 1962, NASM Registrar accession file 001794.
22. Holzman, NASA General Counsel to Dir., NASA OEPS, Memorandum dated 22 June 1962, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
23. Hugh L. Dryden to Abe Silverstein, 20 February 1964, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
24. Julian Scheer to Willis Shapley, memorandum, 16 December 1965, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
25. Eugene Emme to Julian Scheer, 29 April 1964, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
26. Lawrence Vogel to Julian Scheer, 22 December 1965, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
27. James Webb to Julian Scheer, 4 May 1966, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
28. Launius, "NASA History and the Contemporary Past," 63–81.
29. Julian Scheer to James Webb, memorandum dated 1 March 1967, NASA History Office file 14131, NASA Historical Reference Collection, NASA Headquarters, Washington, D.C.
30. "Agreement Between the National Aeronautics and Space Administration and the Smithsonian Institution Concerning the Custody and Management of NASA Historical Artifacts," box 1, Smithsonian Institution Archives, Record Unit 346, National Air and Space Museum, Office of the Deputy Director, NASM Files.
31. M. Neufeld and A. Spencer, eds., *Smithsonian National Air and Space Museum: An Autobiography* (National Geographic, 2010), 202–214.
32. NASM TMS collections database, as of 22 January 2017.
33. Fred Durant to Brian Duff, 2 June 1967, Smithsonian Institution Archives, unit 348, box 8, folder "NASA artifacts."
34. See Molella, "The Museum That Might Have Been," 243–263.
35. Leonard Marks to James Webb, 15 July 1968, USIA Records, Record Group 306, Entry 1054: Osaka World Exhibition Office, 1968–1970, box 25 "Space Exhibit–NASA," NARA II, College Park, Maryland.
36. David Sutton to Jack Masey, 9 April 1969, USIA Records, Record Group 306, Entry 1054: Osaka World Exhibition Office, 1968–1970, box 25 "Space Exhibit–NASA," NARA II, College Park, Maryland. [emphasis added].
37. S. Dillon Ripley to Howard Chernoff, 8 April 1969, USIA Records, Record Group 306, Entry 1054: Osaka World Exhibition Office, 1968–1970, BOX 25 "Space Exhibit–NASA," NARA II, College Park, Maryland.
38. Donald L. Zylstra, "REPORT, National Aeronautics and Space Administration's Apollo 11 Fifty-state Tour, 1970–1971," NASA History Office Historical Reference Collection, NASA Headquarters, Washington, D.C.
39. Jack Masey to Julian Scheer, for August 1969 USIA Records, Record Group 306, Entry 1054: Osaka World Exhibition Office, 1968–1970, box 25 "Space Exhibit–NASA," NARA II, College Park, Maryland.
40. Julian Scheer to Jack Masey, 24 September 1969, USIA Records, Record Group 306, Entry 1054B: Office of the Director/Osaka World Exhibition Office; Files of the Design Office, 1967–1972, Box 4, Folder "E7 3 Space Exhibit NASA," NARA II, College Park, Maryland.
41. Fred Durant to Wade St. Claire, 8 September 1969, NASM Registrar accession file 002412, Washington, D.C.
42. J. R. Hansen, *First Man: The Life of Neil A. Armstrong* (New York: Simon & Schuster, 2005), 564–571; Muir-Harmony, "Selling Space Capsules, Moon Rocks, and America," 134.
43. Charles A. Biggs to Wade St. Clair, 13 November 1969, NASM Registrar accession file 002175, Washington, D.C.
44. Wade St. Clair, memorandum, 27 January 1970, NASM Registrar accession file 002175, Washington, D.C.
45. Data from NASM TMS collections database as of 22 January 2017.
46. Versions of the Division of Space History collections rationale are filed in Smithsonian Institution Archives, Accession 08-137, boxes 1 and 2, folder "Department of Space History NASM Collection Rationale." The current version is: "National Air and

Space Museum Collections Rational, Aeronautics Department, March 2016," signed by NASM Director, John Dailey, 4 March 2016, copy filed in Division of Space History Electronic Files. Citation from page 197.

47. See, M. McMahon, "The Romance of Technological Progress: A Critical Review of the National Air and Space Museum," *Technology and Culture* 22, no. 2 (1981): 281–296, 2d ed. and most recently, R. C. Post, *Who Owns America's Past. The Smithsonian and the Problem of History* (Baltimore: Johns Hopkins University Press, 2017).

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CHAPTER 12

Presenting the Past, Present, and Future of Technological Innovation

The Japanese Pavilion at Expo '70 as a Discourse on Science and Technology Policy

Nobumichi Ariga
Department of Science and Engineering
National Museum of Nature and Science
Tokyo, Japan

The Japan World Exposition held in Osaka in 1970 (Expo '70) was arguably the most celebrated fair ever held in that country. Referred to as *Osaka Banpaku* or simply *Banpaku* in Japanese,[1] the exposition is remembered as a monumental event in Japan's postwar history. Older generations today frequently recount their own experience and memories of the *Banpaku*, where they enjoyed the colorful, odd-shaped pavilions and encountered the culture of countries from all over the world. For the public, it was a great festival, a legendary event in a season of high economic growth.[2]

From another perspective, international expositions have always been an arena for national competition. From the beginning of the Meiji period—Emperor Meiji ruled from 1868 to 1912—the Japanese government participated in international fairs and hosted domestic expositions to promote industry and trade so that the nation, renewed after what became known as the Meiji Restoration, could compete with western powers. Both the Tokyo National Museum and Japan's National Museum of Nature and Science have their origins in their government's Museum Division during the 1870s, although the former came to concentrate on art and antiquities while the latter was originally established as an Education Museum. Japan also had planned to host an international exposition in 1940 to show its national or imperial power; the plan, however, could not be executed. It is likely that Expo '70, the first world fair held in Asia, was organized with similar aims, particularly from the perspective of politicians and government officials.[3]

Although much has been said of the *Osaka Banpaku*, the effort or intention of the Japanese government has not been examined in detail in scholarly literature. It is surprising that the exposition's Japanese Pavilion,[4] a national pavilion created by the Japanese government, has never been analyzed and is rarely mentioned. Further, unlike during the Meiji period, the government at the time of the exposition seemed to have had no plans to establish a permanent museum of science or technology or to transfer the entire set of artifacts from the pavilion to an existing institution.[5] Only a small portion of the displayed items have survived over the years, and this chapter attempts to reconstruct the Japanese Pavilion primarily based on published and unpublished material.[6]

Although the pavilion included sections on nature, traditional culture, and modern life, this essay focuses on its exhibits directly related to science and technology. I discuss what the specific objects of these exhibits represented in a historical context: that they were meant to illustrate that Japan had become a modern nation of science and technology despite its collapse during World War II. Moreover, I argue that these exhibits and their objects indicated two different concepts of technological innovation that were popular during that period. In order to illustrate this point, I refer to white papers about science and technology published by the Japanese government during the 1960s. The artifacts displayed at the Japanese Pavilion in 1970, when viewed from this perspective, clarifies a governmental discourse or reflects an effort during the postwar period by a growing nation to fashion itself as a modern country.

Expo '70 and the Japanese Pavilion

Expo '70, held in the Senri Hills in the northern part of Osaka Prefecture, was open from 15 March to 13 September 1970. During those 183 days, more than 64 million people, or about 350,000 each day, visited the Expo, a significant number. "Progress and Harmony for Mankind" (*jinrui no shinpo to chōwa*) was the central theme of the Expo, but the event was sometimes mocked, by being called "Patience and Long Lines of Mankind" (*jinrui no shinbō to chōda*).[7]

When they first arrived at the Senri site, visitors would have been impressed by the pavilion structures: all of the 116 pavilions had extraordinary shapes or colors. At the center of the site was Festival Plaza with a Grand Roof, and a huge monument—the 65-meter tall Tower of the Sun—as a part of the Theme Pavilion. The Festival Plaza and Tower of the Sun were designed by architect Kenzō Tange and artist Tarō Okamoto, respectively, and these architectural and artistic features seem to have formed the dominant image of the exposition among the people of Japan.[8]

Even so, science and technology were significant components of the event. In the U.S. and Soviet pavilions, the two global powers displayed their brilliant achievements in space exploration; the moon rock in the U.S. pavilion was one of the most popular exhibits.[9] The pavilion by

Japanese companies showed modern inventions. For example, Sanyō Electric (now a member of the Panasonic Corporation group) demonstrated its "Human Washing Machine," a futuristic bathroom in which a machine washes a user's body automatically. Matsushita Electric Industrial Company, Ltd., (later Panasonic) constructed a time capsule, into which objects of modern culture and technology were added.[10]

Compared to these pavilions, the one Japanese Pavilion created by Japan's government might not have appeared very popular, but in fact it was the largest of the pavilions and attracted more than 11 million visitors. The pavilion was designed after the Expo '70 emblem, which represented a cherry blossom; it consisted of a tower encircled by five white, cylindrical structures. Each cylinder was 58 meters in diameter and served as a large exhibition hall. Although some shortcuts were available, visitors were expected to walk through the halls in a particular order. This layout meant that a visitor would need to walk a total of 1.2 kilometers to cover all the halls. Pavilion officials estimated that approximately two hours were required to enjoy the entire pavilion.[11]

This national pavilion, together with a Japanese garden, intended to showcase "true" images of the country to the Japanese public as well as to foreign visitors, including VIPs. According to the pavilion's "fact sheets," probably prepared by Pavilion officials for the press preview four days before the opening, "exhibits of the host country must be the 'face' of the exposition, the 'core' of the whole site." The fact sheet stated, "our country has decided to construct a Japanese Pavilion that shows the true image of Japan and the Japanese people in every aspect of Japanese culture, economy, and society."[12]

The government tried to achieve this purpose by dividing the pavilion into three parts: *Past*, *Present*, and *Future* (*mukashi*, *ima*, and *asu*). Visitors began by walking through the *Past* exhibit in Hall 1, which presented a cultural history of Japan up to the Meiji period. The next two halls were related to the *Present*—modern industry and life in Hall 2 and nature, tradition, and agriculture in Hall 3. For exhibits related to the *Future*, Hall 4 introduced Japanese innovations in modern science and technology, whereas Hall 5 projected an image of the country in the twenty-first century and screened a film titled *Japan and the Japanese*. Because of the shortage of related documents, it is unclear how this layout was designed. The pavilion was apparently conceptualized and realized by a team of bureaucrats at the Ministry of International Trade and Industry, which had little connection to museums. The composition of the pavilion itself seems to have reflected the Japanese system of bureaucracy, with each section supervised by a different ministry or agency.

From the viewpoint of history of science and technology, the first half of Hall 2, which dealt with contemporary industry, and Hall 4, which covered science and technology, deserve special attention. It is particularly notable that these two sections provide different perspectives on technology: the former considers it a driver of economic and social change, while the latter stresses its relation to scientific research. The following sections illustrate how this difference testifies to dual perceptions of technological innovation during the 1960s, as presented in a series of white papers by Japan's government.

Technological Innovation as Techno–Industrial

Gijutsu-kakushin is a Japanese word that has been used, and is still in use, as a translation of "innovation." The term literally means, however, "technological innovation." A more direct translation, *inobēsyon*, is now preferred in Japanese science and technology policy. Nevertheless, when interpreting some of the objects displayed at Expo '70 in the context of Japan's postwar history, it is worth paying attention to this mis-translation.[13]

The term *gijutsu-kakushin* (hereafter referred to as "technological innovation") was first used in the Economic Planning Agency's 1956 *Economic White Paper*, which was famous for the statement "We are no longer in the postwar period." The white paper stated that the global economy was prosperous due to increasing investment in technological innovation and that automation and atomic energy represented technological innovation. While Japan was recovering from World War II, other technological innovations were being developed in other countries, particularly the United States.[14]

Although the *Economic White Paper* mentioned automation and atomic energy as being representative of technological innovation, this term was soon used to describe a wide range of industrial developments in contemporary Japan.[15] By the mid-1960s, the Science and Technology Agency's white paper series about science and technology suggested that the term mainly referred to heavy industrialization. The 1964 *White Paper on Science and Technology*, for example, characterized technological innovation in the postwar period by four technologies: synthetic chemistry, electronics, automation, and atomic energy.[16] Another edition, published in the next year, identified technological innovation as one of the factors that contributed to the transformation of Japan's industrial structure, noting that "we find [as examples of technological innovation] the basic oxygen furnace and development of a strip mill in the steel industry; progress of organic chemistry in chemical industry; progress of electronics in the light electricals sector; the growth of the construction equipment, automobile, and aircraft industries in the field of machinery; and increase in capacity of the power generation equipment in the heavy electricals sector."[17]

This techno–industrial panorama was presented in the *Industries of Japan* (*Nihon no sangyō*) exhibit of the Japanese Pavilion in 1970. When visitors entered the hall, they first faced a 25-meter-tall Giant Steel Wall (*dai-kō-heki*; Figure 1). The gigantic object represented the stern of a tanker, and hence, the steel and shipbuilding industry. It could have also signified the increasing importance of oil and the rise of the petrochemical industry. The government fact sheets describe this artifact as "the symbol of the hugeness and the growth of heavy industries in contemporary Japan that is leading the world, and of the energy of the Japanese people supporting it."[18]

On the upper floor of the same structure was a huge model of an industrial complex made to scale (1:800), spanning an astonishing 30 meters in width (Figure 2). An official book of the Japanese Pavilion emphasized the advantage of creating industrial complexes, explaining that "[an industrial complex] makes it easier to construct large equipment associated with technological innovation, and, by doing so, also helps reduce costs."[19] The fact sheets justify the necessity of industrial complexes in similar terms by pointing to "increasing industrial production, an increase

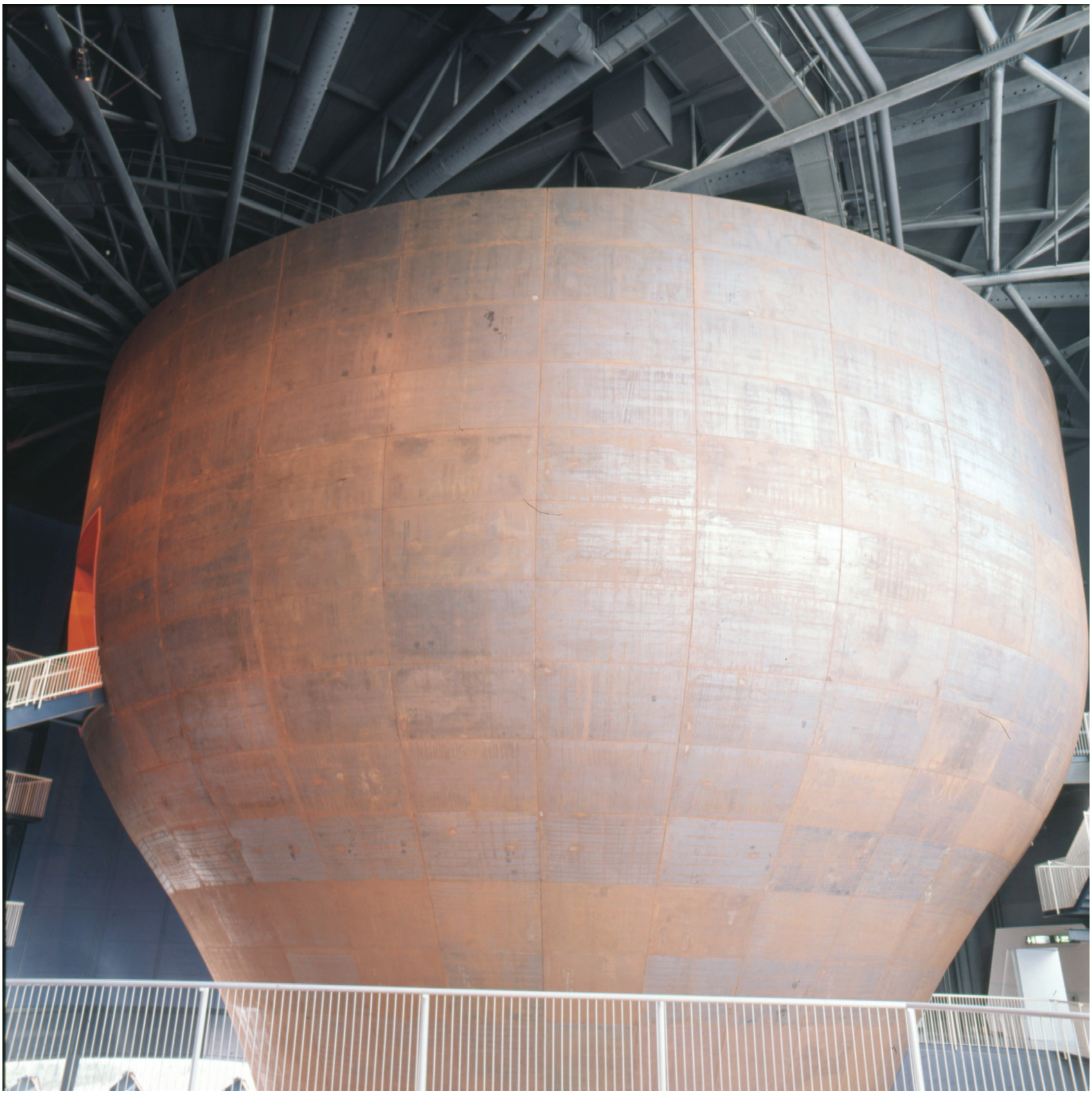

Figure 1. The Giant Steel Wall, a represented the stern of a tanker, displayed at the Japanese Pavilion. Courtesy of the Osaka Prefectural Expo 1970 Commemorative Park Office.

in transportation or water-intensive industries due to heavy industrialization of Japan, and the mammothization (*manmosu-ka*) of factories associated with technological innovation."[20]

The model was designed in great detail. It included several parts corresponding to different industrial sectors, including oil refining as well as the production of petrochemicals, power, steel, ships, and aluminum. Not only did the model accurately represent each sector's scale of production and size, it also estimated each sector's water use, electric power use, and number of workers required. Machinery, another key industry, was placed along the wall behind the complex, where a visitor would learn about manufacturing, particularly automobiles.

At the last part of the industrial section, there was a *Japan in the World* exhibit composed of movies and working models of industrial machines. The movies showed Japanese people working

Figure 2. Model of an industrial complex, displayed at the Japanese Pavilion. Courtesy of the Osaka Prefectural Expo 1970 Commemorative Park Office.

overseas and made-in-Japan products exported to other countries. This last exhibit, together with the Giant Steel Wall and the industrial complex, gave the impression that so-called heavy, thick, long, and large (*jū-kō-chō-dai*) technologies had brought a great change to the country's industry, resulting in Japan becoming one of the leading economic nations. If conceptualized in this manner, the *Industries of Japan* exhibit could be regarded as a discourse on technological innovation.

Technological Innovation as Scientific–Technological

While technological innovation might have been considered virtually a synonym of heavy industrialization from an economic standpoint, it had gained another dimension by the mid 1960s. Over the course of that decade, the technological innovation that had occurred in the previous decade was increasingly considered a process of introducing foreign technologies, and the necessity of developing "independent technology" (*jishu-gijutsu*) was repeatedly emphasized. For a typical example, the 1964 edition of the *White Paper on Science and Technology* discusses:

> Our country's expertise in science and technology has reached a considerable level. . . . However . . . it remains heavily dependent on foreign technology, and . . . it can be said that the research in private companies has been preoccupied with absorbing foreign technologies to, in a short time, fill the technological gap resulting from a blank during the war and from technological innovations achieved by foreign countries afterwards. However, even in private companies, attempts have been made to strengthen research activities to deal with the wave of technological innovation which approached after the war . . . and the total expenditure on research is increasingly on par with the international standard in the private sector. We can say that the foundation is finally becoming in place for the development of independent technologies.[21]

Scientific research was considered crucial to independent technology, that is, technology developed by the Japanese within the country. The 1964 *White Paper on Science and Technology* goes on to speak about "basic research serving as a foundation as well as a source for industrial technology," insisting that "it is necessary to reinforce and promote [basic research] further, and in doing so, national laboratories, universities, and enterprises must collaborate to proceed in an efficient way toward technological developments unique to our country."[22] A similar argument appears in the 1968 edition, which was explicitly subtitled, *Promoting the Development of Independent Technology*.[23] The discourse on independent technology had become dominant among the authorities by the end of the 1960s, when the Japanese Pavilion at Expo '70 was prepared.

The *Japanese Science and Technology* (*Nihon no kagaku-gijutsu*) exhibit, in Hall 4, should be examined in this context. At a first glance, it appears to have been disorganized and without focus: a visitor's guide mentions topics such as maglev, earthquake-resistant buildings, electron microscopy, synthetic chemistry, and the Antarctic. Surprisingly, there was no mention of research in pure sciences such as particle physics, the only field in which Japanese scientists had won a Nobel Prize.[24] The Antarctic research, which was apparently displayed only through graphic panels, may seem like an exception; however, it was described not only in terms of science but also from a utilitarian point of view: "A time will come when the northern and southern limits of human habitat will be pushed to the polar regions."[25] This dual approach can be explained by two factors: (1) The Japanese expression *kagaku-gijutsu* can be interpreted both as "science and technology" and as "scientific techniques;" and (2) the Science and Technology Agency (*Kagaku Gijutsu Chō*, established in 1956) was more technology oriented, as indicated by the editions of *White Paper on Science and Technology*.

Therefore, it is possible that those varied subjects were taken up *because* they were considered representations of cutting-edge technologies to which Japan had contributed significantly.

A classic example of this is the electron microscope, which was developed through research and development (R&D) conducted in cooperation between industry, government, and academia. Research on the electron microscopes in Japan started in 1939 and continued during and after World War II at some universities and independent enterprises. By 1955, there were already 250 operating electron microscopes that were produced in Japan, and Hitachi, one of the leading companies in the field, began to export their products. In the 1960s and 1970s, Hitachi and JEOL, its rival company in Japan, were two of the leading players in the global market.[26] The *White Paper on Science and Technology* refers to the electron microscope in its first issue (released in 1958) as a "technological achievement of which our country should be proud."[27] The visitor's guide to the Expo '70 Japanese Pavilion mentions that pictures of the microscopic world "seen through the superior electron microscopes of Japan" were displayed, and a historical photograph confirms that a unit of the apparatus (a product of JEOL) was also on display (Figure 3).[28]

The earthquake-resistant building provides another, more recent example of technology developed in Japan. The 1970 edition of *White Paper on Science and Technology* refers to earthquake-resistant skyscrapers and *Shinkansen* (a bullet train) as rare cases of independent technology that Japan had developed ahead of foreign countries.[29] Specifically highlighted was the Kasumigaseki Building, completed in 1968 and commonly regarded as the first skyscraper in Japan. An interesting fact about it is that its construction was based on the computer-calculated effects of earthquakes on the building.[30] While the *White Paper* enumerated multiple factors, including development of specific building components or introduction of larger construction machines, the exhibit in the Japanese Pavilion exclusively focused on the science of the vibrating motion of earthquakes. The exhibit consisted of three models of skyscrapers of different heights on a shaking table. Visitors could observe how the same shaking of the earth caused different effects to the tall buildings, and then possibly understand why scientific research was needed.[31]

Another artifact on display was related to synthetic chemistry. The government's choice for the topic was a rather symbolic one: a large molecular model of urea. As the first synthetic organic molecule, urea seems to have a historical implication. The visitor's guide states that Japan succeeded in mass-producing urea for fertilizers in 1948, thus suggesting a technological contribution to agriculture. Agriculture itself was a component of Hall 3, where other modern technologies, including laborsaving devices, radiation breeding of crops, and wood and plastic combination (WPC) materials, were presented. Plastics also appeared in an impressive manner in the cultural history section of Hall 1; most parts of the hall's exhibits, including Buddhist statues, were made of plastic. The accompanying fact sheets recommend "plastic imitation craft" as one of the most remarkable exhibits in the Japanese Pavilion, stressing that such craft requires sophisticated skills.[32] However, as far as Hall 4 was concerned, what mattered was scientific research. "The subsequent R&D [in synthetic chemistry since its initial success in 1948] has been remarkable," the visitor's guide continues, "and this technology has been adopted by many countries."[33]

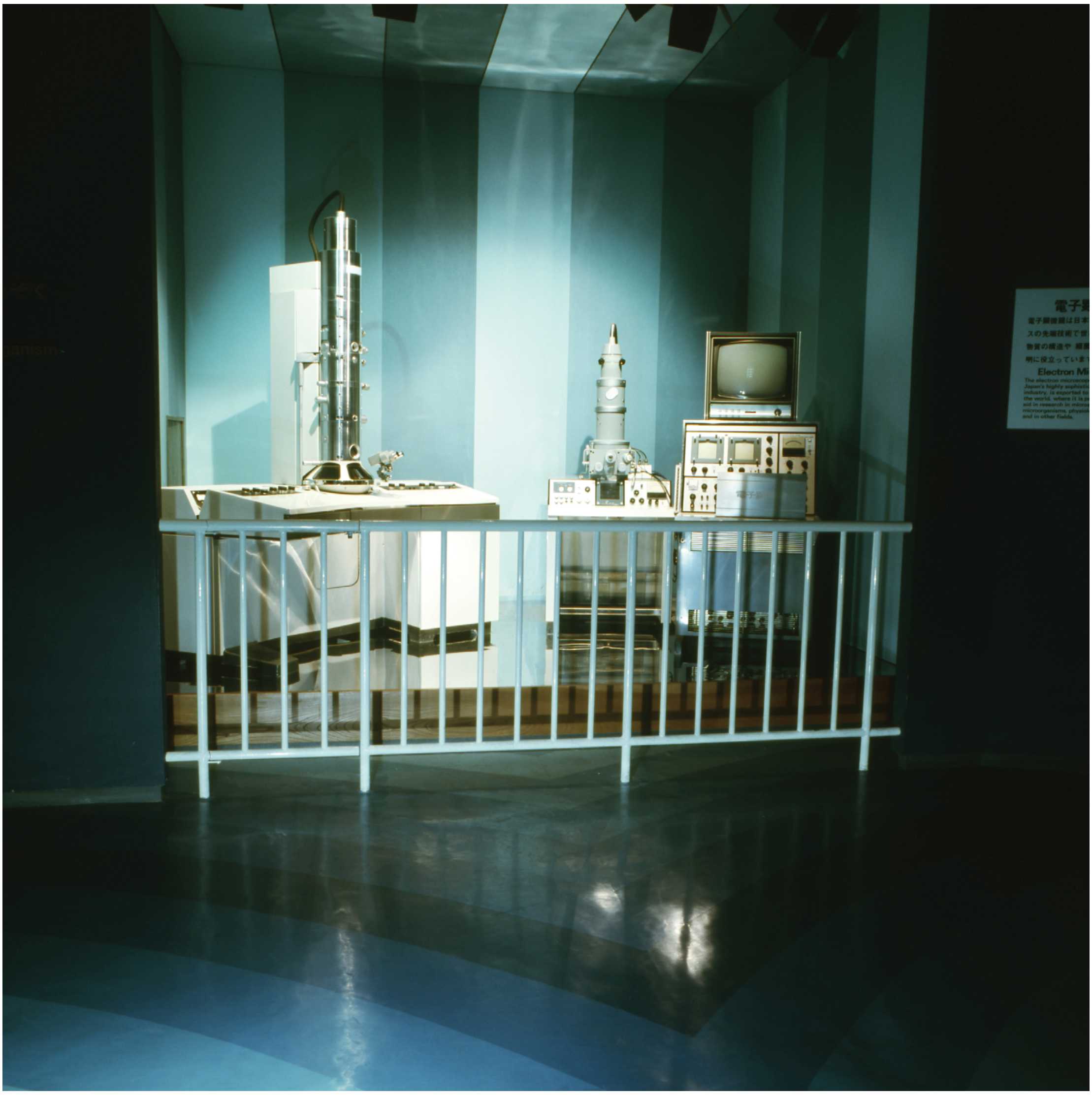

Figure 3. An electron microscope, displayed at the Japanese Pavilion. Courtesy of the Osaka Prefectural Expo 1970 Commemorative Park Office.

Again, it is not clear who selected these varied topics for the *Japanese Science and Technology* exhibit or on what grounds. Judging from the existing documents, a large portion of the exhibits seems to have been decided by government officials at the very earliest stage. A slight change may have occurred in the plan, but there seemed to be virtually no debate. Still, it may be safe to say that the real electron microscope, dynamic models of skyscrapers, and symbolic model of urea represented the supposedly state-of-the-art technologies that were based on scientific research of international standards. These exhibits were intended to highlight independent technologies, and reflect the concept of technological innovation where its source was identified as research activities.

Displaying Future

Technological innovation has been transforming society and will continue to do so, but in what manner? The Japanese Pavilion dealt with this question, both in the industry and the science and technology sections.

Consider, for example, the model of an industrial complex discussed previously. The 1960s in Japan witnessed not only an unprecedented growth in the economy but also severe environmental pollution associated with this progress. Pollution-related diseases had been a serious social issue for many years, and environmental problems were fiercely debated—at long last—at the Japanese Parliament by the end of 1970, only a few months after the closing of Expo '70.[34] In a limited capacity, the Japanese Pavilion also touched on environmental issues and presented the industrial complex as a solution. Aiming for "an industrial city of the sun and greenery," the model offered "a plan of a new town which integrates the arrangement of industries, design of related facilities, plan for preventing pollution, urban planning, and so on." The countermeasures included making greenbelts, establishing an air-pollution observatory, installing assembled or high smokestacks, and promoting low-sulfur fuel oil. The model represented an "ideal" but was not projected as belonging to the distant future; rather, a press release stated it was intended as "a concrete attempt which will be realized in the next five to ten years."[35]

For the public, the ambitious plan of an industrial city seemed less interesting than another model of a futuristic technology: maglev. It was one of the most recommended displays in the *Japanese Science and Technology* exhibit,[36] and, based on a questionnaire answered by 1,000 Japanese visitors, the maglev, a magnet-levitated train, was the third most impressive exhibit in the Japanese Pavilion.[37] In Hall 4, visitors viewed a circular track 20 meters in diameter and a miniature, three-car train running the track at 20 kilometers per hour (Figure 4). The cars were levitated about 10 centimeters above the tracks with repulsive magnetism and propelled by a linear motor system. This exhibit was the first public demonstration of a maglev, and it greatly helped to publicize the Japanese term "linear motorcar" and the concept itself.[38]

As mentioned previously, the 1970 edition of *White Paper on Science and Technology* refers to *Shinkansen*, a high-speed train that began service in 1964, as an example of independent technology. The 1962 *White Paper* discusses the new railway as an example of "synthesization" (*sōgō-ka*) of science and technology, concluding that "this achievement will be recognized by the whole world."[39] Instead of presenting this brilliant example, the Japanese Pavilion, in 1970, decided to focus on what would come next:

> Hall 4 primarily consists of Japan's new science and technology, especially those that have already been realized by the Japanese science and technology, or that have the highest probability of being realized. Among the advanced science and technologies of Japan, we are proud to present to the world, the Japanese railway technology which completed the *Shinkansen* superexpress. And the direction in which this technology is being developed will be demonstrated by the model of a linear motorcar (maglev).[40]

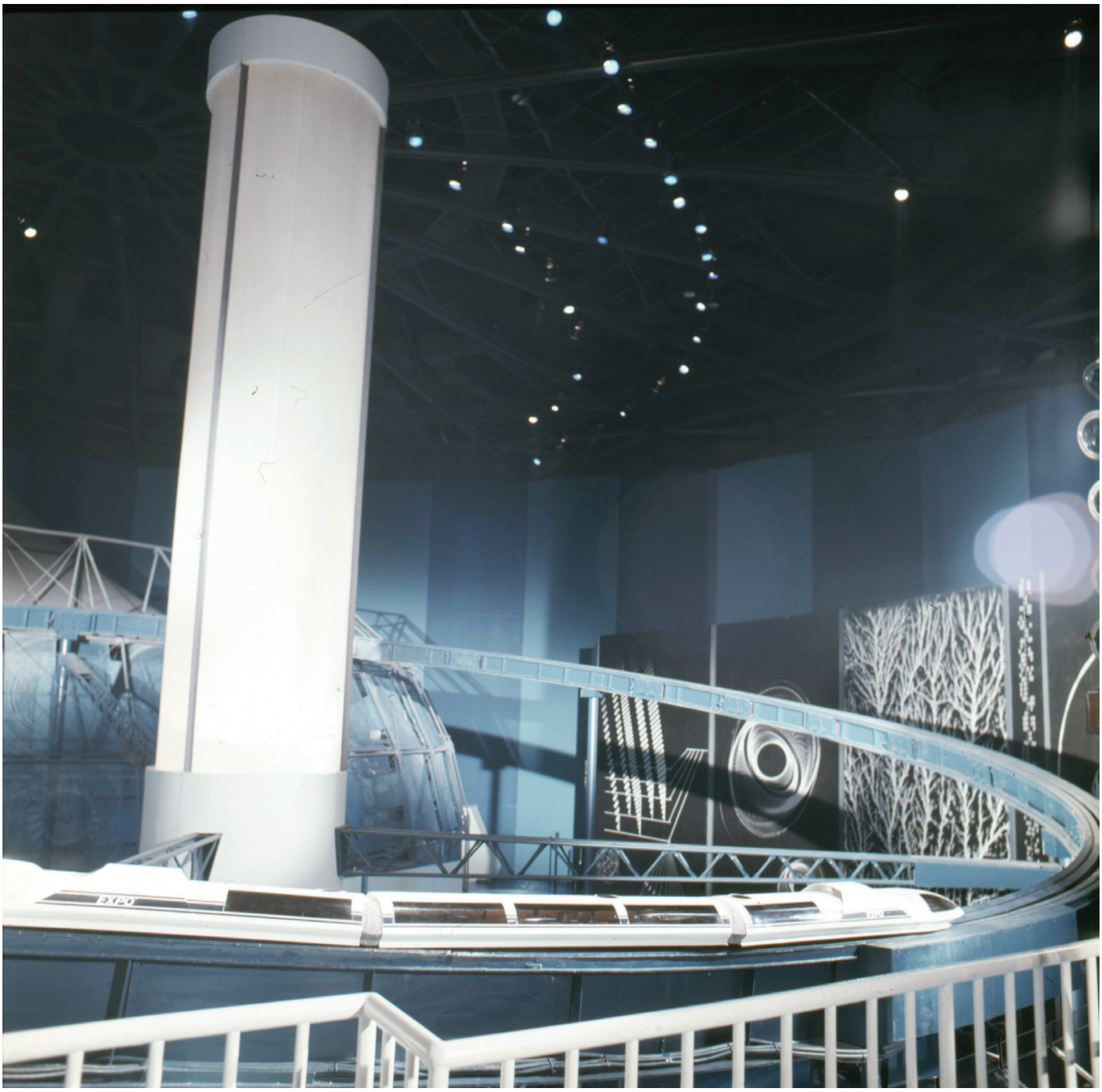

Figure 4. Model of a maglev, a magnet-levitated train, displayed at the Japanese Pavilion. Courtesy of the Osaka Prefectural Expo 1970 Commemorative Park Office.

The planned maglev aimed for a speed of 500 kilometers per hour, which would enable passengers to travel from Tokyo to Osaka in one hour and 10 minutes. A half-century later, this train still belongs to the future.[41]

The past, present, and future are a more sensitive and complicated matter for atomic energy. At the end of the *Japanese Science and Technology* exhibit, there were a pair of displays: *Tower of Sorrow* (*kanashimi no tō*) and *Tower of Joy* (*yorokobi no tō*). Inside these towers, visitors found tapestries with highly abstract representations of the atomic bomb and atomic energy. The visitor's guide insists that "we must, absolutely, avoid this dark, miserable, and meaningless use of atomic energy [atomic bombs]" and that "[t]he atomic energy, if not misused, provides us with wonderful power"—power supply for the entire *Osaka Banpaku*, for instance.[42] This excerpt is an example of the typical discourse on atomic energy in postwar Japan, where blame and regret for its misuse and optimistic determination to promote its correct use are simultaneously emphasized.[43] With the atomic towers closing the exhibit, visitors were once again reminded how science, through technology, had changed and would continue to change society. "Thus, the Tower of Joy symbolizes," the official book explains, "the 'Age of Atomic Power' (*gensiryoku jidai*) that is soon to come and implies peace and prosperity in a brilliant future."[44]

Conclusion

In 1968, Japan's gross national product became the third highest in the world, after only the United States and Soviet Union. The Japanese Pavilion of Expo '70 was thus conceptualized and materialized at the culmination of the so-called economic miracle. For the Japanese government, it was an opportunity for the rehabilitated nation to demonstrate proudly the image of modernity. The project seemed to be entirely governmental and, except for some advisory committees, carried out without any collaboration with existing museums or other institutions. It was planned as a temporary exhibition, or rather, a spectacle for a festival.

Science and technology constituted significant parts of this project, and, in an important way, the *Industries of Japan* and the *Japanese Science and Technology* exhibits complemented each other. In the industrial exhibition, large, even gigantic, artifacts impressed the visitors, and heavy industrialization was represented by the Giant Steel Wall and the model of an industrial complex. It was technology that had transformed Japan's industrial structure, resulting in a great change in society. On the other hand, the science and technology exhibit introduced to the public a number of scientific achievements that were created or being created in Japan, such as maglev. It was science that produced new technologies. The two exhibits were physically separated, but, if taken together, they embodied the so-called linear model of innovation.[45]

The double image of technology being both scientific and utilitarian was also in accordance with the government discourse on "technological innovation." In the mid-1960s, this term was widely used to refer to the technological change associated with heavy industrialization. At the same time, government officials became more and more concerned about the lack of original technologies developed in their country. "Independent technology" was a key term that expressed the goal of science and technology policy in the latter half of the 1960s, when Expo '70 was being organized. It is no wonder that the Japanese Pavilion, a national pavilion planned by the government, became a showcase for technological innovation in the dual sense, techno–industrial and scientific–technological.

This discursive nature of the Japanese Pavilion might explain in part why it was not transformed into a permanent institution. A large number of the displayed items were *constructed*, not collected, for the purpose of communicating a particular message to influence people. It is interesting to note that, after the exposition, the site was turned into a memorial park, where the National Museum of Ethnology was established. While the ethnological museum inherited about 2,500 cultural objects that had been collected from all over the world for the Theme pavilion of Expo ’70,[46] the Japanese Pavilion largely consisted of panels, movies, and different types of models—not genuine objects.[47]

Models were, however, particularly instrumental in displaying technological innovations that were based on scientific research and, although were not yet produced, would transform society. As a result, the exhibit on science and technology was more eloquent than the *White Papers* about “tomorrow.” The model of an “ideal” industrial complex and the maglev with “the highest probability of being realized” both spoke of a probable, near future. Those technological artifacts were, therefore, intended to represent the future of Japanese technological innovation, when science, technology, and industry worked together in harmony—a future visualized in a season of high economic growth.

Acknowledgements

I greatly appreciate the assistance of the staff members at the Osaka Prefectural Expo ’70 Commemorative Park Office and NOMURA Co., Ltd, who kindly provided me access to source materials. Osamu Kamei, my senior colleague, continued to encourage me in the present study, and Teasel Muir-Harmony motivated me to write about this case in English. I also thank Elena Canadelli for her constructive comments on a former version of the draft. This work was supported by JSPS KAKENHI (Grants-in-Aid for Scientific Research), Grant Number JP25242021.

Notes

1. *Bankoku hakurankai* (world’s exposition) is abbreviated to *Banpaku*, not *Banhaku*.
2. The official account of the Japan World Exposition is available in English: [Commemorative Association for the Japan World Exposition], *Japan World Exposition, Osaka, 1970: Official Report*, Volumes 1–3 (Suita, Osaka: Commemorative Association for the Japan World Exposition, 1972). For visitors’ experiences and memories of the *Banpaku*, see D. Anderson and H. Shimizu, “Recollections of Expo ’70: Visitors’ Experiences and the Retention of Vivid Long-Term Memories,” *Curator*, 50 (2007): 435–454. Recent Japanese publications on Expo ’70 include S. Hashizume, *EXPO ’70 Pabirion: Osaka Banpaku Kōshiki Memoriarugaido* (Tokyo: Heibonsha, 2010); Osaka Daigaku 21-Seiki Kaitokudo, ed., *Natsukashiki Mirai “Osaka Banpaku”: Jinrui wa Shinpo Shita no ka Chōwa Shita no ka* (Osaka: Sōgensha, 2012); and A. Hirano, *Osaka Banpaku: 20 Seiki ga Yumemita 21 Seiki = EXPO ’70* (Tokyo: Shōgakukan Kurieitibu, 2014). See also S. Yoshimi, *Banpaku to Sengo Nihon* (Tokyo: Kōdansha, 2011), which provides a critical perspective on *Osaka Banpaku* and subsequent international fairs held in Japan.
3. Japan’s engagement in international and domestic fairs and its implication for the country’s modernization are discussed in M. Low, “Promoting Scientific and Technological Change in Tokyo, 1870–1930: Museums, Industrial Exhibitions, and the City,” in *Urban Modernity: Cultural Innovation in the Second Industrial Revolution*, ed. M. R. Levin, S. Forgan, M. Hessler, R. H. Kargon and M. Low (Cambridge, Mass.: MIT Press, 2010), 205–253; and “Modernity on Display: The 1940 Grand International Exposition of Japan,” in *World’s Fairs on the Eve of War: Science, Technology, and Modernity, 1937–1942*, ed. R. H. Kargon, K. Fiss, M. Low and A. P. Molella (Pittsburgh: University of Pittsburgh Press, 2015), 83–107.
4. Its official English name seemed to be “Japanese Government Pavilion,” but I have simply used “Japanese Pavilion” since the Japanese name (*Nihonkan*) does not contain the word corresponding to “government.” Moreover, some official materials display “Japanese Pavilion” in English on their covers. (See note 11 below.)
5. Some authors suggest that there was a plan to create a museum of industrial technology at that time, but I have not seen any historical material that would confirm this story. Cf. T. Nakamura, “A Study of the Suspended New Museum Projects: The Project of the National Industrial Science Museum” [in Japanese], *JMMA* 3 (1999): 26.
6. Unfortunately, documents related to the Japanese Pavilion have not been properly archived. I consulted the *Hakurankai Siryō Collection* (Exposition Materials Collection) held by NOMURA Co., Ltd., one of the major companies in space design, and materials kept by the Osaka Prefectural Expo ’70 Commemorative Park Office.
7. Although this wordplay is sometimes mentioned, its original source is unclear. I found and translated a very similar sentence in a newspaper article that appeared just before the closing of the event (*Mainichi Shinbun*, 13 September 1970): “It was the six months not of ‘progress and harmony’ but of ‘patience and long lines.’”
8. On the development of the Festival Plaza and Tower of Sun, see W. O. Gardner, “The 1970 Osaka Expo and/as Science Fiction,” *Review of Japanese Culture and Society* 28 (2011): 26–43.

9. See Anderson and Shimizu, "Recollections of Expo '70," 444, for its popularity among the public; and T. Muir-Harmony, Project Apollo, Cold War Diplomacy, and the American Framing of Global Interdependence (Ph.D. diss., Massachusetts Institute of Technology, Boston, 2014), chapter 6, for its political context. It should be also mentioned that another moon rock was added to the Japanese Pavilion during the course of Expo '70. The rock was one of the gifts sent by the United States to its friendly nations, and it is now a part of the collection at the National Museum of Nature and Science.
10. For the time capsule, see [Matsushita Electric Industrial Company], *The Official Record of Time Capsule Expo '70: A Gift to the People of the Future from the People of the Present Day* (Kadoma, Osaka: Matsushita Electric Industrial Company, 1980).
11. Besides a description in [Commemorative Association for the Japan World Exposition], *Official Report*, Vol. 1, 180–185, my account of the Japanese Pavilion is based on the following unpublished materials: Ministry of International Trade and Industry (MITI) and Japan External Trade Organization (JETRO), *Nihonkan: Nihon to Nihonjin*, a visitor's guide, 24 pp.; MITI, *Nihonkan*, an explanatory book on the Japanese Pavilion, 134 pp.; JETRO, *Nihon Bankoku Hakurankai Nihonkan Un'ei Hōkokusho* (Tokyo: JETRO, 1971), an operational report of the Japanese Pavilion, 254 pp.; [MITI], *Nihonkan: The Japanese Pavilion*, a photography book without page numbers; and "Japanese Pavilion: Press Information," which consists of 15 "fact sheets." While the first four items are included in NOMURA's collection or are available at a few libraries, the fifth is in the possession of Expo '70 Commemorative Park Office. I also consulted photographs kept by the latter.
12. "Japanese Pavilion: Press Information," fact sheet no. 1. All quotations are my own translation from Japanese unless otherwise noted.
13. For a historical survey of the term *gijutsu-kakushin* that appeared in the *White Paper on Science and Technology*, see N. Ariga and O. Kamei, "Historical Changes in the Meaning of 'Gijutsu-Kakushin' seen from the Japanese White Paper on Science and Technology" [in Japanese], *Bulletin of the National Museum of Nature and Science. Series E, Physical Sciences and Engineering* 37 (2014): 25–41.
14. Keizai Kikaku Chō, *Shōwa 31 Nendo Keizai Hakusyo* (Tokyo: Shiseidō, 1956), 33–35.
15. For a general account of Japan's industrial development, or so-called "economic miracle," see, for example, T. Morris-Suzuki, *The Technological Transformation of Japan. From the Seventeenth to the Twenty-first Century* (Cambridge [England]: Cambridge University Press, 1994), chap. 7; and A. Gordon, *A Modern History of Japan: From Tokugawa Times to the Present*, 3rd ed. (Oxford: Oxford University Press, 2014), chaps. 14 and 15. See also K. Gotō, "Introduction: High Economic Growth and the Road to Becoming a Power in the Fields of Science and Technology," in *A Social History of Science and Technology in Contemporary Japan*, ed. S. Nakayama, K. Gotō, and H. Yoshioka (Melbourne: Trans Pacific Press, 2006), Vol. 3, 1–63, for a critical discussion on the state of Japanese science and technology in the 1960s.
16. Kagaku Gijutsu Chō, *Shōwa 39 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1964), 18.
17. Kagaku Gijutsu Chō, *Shōwa 40 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1965), 150.
18. "Japanese Pavilion: Press Information," fact sheet no. 7.
19. MITI, *Nihonkan*, 60.
20. "Japanese Pavilion: Press Information," fact sheet no. 12.
21. Kagaku Gijutsu Chō, *Shōwa 39 Nendo Kagaku Gijutsu Hakusyo*, 5.
22. Kagaku Gijutsu Chō, *Shōwa 39 Nendo Kagaku Gijutsu Hakusyo*, 5.
23. Kagaku Gijutsu Chō, *Shōwa 43 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1969).
24. By 1970, only two Nobel Laureates were in Japan: Hideki Yukawa in 1949 and Sin-Itiro Tomonaga in 1965, both of whom won the prize for Physics.
25. MITI, *Nihonkan*, 109.
26. Kenji Kojima, "A Systematic Survey of the Technical Development of Transmission Electron Microscope" [in Japanese], in *Gijutsu no Keitōka Chōsa Hōkoku*, Vol. 11, ed. Center of the History of Japanese Industrial Technology (Tokyo: National Museum of Nature and Science, 2008), 1–51.
27. Kagaku Gijutsu Chō, *Shōwa 33 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1958), 17.
28. MITI and JETRO, *Nihonkan*, 20. Japan Business History Institute, ed., *Nihondenshi Sanjūgonenshi* (Akishima, Tokyo: JEOL, 1986), 183, briefly mentions this exhibit.
29. Kagaku Gijutsu Chō, *Shōwa 45 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1971), 13.
30. [Committee for Construction of Kasumigaseki Building], dir., *Kasumigaseki Building* [in Japanese] (Tokyo: Mitsui Fudōsan, 1968), 36–53.
31. The models of skyscrapers and the shaking table have been kept by the Osaka Prefectural Expo '70 Commemorative Park Office. I also discovered a seismograph, a product from 1970, next to them. However, I have found no evidence suggesting that they were displayed together.
32. "Japanese Pavilion: Press Information," fact sheet no. 11.
33. MITI and JETRO, *Nihonkan*, 20.
34. For a historical survey in English of the pollution and related diseases in the 1960s, see Z. Suzuki, "Anti-pollution Measures," in *A Social History*, ed. Nakayama, Gotō, and Yoshioka, Vol. 3, 441–451.
35. "Japanese Pavilion: Press Information," fact sheet no. 12, and MITI, *Nihonkan*, 61.
36. "Japanese Pavilion: Press Information," fact sheet no. 14.
37. JETRO, *Nihonkan Un'ei Hōkokusho*, 125. The first and second places were occupied by "History of Japan" and "Buddhist Statues," respectively.
38. An engineer, sometimes referred to as the "Father of Maglev," looks back on this demonstration. Y. Kyotani, *Linear Motorcar: Chōdendō ga 21-Seiki o Hiraku* (Tokyo: NHK Publishing, 1990), 28–30.

39. Kagaku Gijutsu Chō, *Shōwa 37 Nendo Kagaku Gijutsu Hakusyo* (Tokyo: Ōkurashō Insatsukyoku, 1962), 349. For the development of *Shinkansen*, see T. Koyama, "The Shinkansen (Bullet Train): A New Era in Railway Technology," in *A Social History*, ed. Nakayama, Gotō, and Yoshioka, Vol. 3, 379–389.
40. "Japanese Pavilion: Press Information," fact sheet no. 14.
41. It should be added, however, that Central Japan Railway Company started construction on the maglev in 2014. As of 2017, the company plans to start service for a section between Shinagawa (in Tokyo) and Nagoya in 2027.
42. MITI and JETRO, *Nihonkan*, 21, and MITI, *Nihonkan*, 118.
43. See A. Yamamoto, *Kaku Enerugī Gensetsu no Sengoshi 1945–1960: "Hibaku no Kioku" to Genshiryoku no Yume"* (Kyoto: Jinbun Shoin, 2012), and *Kaku to Nihonjin: Hiroshima Gojira Fukushima* (Tokyo: Chūōkōron-Shinsha, 2015).
44. MITI, *Nihonkan*, 118.
45. Cf. B. Godin, "The Linear Model of Innovation: The Historical Construction of an Analytical Framework," *Science, Technology, and Human Values* 31 (2006): 639–667.
46. A special exhibition on this subject, "A 'Tower of the Sun' Collection: Expo '70 Ethnological Mission," was held at the National Museum of Ethnology in 2018.
47. The Japanese Pavilion could have been characterized by its extensive use of movies. This point seems to merit another serious study in the history of fairs or museums.

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Conclusion

Science and Technology in the Twentieth Century Exhibitionary Complex

Robert Friedel
Professor
Department of History,
University of Maryland
College Park, Maryland, USA

Just over 50 years ago, one of the founding figures of the history of technology in the United States, Eugene Ferguson, published an article on "Technical Museums and International Exhibitions" in Technology and Culture.[1] There, he explored the deep roots of twentieth-century technical museums in world's fairs, going so far as to say, "with few exceptions today's technical museums owe their existence to the international exhibitions of the nineteenth century."[2] The key examples he cited were indeed the principle traditional science and technology museums of the mid-twentieth century. London's Science Museum was an offshoot of the Victoria and Albert Museum, itself a product of the 1851 London Great Exhibition. The Vienna International Exhibition of 1873 led to the formation of that city's Technisches Museum. The Smithsonian Institution's museum efforts were given momentum by the acquisition of enormous amounts of material from the Philadelphia Centennial Exhibition of 1876. Some of the later major museums, such as Munich's Deutsches Museum and Chicago's Museum of Science and Industry, Ferguson pointed out, could also trace important linkages to expositions, if perhaps a bit less directly.

For the most part, the connections to which Ferguson drew attention were financial and programmatic, in a very general sense. As he pointed out, a number of the first international expositions were designed to expose large audiences (particularly working classes) to best practices, both foreign and domestic. The first fairs were often connected with mechanics' institutes or other educational initiatives, and this made the possibility of establishing more permanently at least some of the attractions and instructional functions of the fairs readily apparent to many.

In some cases, as with the Smithsonian, the world's fair presented opportunities for collectors and curators, and the collections that resulted were the product of their initiative. George Brown Goode was an ambitious young curator, just beginning to pull together elements of a "U.S. National Museum" when the Philadelphia Centennial Exhibition presented unique opportunities for advancing this agenda. In the case of both the London and Philadelphia fairs, it should be noted, the chances presented were not directly related to science and technology. The emergence and consolidation of collections in these areas were the products of particular circumstances over succeeding years.

This historic connection between the great expositions and museums of science and technology was seen by Ferguson as a source of some of the difficulties such museums encountered. The central problem lay in different goals, as Goode suggested and as quoted by Ferguson: "The exposition or exhibition and fair are primarily for the promotion of industry and commerce," whereas, he went on to say, "the museum for the advancement of learning." But the learning in a museum is of a distinctive kind, quite different from that in books and schools. As Ferguson pointed out, the English economist and critic William Stanley Jevons recognized this in the 1880s: " . . . The purpose of a true Museum is to enable the student to see the things and realise sensually the qualities described in lessons and lectures; in short, to learn what cannot be learnt by words." Ferguson went on to provide examples of the eloquence of original objects in both large and small science and technology museums, and suggested that making room for such eloquence and enhancing it by good labeling and demonstrations should be central to the mission and programs of such museums. Otherwise, he warned, "As long as technical museums are equated, by public and curator alike, with a permanent trade fair, so long will the museums continue to be popular—and largely vacuous."[3]

In the half-century since Ferguson's remarks, much additional scholarship has been directed toward aspects of his subject. Particularly rich has been the literature on the great international exhibitions and their relationships to nineteenth- and early twentieth-century culture. The larger fairs, such as the Crystal Palace of 1851, the great series of Paris exhibitions from 1855 to 1900, and the 1893 Columbian Exposition in Chicago, have received particular attention, but the larger phenomenon of international expositions has also been the focus of good and useful scholarship. The origins and development of science and technology collections and museums have received less attention, although our knowledge has certainly expanded since Ferguson's day. The connections between world's fairs and museums, however, still remains territory explored by only a few.[4] While some twentieth-century expositions have received attention, the linkages between these and longer-lived institutions such as museums remain, until this volume, largely ignored.

The most useful and provocative discussion of such linkages, largely still focused on nineteenth-century events, is that dealing with what Tony Bennett called "the exhibitionary complex." In an essay that first appeared in 1988, Bennett sought to build on some earlier remarks suggesting that museums might usefully be subjected to the same critical analysis that Michel

Foucault applied to asylums, prisons, and clinics. He pointed out that the nineteenth century saw a "wide range of institutions—history and natural science museums, dioramas and panoramas, national and, later, international exhibitions, arcades, and department stores" which composed a "complex of disciplinary and power relations," different from, but similar, to that which was represented by the institutions of confinement and control that Foucault had so usefully explored and linked together.[5] To Bennett, the great expositions were spectacular and transitory examples of a larger process by which the public was being drawn into carefully organized and managed displays—largely of things, but also of people—that the great national and civic museums made permanent. It is through exhibition rather than confinement that these institutions manifested the interests and power of the state to organize knowledge and to convey its particular control of it to the public at large.

The shared interests of expositions and museums in display, power, and knowledge have been most obvious in scholarly discussions of the rise of ethnography, anthropology, and sciences of race. Many world's fairs created spectacles of non-Western peoples, presenting them as educational contrasts to the advanced European and American civilizations so impressively on display. These spectacles were sometimes just that—sideshows that appeared designed more to fascinate and amuse than to educate. But just as often, the study of non-Western peoples and artifacts was seen as part of a scientific agenda, an effort to comprehend and describe the varieties of the human state and condition. The result was hardly any less directed toward messages of racial superiority and inferiority in spite of its scientific dress, but the anthropological program became an important contributor to some of the museums that emerged at the twentieth century's end.[6]

Their role in exploring and displaying contrasts between "advanced" and "primitive" peoples highlighted one of the key tensions that characterized both fairs and museums: whether to focus on the universal or the local, especially the national. This tension ran throughout the expositions of the nineteenth century, but it became even more central to the experiences of the twentieth-century expositions, particularly in the decades between the world wars. The fairs were always meant to showcase the achievements of local artisans and industries as well as feature "international" examples so as to provide favorable contrasts to local productions and sometimes to suggest aspirations in areas not yet mastered. With world's fairs having ever greater emphasis on the most modern technologies, culminating in the spectacle of Chicago's White City in 1893 and the technical marvels of Paris in 1900, the nationalistic overtones could be drowned out by century's end. Yet in the twentieth century, the fairs just as readily stressed national achievements. The Paris fair of 1937 provided perhaps the most obvious instance of this, with dueling pavilions from the Soviet Union and Nazi Germany facing each other across the Champs de Mars.[7]

In the years after World War II, the Cold War rivalry between West and East blossomed in almost every conceivable venue, including prominent world's fairs. At the center of the public contest between the two blocs, which claimed to represent two contrasting systems of social and economic organization, was a claim to scientific and (especially) technological superiority. Since 1851 these kinds of claims were given a place in the world expositions, but the Cold War gave them a new kind of urgency. Explicit national and international efforts toward demonstrating one system or the other's capabilities in nuclear energy, air and space travel, and other marvels of the age commanded enormous expenditures and unceasing public pronouncements and demonstrations. The exhibitionary complex became a part of a high-stakes international contest. At the same time, in the decades after World War II, world's fairs joined other events, such as the Olympic Games, as means for announcing recovery and advancement for nations that had been devastated by the conflict. The 1970 world's fair in Osaka joined the Olympics in Rome (1960), Tokyo (1964), and Munich (1972) in marking the return of the defeated Axis powers to the ranks of successful nations.

This tension between the nationalistic and the universalistic runs through the history of modern museums as well. At least since the "British" Museum and on through the "U.S. National" Museum and the "Deutsches" Museum, the most prominent (non-art) museum efforts have loudly proclaimed their national—and nationalistic—concerns. At the same time, however, museum missions as well as the exhibits and programs they fostered encompassed transnational and universal agendas. This was typically true for art museums (with a few exceptions in the twentieth century), but also to some extent for museums that focused on science and technology. As these institutions sought to convey the core values of modern science and its applications to the larger public, they often attempted to reflect universalistic ideals of a pursuit of natural knowledge free from national boundaries. But this balance turned out to be difficult to achieve, and a number of the chapters in this volume testify to the extent to which efforts to define and popularize national visions of science and scientific achievement provided the key impetus for displays and museums. Thus the laboratory and apparatus of Lavoisier became visible testimony to the significance of French chemistry, not only in the past but in the early twentieth-century world as well. The displays of early German electrical experiments in telegraphy similarly testified to the ascendency of German invention going back to the early nineteenth century, before the nation of Germany even appeared on the map.

Even earlier histories were sometimes called upon to support claims for national scientific traditions. A particularly evocative example of this could be seen in the Italian efforts of the 1920s and 1930s. Three papers in this volume outline the origins and significance of these efforts, stretching from the spectacular display of historical scientific instruments in Florence in 1929 to the elaborate—but unfulfilled—plans for exhibits at a world's fair to be held in Rome in 1942. Italian efforts most typically were tied to representations of scientific heroes, particularly ones with strong local affiliations. Just before the start of the twentieth century, the city of Como celebrated its most famous scientific son, Alessandro Volta, by displaying as many of his instruments and inventions as it could find. The exhibition was, unfortunately, largely destroyed in a fire, with most of the historical items lost. This loss did not deter the construction of Italy's first major museum of science and technology in the Tempio Voltiano, built on the shores of Lake Como in 1928.[8] In the following year, the Florentine Andrea Corsini was able to put together a more broadly based exhibition of historical scientific instruments, drawing from all over Italy. In spite of aspirations for a more inclusive approach, the exhibition failed to avoid a strongly Tuscan slant, centering on the heroic figures of Leonardo da Vinci and, especially, Galileo. Once efforts moved beyond Tuscany, however, a broader Italian image of scientific heritage could be projected, as represented in the displays prepared for the Chicago Century of Progress exposition of 1933. These were still designed to project a distinctively Italian picture of scientific progress, and this is one reason the artifacts proved of little use to the Chicago Museum of Science and Industry, which sought to carry on some of the educational goals of the 1933 fair. Not surprisingly, the Italian orientation presented no barriers to the conceptualization of new museums of technology and of science in Milan and Rome, respectively. Politics, war, and economics were greater hurdles to these efforts, of course, as illustrated by the difficulties encountered by those who planned the scientific displays at a world's fair in Rome in 1942 and the museums projected to follow.

The Italian cases highlight a couple of key themes that are echoed elsewhere in this volume. The first is the puzzle—and the key role—that displays of scientific instruments represented in both international exhibitions and in the museums that followed them. The second is the role that exhibitions of scientific and technical heritage played in twentieth-century contests for defining the relationship between nation-states and the historical regions that retained enormous significance for many populations. The questions that might be raised about the usefulness of displaying scientific instruments were remarked upon as long ago as the 1880s when Jevons, the English reformer and economist, expressed his skepticism:

> I think it is a happy thing that the Loan Exhibition of Scientific Instruments [presented in London, 1876] was dispersed and not converted into a permanent Museum, as some scientific men wished. . . . Were all the apparatus used [by scientists] to be treasured up at South Kensington, it could only produce additional bewilderment in those whose brains have already been scattered by the educational and other numerous collections of that locality.[9]

Within a decade, of course, the foundations of what was to become London's Science Museum were established by "some scientific men." But the problem Jevons alluded to remained: what meaning could the typical museum-goer gain from devices whose workings could only be understood by experts—and a narrow range of them at that? Nonetheless, several chapters here attest to the fact that such instruments, particularly those with associative or heroic values, were important agents of engendering historical museums of science in the twentieth century.

The twentieth-century museum efforts—and the fairs often associated with them—tended over time to give greater attention to science than to the products of advanced technology. The latter were always important, of course, especially when they contributed to a sense of spectacle and wonder. But for a range of reasons, both fairs and museums saw their mission as communicating the rapidly expanding scientific world that the twentieth-century public saw as the primary sources of modern change. The challenge of finding aspects of modern science that could be effectively presented in the fair or museum setting, especially given the increasing complexity of instrumentation, was met in a variety of ways. One approach was to focus on astronomy, which turned out to have great popular appeal and, as a largely observational field, was intellectually accessible to general audiences. The opening of Chicago's Adler Planetarium in conjunction with the 1933 fair, the popularity of the astronomy exhibits at the Palais de la découverte and the Paris International Exhibition of 1937, and even the post–World War II exhibits of space achievements by both the Soviet Union and the United States testify to the broad appeal of space for both fair and museum audiences. Sputniks, space shuttles, telescopes, and moon landers were means of evoking wonder in a time when television and other media made every other sort of experience immediate and even commonplace.

The other element running through the Italian studies in this volume—the tension between national and regional identities while defining and displaying scientific and technical heritage—shows up in other cases here as well. Perhaps the most remarkable of these is that of the Catalan forge (*farga catalana*), which was less an artifact than a method of making bloomery iron. For about 20 years, engineer Santiago Rubio and his colleagues pushed to recover what they termed the "technological soul" of Catalonia, all in service of manifesting a particular regional identity that was always in danger of being lost in the national hegemony of Spain. The forge was a central instrument in the effort to identify a more modern, less pastoral Catalonian identity that would serve the Catalans effectively in the twentieth century. At the Barcelona International Exhibition in 1929, a re-created forge was a material manifestation of the larger effort to announce the region's active role in modern technology. In the museum efforts that followed the 1929 fair, the forge continued to be used to define a regional technological identity. It is not surprising, therefore, that upon suppression of Catalan aspirations that followed the fascist defeat of the Spanish Republic in 1939, all traces of the forge display disappeared. Here was a case in which the changing power relations of the "exhibitionary complex" expressed themselves through the removal of a display rather than its establishment.

Not all exhibitions were oriented to the nationalist and regionalist proclivities of the twentieth century. In the effort to provide space for examining and displaying expressions of thought at the Paris Exposition of 1937, scientists sought with some earnestness to promote the international nature of the scientific enterprise. From the outset, their efforts were oriented toward the creation of a permanent institution, the Palais de la découverte. The Palais consciously avoided history in its ambit, as a means of furthering *la science vivante* (living science) at the heart of its mission, not incidentally making a universalist approach that much more natural. The techniques applied to making science "living" included lectures and demonstrations, models, and, most significantly, cinema. To a degree, the Palais sought to be an "anti-museum," firmly oriented toward "the act of discovery" rather than the artifacts of science. In doing so, it can be argued, the Palais highlighted the inherent limitations of traditional science and technology museums for interpreting modern science to their audiences.

During the course of the twentieth century, interpreting modern science became one of the common programs of world's fairs, and in so doing, it became more central to the missions of a new type of museum. Earlier fairs, going back to the mid-nineteenth century, engaged in the display of scientific and technical wonders, but they generally stopped short of taking on educational tasks. This was generally true up to the beginning of World War II. The great fairs at Chicago and New York in the 1930s, for example, were not short on scientific content, but their goal was much more to impress than to educate. The attention the 1937 Paris fair gave to so-called intellectual work may be seen as an important shift in this regard, and the exhibits of the Palais reflected this. After World War II, world's fairs began to acquire a new character: a more explicit educational mission, particularly regarding modern science, emerged. The world's fair at Seattle in 1962 [see Schirrmacher, this volume] was arguably a turning point, when the U.S. Science Exhibit was organized around a host of programs for demonstration and education, with particular attention given to younger visitors. Its "Junior Laboratory of Science" offered a new version of *la science vivante* in the spirit of the Palais de la découverte. Unusual circumstances, especially a large amount of government support, gave the Seattle fair the opportunity to forge these new directions. Just how unusual these circumstances were become apparent at the 1964–1965 New York world's fair, where more parochial commercial agendas were once again allowed to take charge. At Montreal 1967, some of the spirit of the Seattle effort became apparent, although neither the funding nor the leadership was present to bring much about. The influence of Seattle and other efforts on the science center movement is not straightforward, but it is reasonable to see some linkages, either through institutions such as Seattle's Pacific Science Center or through individuals, such as Frank Oppenheimer. After being exposed to European museums that left important impressions on him (perhaps more for what did not work than for what did), during the mid-1960s Oppenheimer began giving voice to the ideas that led to the formation in 1969 of San Francisco's path-breaking Exploratorium. Direct ties between the fairs of this time and the new science center movement need not be required to infer a broader re-conception of science display and education that motivated the period's changes.

Fairs and museums changed over the course of the twentieth century, and the changes continue today. The changes, however, resist simple characterization. Whereas each forum has distinctive dynamics, some of the same forces are at work in both. For example, the competition for public attention and resources from print and, especially, electronic media require both fairs and museums to redefine their missions. No longer does it make sense to assume that audiences do not have access to news and information about the latest technologies, the best practices, or the variety of cultures and approaches that the world offers. No longer is advanced instruction in crafts, techniques, scientific methods, or natural and technical knowledge restricted to a few locales and a limited range of populations. Worldwide exchange of ideas and products is all around us, thanks to global trade and institutions on a scale unimaginable just a couple of generations ago. The shopping mall—whether in suburban Chicago, central Berlin, Tel Aviv, Mumbai, Shanghai, or almost anywhere else—has become a permanent fair of what the world has to offer, significantly supplemented by Internet-based commerce that knows no boundaries. The exhibitionary complex of the twenty-first century is virtual as much as it is substantive, and the role of traditional elements of that complex and the power relations therein are in constant flux.[10]

An evocative example of the shifting nature of the complex and its implications for museums is offered by the world's fair running coincident with the conference that gave birth to this volume: Milan's Expo 2015. As has been typical of more recent fairs, this one was organized around a fairly specific theme with technical and political elements: the production, preparation, and consumption of food. It thus, again typically, made none of the claims of earlier fairs to being a comprehensive exposition of the twenty-first century world. (Compare, for example, the Expo 2015 motto of "Feeding the Planet, Energy for Life" with the 1970 Osaka fair's "Progress and Harmony for Mankind.") At Expo 2015, 145 nations participated, with most hosting individual pavilions. But careful management by the fair organizers, and possibly financial considerations, kept the scale of each pavilion modest, and richer and poorer nations had comparable presentations. The commercial presence was explicit but not overwhelming, although pavilion after pavilion did feature products and their attendant trademarks. The theme provided considerable latitude to the exhibiters, and both the architecture of the pavilions and the content of the displays showed considerable imagination and variety. Conspicuously absent, however, were artifacts claiming historical significance or, indeed, any larger importance beyond their display value. It can be argued that today's fairs, which struggle in any case to maintain their relevance in an age of universal imagery and information, have quite lost any attachment to the celebration of objects. Objects are displaced by experiences, and this displacement is perhaps their greatest similarity to the modern museums of science and technology.

The one place in both fairs and museums in which objects have retained their key places is in the shops. In each pavilion of the Milan fair, there were spaces, some large and some more modest, in which visitors were invited to purchase something to take away. Sometimes these were t-shirts or other typical souvenirs; in other cases, distinctive products—ethnic food, crafts, and clothing—were on offer, in some ways announcing more evocatively than the exhibits what seemed most remarkable in the modern material culture of the exhibiting nation. Likewise, no visitor to the modern museum of science and technology can help but be struck by the expanding place of the shops in such institutions. What may have once been largely specialized bookstores are now remarkable collections of objects, again mixing the typical souvenir with more special items, ranging from kites to telescopes to models of both animals and machines. Here, too, the museums convey new messages about what is most important and distinctive in what they offer to their visitors. The act of self-education that was always a shared aspect of both fairs and museums has been translated into an act of purchase and consumption.

In assessing how American culture and values had changed, mid-twentieth-century sociologists spoke of a transition from "heroes of production" in the nineteenth century to the "heroes of consumption" in the mid-twentieth.[11] The heroes of production were also central figures in the nineteenth-century world's fairs, with their emphasis on crafts and machinery. As the twentieth century wore on, the heroes of consumption—celebrities and champions of the almighty market—also made their mark in the world expositions in the form of corporate pavilions (where the latest and promised products were the celebrities) and boastful national displays. In the flush of worldwide prosperity and global information access at the century's close, these heroes faded away, at least in this setting. What took their place were not heroes but experiences—a world in which exposure to images and virtual experiences competed constantly with the concrete and the real. The addition of cinema to events such as the 1937 Paris International Exhibition to supplement artifacts and demonstrations marked the twentieth century's path from traditional notions of display to the modern purveying of sight, sound, and experience. This transition characterized the remainder of the twentieth century, and to some degree both world's fairs and museums have been part of a rearguard resistance to the dematerializing of experience.

A couple of years before the Paris International Exhibition of 1937, the German critic and philosopher Walter Benjamin published a seminal essay on "The Work of Art in the Age of Mechanical Reproduction." He attempted to define what makes a piece of art special and what was lost through its ready reproduction. He thus identified "that which withers in the age of mechanical reproduction is the aura of the work of art." In describing this "aura," Benjamin suggested that it gave a work of art the capacity for "historical testimony," which in turn rested on its "authenticity." With new reproducible media, especially cinema, Benjamin saw a "shattering of tradition" or "the liquidation of the traditional value of the cultural heritage." The new media meant that the traditional "cult value" of art (having its origins in ritual and context) was giving way to "exhibition value," emphasizing the information conveyed by the work. In the development of world's fairs and science museums in the twentieth century, one can readily see this shift from cult value to exhibition value, from association with acts of creation to the delivery of information about science and the technical world. This is not, following Benjamin, a bad thing or, for that matter, a good thing, but it is a necessary part of the adoption of new techniques and the accommodation of the interests of audiences, for whom cult and ritual have increasingly diminished values.[12]

Notes

1. E. S. Ferguson, "Technical Museums and International Exhibitions," *Technology and Culture,* 6, no. 1 (Winter 1965): 30–46.
2. Ferguson, "Technical Museums and International Exhibitions," 30.
3. Goode, from U.S. National Museum, *Annual Report* (1896–1897, part 2), quoted in Ferguson, "Technical Museums and International Exhibitions," 44 and 46; W. S. Jevons, "The Use and Abuse of Museums," in *Methods of Social Reform and Other Papers* (London: Macmillan, 1883), 66.
4. See, for example, A. C. de Matos, C. Demeulenaere-Douyère, and M. H. Souto, "Introduction. The World Exhibitions and the Display of Science, Technology and Culture: Moving Boundaries," *Quaderns d'Història de l'Enginyeria* 13 (2012): 3–10; the chapters in that volume; and R. W. Rydell, "World's Fairs and Museums," in *A Companion to Museum Studies*, ed. S. Macdonald (Malden, Mass.: Blackwell Publishing, 2006): 135–150.
5. T. Bennett, "The Exhibitionary Complex," *New Formations,* 4 (Spring 1988): 73–102. See quotations on page 73.
6. Some of these connections are discussed in Rydell, "World Fairs and Museums," 133–150.
7. See R. H. Kargon, K. Fiss, M. Low, and A. P. Molella, *World's Fairs on the Eve of War: Science, Technology, and Modernity, 1937–1942* (Pittsburgh, PA: University of Pittsburgh Press, 2015), especially chapter 2 on the 1937 Paris fair.
8. P. Brenni, "Universal and International Exhibitions and the Birth of Museums of History of Science and Technology," in "Esposizioni Universali in Europa. Attori, pubblici, memorie tra metropoli e colonie, 1851–1939," ed. G. L. Fontana and A. Pellegrino, Special issue, *Ricerche storiche,* 45, no.1–2, (2015): 126–127; Barreca (this volume).
9. W. S. Jevons, "The Use and Abuse of Museums," 67–68.
10. A number of authors have remarked on the transformation of the exhibitionary complex. See, for example, R. Brain, "Going to the Exhibition," in *The Physics of Empire*, ed. R. Staley (Cambridge: Whittle Museum of the History of Science, 1994), especially 137.
11. This terminology has been picked up by a number of authors, but it appears to originate in the work of Leo Lowenthal, who wrote of this in "Rise of Biography as a Popular Literary Type," in *Radio Research 1942–1943*, ed. F. N. Stanton and P. F.

Lazarsfeld (New York: Duell, Sloan, and Pearce, 1944). David Riesman makes use of this terminology in his classic book *The Lonely Crowd* (New Haven, Conn.: Yale University Press, 1950).

12. W. Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in *Illuminations*, ed. H. Arendt (New York: Schocken Books, 1969), quotations from page 221. The discussion of cult and exhibition values is on pages 224–225.

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About the Contributors

Nobumichi Ariga, Ph.D., is a historian of science and curator at Japan's National Museum of Nature and Science. He considers the big picture of how to integrate Western and Japanese histories of science. His research interests are broad and diverse, ranging from the history of physical and mathematical sciences—classical mechanics and computer simulations—to the historical relationship between science and technology in modern Japan. In addition, he is increasingly engaged in helping to archive materials related to Japanese scientists and research institutions.

Francesco Barreca is a postdoctoral researcher at the University of Florence and a consultant for the Museo Galileo in Florence. His research interests focus on the Renaissance, early modern science, and the Italian historiography of science.

Marco Beretta is a professor of history of science at the University of Bologna. He has published extensively about the history of ancient and early modern chemistry.

Andrée Bergeron is an associate professor in epistemology and history of science at Universcience, a member of the Institute for Research and Innovation in Society, and a researcher at the Centre Alexandre-Koyré, part of the Centre National de la Recherche Scientifique in Paris. She has worked extensively on the intersections among science, culture, and politics. Her primary research interests are the history of French cultural policies on science in the twentieth century, the history of science museums and international exhibitions in the twentieth century, the history of depictions of science on French public TV of the 1960s, and the history of international science popularization policies.

Charlotte Bigg is a research fellow at the Centre Alexandre-Koyré, part of the Centre National de la Recherche Scientifique in Paris. She has published widely on the social and cultural history of the physical and astronomical sciences in the nineteenth and twentieth centuries. Her work focuses especially on the elaboration of optical instruments and visual cultures in scientific practice and their communication to a range of scientific and popular audiences. With Andrée Bergeron she leads the international collective project *Matières à Penser: les mises en scènes des sciences et leurs enjeux, XIX–XXIe siècles*, which examines cultural and political implications of public displays of science.

Elena Canadelli is an assistant professor in history of science and naturalistic museology at the University of Padova and associate editor at *Nuncius: Journal of the Material and Visual History of Science*. Her research interests include visual and material aspects of science, with special attention to the history of science and natural history museums in the nineteenth and twentieth centuries. She has recently been working on the history of the Leonardo da Vinci National Museum of Science and Technology in Milan and on national and international science exhibitions between the nineteenth century and the first half of the twentieth century.

Bernard Finn is a curator emeritus at the Smithsonian Institution's National Museum of American History. His publications and his exhibitions have focused largely on the history of electrical power and communications, especially submarine telegraphy. He is also interested in the development of science and technology museums and the ways they have used objects for exhibits and research, which led him to cofound the *Artefacts: Studies in the History of Science and Technology* series in the mid-1990s.

Robert Friedel has taught the history of technology and science and environmental history at the University of Maryland since 1984. He has been a historian at the Smithsonian Institution's National Museum of History and Technology (now the National Museum of American History) and director of the IEEE Center for the History of Electrical Engineering. He has published several books on the nature of invention in the late nineteenth and early twentieth centuries, a survey of technological history, *A Culture of Improvement: Technology and the Western Millennium* (MIT Press, 2007), and numerous articles in a range of journals.

Claudio Giorgione graduated with a degree in history of art from the University of Milan. His dissertation discussed the Renaissance Milanese painter Bernardino Luini. Since 1997, he has been working at the Leonardo da Vinci National Museum of Science and Technology, where he is currently curator of the museum's Leonardo, Art and Science department and coordinates conservation projects. He is the author of the book *Leonardo da Vinci: The Collection of Models*, published by the museum in 2009, and has edited and written several essays about Leonardo da Vinci as an engineer.

Tina Kubot graduated with a degree in electrical engineering from the Technical University Braunschweig and, after a few years as an engineer in the electronics industry, earned a Ph.D. in semiconductor technology from the University of the Germany Federal Armed Forces. Because of her research interest in the history of technology, in 2013 she joined the Deutsches Museum in Munich as curator for Electronics and Telecommunication Technology. In 2017 she left to work with the collection of the Museum für Kommunikation Frankfurt, where she curates the media history collection. Her current research interest is the history of semiconductor and communications technology.

Cathleen Lewis is curator of International Space Programs and Spacesuits at the Smithsonian Institution's National Air and Space Museum, specializing in Soviet and Russian history. Lewis completed bachelor's and master's degrees in Russian and East European studies at Yale University and completed her Ph.D. in history at the George Washington University. Her current research is the re-examination of cosmonaut culture during the past six decades. Having analyzed artifacts in the Smithsonian's collections, she has written articles that compare Soviet and American approaches to exhibiting and portraying spaceflight. She is currently writing a history of the development of spacesuit gloves.

Allan A. Needell earned a B.A. in physics from Cornell University and a Ph.D. in the history of science from Yale University. He served as associate historian at the Center for History of Physics at the American Institute of Physics from 1978 until 1981, when he joined the Smithsonian's National Air and Space Museum. As a curator, he is responsible for the Apollo artifacts collection. He is the author of *Science, Cold War and the American State: Lloyd V. Berkner and the Balance of Professional Ideals* (Routledge, 2000), and has written about the history of physics and American government–science relations.

Pedro M. P. Raposo, D.Phil., is the curator and director of collections at the Adler Planetarium in Chicago, where he oversees world-class collections of astronomical instruments, prints, and rare books. He has published on topics such as the history of nineteenth-century observatories, astronomy and empire, and the history of modern planetaria. Raposo has acted as content expert and curator for several exhibitions, including *What Is a Planet?*, which won First Prize in the Great Exhibitions competition of the British Society for the History of Science in 2016. His current research interests include the history of visual and mechanical representations of the solar system; the notions of size and scale in astronomical imagery; and the role of photography in collecting, documenting, and curating techno-scientific artifacts. Raposo has served as member-at-large for the Committee of the Historical Astronomy Division of the American Astronomical Society.

Laura Ronzon is head of collections and curators at the Leonardo da Vinci National Museum of Science and Technology in Milan, where she has been working since 2001. At the museum she has organized collection management to foster public accessibility and coordinates the curators team that is responsible for the renovation of the museum's permanent exhibitions. At present, she is working with a range of different universities to develop a research program about the history of the museum and its collections as well as plans for future exhibitions. Her research interests focus on collection practices, museology, and cultural heritage. She is coeditor (with Giovanni Paoloni and Roberto Reali) of *I "Primati" della scienza. Documentare ed esporre scienza e tecnica tra fascismo e dopoguerra* (Hoepli, 2018).

Arne Schirrmacher studied natural sciences and philosophy in Hamburg, Oxford, and Munich before he became a research scholar at the Deutsches Museum working on the history of physics and on twentieth-century science communication. He was also an editor of the Hilbert Edition in Göttingen and a principal investigator in a research group on the history of quantum physics at the Max Planck Institute. In 2010, he joined the Department of History at Humboldt University in Berlin and held interim professorships both there and at the University of Regensburg. He was a visiting research scholar at University of California, Berkeley, during 2017–2018.

Jaume Valentines-Álvarez studied history at the University of Barcelona and engineering at the Barcelona School of Industrial Engineering, which exhibits a large drop hammer of a Catalan forge in one of its patios. Since 2014 he has been a postdoctoral researcher at the Interuniversity Centre for the History of Science and Technology in Lisbon and an assistant professor at the Nova University of Lisbon. He wrote his chapter about the forge while a visiting scholar at the Max Planck Institute for the History of Science. He is a member of the historians cooperative *Allaqqat*, an ancient Arabic term that is the etymological root of *alicates* ("pliers" in Catalan).

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The latest in the Artefacts series, *Behind the Exhibit* examines scientific heritage and narratives behind public display of scientific artifacts in national and international exhibitions and science museums throughout the twentieth century. Developed from the Artefacts XX conference, convened 20–22 September 2015 at the Leonardo da Vinci National Museum of Science and Technology in Milan, during Expo Milan 2015, this volume brings together museum curators and historians of science and technology to present case studies from the United States, Europe, Russia, and Japan. What emerged is a study of the tension between basic science and technological applications, the multilayered role of history, the appearance and disappearance of artifacts, and the search for a balance between entertainment and education.

Elena Canadelli is an assistant professor in history of science and naturalistic museology at the University of Padua and associate editor at *Nuncius: Journal of the Material and Visual History of Science.*

Marco Beretta is a professor of history of science at the University of Bologna.

Laura Ronzon is head of collections and curators at the Leonardo da Vinci National Museum of Science and Technology in Milan.

Contributors: Nobumichi Ariga, Francesco Barreca, Marco Beretta, Andrée Bergeron, Charlotte Bigg, Elena Canadelli, Bernard Finn, Robert Friedel, Claudio Giorgione, Tina Kubot, Cathleen Lewis, Allan A. Needell, Pedro M. P. Raposo, Arne Schirrmacher, and Jaume Valentines-Álvarez

Smithsonian Institution
Scholarly Press

https://scholarlypress.si.edu

ISBN (print): 978-1-944466-22-0
ISBN (online): 978-1-944466-23-7

https://doi.org/10.5479/si.9781944466237