SCIENCE ON DISPLAY:

RESEARCH EXHIBITIONS IN INTERWAR WASHINGTON

by

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ABSTRACT

As scientists who espoused basic research tried to organize for its support during the interwar era, they strove to find means to communicate recent developments to both the public and each other. Two prominent establishments in American science, the Carnegie Institution of Washington and the National Academy of Sciences, implemented exhibition schemes, which featured dynamic displays with contemporary basic scientific themes, as part of these communication experiments. Members of the scientific community used these exhibits in their struggle to create a new visual vocabulary in an era when research was becoming increasingly specialized and to distinguish themselves from the magical connotations of science that corporations presented at World's Fairs. This thesis provides a close examination of these exhibitions, revealing the role they performed in institutional efforts to strike a balance between conversation among scientists and communication to the public as well as their contribution to the establishment of modern science museum exhibit techniques.

Chapter 1

INTRODUCTION

In the late Victorian era, the term “science” carried connotations of pure and ennobling practices, and by the early twentieth century the invocation of science had become ubiquitous in American life. Technology and science were conflated, and science was used to describe such disparate subjects as domestic science, engineering projects, public utility systems, and even Frederick W. Taylor’s scientific approach to management in the workplace. As historian Mark Rose has written, for many Americans science “was a valuable idiom for expressing and legitimatizing their own forms of knowledge, their local organizations, and their group identities.”[1] At the immensely popular World’s Fairs, corporations dazzled the public with the technological sublime in seemingly magical displays of electricity and visions of a technological utopian future,[2] and journalists perpetuated the idea that science was an almost mystical force in American life.[3]

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1 Mark H. Rose, "Science as an Idiom in the Domain of Technology," Science & Technology Studies 5, no. 1 (Spring, 1987): 9.

2 David E. Nye, *American Technological Sublime*, (Cambridge, Mass.: MIT Press, 1994), 215-216.

3 David A. Hollinger, "Free Enterprise and Free Inquiry: The Emergence of Laissez-Faire Communitarianism in the Ideology of Science in the United States," *New Literary History* 21, no. 4, Papers from the Commonwealth Center for Literary and Cultural Change (Autumn, 1990): 903.

As innumerable topics seemed newly susceptible to scientific analysis in the early twentieth century, many American scientists found themselves negotiating their place in American society. Some, like Robert Woodward of the Carnegie Institution of Washington, worried that popular misconceptions surrounding science was having a detrimental effect on scientific organizations. Woodward wrote in 1915 that “the phrases 'scientific management,' 'industrial efficiency,' and the like, are now so much overapplied and so often misapplied as to render them offensive to judicially conservative minds."[4] To combat this, leaders in American science such as Woodward and George Hale championed basic research and advocated for the elevation of the scientist in the eyes of a disconnected public. Hale advanced ideas of collaborative research and the creation of a national science, while Woodward promoted careful planning in research projects and concentrated on implementing new patronage systems.

Taking a cue from the World’s Fairs and the American exhibition culture of the early twentieth century, two prominent Washington, DC scientific establishments with which Woodward and Hale were affiliated adopted scientific exhibit schemes to promulgate various aspects of basic scientific research. The Carnegie Institution exhibits, while ostensibly directed at the general public and the institution’s trustees, became a vehicle for encouraging interdepartmental collaboration and organizational unity. At the National Academy, Hale anticipated that impressive exhibits would solidify the agency’s place in the eyes of the public as the face of American science while also stimulating cooperative research. Subsequently, the National Academy

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4 CIW (Carnegie Institution of Washington). *Year Book.* No. 14 (Washington: CIW, 1915), 7.

created a niche in Washington for innovative exhibits that reached a broad general audience and changed the direction that institutional science museums would take for the rest of the twentieth century.

The Carnegie Institution of Washington and the National Academy of Sciences borrowed from and reacted against science as idiom to pioneer interactive science exhibits which attempted to present contemporary basic scientific research in an accurate and positive light. This thesis seeks to tell the account of these exhibits as part of a larger effort within the scientific community to reach an equilibrium between internal and external communication. How did leaders at each institution attempt to use exhibits as a way of encouraging meaningful dialogue between scientists in increasingly specialized fields? How were exhibits used in efforts to elevate and maintain the role of the basic scientist in the estimation of the American public? This thesis will show how some scientific statesmen employed exhibitions to negotiate the priorities and perspectives of these disparate audiences, viewed varyingly as complementary and conflicting throughout the interwar era.

Public Assumptions and Artificial Dichotomies

> "America has become a nation of science. There is no industry, from agriculture to architecture, that is not shaped by research and its results; there is not one of our fifteen millions of families that does not enjoy the benefits of scientific advancement; there is no law in our statutes, no motive in our conduct, that has not been made juster by the straightforward and unselfish habit of thought fostered by scientific methods."[5]

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[5] W. J. McGee, "Fifty Years of American Science," *Atlantic Monthly* (September 1898): 320.

W. J. McGee in *Atlantic Monthly*, 1898

When W. J. McGee, acting president of the American Association for the Advancement of Science (AAAS), wrote about science in American history and life in *Atlantic Monthly* in 1898, he tapped into the public's rapidly growing interest in science.[6] Much of what the public thought of as science, however, was "applied science." Although McGee and other scientists argued that applied or industrial developments grew out of "basic" or "pure science," many in the scientific community grew concerned that the public and large corporate sponsors would not support basic research.

Basic or pure science referred primarily to experiments and research being conducted at university laboratories to understand fundamental natural phenomena without any concern to potential commercial applications. Industrial or applied science could refer to new technologies, such as electric lighting and synthetic dyestuffs, whether or not those who developed these applications had utilized a theoretical scientific underpinning in their work. With the rise of industrial research and development laboratories in the late nineteenth and early twentieth century, promoters of corporate research such as Charles M. A. Stine, head of Du Pont's central research

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6 The AAAS had been founded half a century earlier to encourage scientific dialogue and collaboration as well as to advocate for better resources for scientific research on behalf academic practitioners, and it began to gain a stronger foothold in the early twentieth century. While the AAAS is not the focus of this thesis, the society's dual missions of collaboration and public outreach would also become concerns of the CIW and the NAS when they established exhibitions.

organization, referred to the work there as “fundamental research” in order to attract more scientists to work in industry.[7]

While academic scientists struggled to obtain funding at universities, applied research found many corporate sponsors. By the turn of the twentieth century, General Motors, General Electric, Bell, Du Pont, Kodak, and Standard Oil of New Jersey had all established major laboratories focused on research that could lead to commercial applications. By 1929, there were more than a thousand industrial laboratories in the United States. In scientific circles, however, academic scientists held higher status than those in industry, as scientists remained sensitive to the profit-driven and materialistic objectives of American business.[8]

The debate within the science and technological communities between the relative merits of pure and applied science began decades earlier. A pivotal moment came when physicist Henry A. Rowland made an impassioned “Plea for pure science” during the 1883 meeting of the American Association for the Advancement of Science (AAAS). Reacting to Thomas Edison’s being lauded by the American public as a scientific man, Rowland bemoaned that:

> It is not an uncommon thing, especially in American newspapers, to have the applications of science confounded with pure science; and some obscure American who steals the ideas of some great mind of the past, and enriches himself by the application of the same to domestic uses, is often lauded above the great originator of the idea, who might

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7 Thomas Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm 1870-1970*, (New York: Penguin Books, 1989), 171-180.

8 Ibid.

> have worked out hundreds of such applications, had his mind possessed the necessary element of vulgarity.[9]

Historian of Science David Hounshell argues that Edison's strained relationship with the American scientific community in the 1870s and 1880s "helped to shape a powerful reactionary ideology that resulted in the dichotomy between pure and applied science."[10] By 1915, Robert Woodward wrote that the distinctions between fundamental and applied research were artificial, but he found reason to be optimistic that "the invidious distinctions between them, often set up disadvantageously to both, seem to be slowly disappearing."[11] This dichotomy persisted throughout the early twentieth century, however, and in many ways continues today.

In addition to the concern that Americans did not understand the importance of basic science, two major assumptions concerning the scientific community persisted in the 1920s and 1930s that complicated efforts to present an accurate portrait of research. First, the American public largely denied the existence of a "scientific community," believing that scientists labored individually. The second assumption was that scientists operated outside of society, even though science's impact on society was acknowledged.[12]

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9 H. A. Rowland, *Physical Papers of Henry A. Rowland* (Baltimore: Johns Hopkins Press, 1901), 594, quoted in David A. Hounshell, "Edison and the Pure Science Ideal in 19th-Century America," *Science* 207, 4431 (1980): 612.

10 Hounshell, "Edison and the Pure Science Ideal," 612.

11 CIW. *Year Book.* No. 14 (Washington: CIW, 1915), 8.

12 Hollinger, "Free Enterprise and Free Inquiry," 898.

While many scientific promoters in the early twentieth century took advantage of the assertion that science was responsible for social progress and economic growth, some found the usurpation of science by nonscientific fields to be disconcerting. Woodward believed such loose definitions of science to be inimical to the interests of scientific research institution, as popular misconceptions concerning the cost and benefits of basic research threatened the solvency of scientific organizations.

In response to these concerns, the scientific community employed a variety of methods to reach the American public. Scientists and science journalists wrote for both popular and specialized magazines and newspapers. These have been well studied to determine how the American public perceived science in the first decades of the twentieth century. Historian Marcel La Follette describes the multifaceted definition of "science" that Americans received in popular publications, arguing that "science" as described by scientists and journalists could refer to the scientific community, research methods, a body of knowledge, and an acting and mysterious force in society. "Scientists" could refer to those in many different fields, and almost always connoted brilliant and dispassionate white males.[13] Communications historian Mary Zuegner notes that after World War I in the *Scientific American*, applied science in the form of inventions and engineering projects dominated headlines, while pure science was marginally covered.[14] Universities and research institutions held public lecture series. With the rise of radio in the 1920s and 1930s, popular shows like the

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13 Marcel La Follette, *Making Science our Own: Public Images of Science 1910-1955* (Chicago: The University of Chicago Press, 1990), 5-6.

14 Mary C. Zuegner, "The Watchword is Science: Portrayal of Science in *Scientific American*, 1921-1986" (PhD diss., University of Tennessee, Knoxville, 1999): 33.

Smithsonian Institution's *The World is Yours* and DuPont's *Cavalcade of America* served both to popularize and fictionalize science.[15] Schools and museums formed another arm of the public outreach strategy. Finally, some societies and institutions began organizing their own exhibitions.

How effective were these various methods? La Follette argues that the mass print media were the main shapers of public opinion on science before World War II, with schools and museums acting as ineffective filters of the information disseminated in print. She argues that from 1910 to 1955, scientists and scientific journalists failed in their mission to paint an accurate portrait of American scientific research.

By the turn of the twentieth century, Americans accepted that science, or what they thought of as science, was having a major impact on their daily lives. As man-made technology dazzled the American public as nature once did,[16] the structure of the scientific community was changing as new agencies and private institutions arose. With the founding of Carnegie Institution, the tightening of scientific bureaus in government, and the rise of the National Academy of Sciences and the National Research Council, Washington, DC became a stronghold of basic science in the United States. Thus, Washington provides a focal point through which to examine the major concerns and responses of the scientific community.

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15 Marcel La Follette, *Science on the Air: Popularizers and Personalities on Radio and Early Television* (Chicago: The University of Chicago Press, 2008).

16 Nye, *American Technological Sublime*, xiv, 282. Nye defines this phenomenon as the technological sublime, an American trope wherein man-made technology is idealized, provokes an awe-inspiring response, and becomes a justification for national destiny.

Ecology of Science in Washington, DC in the Early Twentieth Century

While debates over pure versus applied science influenced public opinion and policy, the organization of basic scientific research was changing. By the turn of the twentieth century, universities in the United States and Britain had become centers for fundamental scientific research in way they had not been in the early nineteenth century, although most research departments in universities continued to be underfunded and lacked proper instrumentation.[17] During the Progressive Era, the research university emerged and government bureaus such as the Public Health Service, the Bureau of Standards, and the National Advisory Committee for Aeronautics performed research and established closer ties with industry. [18] Lagging behind in this burgeoning ecology of science in Washington, DC, was the National Academy of Sciences (NAS).

Established in 1863 to advise the government on science, the NAS functioned as little more than an honorary society by the turn of the twentieth century and was ineffective as an advisory or organizational tool. Leaders in the scientific community such as George Ellery Hale soon turned their attentions to reforming the practically defunct institution when opportunity arose during the First World War. Hale, a well-known astromer and director of the Carnegie Institution's Mount Wilson Observatory, led reform efforts in the NAS to involve scientists in the war effort, which lead to the formation of the National Research Council (NRC) under the umbrella of the NAS. Hale and others saw the NRC as an opportunity in the long-term to stimulate basic

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17 Rose, "Science as an Idiom," 6.

18 A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities to 1940* (New York: Harper Torchbooks, 1957), 271-301.

research, coordinate the various scientific societies, and represent the United States in the international scientific community. Private donors, including the Carnegie Corporation and Rockefeller Foundation, supplied most of the funding for both the NAS and NRC between the world wars.[19]

By the late 1920s, the NAS was plagued by dysfunction and the NRC had lost its original grand vision and enthusiasm. Historian Glenn Bugos discusses the failed attempts at the NRC to facilitate cooperative and borderlands research in the interwar era. During peacetime, scientists were less willing to participate in cooperative research than they had been during World War I. Those who did participate were only willing if cooperation was the only way they could address their own research problems fully. The NRC, however, committed to efforts to coordinate government, academic, and industrial science, and their leaders were of the opinion that cooperative research would help stem the tide of over-specialization and fragmentation in science. Seeking to expand in the 1930s, the NRC focused on identifying new scientific disciplines and developing a community of researchers around those new fields.

The committee structure of the NRC worked against efforts to organize cooperative research. First, while the NRC could provide a sense of institutional legitimacy to borderland fields, the financial and scientific conservatism, upon which that legitimacy had been built, hampered more ambitious research plans in those same fields. Also, the committees could not fashion the necessary infrastructure when they were not meant to conduct the research, only facilitate it. As the NRC sought to

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19 Ibid., 309-30; Robert Kargon and Elizabeth Hodes, "Karl Compton, Isaiah Bowman, and the Politics of Science in the Great Depression" *Isis* 76, no. 3 (Sep., 1985): 303-4.

promote cooperative projects, the committees failed to effectively attract young scientists who remained interested in individual scientific ambitions. The committees did not significantly affect the way scientists worked, while individuals wanting to conduct cooperative research were more successful at organizing their own teams. Although the NRC did implement a new borderlands policy in 1934, the administrative obstacles continued and the NRC was soon eclipsed by the government as the new patron of science.[20] While Bugos analyzes the problematic committee structure thoroughly, he fails to recognize the role that exhibitions served in efforts to bring together American scientists.

According to historians of science Robert Kargon and Elizabeth Hodes, attitudes toward government support and long-range planning in scientific research fluctuated during the interwar period. Some scientific leaders directed their efforts toward organization building and intersectorial planning. Believing that science should be planned, coordinated, and managed in a method similar to liberal corporate practices, they attempted to reform the structural framework of institutional science. Before World War II, however, scientists largely preferred to keep their research completely separate from government intervention and thus sought funding primarily through private and foundational sources.[21]

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20 Glenn E. Bugos, "Managing Cooperative Research and Borderland Science in the National Research Council, 1922-1942," *Historical Studies in the Physical and Biological Sciences* 20, no. 1 (1989): 1-32. Bugos compares “borderland” and “cooperative” in the 1930s to the word “interdisciplinary” in the 1980s as buzzwords to secure funds from patrons.

21 Ibid., 300-2.

Historian Robert Kohler discusses patronage in American science in the interwar era and describes "an ecology of patronage, which shows how the distribution of resources was shaped by the social systems of science." In the nineteenth-century, university professors had only minimal funds available for research and extramural patronage was comparatively modest. The NAS and American Academy of Arts and Sciences endowed small individual grants for academic science, and the system did not attract wealthy philanthropists. This spare framework supporting academic research stemmed from the caution of academic scientists toward what they considered to be external interference by philanthropists. Furthermore, philanthropists thought that scientific research was too crucial to be left to scientists who divided their between research and teaching. Thus, both Andrew Carnegie and John D. Rockefeller opted to create research institutes that would not be affiliated with any university.[22]

The Rise of the Private Institution

In the first decades of the twentieth century, basic scientific research in the United States transformed as the nineteenth-century individualist and small groups were replaced by grand team projects. The research supported by leading philanthropists such as Carnegie, Rockefeller, and Andrew W. Mellon profoundly affected these fundamental changes, as new patronage networks shaped and were shaped by the construction of scientific knowledge within new institutions dedicated to basic science.[23] One of these institutions, the Carnegie Institution of Washington

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22 Kohler, *Partners in Science: Foundations and Natural Scientists 1900-1945* (Chicago: The University of Chicago Press, 1991), 2-14, quotes on 5 and 10.

23 Ibid.

(CIW), became a critical part of the scientific ecology of Washington along with the National Academy and the National Research Council.

The early history of the CIW has been well documented.[24] As director of the US Geological Survey and president of the Washington Memorial Association - a group committed to founding a national university in Washington - Charles D. Walcott took the lead in working toward establishing a scientific institution in the area. Walcott decided to approach Andrew Carnegie for possible funding, knowing that the philanthropist may be amenable to the enterprise. Carnegie did not agree to back an entire educational institution, but he did agree to fund an institution for scientific research and postgraduate training. As this satisfied the loosely defined goals of the Washington Memorial Institution, Carnegie proposed a gift to the nation of $10 million to President Theodore Roosevelt for research, a gift which was announced in December, 1901. The Carnegie Institution of Washington, as it was named, was incorporated on January 4, 1902.

Carnegie carried the nineteenth century ideal of the solitary scientist-inventor toiling away in an isolated laboratory, and consequently intended his financial contribution to primarily support individual grants. The Executive Committee for the

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24 John W. Servos, "To Explore the Borderland: The Foundation of the Geophysical Laboratory of the Carnegie Institution of Washington," *Historical Studies in the Physical Sciences* 14, no. 1 (1983): 147-185; Ellis L. Yochelson, "Andrew Carnegie and Charles Doolittle Walcott: The Origin and Early Years of the Carnegie Institution of Washington," in *The Earth, the Heavens and the Carnegie Institution of Washington*, ed. Gregory Good (Washington: American Geophysical Union, 1994), 1-21; Hatten S. Yoder, Jr., *Centennial History of the Carnegie Institution of Washington: The Geophysical Laboratory*, vol. 3 (Cambridge: Cambridge University Press, 2004).

Board of Trustees, as organized by Walcott who also served as secretary, had other ideas. The individualistic ideal, if it had ever existed, was being rapidly replaced by collaborative research endeavors in both universities and industry. The Executive Committee organized smaller advisory committees to report on specific needs in the various scientific subjects. While the institution did issue a number of grants to individuals in its first decades, Walcott ensured that the CIW had a strong centralized organization which could support the establishment of field-specific laboratories. Walcott, along with many other scientists, believed that collectivism was the way forward in science, articulating "individualism is the old view that one man can develop and carry forward any line of research, whereas collectivism embodies the modern idea of cooperation and community of effort."[25]

In a letter to Walcott in 1905, Carnegie reiterated his opposition to using his contribution for large laboratories,

> You know my own opinion is that no big institution should be erected anywhere, but the exceptional men should be encouraged to do their exceptional work in their own environment. There is nothing so deadening as gathering together a staff in an institution. Dry rot begins and routine kills original work.[26]

Since the endowment had already been established, however, the Board of Trustees could act as they thought befit the institution. Forming a unified organization with interdepartmental collaboration would be become a key concern for subsequent CIW presidents.

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25 Charles D. Walcott to Andrew Carnegie. Facsimile in Yoder, *Centennial History*, 4

26 Andrew Carnegie to Charles D. Walcott, 19 December 1905. Facsimile in Yoder, *Centennial History*, 11.

CIW became the first experiment of academic science sponsored on a large scale. Robert Kohler identifies Robert Woodward, who served as CIW from 1904 to 1920, as “the first modern manager of science.”[27] Struggles between Woodward, CIW’s board of trustees, and academics who expected the grants they received from the institution to have few stipulations dominated the early years of CIW. These struggles were indicative of a new patronage system for science being established by the end of the 1910s. CIW’s research departments became the institutional focus. Individual grants from CIW and other institutions diminished in the 1920s, and were replaced by large institutional grants made by foundations to construct facilities, as well as endow research, and fellowships. As Woodward argued in 1914, “Research, like architecture and engineering, is increasingly effective in proportion as it is carefully planned and executed in accordance with definite programs.”[28]

As universities and new research institutions like CIW gained in prestige, the scientific community concerned themselves with increasing communication networks. According to Dupree, “Since communication is component part of science, the increased activity of public and private agencies, instead of producing unhealthy competition, made a denser matrix of new lines of discovery which aided all investigators…This new partnership made government science seem to lose out in what was really a period of outstanding accomplishment.”[29] Debates on the relationship of basic and applied science were represented in a 1903 report by

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27 Kohler, *Partners in Science*, 16.

28 CIW. *Year Book.* No. 13 (Washington: CIW, 1914), 16.

29 Dupree, *Science in the Federal Government*, 299.

Theodore Roosevelt's Committee of Organization of Government Scientific Work, which recommended research done by government bureaus be problem-focused and leave the basic research to the private institutions and universities. Public exhibitions hosted by CIW and NAS-NRC would suggest to the public that private foundation and universities tad taken up the gauntlet thrown down by the Roosevelt Committee.

Organization and Scope of Thesis

This thesis examines the scientific community's participation in exhibition culture during the interwar war. The exhibitions at the National Academy and the Carnegie Institution were significant components in a plan to address larger objectives including the improvement of public outreach and internal communication. Leaders at both establishments observed the power that exhibitions at World's Fairs could have in a culture obsessed with display and decided to implement exhibit schemes on a smaller scale. Historians of science have thus far largely ignored the role such exhibitions played in public outreach and scientific planning and organization efforts in the interwar era. Furthermore, historians of museums have not scrutinized the innovative methods of display with which the NAS and the CIW experimented.

Chapter One examines the exhibition culture of the era, highlighting worlds' fairs and museums. By placing the CIW and the NAS exhibitions into the broader historiography of exhibition culture, their methods can be recognized for their innovation. Both institutions sought to minimize the magical connotations of science that thrived at the World's Fairs and in popular media. They also offered visitors something science and technology museums did not: a lively glimpse into contemporary scientific practice. Natural history museums continued to display staid collections, and technology museums touted technological progressivism deprived of social context. In an era when industrial factory tours were thriving but laboratories kept their doors closed to most visitors, installations at the CIW and the NAS enabled the public to see what they otherwise could not access.

Chapter Two details the annual exhibitions held at the Carnegie Institution of Washington from 1909 to 1942, focusing in closely on one exhibition during each of the three presidents within that period. The first exhibition, held during Robert Woodward's tenure as president, celebrated the dedication of the institution's Administration Building in Washington and was intended primarily for the benefit of the Board of Trustees and the general public. Scientists from each of the organization's departments prepared displays for the weekend event illustrating their most recent results. Upon observing the ways in which the exhibits brought together the scientists of the disparate institution departments, Woodward recommended the exhibition become a triennial event. John C. Merriam made the exhibition annual after he became president in 1920, believing strongly in their utility in building interdepartmental unity and in informing the public of the institution's mission and work through dynamic exhibits. When Vannevar Bush took over as president in 1939, he turned away from public outreach projects and sought to refocus priorities on research. In order to free up more of the scientists' time for research, Bush contracted out some exhibits to museums. The resulting exhibits were directed solely at a public audience and consequently no longer acted as an interdepartmental communicative tool. During their heyday, however, the CIW exhibitions had been an innovative experiment in both scientific communication and public outreach.

Chapter Three focuses on exhibitions held by the National Academy of Sciences in conjunction with the National Research Council in their Washington, DC building from 1924 until their premature cessation due to World War II. Director of CIW's Mount Wilson Observatory, George Hale had participated in CIW's initial exhibitions by the time he began to advocate for similar exhibits at the National Academy. The NAS exhibits, in contrast to their CIW counterparts, began as a significant component in efforts to accomplish the agency's major priorities of stimulating cooperative research and building institutional legitimacy. Whereas the finite size of the CIW and the short duration of their exhibitions had allowed them to be a useful way for scientists to communicate, the longer exhibits at the NAS proved to be impractical as a method to facilitate collaboration amongst the nation's scientists. The innovative interactive displays that were incorporated into the exhibits struck a chord with the public, however, and the NAS building transformed into the first large-scale experiment in modern science museum display methods.

This thesis takes a detailed look at how and why the Carnegie Institution and the National Academy of Sciences organized exhibitions and how the installations evolved over time, and thus reveals the contribution these institutions made to the development of modern scientific museum methods. The exhibitions represent some of the first efforts to present an accurate account of contemporary American basic scientific research to a disparate audience, and examining these exhibitions provides a window into the efforts that scientists employed to address a variety of concerns within the scientific community. This examination reveals the important and multifaceted roles exhibitions played in material culture of science in Washington, DC before World War II by facilitating communication amongst scientists, building organizational unity, and informing and educating the public.

Chapter 2

EXHIBITION CULTURE

When leaders at the CIW and the NAS-NRC decided to host their first public exhibitions in the 1910s and 1920s, American audiences were already well attuned to exhibition culture. In order to discuss the exhibitions of both establishments, it is useful to examine this culture, looking particularly at how historians have thus far interpreted the scientific displays at World's Fair and their counterparts in museums of science and technology of the era.

In his books on worlds' fairs, Robert Rydell describes the rise of the exhibition in the Victorian era, beginning in full force London's 1851 Great Exhibition of the Works of Industry of All Nations. The fairs "reflected profound concerns about the future and deflected criticism of the established political and social order." The fairs created a platform for those in authority – government officials, industrial leaders, and leading intellectual – to reinforce their own authority and provide direction to the public. The popularity of worlds' fairs diminished during World War I but experienced a recrudescence during the Depression, becoming a true "world of fairs."[30]

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30 Rydell, *All the World's a Fair: Visions of Empire at American International Expositions, 1876 – 1916* (Chicago: The University of Chicago Press, 1984); Rydell, *World of Fairs: The Century-of-Progress Expositions*, (Chicago: The University of Chicago Press, 1993), 5.

By the 1920s, powerful authority figures were committed to the medium of the fair "as a proven means for lending legitimacy to their positions of authority." In the Depression era, American fairs tended to emphasize the role science and technology melded with the modern corporation could play in creating a better future, and scientists often were heavily involved in creating the ideological content of the science-themed portions of the fairs. These fairs, including the 1933 Chicago and 1939 New York fairs, were designed to reaffirm the ability of America's leaders to steer the country out of the Depression to "a new, racially exclusive, promised land of material abundance."[31]

Academic scientists did participate in some of the fairs. For the 1933 Century of Progress International Exposition in Chicago, fair organizers solicited the guidance of members of the NAS. The exhibits emphasized the ways in which science served American civilization, showing that science united with industry could work to enforce order into an American culture destabilized by the Depression.[32] Academics lost their place as an educational authority, however, by the 1939 New York World's Fair, when, as historian Peter Kuznick argued, the "corporate vision of mystified and commodified science" took over completely.[33] The guide book for the fair states this occurrence explicitly: "the teaching of specific theories and facts in the world of

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31 Rydell, *World of Fairs*, 6-9.

32 Robert Rydell, "The Fan Dance of Science: American World's Fairs in the Great Depression," *Isis* 76, no. 4 (Dec., 1985): 525-535.

33 Peter Kuznick, "Losing the World of Tomorrow: The Battle Over the Presentation of Science at the 1939 New York World's Fair." *American Quarterly* 46, no. 3 (1994): 342.

science is…left to the commercial exhibits"[34] The technological sublime, as historian of technology David Nye explains, enraptured visitors to the fair, but the vision was a distinctly corporate one.[35]

Historian Eugene Ferguson recognizes that international exhibitions and their "enthusiasm and uncritical spirit" had a significant impact on the creation and philosophy of burgeoning museums of science and technology.[36] Often fair materials formed the foundation of new museum collections and selected total exhibits became institutionalized in museums.[37] Stella Butler traces the rise of the Science Museum in London from the South Kensington Museum to the Great Exhibition of 1851, and details how scientific reformers in the second half of the nineteenth century regarded such exhibitions as a way to both educate the public and cultivate support for future investigations.[38] According to Butler, the Exhibition made glaringly obvious the fact that Britain lacked organized technical and scientific education, and reformers worried that this would lead Britain to lag behind other countries.

Kenneth Hudson argues that, since the rise of industry, museums and other forms of display have become a key method for illustrating and explaining how new

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34 *Official Guide Book of the New York World's Fair*, (New York: Expositions Publications, Inc., 1939), 197.

35 Nye, *American Technological Sublime,* 215-216.

36 Eugene S. Ferguson, "Technical Museums and International Exhibitions," *Technology and Culture* 6, no. 1 (1965): 31.

37 Rydell, *World of Fairs*, 31.

38 Stella Butler, *Science and Technology Museums* (Leicester: Leicester University Press, 1992), 8-11.

technologies work to people who would not be able to go into the factories and see for themselves. Borrowing Victor Danilov's Three Phase structure of technical museum history, Hudson explicates the key institutions in each phase and adds a fourth phase.

In the first phase, museums housed collections of historic apparatus, even if they began as institutions dedicated to teaching contemporary technology. Two key institutions of this phase include the Musée National des Techniques in Paris, opened in 1799, and the Science Museum in London, which grew out of the South Kensington Museum in the mid-nineteenth century. Both institutions became national repositories for technological apparatus.

The primary example of Phase Two, in which museums incorporated working machinery in exhibits of historic to contemporary technological and scientific progress, was the Deutsches Museum in Munich. The museum opened formally in 1925, but temporary exhibits had been on display since 1906. The Deutsches Museum was the best known of museums of science and technology between the wars. Along with the Technical Museum in Vienna, it used films to illustrate technical processes in the 1920s – marvel museum strategy for the time. According to La Follette, museums of this era failed to be dynamic forums for presenting science, with staid exhibits "with little accompanying discussion of science in its social context and little audience engagement."[39]

In the third phase, museums focus on the present, with predominantly participatory exhibits with contemporary themes. Hudson identifies the Palais de la Découverte in Paris, founded in 1937, and the Chicago Museum of Science and

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39 Follette, *Making Science our Own*, 19.

Technology, whose participatory exhibits began in earnest after World War II, as influential examples of this phase.

According to Hudson, there is a Stage Four, wherein museums place science and technology in their social context, “without any a priori assumption that they are Good Things, museums with a social conscience.” Garnering support for an institution which may take a critical view of the history of science and technology and its impact on society, however, can be impeded by the regional political situation and industrial machinations, and thus these types of museums are slow to develop.[40] La Follette, Buchholz, and Zilber have examined the potential of science and technology museums to shape public opinion on policy issues. She has found that too often in the past science museums valued the products and artifacts of science as a source of visitor entertainment, rather than process and procedure behind those items.[41]

In recent decades, historians of science have begun to pay more attention to museums and their histories. Stella Butler explores the ways in which museums historically have demonstrated contemporary knowledge of the physical world, the change in ideas about science over time, and the social system that has built up around the practice of science. She states, “That we put science and technology in museums suggests that both are highly valued, and form distinct expressions of culture within society and that like art, there are physical artefacts which can somehow tell this

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40 Victor Danilov, *Science and Technology Centers* (Cambridge, Mass.: MIT Press, 1982), 17-41; Kenneth Hudson, *Museums of Influence* (Cambridge: Cambridge University Press, 1987), 88-112, quote on 108.

41 Marcel C. La Follette, Lisa M. Buchholz, and John Zilber, "Science and Technology Museums as Policy Tools- an Overview of the Issues," *Science, Technology, & Human Values* 8, no. 3 (Summer, 1983): 41-46.

story."[42] In twentieth century science, practitioners must go through a long education process which involves learning specialized language, which helps facilitate language among scientists. It also excludes, however, those who have not received such training from participating in discussion. The language barrier this creates is a significant struggle for museums whose primary audience is the "so-called scientifically illiterate." [43]

Sally Kohlstedt, in describing post-modernist critiques of science museums, states "museums, too, appeared to be cultural sites where stratified ideas about gender, race, ethnicity, and class were built into their very purposes and local self-expressions, even as museum managers laid claim to universal themes and comprehensive, even global, representation." [44] Steven Conn places the growth of American museums in the intellectual history of the late nineteenth century, viewing museums as social constructions and centers of intellectual and cultural debate.[45] Eilean Hooper-Greenhill argues that the materiality of science museums allow for an artificial stability to be created and classification and ordering schemes to be developed, all while serving as a intermediary for science, politics, and society. [46]

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42 Butler, *Science and Technology Museums*, 2-3.

43 Ibid., 12.

44 Kohlstedt, "'Thoughts in Things' Modernity, History, and North American Museums," *Isis* 96, no. 4 (December, 2005): 594.

45 Conn, *Museums and American Intellectual Life, 1876-1920* (Chicago: The University of Chicago Press, 1998).

46 Hooper-Greenhill, *Museums and the Shaping of Knowledge* (London: Routledge, 1992), 167-190.

Historian Sophie Forgan addresses science museums and their particularity of place, which aids in establishing credibility and relationship to knowledge. The NAS-NRC, having dedicated exhibition space so close to other national institutions of the era, would use its location in a quest to become the foremost exhibitor of contemporary science in DC.[47]

Writing in 1974, historian George Basalla noted that scientific and technical museums have historically catered to notions of technical utopianism, the idea that there exists some societal ideal which can only be reached through the continued progression of technological innovation and application.[48] This results in uncritical museum displays which strip technology and science away from any social context. Thomas Hughes has also written against technological progressivism in museums. Museums and historians of science and technology, according to Hughes, need to take critical stances, for only then "Americans will realize that not only their remarkable achievements but many of their deep and persistent problems arise, in the name or order, system, and control, from the mechanization and systematization of life and from the sacrifice of the organic and the spontaneous."[49]

Scientific and technological progressivism worked both for and against policy makers at the leading science institutions in the interwar era. While the idea that

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47 Forgan, "Building the Museum: Knowledge, Conflict, and the Power of Place," *Isis* 96, no. 4 (December, 2005).

48 Basalla, "Museums and Technological Utopianism," *Curator* 17, no. 2 (1974): 105-118.

49 Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm 1870-1970* (New York: Penguin Books, 1989), 4.

science and technology pressed society forward could be useful in gathering popular support for research, presenting the objects and results of research as *fait accompli* in a museum setting would only serve to reinforce popular notions of the magic of science and thus counteract efforts of showing what scientific research actually entailed.

In a culture replete with international expositions, department stores, museums, and local fairs, CIW and NAS-NRC chose exhibits in accordance with an established cultural affinity to displays as an effective method of reaching the public. While museum exhibits of the interwar era may have struggled with giving an accurate portrayal of American science, the exhibitions of CIW and NAS-NRC reflected the nature and agendas of the institutions organizing them. The Carnegie Institution of Washington organized and hosted public exhibits for the first time in 1909, and the event became annual in the 1920s and 1930s. Similarly, on the occasion of the dedication of the new Academy building close to the National Mall, NAS-NRC held an inaugural public exhibition. The building remained open throughout the year, hosting permanent and temporary exhibits catering to the varied Washington visitor.

Both institutions made efforts to distinguish their displays from the industrial displays of the worlds' fairs. Since the exhibits were produced within the organization, the CIW did not need to worry about their displays operating as an advertisement. Although the NAS-NRC did acquire exhibits from industrial sources, leaders took pains to ensure the exhibits would not serve as advertisements. Their displays were distinct from museums of the era by showing scientific investigations in development as opposed to science in an historic context. Both also reintroduced the human element of science and technology, having a scientist or other capable demonstrator at the exhibits to interact with the public; this contrasted heavily with technological museums treating objects stripped of any context.

These institutions strove, if not quite succeeded, for verisimilitude in exhibits on the research happening in the field and in the laboratories, and often were willing to invest much in the endeavor. If museums were mere filters of mass media information, as La Follette argues, why did CIW and NAS invest heavily in their exhibit campaigns? Through these exhibitions, both CIW and NAS illustrated their commitment to the material culture of contemporary fundamental scientific research and to showing the public what that culture entailed. Furthermore, the exhibitions took part in the larger material economies of research in the era, reflecting the complex social influences at work.

On a small scale, CIW pioneered exhibition techniques not seen in science and technology museums of the era. There was no national museum on the subject from which to draw ideas, and the Chicago Museum of Science and Industry was not established until 1933. While the National Museum of Natural History was well established, what worked in the display of the natural sciences differed dramatically from that of the physical sciences, the foci of many of CIW's investigations.

Conclusion

As basic scientific scholarship became increasingly technical and specialized, scientists during the interwar era strove to articulate their research to both the public and to each other. As they struggled to create a new visual vocabulary and distinguish themselves from the magical connotations corporations presented at expositions, some scientists borrowed from commercial techniques and experimented with exhibits as a forum for assorted communication. As such, exhibits at the CIW and the NAS-NRC anticipated Danilov's third phase of museum development. In a role previously unacknowledged, these establishments created dynamic exhibits on current research in basic science. Consequently, both had an impact on the direction science museums took toward interactivity and contemporary themes.

The Carnegie Institution dedicated their new Administration Building in Washington in 1909. To celebrate the event, leaders organized the first institutional exhibition to show the progress made during the first ten years of the CIW to the public and the trustees. A closer look will provide an insight into how these exhibitions became a productive experiment in innovative display techniques, public outreach, and organizational communication.

Chapter 3

ANNUAL EXHIBITIONS AT THE CARNEGIE INSTITUTION

Weekend exhibitions at the Carnegie Institution began during Robert Woodward's time as president. In the exhibition culture of the era, it seemed a natural way to illustrate the current progress of research to the trustees. Woodward observed, however, that at the inaugural 1909 exhibition many of the scientists of the institution's disparate departments[50] met each other for the first time. After this, exhibits were utilized as an effective communication tool. By the time John Merriam became president in 1920, the exhibits were well established as a key tool in fostering interdepartmental collaboration and were also proving to be useful in public outreach. The short weekend structure proved ideal for the purposes of fostering interdepartmental communication and collaboration because the short duration did not disrupt the restrictive material economy in which scientists operated. Furthermore, the scale and departmental organization of the CIW made it possible for the exhibits to play a role in fostering collaboration in a way exhibits would not be able to at the NAS.

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50 The departments of the CIW included the following: Plant Biology (1903-present), Historical Research (1903-1958), Genetics (1904-1971), Marine Biology (1904-1939), Economics and Sociology (1904-1916), Terrestrial Magnetism (1904-present), Mount Wilson Observatory (1904-present), Geophysical Laboratory (1905-present), Meridian Astrometry (1905-1938), Nutrition Laboratory (1907-1946), and Embryology (1914-present).

With a new president in 1939 came new institutional direction. As president, Vannevar Bush sought to reign in expenditures and refocus the scientists' attention on research. As a result, the communicative component of the exhibits was eliminated as the meetings held in conjunction with the weekend took over that role completely. The public outreach component of the exhibitions proved not enough to sustain the exhibits, for by 1939 science museums were taking over that responsibility. World War II brought a formal end to height of the exhibition period at the CIW. During their heyday, however, the exhibits at the CIW were able to reach vastly different audiences and were a productive experiment in scientific communication techniques. This chapter will take a close look at three of the exhibitions, one during each president's tenure, to show the complex ways in which the CIW utilized the events to address an array of institutional objectives.

Beginnings under Robert Woodward: For the Trustees

The Administration Building of the institution opened in Washington, DC in 1909, and a Publications Office was established to disseminate the institution's findings. In addition to prolific publications detailing the minutiae of research, the office produced an annual yearbook to summarize the institutional activities each year for the trustees. These yearbooks provide important insights into the initial motivation for the exhibitions, and how these motivations changed over time.

The Board of Trustees made financial decisions and contributed to the funding of the Institution. The 1909 Yearbook mentions the difficult national economic climate in which the Institution was operating, and President Woodward was acutely aware of the need to impress the Board at their annual December meetings. He remarked, "ultimate success will depend in the main on concentration of effort and persistence of industry, along with ample financial and patient moral support from the Board of Trustees."[51]

As part of the effort to make the best impression, members of the Institution's Executive Committee decided that an exhibition would be appropriate for the upcoming meeting, to be held during the opening of the Administration Building on P Street in December, 1909. They invited the heads of each department to organize displays of the research each department had conducted along with any consequent interesting results. Woodward hoped that through these exhibits, "the Trustees may thus become more intimately acquainted with the general features if not with the complex details of departmental researches."[52]

The dedication of the Administration Building included formal speeches and lectures, and afterward the Board and their guests went up to the top floor to view the exhibits on Monday December 11, 1909. Each department including publication and administration was represented. The yearbook does not detail what the exhibits entailed further than noting they included a map of the world that demonstrated where research was being conducted and showed the routes of any surveys and explorations completed by CIW. The exhibits were then open to the general public in the afternoons for a week after the dedication, receiving between 3000 and 4000 visitors.

While the inaugural exhibition succeeded in showing the trustees current institutional research, Woodward observed another unintended, yet welcome, result. He remarked in his annual report for 1910 that the event was the first time that the

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51 CIW. *Year Book.* No. 8 (Washington: CIW, 1909), 28.

52 Ibid., 29.

directors of every CIW department had had a chance to become acquainted. In an organization comprised of disparate research departments scattered around the United States and investigating vastly different sciences, some directors met each other for the first time at the Administration Building dedication. This fortuitous outcome and the positive effects that Woodward and other noted became a crucial factor in the justification of the continuance of exhibitions in the future. The sense of community the event fostered and the interdisciplinary projects it encouraged would be prominent themes in future exhibits.

After the inaugural exhibition, Woodward also saw the exhibits' potential as a public outreach tool. He reported that the exhibition served the purpose of counteracting false impressions that may have been circulating around the public sphere concerning the mission and work of CIW. According to him, "in proportion as the work of the Institution is novel, advanced, or fundamental it will be difficult to understand and slow to receive popular appreciation. Some of it, indeed, must be expected to meet initially with disapproval because misunderstood." In Woodward's estimation, the exhibition, along with a 32-page companion pamphlet, had done more than any previous attempt to give an accurate indication of the Institution's work. Furthermore, he found the reception of the exhibits by the public to be "very gratifying."[53]

Woodward recommended holding exhibitions at the Administration Building every three to five years, in order to "counteract false impressions, to keep the investigator in touch with his contemporaries in other occupations, and to maintain an

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53 CIW. *Year Book.* No. 9 (Washington: CIW, 1910), 10.

intelligent public interest in the work of the Institution."[54] In an era of organization building in the sciences, the exhibitions were deemed an essential component in bolstering CIW as a unified institution with a coherent mission in the eyes of both the public and the researchers the Institution employed across the nation.

While a precedent had been set with the dedication exhibition of 1909, the event did not become an institutional priority right away. The next exhibits were held in 1911, but few mentions of them are made in the yearbooks. President Woodward reiterated his view in 1913, however, that exhibits and an annual conference were needed to stimulate "a fraternity of interest and a solidarity of purpose" due to the relative autonomy and isolation of the departments.[55]

The Executive Committee decided that the institution should participate, after receiving an invitation, in the Panama-Pacific International Exposition, which would be held in San Francisco in February 1915. In the 1914 institution budget appropriations, the board allocated $10,000 for such an exhibit and transportation considerations. The displays that went to the exposition were largely featured first in another Administration Building exhibition in December 1914. The exhibits featured an outline of the institution's scope and focused on the international nature of the research being conducted at CIW, with the natural and biological sciences being particularly well-represented.[56] A catalog for the December 1914 event provides a

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54 Ibid.

55 CIW. *Year Book.* No. 12 (Washington: CIW, 1913), 15.

56 Will Carson Ryan, *Education Exhibits at the Panama-Pacific International Exposition* (Washington: U.S. Government Printing Office, 1916), 91-92.

detailed outline of what each department's display consisted. As this was only the third exhibition for the institution, an analysis of the catalog hints at early practices as the institution experimented with content and purpose.[57]

The exhibits in 1914 were left up to each individual department with little to no effort to show broader institutional themes. This suggests that, while the institution had committed to hosting these exhibits, the organizers did not yet have a unified vision that could be easily diffused to departmental participants. For example, The Mount Wilson Observatory's (MWO) contribution was extensive, taking up over seven pages in the catalog compared to the Geophysical Laboratory's quarter page. MWO's exhibit included photographs of the laboratories, instrumentation, grounds, and instrument shops of the department as well as photographs and transparencies of various spectra and observations made by the department in Pasadena. In contrast, the Geophysical Laboratory brought fewer items, but they tended to be larger, including plaster of Paris models demonstrating mineral syntheses done by the department. Their contribution also included what was possibly that year's only interactive exhibit, described in the catalog as "A Working Exhibit on the Manner of Making Thin-Sections of Lavas and Rocks for Optical Study, and a Small Projection Apparatus to show these Sections on the Screen."[58] Given the proximity of the Geophysical Laboratory and the Department of Terrestrial Magnetism (DTM) to the Administration

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57 "Catalogue of Third General Exhibit of Work of Departments of Research, Administration Building," December 1914. Exhibits Committee Papers, Carnegie Administration Files, Carnegie Institution of Washington (hereafter cited as CAF-CIW).

58 Ibid.

Building compared to the other departments, those departments were in a better position to bring in actual equipment from their laboratories rather than photographs.

Other than the contributions of the Geophysical Laboratory and DTM, the displays predominantly consisted of two-dimensional objects, including photographs, maps, illustrations, and diagrams. DTM's displays had four large objects: a scale model of the non-magnetic ship *Carnegie* used in magnetism expeditions, a 30-inch globe marked with metal pins showing the location of department surveys, an ion-counter, and a combined magnetometer and earth-inductor.[59] Both instruments were either created or heavily modified by DTM, which housed its own instrument shop.[60] Due to their general nature, the ship model and globe would have primarily interested the trustees and the public. DTM investigators used the exhibit further to highlight their improvements to instrumentation, which allowed other scientists an opportunity to examine the apparatus in person, rather than a schematic diagram in a published journal.

Individual exhibits varied in their attempts to present a unified picture of a department. MWO was the only department to present a departmental objective statement and a summary of the exhibit that tied their contribution together in a unified manner around the objective.[61] MWO's success in presenting a unified

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59 Two of these objects still exist. The *Carnegie* model sits in the entrance hall to the DTM-Geophysical Laboratory campus, and the globe is on display in the library of CIW's Administration Building.

60 "Catalogue of Third General Exhibit."

61 Ibid. The MWO Object is as follows: "The study of the evolution of the stars and the structure of the universe." The MWO Summary is: "The exhibit consists of two parts: photographic prints mounted in swinging frames, and glass transparencies of

portrait may be due to George Hale's role, as Hale already had experience facilitating organization. In contrast, the Department of Embryology arranged their displays around different researches on human embryos, but the displays did not present a cohesive story. For example, one component of the exhibit was labeled, "Some of the Stages in the Development of the Human Nervous System."[62] The display included models of the brain and nerves of an embryo, for which the department included a photo of a stained section to show nerve development at a particular moment, but together the components failed to explain the development of the human nervous system.

A look at the Department of Botanical Research's contribution to the 1914 exhibition reveals that some participants used the exhibits for purposes similar to those of world's fairs and science museums. The department used the event as a venue to present a new classification scheme concerning portions of conducted research, following in the tradition of world's fairs where exhibits leant authority to the presenters.[63] One of their contributions was a "Revised Map of the Vegetation of the United States, based on Physiological and Anatomical Characteristics rather than Floristic Relationships."[64] That they presented this scheme in an exhibition setting has

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various astronomical subjects photographed with the instruments of the Observatory. The prints are intended to illustrate, in as connected a manner as possible, the various phases of the Observatory's work. The transparencies, on the other hand, are selected photographs, reproduced in this form in order to show delicate details which paper prints will not reproduce."

62 Ibid.

63 Rydell, *World of Fairs*, 6.

64 "Catalogue of Third General Exhibit."

intriguing parallels with Eilean Hooper-Greenhill's findings concerning the materiality of science museums lending credence to new ordering and classification creations. The department was able to borrow both from the rising prestige of the institution and the legitimizing atmosphere of a museum-type setting to lend credence to their proposed ordering scheme for vegetation.[65]

Even though the 1914 exhibition lacked focus, Woodward was heartened by the public response to CIW's contribution to the Panama-Pacific Exposition, which was based on the 1914 Administration Building exhibits. He wrote that, while the public remained slow to comprehend what contemporary scientific research entailed, "there is manifest an active leaven of intelligent desire to promote altruistic investigation, to differentiate these essentials from what is adventitious to them, and to measure the Institution's right to existence by the more stable standards of capacity to contribute permanent additions to the sum of verifiable and hence available knowledge."[66] Presumably, though, World War I suspended further exhibits, as no mention of them is made in the institution yearbooks until 1921.

Although Woodward spoke of the role that the exhibits were playing in showing the general public what modern basic research entailed, he did not see public outreach to be an institutional priority. In one institutional report on public relations, it is noted that as late as 1913 Woodward and others at the CIW were against publishing transcripts of public lectures in print due to the concern that such

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65 Eilean Hooper-Greenhill, *Museums and the Shaping of Knowledge* (London: Routledge, 1992), 167-190.

66 CIW. *Year Book.* No. 14 (Washington: CIW, 1915), 6.

publications "might confuse ideas with regard to the function of the Institution and convey wrong impressions, it not being the purpose of the Institution to popularize science."[67] This view would shift with the appointment of John Merriam to president of the Carnegie Institution in 1920.

Exhibits under John C. Merriam: A Turn to the Public

Dr. John C. Merriam, a paleontologist, took over as president of CIW in 1920, and during his tenure, he made it an institutional priority to develop a program of research interpretation by which CIW could not only share their researchers' work with other researchers, but with a broader public. Exhibitions became a key element in this endeavor, and after 1921the Administration Building exhibits became an annual affair. A permanent committee was formed to be responsible for putting on the event each year. Scientists in every department served on a rotational basis.

Each year in December, visitors to the Administration Building had the opportunity to engage directly with scientists and the apparatus with which they worked at the four-day Annual Exhibition. According to CIW's report on the 1928 exhibition, the purpose of the event was to highlight the current research of the Institution and give "the visitor a balanced, connected impression of its [the Institution's] significance and of the interrelationship of its activities." Comprised of selected exhibits from each of CIW's various departments and a series of lectures, the exhibition played the central role in CIW's public engagement initiatives, as headed by Merriam, and as such the institution put great efforts into ensuring its success.

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67 "Carnegie Institution of Washington and Relations to the Public," c. 1936. Exhibits Committee Papers, CAF-CIW.

Advertisements were included in Washington area newspapers before the events. Afterward, accounts of the exhibitions and transcripts of the lectures were often published in scientific and other popular journals, including *Science*, *Scientific Monthly*, *Scribner's Magazine*, and *Harper's Monthly*.

The 1925 exhibition pamphlet indicates a shift in exhibit methods towards more objects, instruments, live specimens, and interactive displays. While the displays still featured many maps, diagrams, and photographs, the exhibition had become much more three-dimensional.[68] As the objects became more complex and extravagant, transportation costs increased.

According to the exhibits committee in 1925, there were four primary types of exhibits illustrating some aspect of contemporary basic science research. First, some highlighted the object or materials being studied. Others underscored the methodology of the research, particularly the specialized instrumentation involved. Third, some focused on the underlying principle of a research problem and employed models or an experimental set-up to do so. Finally, some scientists centered their exhibits on experimental results, utilizing models, graphs, tables, or other appropriate materials.[69]

Another metric separated exhibits by level of audience interaction. Those exhibits which functioned with the press of a button were preferred. The others consisted of functioning exhibits that required an attendant to be present or "still life"

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68 "Exhibits Representing Results of Recent Research Activities," December 1925. Exhibits Committee Papers, CAF-CIW.

69 "Report of the Committee on Exhibits for 1925." 2. Exhibits Committee Papers, CAF-CIW.

exhibits, ones that did not operate during the event. The committee was well aware that people preferred not to see static instruments. They wrote in their 1924 preparations that, "an isolated piece of apparatus, no matter how ingenious and perfect, is not interesting to the average individual, because he does not appreciate its function which after all is the important thing."[70]

Historian Kenneth Hudson identifies the founding of the Palais de la Découverte in Paris in 1937 as the beginning of a new phase in science and technology museums, wherein the present is foregrounded through participatory exhibits with contemporary themes. Hudson and fellow historian Victor Danilov identify the Chicago Museum of Science and Industry as the first such museum in the United States. Before this, technologies and apparatus were mostly exhibited in static displays showing a progression of technological history or objects as aesthetic pieces stripped of context, such as in the Duetsches Museum in Germany.[71] The exhibit committee at the Carnegie Institution, however, was discussing the utility of interactive demonstrations much earlier. By emphasizing current research, CIW's exhibitions addressed a gap in museums of the era to show contemporary scientific practice in action. This was particularly true for the physical sciences, for there was no national museum for those subjects as there was for natural history. While the crowded

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70 "Committee on Exhibits for 1924 Preliminary Report No. 2" 12 May 1924, 2. Exhibits Committee Papers, CAF-CIW.

71 Hudson, *Museums of Influence;* Danilov, *Science and Technology Centers,* 17-41.

Smithsonian's Arts and Industries Building displayed scientific and technological apparatus, it remained focused on historic themes.[72]

In the 1925 exhibition, there were no fewer than four demonstrations mentioned in the pamphlet. Merle Tuve of DTM highlighted recent ionospheric sounding experiments by "Demonstration by echoes of radio waves from Naval Research Laboratory and Bureau of Standards." The Nutrition Laboratory featured an interactive feature that allowed visitors to measure their energy consumption while performing work – in this case ironing clothes—an exhibit that catered particularly to female visitors.[73]

Furthermore, most exhibits had a demonstrator, often the scientist behind the research, present to speak about or operate a particular apparatus throughout the weekend. For example, D. N. Lehmer stayed in the Administration Building library and showed visitors how to use a "stencil device for factoring of numbers."[74] These efforts paid off according to the committee, as they observed that people tended to gather around the exhibits that had demonstrators, especially ones who were able to express their work in clear, non-technical language. The committee even thought that, in a few cases, the scientists had been too enthusiastic. They critiqued, "several of the

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72 Pamela M. Henson, ""Objects of Curious Research": The History of Science and Technology at the Smithsonian." *Isis* 90, Supplement, Catching up with the Vision: Essays on the Occasion of the 75th Anniversary of the Founding of the History of Science Society (1999): S249-S269.

73 "Exhibits Representing Results of Recent Research Activities," December 1925. Exhibits Committee Papers, CAF-CIW.

74 Ibid.

automatic exhibits were extraordinarily well made, possibly a little too well for the purpose. Some expense could have been spared if they had not been so exquisitely finished, and the purpose would have been equally well served." [75]

Merriam's annual report for 1925 included a section on the exhibits in which he emphasized their role in stimulating cooperative research between different institutional departments. He believed such efforts aided in counteracting the negative consequences of specialized researched. He argued, "At this time of highly specialized science it is not only extremely important to carry each investigation to the uttermost attainable limit, but it is more and more desirable to know the extent to which information on a given subject may find its interpretation through organized knowledge in other fields."[76]

Merriam listed examples of interdisciplinary research that had resulted from discussions investigators had at the annual exhibitions. In one case, the Department of Genetics and the Nutrition Laboratory collaborated on a study on metabolic pathways and the influence of the thyroid gland in pigeons. In another instance, Dr. Benedict of the Nutrition Laboratory had displayed a new respiration calorimeter used to study human energy consumption at the 1925 exhibition. Subsequently, members of the Department of Terrestrial Magnetism were trained to use the device in order to study the inhabitants living near the Carnegie observatory in South America for their colleagues at the Nutrition Laboratory.[77]

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75 "Report of the Committee on Exhibits for 1925." 4. Exhibits Committee Papers, CAF-CIW.

76 CIW. *Year Book.* No. 25 (Washington: CIW, 1925-26), 11.

77 Ibid., 12.

In terms of reaching out to the general public, the Exhibits Committee was encouraged by the 1925 exhibition. Their efforts to make the displays more comprehensible to a general audience paid off, as local newspaper reports commented enthusiastically about them. It also helped that the exhibition attracted a more sophisticated audience with a "higher order of intelligence" than the previous year had. According to the committee, the scientists demonstrating that year found it "gratifying…to be asked intelligent questions and to hear the many expressions of appreciation from the visitors of the efforts that are being made to show them what the Carnegie Institution is doing and to make the results of its scientific work intelligible to them." [78]

The committee observed in their reports that more effort could be made to facilitate the comfort of the visitors. They stressed the need to improve ventilation. They calculated that the building exhibits could comfortably accommodate only 100 visitors per hour and suggested adding evenings to the event to relieve congestion on other days. There were enough female visitors to the events to justify providing a larger cloak room, more benches for elderly visitors, and a table in the ladies room "equipped with combs, hair pins, etc."[79]

CIW celebrated its twenty-fifth anniversary in 1928 through a series of retrospectives and lecture at Cold Spring Harbor on Long Island, NY, the site of the Department of Genetics housing the Station for Experimental Evolution and the

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78 "Report of the Committee on Exhibits for 1925." 1. Exhibits Committee Papers, CAF-CIW.

79 Ibid., 5,7.

Eugenics Record Office. New exhibits were organized for the occasion, and again a major theme was organizational research collaboration. In his address for the event, Merriam praised the exhibits for being “concrete illustrations of the tendency to relationship among investigating groups of the Institution.” One display highlighted a collaborative project between the Department of Genetics and the Nutrition Laboratory, a project which determined the relationship between the thyroid glands and the process of metabolism. Another exhibit showed research conducted by the Division of Plant Biology in conjunction with the University of California. [80]

Merriam also spoke of the uniqueness and educational possibilities of such exhibits. The exhibits gave the visitor a singular opportunity to see basic research projects “through the eyes of those who have conducted the investigations.” He praised their clarity of communication: “if the story could always be told as effectively as it is developed here, we should have advanced far in bringing research to a point at which the statement of its results would be at once an extremely effective form of education.”[81]

Another speaker at the Cold Spring event also acknowledged public outreach themes, which showed a continued commitment by CIW representatives to the improvement of both internal and external communication in science. Edwin Conklin, a zoologist and active promoter of science to the public, spoke of the CIW’s success at demonstrating the importance of basic research to the American public. He exaggerated, “There is now universal recognition of the importance of research, not

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80 CIW. *Year Book.* No. 28 (Washington: CIW, 1928-29), 21-22.

81 Ibid.

only for the increase of knowledge for its own sake, but also for the preservation and promotion of national welfare."[82]

In 1930, the board of trustees approved a proposal for an extension of the Administration Building of the institution. The extension included a lecture hall and a new space for exhibits, as well as conference rooms and offices, showing an established commitment to the exhibition scheme. In a 1931 memo, President Merriam stated the multitudinous objectives of the exhibitions: developing "to aid in developing mutual support among the departments, as also mutual support between the departments and the Institution, and between the Institution as a whole and other agencies. It is also important to bring the information regarding the development of these results to a wide range of persons in scientific fields and those interested broadly in the significance of science."[83] The institution obtained sufficient funds to begin construction in 1937, and the extension was dedicated in December, 1938.

For Merriam, the exhibits constituted a significant component in a larger program of public outreach throughout the 1920s. Under his tenure, the CIW's Division of Publication disseminated popular accounts of research being conducted that the institution. For example, accounts of the Department of Terrestrial Magnetism's experiments in the 1920s with high voltage apparatus were printed with headlines such as "Shattering the Atom."[84] The exhibits, lecture series, and popular

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82 Ibid., 27.

83 "Report of the Committee on Exhibits for 1925." 4. Exhibits Committee Papers, CAF-CIW.

84 CIW, "Shattering the Atom," *CIW Press Service Bulletin* (11 November 1928).

printed accounts made up a dynamic public relations effort while Merriam served as president of the CIW.

The Vannevar Bush Years: Refocus on Research

While President Merriam had placed a high priority on the exhibitions, Dr. Vannevar Bush changed course upon his appointment as president of the Carnegie Institution beginning in January, 1939. In Merriam's final report as president in 1938, he had extolled the newly completed lecture hall and reiterated a strong belief in the utility of the exhibitions. In contrast, Bush's first annual report makes no mention at all of the exhibition. Indeed, Bush never mentions exhibitions in his reports throughout the next decade.

In a summary of a meeting held on April 28, 1939 between Bush and the exhibits committee, the relative importance of the purposes of the exhibitions had clearly shifted. President Bush brought the trustees back to the foreground, emphasizing the importance of the exhibits to facilitating positive relationships with the board. The meeting summary stated, "it is very important to keep the trustees enthusiastic and apprised of these activities, and the exhibits certainly help toward this goal." The general public outreach purposes of the exhibit were restated, too: "It is felt that the relationship between the Institution and the public in Washington has been improved through the exhibit activities." Public interests, however, cease to be a primary concern in the committee papers. The organizational effects were also recognized, but not to the extent seen in previous years.

While Bush supported the continuance of exhibits, the tone was distinct from his predecessor. Knowing that the institution was suffering financially, he emphasized curtailing the expense that went into creating the exhibits. "there is…no question of their being expensive in both the use of funds and time." Bush also expressed a worry that the exhibitions had become too much of a distraction to his researchers. The report stated, "it must be kept in mind that the Institution's primary duty is research." As a result of these concerns, the committee and Bush decided that the "whole exhibit problem, therefore, may be considered to be in a state of trial, or flux." [85]

The committee implemented several changes to accommodate these concerns. In an attempt to free up the time of the institution's established researchers, Bush recommended that most demonstrators should be younger members. In addition, Saturday morning and afternoon of the event would be reserved for an interdepartmental meeting, and thus the exhibits would be closed to the public until the evening.

Another drastic change included outsourcing the exhibit design and construction away from the departments. R. P. Shaw, director of the New York Museum of Science and Industry, agreed to collaborate with the Carnegie Institution in "an attempt to make the exhibits more accessible to the public, and, at the same time, to relieve some departments of the burden of building exhibits."[86]

Milislav Demerec, of the Department of Genetics and chairman of the Exhibits Committee for 1939, issued a "Memorandum on Exhibits" summarizing the meeting the committee had with President Bush that March. In it, he detailed the two types of exhibits featured at the annual exhibitions, which included ones that only showed the most recent developments and results of a current problem and those which gave a

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85 Report dated 28 April 1939, 1. Exhibits Committee Papers, CAF-CIW.

86 Ibid.

more comprehensive overview of a research subject. The latter type "usually requires a great deal of time and labor;" thus, exhibits of this type, if possible, would be the ones handed over to the New York Museum of Science and Industry.[87]

In their original agreement, the museum agreed to supply three or four exhibits per year for the annual CIW exhibition, which would then be loaned to the museum for three to five years. CIW would furnish all of the materials "namely static exhibits, moving exhibits, photographs, transparencies, dioramas, charts, sketches, drawings, specimens, models, instruments, projection slides, motion picture films, etc." The museum would then create appropriate housing and displays with the material. Carnegie covered the material expenses and transport of the material to the museum and then to Washington, and agreed to share the housing and labor costs with the museum. The museum agreed to pay for transportation of the exhibits from their last location to the museum and any subsequent costs after that. Furthermore, the loan was on the understanding that the museum was not responsible for any loss or damage while they retained the items.[88]

The 1939 exhibition reflected the shift in exhibit policy that Dr. Bush implemented. Scientific idea exchange was only referred to in relation to the interdepartmental meetings held in conjunction with the exhibits each year. The foreword references the scientist's part in the exhibits in relation to enhancing the visitor experience, "When scientists personally present their results, as is the adopted

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87 M. Demerec, "Memorandum on Exhibits," 17 March 1939. Exhibits Committee Papers, CAF-CIW.

88 "Memorandum on a Conference held in New York, March 24, 1939 with Mr. R. P. Shaw." New York Museum of Science and Industry Correspondence. CAF-CIW.

procedure at these annual exhibits, it is felt that an especially effective means is provided for giving visitors an insight into the work of the Institution."[89]

The number of exhibits was reduced to twelve, of which one was completed by an individual research associate and four were prepared by either Museum of Science and Industry of New York or the Franklin Institute of Philadelphia. While the exhibits remained predominantly concerned with recent research of the institution, each one had a clear theme. The titles included "Cosmic Rays," "Gases in Rocks," "Leukemia in Mice," "Earliest Known Stages in the Development of Man," "Combustion of Carbohydrates by Man," "Unsymmetrical Molecules: Their Origin and Significance," Restored Drawings of Maya Buildings," "The Formation of Diatomaceous Peat Deposits," "The Earth's Magnetism," "High-Energy Transmutations of Uranium Atoms." MWO had a three component exhibit, entitled "Variable Stars in the Milky Way," "The Rotation of the Galaxy," and "Astronomical Photography."[90]

By the 1940 exhibition, the transformation appeared to be complete. That year, there were six main exhibits. The Museum of Science and Industry of New York produced two of them while the Maryland Academy of Sciences did another. An individual CIW research associate, Frank A. Perret, completed another one on volcanoes.[91]

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89 "Exhibition Presenting Results of Recent Research Activities of the Carnegie Institution of Washington," 16-18 December 1939. Exhibits Committee Papers, CAF-CIW.

90 Ibid.

91 "Exhibition Presenting Results of Recent Research Activities of the Carnegie Institution of Washington," 1940. Exhibits Committee Papers, CAF-CIW. At the time Perret was the director of the Volcanological Museum in St. Pierre, Martinique, and

The forward of the exhibit pamphlet that year did not mention a projected role to stimulate communication amongst scientists. Instead, the exhibits were solely directed at the public, "Rather, it is for the scientist and the popular interpreter of his work to put the material of science into such a form that this barrier of technical language is broken down, making it understandable to the layman and stimulating to his imagination." The exhibit titles and descriptions reflect this shift in intended audience. Each one had a clear theme and generic titles directed at a non-specialist audience. These included the following: "The Gene-Unit of Heredity," "Interpretation of Maya Religion," "The Attainment of Extreme Pressures," "Supernovae," "Volcanoes," and "Have Our Continents Migrated?" [92] While these titles indicate that the exhibits still concerned research completed at CIW, they no longer appeared concerned with showing the most current findings in favor instead of presenting a full story of a research problem to the public.

Bush's annual reports never mention the exhibitions, and departmental reports do not mention them either after 1940-1941. The last mention of them is by the Department of Terrestrial Magnetism: "The Department's contribution to the annual exhibition of scientific work of the Institution was limited to a private demonstration of the justifying typewriter by Root and A. M. Schmidt to the Trustees. A small exhibit of apparatus was also prepared for the meeting and symposium of the American Philosophical Society in commemoration of the life and work of Alexander

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the photographs he showed at CIW had previously been exhibited at the 1939 New York World's Fair.

92 Ibid.

Dallas Bache, at Philadelphia, February 14 and 15, 1941."[93] Without their purpose of fostering collaboration and communication among the CIW's scientists, the exhibitions lost their distinctiveness. The exhibitions were suspended for World War II, and when they eventually returned they had reverted back to being directed at the trustees and the staff of the Administration Building, who did not often visit the departments across the country.

Conclusion

Although Bush's appointment as CIW's president began an institutional shift away from the identification of exhibits as internal communication tools, the outsourcing of the CIW exhibits to external institutions, primarily museums, is indicative of the contributions such exhibits made to a shift in museum practice. Whereas earlier scientific museums had primarily shown technology in an historical context, the interest the Museum of Science and Industry of New York showed in the CIW exhibits highlights a turn toward contemporary scientific themes in museum displays. Furthermore, that Bush handed over the exhibits to an external source prefigures postwar public science, as more scientists would leave public outreach to museums and other sources in order to focus solely on research.

Along with the Carnegie Institution, another major player in the Washington scientific community began exhibits as part of a project to present contemporary basic research to the public when no museums were addressing the subject and when international expositions had a distinctly commercial slant. Two prominent scientists at the Carnegie Institution took their experience with the Administration Building

93 CIW. *Year Book.* No. 40 (Washington: CIW, 1940-41), 111.

Exhibitions to the National Academy of Sciences. George Hale, a lifelong promoter of science to the American public and director of the Mount Wilson Observatory, and Fred Wright, a geophysicist at the Geophysical Laboratory, were active participants in the annual exhibits at the Administration Building. Their involvement at the CIW informed the decisions the pair would make as leaders in an exhibition scheme at the National Academy of Sciences, a scheme that would impact the ways in which other institutions approach public engagement with contemporary science.

Chapter 4

EXHIBITS WITHOUT THE MUSEUM: THE NATIONAL ACADEMY OF SCIENCES

The Vision of George Hale

"I shall never forget my own delight in first seeing some of Henry Draper's original negatives of stellar spectra," wrote George Hale in his treatise on his plan for the future of the National Academy of Sciences.[94] As Hale became more involved in the National Academy in the early twentieth century, he outlined his vision in *National Academies and the Progress of Research*, published in 1915. Hale had two main objectives: to create a centralized location from which to organize national and international collaborative research and to elevate scientific research in the estimation of American culture. In the new NAS, the agency would enjoy the prestige that government patronage could provide, as the older academies in Europe possessed, but would still be free from government interference in research and activities.[95] In Hale's

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94 Hale, *National Academies and the Progress of Research* (Lancaster, PA: New Era Printing Co., 1915), 137. Hale originally published this work as a series of essays in *Science* from 1913 to 1915.

95 Hale, *National Academies and the Progress of Research,* 102-103; Dupree, *Science in the Federal Government*, 135-148; Ronald C. Tobey, *The American Ideology of National Science, 1919-1930* (Pittsburgh: University of Pittsburgh Press, 1971), 21,24. The idea to have the NAS act as a centralizing force in American science did not originate with Hale; it was a goal of founding members Alexander Bache, Charles Davis, Joseph Henry, and Louis Agassiz in the 1860s. Efforts had stalled, however, by the time Hale developed his proposals for the NAS n the early twentieth century.

view, exhibits would be a crucial element in realizing both objectives once the NAS acquired a building near the National Mall.

Hale envisioned a grand exhibits scheme for a new NAS building, a scheme he believed had the potential to bolster the agency's prestige in the same way government patronage could. He recognized the power of the exhibition culture in which he operated, proclaiming that "no method of bringing the true state of affairs to easy comprehension, both to men of science and to the public, could equal that of the proposed exhibit."[96] For Hale, these audiences were complementary, and Hale thought that exhibits could be an effective way to reach out to both.

The exhibits George Hale had in mind included historic and contemporary displays. In the endeavor, Hale wanted to employ contemporary museums display methods, not the "dry and forbidding exhibition methods of former times."[97] Historians thus far have neglected Hale's commitment to exhibits in other analyses of his motivations and impact on American scientific organization in the early twentieth century.[98]

Tobey attributes this stall to science sponsorship by other organizations including state and private universities and philanthropic institutions such as the CIW and museums.

96 Hale, *National Academies and the Progress of Research,* p. 137-8.

97 Ibid.

98 Bugos, "Managing Cooperative Research and Borderland Science;" Dupree, *Science in the Federal Government*; Hollinger, "Free Enterprise and Free Inquiry;" Kevles, "George Ellery Hale, the First World War, and the Advancement of Science in America;" Tobey, *The American Ideology of National Science,* 21-30. Tobey mentions that Hale believed exhibits could show American industry that supporting pure science would benefit applied science and that exhibits would assist in public education efforts to relate pure science to everyday life, but Tobey does not mention how the exhibits were incorporated once the NAS was built. Helen Wright, Joan Warnow-Blewett, and

Hoping to create an institution in the tradition of the national scientific academies in London, Paris, Berlin, St. Petersburg, and Stockholm, Hale openly admired the historic and well known collections he saw at the Royal Society in London. Hale planned to have a gallery in a new NAS building for exhibits of historic content. Hale used phrases such as "continuous progress" and "continuous chain" to describe this exhibit, indicating that technological, or rather scientific, progressivism would be the clear theme. Like Draper's spectra had done for him, Hale presumed that the historic exhibits showing a clear progression of American science would "prove an inspiration to many a young and enthusiastic aspirant to the pleasures of original discovery."[99] Furthermore, Hale thought the historic exhibits would demonstrate where disparate research programs were converging, thus aiding "in the Academy's work of correlating science."[100] The historic exhibit and the collections on which they drew would serve another purpose: preserving the history of American science. A permanent committee within the NAS was set up in November 1913 to collect historic instruments, portraits, and manuscripts.[101] Hale also suggested that the new building have plenty of space for experimental demonstrations as a part of the exhibits agenda in the way other national academies had.

Charles Weiner; *The Legacy of George Ellery Hale: Evolution of Astronomy and Scientific Institutions, in Pictures and Documents* (Cambridge, Mass.: MIT Press, 1972); Helen Wright, *Explorer of the Universe: A Biography of George Ellery Hale* (New York: Dutton, 1966), 313-315. Wright mentions the exhibits briefly but does not explicate further.

99 Hale, *National Academies and the Progress of Research,* 135.

100 Ibid, 142.

101 Ibid., 134-5.

While the historic collections made up an important component to Hale's exhibit scheme, displays concerning the most recent advances in American science, both basic and applied, would dominate the main hall of a new NAS building:

> The public would undoubtedly appreciate an opportunity to see under microscopes the most recently discovered bacilli, and to examine specimens illustrating the experimental variation of plants or animals, photographs showing new astronomical discoveries, experimental demonstrations of physical phenomena like the recently found Stark effect (the influence of an electric field on radiation), the structure of crystals, X-ray spectra and their bearing on the constitution of the atom, etc.[102]

Such an exhibit, Hale believed, would help raise the prestige and institutional legitimacy of the NAS in the mind of the American public. Hale hoped that through exhibits and publications, the American people would soon recognize the Academy's "true character as the natural center and promoter of the scientific work" in the nation.[103]

Hale also hoped that as the collections of the NAS grew, a large lending collection would grow out of them to support academy members. Supplemented by basic instrumentation that grant recipients no longer used, the collection would help address the scarcity in the material economy of American science. Hale stated, "the objection which is sometimes made to the purchase of standard instruments by the recipients of grants would thus be removed, as such instruments might prove of great

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102 Hale, *National Academies and the Progress of Research,* p. 139, 142.

103 Ibid, 142.

service in a collection for general use."[104] European societies had similar practices in place already.

With the coming of World War I, Hale turned his attention to establishing the National Research Council within the NAS. After the war, the Carnegie Corporation appropriated $5,000,000 for a new building for both agencies near the Lincoln Memorial. Hale was actively involved in the planning stages for the building and ensured that ample space would be dedicated to exhibits.

The methodology that Hale and his colleagues, particularly exhibit secretary Paul Brockett and talented instrument maker Frank Schloer, would employ to create exhibits for the NAS anticipated developments in science and technology museums. When the NAS building opened in 1924, the Science Museum in London and the Deutsches Museum in Munich were regarded as being at the vanguard of museums in science and technology.[105] Those institutions led the way in implementing working models of industrial processes and new technologies into their displays. At both institutions and at the Smithsonian's Arts and Industries Building, however, the contemporary technologies were rooted firmly in a larger context which emphasized each nation's technological progress over the course of history, and institutional collection policies centered on the conservation of historically significant objects.[106]

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104 Ibid., 138.

105 Kenneth Hudson, *Museums of Influence* (Cambridge: Cambridge University Press, 1987), 88-101; The Deutsches Museum did not open completely until 1926, but had temporary exhibits open to the public as early as 1906.

106 Pamela M. Henson, "'Objects of Curious Research': The History of Science and Technology at the Smithsonian." *Isis* 90, Supplement, Catching up with the Vision: Essays on the Occasion of the 75th Anniversary of the Founding of the History of

Though Hale initially sought to include historic items in the NAS exhibits, later decisions would lead to the elimination of technological progressivism from their exhibits to focus solely on current science.

Although never identified as a museum, the NAS would be the first institution in the United States to feature exhibits throughout the year that highlighted contemporary scientific themes and emphasized interactivity. The combination of those elements places the NAS at the forefront of the modern science and technology museum movement in the United States, which others argue began with the Chicago Museum of Science and Industry in the 1930s.[107] From 1924 to their premature termination with World War II, the NAS exhibitions were an exemplar of modern science displays, taking inspiration from and influencing international exposition techniques.

New Building and the Organization of Exhibits

With building plans underway, George Hale formed the National Academy of Sciences and National Research Council Joint Committee on Exhibits in 1923. The committee aimed to prepare exhibits for the dedication of the new building in April 1924, after which the exhibits would remain on view and be changed periodically.

Before the committee had been formed, exhibition spaces were planned for and accommodated in construction plans of the building. The building featured a domed

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Science Society (1999): S254, S259-S260; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1921*, (Washington: Government Printing Office, 1921), 121-122.

107 Victor Danilov, "Science/Technology Museums Come of Age." *Curator: The Museum Journal* 16, no. 3 (1973): 185,206; Hudson, *Museums of Influence*, 104-107.

great hall which was flanked by seven galleries, all of which would feature exhibits. The hall and galleries accounted for approximately half of the total floor space on the first floor. Hale made arrangements for a large coelostat telescope, spectroscope, and Foucault pendulum to feature prominently in the great hall. Due to their size and weight, these objects had to be accounted for before construction began.[108] Historian Stella Butler has noted, the bulky size of aesthetically lacking modern scientific equipment creates new issues for modern science museums. In planning for these items, the National Academy was one of the first American institutions to confront such issues.

The Joint Committee appointed an Executive Committee to be responsible for the majority of decisions concerning exhibits. Hale served as chairman and as such was "left a great deal of latitude in all matters relating to the exhibits," with Arthur Day, Vernon Kellogg, John Merriam, and Charles Walcott also serving on the Joint Committee. Hale, Day, Merriam, and Walcott were all associated with the CIW and had been involved in that institution's exhibits program. Paul Brockett, Assistant Secretary of National Academy of Sciences in charge of the buildings, was elected Executive Secretary, and the committee decided that "all suggestions and other matters relating to exhibits be sent automatically to Mr. Brockett."[109] Formerly the director of the Smithsonian Institution libraries, Brockett proved to be an effective manager. As Hale was often in poor health, Fred Wright of the Geophysical

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108 George Hale to Paul Brockett, 11 November 1923. Exhibits Annual Reports on 1923-1943, Central Policy Files, NAS-NRC Archives (hereafter cited as CPF NAS-NRC).

109 Minutes, Joint Committee, 5 October 1923. Executive Building Committee on Exhibits, CPF NAS-NRC.

Laboratory of the CIW was appointed Vice Chairman of the committee in 1926 to conduct affairs if Hale was absent or incapacitated.[110] Like Hale, Wright brought exhibition experience from the CIW, as he had been chairman of that institution's Exhibits Committee in 1924 and 1925.[111]

Hale and Brockett hired Frank H. Schloer as the exhibit instrument maker, and he provided advice on the layout and construction of a machine shop in the building for the sole purpose of catering to the exhibits. Schloer played a prominent role in directing the exhibits toward interactivity. When Schloer received an offer from another institution in 1925, Hale quickly wrote to Brockett to make every effort to keep him. Hale admired Schloer's work with the exhibits, writing "it is almost impossible to find a good instrument maker who also has the other good qualities of Schloer…most instrument makers are cranks and quite incapable of presenting results to the public in the way Schloer likes to do… we might search ten years and not find nearly so good a man."[112] Because Hale considered Schloer to be so vital to the exhibits scheme, Hale recommended eliminating an exhibit of growing plants, which was using a great deal of electricity, to cover the expense of a salary increase.

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110 George Hale to Joint Committee Members, 8 June 1926. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

111 "Carnegie Institution of Washington and Relations to the Public," c. 1936. Exhibits Committee Papers, CAF-CIW.

112 George Hale to Paul Brockett, 28 May 1925. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

The initial funding for the exhibits was been set aside from building construction costs. To fund their continuation for five years, the committee applied for a grant of $75,000 from the Laura Spellman Rockefeller Fund. After this, only a very small budget was allocated for the continuation of exhibits, as it was expected that contributing institutions and instrument manufacturers would cover the majority of the expenses. The budget accounted for Mr. Schloer's salary, limited purchases of new instruments, limited committee transportation expenses, and the cost of maintaining existing exhibits.

Although Hale maintained that exhibits were essential to his vision of enabling scientific communication and thus needed a eminent place in the new NAS, the exhibits program was consistently held back by a tenuous financial position. Suffering from ill health and finding it difficult to manage the exhibits while at Mount Wilson, Hale expressed a desire to step down as chair of the committee in 1926 but remained due to fear his scheme would lose funding. He wrote to Wright that he would step aside as chairman "as soon as we can be sure that those who want the money for other purposes will not take our appropriation away…It is a great relief to know you are at the helm as I have keenly felt my inability to conduct this important phase of our work from here."[113]

The members of the committee proposed two types of displays. The first would be permanent installations used to illustrate fundamental natural concepts. The committee intended the second type to be reserved for rotating displays of research

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113 George Hale to Fred Wright, 10 December 1926. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

being conducted by scientists in the fields recognized by NAS and the NRC.[114] Hale's original idea of exhibits on historic collections and experiments was not incorporated into the plan. The standing committee on accumulating historic items had not collected many objects before the building was finished, and the collection never became an institutional priority.[115] Furthermore, the committee on exhibits decided that such "museum exhibits of the ordinary type" on the history of science should not be a focus for NAS and that it was best to allow museums to address those needs, particularly in light of the National Museum of Natural History being so close to the NAS building. Hale thus revised his original plan for exhibits to accommodate for funding issues and space limitations, believing the display of recent research results to be a higher priority than historic exhibits.[116] The decision to relegate history in the exhibits propelled Hale and the committee toward modern exhibition techniques which focused on contemporary themes.

Instead of displaying historic instruments, the architecture and interior of the new building addressed the purposes of connecting the institution with the past. This helped to create a sense of institutional legitimacy that a large museum building could provide, as historian Sophie Forgan has argued is the case with other scientific

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114 Paul Brockett to Edwin Hubble, 5 January 1925. Exhibits, Building and Grounds, CPF NAS-NRC.

115 George Hale to Joseph Ames, 13 December 1924. Executive Building Committee on Exhibits, CPF NAS-NRC.

116 Minutes, Executive Committee, 16 November 1923; quote from George Hale to Joseph Ames, 13 December 1924. Executive Building Committee on Exhibits, CPF NAS-NRC.

institutions.[117] Artist Lee Lawrie designed imposing eight-paneled bronze entrance doors and six large interior bronze panels, all of which depicted episodes in the history of science "from Aristotle to Pasteur." Soffit arches in the interior "bear the insignia of Alexandria, the great Academy of antiquity, and of the three historic National Academies of Europe: the Accademia dei Lincei of Rome, the Académie des Sciences of Paris, and the Royal Society of London." These architectural features were imposing reminders that the National Academy leaders believed they were taking their rightful and earned place in a progressive and linear history. Finally, the inscription in the pendentive dome pointed to the idea that science connected every aspect of modern life: "To Science, Pilot of Industry, Conqueror of Disease, Multiplier of the Harvest, Explorer of the Universe, Revealer of Nature's Laws, Eternal Guide to Truth."[118] Hale and his fellow committee members thought visitors to the building would connect the historical narrative on the walls and ceiling with the contemporary exhibits and thus come away with an impression of the strength of modern scientific research in the United States.

With history dispensed with in the architecture, the exhibits committee focused on creating a coherent presentation. They were careful to strike the word "museum" from any description of the exhibits because, to them, museum carried too many connotations of a permanent institution that illustrated the cumulative progression of

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117 Sophie Forgan, "Building the Museum: Knowledge, Conflict, and the Power of Place," *ISIS* 96, no. 4 (December 2005).

118 "Brief description of the New Building of the National Academy of Sciences and National Research Council and the Scientific Exhibits," 1924. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

science. Whereas science museums of the era centered on technological progressivism, Hale and his fellow committee members sought "latest live material in any subject." This decision anticipated later museum trends toward interactivity.[119] Furthermore, the Academy Council preferred to show "fundamental pure science" rather than commercial applications. Like with "museum," the exhibit committee then decided to remove the word "industrial" from discussion.[120]

When discussing the intended audience for the exhibits, Hale and the committee initially shared the grand ambitions expressed in Hale's *National Academies and the Progress of Research.* The exhibits should attract:

> All classes of people, including the small boy absorbed in wireless, the wide-awake farmer, the Member of Congress, the manufacturer who may discover that his processes are out of date, the scientific investigator anxious to improve his research instruments and methods by borrowing ideas developed in other branches of science, and also the casual visitor to Washington.[121]

With this disparate audience, the committee thought, like Hale had in 1915, that the exhibits could be a key component of NAS's mission to stimulate cooperation and organization in all levels of American Science. According to the committee, the

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119 Hudson, *Museums of Influence*, 106. With the changing nature of science museums toward interactivity beginning with the Chicago Museum of Science and Industry and completed with the opening of the Exploratorium in San Francisco in 1969, the connotation of "science museum" has now completely shifted away from the meaning it held for Hale and his fellow committee members.

120 Minutes, Executive Committee, 16 November 1923. Executive Building Committee on Exhibits, CPF NAS-NRC.

121 George Hale to the Executive Committee of the Joint Committee on Exhibits, 3 November 1923. Executive Building Committee on Exhibits, CPF NAS-NRC.

exhibits should “aid in enlisting the cooperation with the Academy and Council of government bureaus, university laboratories, industrial research laboratories, the scientific agencies of the various states, and all societies and institutions dealing with research.”[122] By reaching out to practitioners of both basic and applied science, the committee sought to minimize the artificial dichotomy between them by demonstrating basic science’s role in the applied sciences.

The goal of stimulating cooperation while maintaining public interest motivated the committee’s decisions on exhibit design. Dr. Hale advocated for clear displays that limited the number of objects for the sake of clarity. He based this opinion on his “own confused impression of many exhibits I have seen in museums” and looked to the Royal Society’s *Handbook to the Exhibition of Pure Science*, completed for the British Empire Exhibition in 1924, for more ideas. He further recommended that the instruments and methods represented in the exhibits be applicable in more than one field in order to stimulate innovative and cooperative of research. Concerning this he wrote, “the use of an ultra-microscope…or other device hitherto principally employed by men in single branches of science, and rarely seen in action by men in other fields, may greatly enhance the suggestive value of exhibits to men of science, and also be effective with the public.”[123]

Dr. Hale and the committee employed “live exhibits” in their design from the beginning. Live exhibits included instruments that a visitor could operate

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122 George Hale to the Executive Committee of the Joint Committee on Exhibits, 3 November 1923. Executive Building Committee on Exhibits, CPF NAS-NRC.

123 George Hale to Joseph S. Ames, Johns Hopkins University, 18 October 1924. Executive Building Committee on Exhibits, CPF NAS-NRC.

mechanically or electrically with the press of a button as well displays which ran continuously or biological exhibits that were actually alive. If at times having a self-operated apparatus was not feasible, Mr. Schloer would be available at stated hours to demonstrate it to the public. Interactive exhibits were still relatively new, and NAS committed to these contemporary methods.[124] The innovative display methods, while proving to be more interesting to average visitors, could also serve to reinforce to visitors that the NAS, and consequently American scientists, were on the cutting edge of their fields. Brockett kept up with the most recent lectures and literature in his search for new exhibits; as he wrote to Hale in 1925, "I am checking all the papers delivered here during the last week and I hope to make out a list of recent things that will suggest what can be shown. I am also covering all periodicals. Our exhibition here must be a success."[125]

For the dedication of the new NAS building in April 1924, Hale and Brockett coordinated exhibits from institutions around the country. Mr. Schloer constructed a few items, including the coelostrat and Foucault pendulum in the Great Hall and various other apparatus, display cases, and tables. Individual academics contributed equipment. For example, Albert Michelson of the University of Chicago built an interferometer, and C.T.R. Wilson of Cambridge sent stereoscopic images of his work

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124 The dedication to demonstration and interactivity in science exhibits may have grown out of the centuries' old traditions of public lectures and experiment demonstrations at European Science Academies, which Hale had referenced in this 1915 book.

125 Paul Brockett to George Hale, 5 January 1925. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

on alpha and beta particle tracks. The NAS purchased a couple of objects, including a Wilson-Shimizu apparatus from the Cambridge & Paul Scientific Instrument Co. to go along with Wilson's images. Private institutes participated: the Rockefeller Institute leant a beating heart in saline, and the Department of Terrestrial Magnetism at CIW provided a magnetograph. Corporate research labs also sent exhibits; Ernest Nichols at General Electric's Nela Laboratory built a radiometer, and A.T. &T. Co. supplied three additional exhibits on telephony. Finally, instrument dealers and manufacturers provided some objects. For example, Bausch & Lomb Co. and Spencer Lens Co. donated microscopes and projection lanterns to be utilized in several of the exhibits.[126] Dr. Hale and Mr. Brockett found most institutions to which they reached out to be willing supporters of the NAS exhibit plans, and the committee estimated that the exhibits cost contributors $50,000 in total.[127] By seeking exhibits from myriad sources, Hale and the committee positioned the NAS to be the face of basic science, and consequently its applications in industry, in the United States.

The opening and dedication accompanied the annual meeting of the National Academy in April 1924. The contributors and visiting scientists found the exhibits pleasing as a whole. Dr. John Fleming, Acting Director of the Department of Terrestrial Magnetism at CIW, wrote to Mr. Brockett, "all of us were pleased and considered it a privilege to have been called upon to cooperate in the development of

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[126] George Hale to Paul Brockett, 11 November 1923. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

[127] George Hale to Joseph S. Ames, Johns Hopkins University, 18 October 1924. Executive Building Committee on Exhibits, CPF NAS-NRC; Report on Exhibits, April 25, 1925. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

the plans for the exhibit. We heartily congratulate you and your Committee upon the very successful accomplishment."[128]

The exhibits committee intended for the objects at the dedication exhibit to remain in the building for several months after the opening. Several of the newest instruments, which were mostly likely the ones of most interest to visiting scientists, however, could only be exhibited during the dedication events before being returned to their lenders. A loan from the Department of Terrestrial Magnetism was "dependent upon the exigencies of the investigational work of the Department."[129] This indicates a flaw in the communicative component of Hale's scheme, for while Hale was successful in showing the newest scientific instruments for a short time when scientists were expected to visit en masse, the lenders could not afford to display the instruments longer. For example, at the meeting Albert Michelson of the University of Chicago and Fred Wright of the Geophysical Laboratory of CIW each exhibited their version of a "first experimental form of new gravity meter."[130] Having these two objects side by side encouraged discussion between the exhibitors and visiting scientists, which had been Hale's primary objective for the exhibits from their inception. Since both scientists needed their gravity meters to continue their research,

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128 John Fleming to Paul Brockett, May 24, 1924. Exhibits, Carnegie Institution of Washington, Building and Grounds, CPF NAS-NRC.

129 Louis Bauer to John Merriam, May 18, 1923. Exhibits, Carnegie Institution of Washington, Building and Grounds, CPF NAS-NRC.

130 "Brief description of the New Building of the National Academy of Sciences and National Research Council and the Scientific Exhibits," 1924. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

however, the objects left the NAS building after the meeting. In contrast to the weekend exhibition structure that CIW employed, the scarcity of the material economy of scientists did not afford them the opportunity to lend materials for more than a short time. Geography was also a concern; a Dr. Stebbins[131] recognized this when he commented to Brockett that the collaborative scheme "cannot be done as easily in this country, where so many of our scientists are far from Washington, as in England where the distance the research men have to travel to reach London is comparatively short."[132] Due to the pragmatic research needs of contributing researchers and geographical limitations, the NAS exhibit structure thus proved ineffective at bringing together state-of-the-art apparatus to inspire collaboration amongst scientists.[133]

Though the dedication exhibits were well received, the exercise highlighted new challenges for Hale and the committee. While several aspects of the exhibits pleased him, Hale wrote in December 1924, "I was somewhat disappointed with some of the exhibits and we could not hope in this way to keep up with research progress –

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131 "Dr. Stebbins" was likely astronomer and NAS member, Joel Stebbins.

132 Paul Brockett to George Hale, 5 January 1925. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

133 "Brief description of the New Building of the National Academy of Sciences and National Research Council and the Scientific Exhibits," 1924. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC; Bugos, "Managing Cooperative Research and Borderland Science." Bugos has written about the failure of NRC to inspire collaborative research due to the hindering committee structure; Tobey, *The American Ideology of National Science, 30.* Tobey attributes the failure of the NAS to create a centralized national science to professional isolation and cultural dichotomy.

the essence of the whole plan."[134] Hale had hoped that the exhibits would be updated at least once or twice a year to account for new research, but the financial constraints of the committee left limited options.[135] Furthermore, the lending collection Hale had imagined in 1915 never materialized.

Hale also ran into problems trying to balance the exhibits around all scientific disciplines. Biology posed a particular challenge, as live exhibits proved difficult to maintain for extended periods, and some research proved too dangerous to expose to the public. Hale wrote to Joseph S. Ames, chairmen of organizing exhibits of the physical sciences and scientist at Johns Hopkins University, "I did my best last spring to get more 'live exhibits' from the Rockefeller Institute, but yellow fever bacilli were too dangerous, living tissues could not be grown according to Barret without a corps of attendants, and other obstacles stood in the way."[136] Furthermore, Brockett expressed concern that some committee members did not fully comprehend what Hale was trying to accomplish and thus could not provide useful suggestions for new exhibits.[137] While the committee continued their attempts to incorporate biological

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134 George Hale to Joseph Ames, 13 December 1924. Executive Building Committee on Exhibits, CPF NAS-NRC.

135 George Hale to the Executive Committee of the Joint Committee on Exhibits, 3 November 1923. Executive Building Committee on Exhibits, CPF NAS-NRC.

136 George Hale to Joseph S. Ames, Johns Hopkins University, 18 October 1924. Executive Building Committee on Exhibits, CPF NAS-NRC.

137 Paul Brockett to George Hale, 5 January 1925. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

exhibits, the challenge of keeping specimens alive and of "having it so that the public is not afraid of it" did not go away. [138]

While the NAS administration determined that the exhibits were worthwhile to continue, they directed minimal financial support to the exhibit committee after the dedication. In most years, the allocation covered the costs of Schloer's salary and general maintenance, which lending institutions were expected to cover all other costs. At times Brockett expressed frustration when funds were diverted away from exhibits. He wrote to Hale in 1926, "With the setting up of individual books for Building and Grounds, the amount that I had been saving from the last two years in order to have a somewhat substantial sum for exhibits equipment was reverted without my knowing it."[139]Although financial and other challenges meant that the exhibits would not always represent the cusp of research, the committee found that the general public remained interested. [140] Thus, while the goal of stimulating new cooperative research fell away, enlightening an attentive nonscientific public on recent research became a new institutional focus at the NAS after 1924.

New Directions

> The interest shown by the many questions asked by the public, and the desire of visitors to study the exhibits in detail gives assurance that the methods adopted of making it possible for the visitor himself to

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138 Paul Brockett, "Report on Exhibits," 1930. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

139 Paul Brockett to George Hale, 9 October 1926. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

140 Paul Brockett, "Report on Exhibits," 25 April 1925. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

> perform an experiment and to observe the results obtained, are accomplishing the object for which this exhibition was established.[141]
>
> Paul Brockett, 1935

For the American tourist in Washington in the 1920s, the exhibits at the National Academy of Sciences offered something different from what other museums in the city offered. In an era when industrial factory tours enjoyed unprecedented popularity and the average visitor did not have access to laboratories,[142] a visit to the NAS exhibits offered a glimpse at the world of science the public heard so much about in popular print media. The exhibits committee recognized this and began to focus more and more on their growing nonscientific audience. Committee reports after 1924 reflect this shift.

As with contemporary science institutions, the NAS had to face the challenges of portraying technical subject matter to a non-technical audience. Paul Brockett observed in 1924 that general visitors tended to think the exhibits were "way over their heads." At that juncture, he blamed this problem on the labeling, which did "not tell how the theories that the exhibits prove are put to use in connection with our daily life" and instead, "with their correct scientific terms and names, are perhaps too

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141 Paul Brockett, "Report on Exhibits," 1935. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

142 William Littmann, "The Production of Goodwill: The Origins and Development of the Factory Tour in America," *Perspectives in Vernacular Architecture* 9, Constructing Image, Identity, and Place (2003): 71-84. In the first three decades of the twentieth century, factory tours and their promotion in advertisements became important factors in developing company name recognition and impressing the public with sanitized views of immense production, thus countering Progressive Era criticisms.

technical for the average visitor." He also observed, however, that the exhibits, particularly the operational ones, were effective as retaining visitor attention.[143] Furthermore, Brockett remained confident that exhibits could be accessible to researchers and the general visitor, as he stated, "I have never yet found a human being who could not understand any problem when it was properly explained."

The exhibits committee struggled to counteract visitors' assumptions that the material they were viewing was incomprehensible without advanced knowledge. Brockett wrote,

> When I was downstairs making my rounds this morning, a woman came up to me to ask some questions and said, "All of these things are so much over my head." I told her that they were perfectly simple, and explained some of them to her. She was then very much surprised to find that she could understand them. I find that the public in general is inclined to feel the same way this woman did, until the exhibits are explained.[144]

To respond to visitors' needs, Brockett and Hale worked to incorporate even more "live" exhibits and correct labeling, and Mr. Schloer was often there to explain exhibits to visitors in person. These efforts paid off; annual attendance at the exhibits from 1928 to 1940 ranged from 32,185 to 82,526 with an annual average of 49,925. Brockett wrote optimistically in 1927: "The number of visitors increases every day and the interest is exceptional. Those who come comprehend more and more what we

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143 Paul Brockett to George Hale, 10 October 1924. Exhibits, (Committees), Building and Grounds, CPF NAS-NRC.

144 Paul Brockett to George Hale, 5 January 1925. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

are trying to do."[145] While Brockett was pleased with the results, however, the struggle to present material clearly without resorting to overly technical language was never resolved completely. In the 1937 Federal Writers' Project guide to Washington, praise of the dynamic exhibits at the NAS was qualified by the statement, "there is little attempt to prepare the lay spectator with a theoretical analysis."[146]

The focus on education and inspiring the general public about basic science dictated the actions of the committee. Although they could not offer to pay any contributors, Hale and Brockett could discriminate in their selection of new exhibits as they rarely struggled to find amenable participants. In 1925, the U. S. Naval Research Laboratory appropriated "$3,000 to $4,000" to prepare a sonic depth sounding device that could be operated by NAS visitors.[147] The General Electric Company, a longtime contributor, appropriated $2000 to its research laboratory in 1926 to continue to add to their NAS exhibits.[148] While the committee insisted that the exhibits not be commercial in nature and rejected multiple offers from various companies, it agreed

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145 Paul Brockett, "Report on Exhibits," 14 December 1927. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

146 Federal Writers' Project, *Washington: City and Capital* (Washington: Government Printing Office, 1937), 526.

147 Paul Brockett, "Report on Exhibits," 17 February 1925 and 24 April 1926. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

148 Paul Brockett, "Report on Exhibits," 14 December 1926. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

when Steinway Bros. lent a grand piano to show the incorporation of new research into musical instrument construction.[149]

While Hale and Wright agreed to present exhibits produced by corporations as long as they clearly linked applications with basic scientific phenomena, they were very careful that the displays did not cross the line to advertisement. This allowed the NAS to maintain institutional legitimacy as the public face of basic and fundamental science. For example, in 1929 Brockett acquired an atmospheric gas set, which consisted of eight spectrum tubes filled with elemental gases illustrating the gases that make up the atmosphere and could be used for spectroscopic purposes, from the Air Reduction Sales Company of New York. In his request to the company, Brockett explained that the NAS was seeking to avoid appearing commercial and thus would not allow any advertising in their exhibits, except to mention what company provided the apparatus on the exhibit label. He thought the gas set would fit in with the NAS exhibits, for "it is the policy of the Committee on Exhibits of the Academy to show only the fundamentals and those things which have to do with recent progress in science." A representative of the company responded and agreed to the terms, saying the company label could easily be removed from the set if the committee so chose.[150] When the set went on display, the visitor could press a button to send a voltage through the gases, which would cause them to be illuminated at different wavelengths.

149 Paul Brockett, "Report on Exhibits," 17 February 1925 and 24 April 1926; Paul Brockett, "Report on Exhibits," 1930. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

150 Paul Brockett to F. P. Gross, Jr., 26 March 1929; F. P. Gross to Paul Brockett, 28 March 1929. Exhibits, Building and Grounds, CPF NAS-NRC.

In the selection process, Brockett and the committee chose exhibits that were either already interactive or that Mr. Schloer could work to make operational. Their efforts were so successful that by 1928 Brockett could report that the Academy's ninety-three exhibits were "all alive and move and do things." [151] When funds were available, exhibits could be reworked based on visitor response. For example, Dr. Wright and Mr. Schloer collaborated on a model showing the earth's rotation to help demonstrate the idea behind the Foucault Pendulum in the Great Hall so that "by pressing a button and watching the earth turn one may more easily understand the problem."[152]

Once an institution agreed to lend exhibits to the NAS building, they often paid to monitor their condition and to rework them to better suit visitors. Sperry Gyroscope Company contributed a working model to show how their instrument related to the movement of the Foucault Pendulum in the Great Hall, and when it broke the company sent for the model and overhauled it at the company's expense.[153] The National Weather Bureau sent a person every day to care for the registering mercury barometer while he made rounds to all bureau stations in the city. [154]

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151 Paul Brockett, "Report on Exhibits," 17 April 1928. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

152 Ibid.

153 Paul Brockett, "Report on Exhibits," 1935. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

154 Paul Brockett, "Report on Exhibits," 17 April 1928. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

Mr. Schloer, as the representative of the NAS who interacted daily with visitors, became a principle actor in shaping the exhibits to accommodate the public. In his onsite shop, he built new instruments and new methods of making them operational. He built a new interferometer when the one on loan had to be returned to Dr. Michelson in Chicago, and he came up with creative display methods when material came that was not suited to standard museum cases.[155] He also worked to simplify exhibits "so that the public can get results more easily and quickly" whenever the need arose.[156] In a significant example, he developed a simple electric switch to be incorporated into the exhibits, which would prove so effective that representatives from the 1933 Chicago Century of Progress Exposition asked to borrow one so that thousands of copies could be produced and implemented into their automatic exhibits.[157]

Although the NAS did not perform systematic visitor surveys, Paul Brockett noted in his reports some of the encouraging feedback he or Mr. Schloer received from the public. He wrote in 1928 that the displays had inspired "a youngster who has been here Saturday after Saturday has sent his mother down to check up his construction of a coelostat."[158] In 1929, he boasted that the National Academy building had become

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155 Ibid.; Paul Brockett, "Report on Exhibits," 12 October 1926. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.)

156 Paul Brockett, "Report on Exhibits," 1929. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

157 Ibid.

158 Paul Brockett, "Report on Exhibits," 17 April 1928. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

"one of the greatest attractions in Washington."[159] Schools and colleges increasingly sent field trips to the building, and Brockett remarked that " the overheard remark of one of a group of girls leaving the building that 'I got a kick out of every button I pressed,' shows that the girls are interested as well as the boys."[160]

Competition and Imitation: Transforming the Science Museum

As the exhibits at the National Academy building became more popular, their innovative exhibition methods caught on in other places and, ironically, began to cut into NAS's sources. In 1929, Brockett bemoaned that it was more difficult to acquire new material that year, but not because their contributors no longer desired to participate. Instead, Brockett attributed it to new competition for the same resources and remarked, "the idea of a live exhibit has grown so fast that it has been almost impossible for the man of science to contribute to all, and have time left to do his own work." [161]

World's Fairs became the primary competitor with the institution for apparatus. The U.S. Government insisted the various bureaus exhibit their best material, which was often already sitting at the NAS. For example, the National Advisory Committee for Aeronautics and the Bureau of Standards pulled their exhibits

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159 Paul Brockett, "Report on Exhibits," 1929. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

160 Paul Brockett, "Report on Exhibits," 1930. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

161 Paul Brockett, "Report on Exhibits," 1929. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

and sent them to the Philadelphia Sesquicentennial in 1926 and the International Exposition at Madrid in 1929. Both agencies promised to return the displays with new research incorporated after the close of the expositions, however. The National Advisory Committee for Aeronautics material, which hinted at the material which would be incorporated into the National Air and Space Museum decades later, included a scale model of a vertical wind tunnel, a model of a Boeing pursuit plane, and operational models highlighting tail pressure distribution and air-ship envelopes.[162] Brockett wrote to Hale in 1926 praising the exhibit for showing the fundamentals of aeronautics and believed the NAS could take credit for inspiring their approach, stating "I think they have taken the idea of live exhibits from here and made it a feature of the instruments they have shown."[163] The bureau's exhibits proved so popular that they were also taken away from the NAS for the Spanish-American Exposition at Seville in 1931, the Chicago Century of Progress Exposition in 1933, and the San Diego Exposition in 1935. Exhibition culture encouraged attendance and catalyzed new exhibit methodologies, but also hindered the ability of the NAS to continue acquiring new and innovative material.

Brockett and the committee faced pressure from others at the NAS and NRC to cooperate with the organizers of the Chicago World's Fair in 1933. Fair leaders had turned to the NRC for advice on the presentation of science and to lend institutional prestige, by this time well established, and NRC leaders had obliged, believing it to be

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162 Ibid.

163 Paul Brockett to George Hale, 9 October 1926. Exhibits (Miscellaneous Correspondence), Building and Grounds, CPF NAS-NRC.

a great opportunity to advance science in the eyes of the American public.[164] Ironically, the exhibits in Washington suffered as a consequence of the NRC's involvement in the fair. In 1931, Major L. R. Lohr, one of the fair organizers, inquired about a loan of the NAS material for the duration of the exposition. Brockett initially denied the request because he was concerned that a large loan would force the NAS to close the galleries and because the exhibits, which were intended to be viewed by a limited amount of people at a time, would be ineffective with large fair crowds.[165] Hearing of this, George K. Burgess, Chairman of the Executive Council of the NRC,[166] intervened and agreed to loan the material to Chicago against the wishes of Brockett and Wright. Although Burgess agreed that the small exhibits would not be the best fit for the large exposition, he felt that Brockett and Wright did not "fully appreciate the intangible but real value that would accrue to us if we displayed a certain graciousness in the matter."[167] While lending the exhibits allowed for the NAS to reach a wider audience and to remain in the good graces of powerful exposition leaders, the galleries in Washington were adversely affected as a result.

In addition to new competition for their exhibits, other institutions began to imitate the Academy's methods. According to Brockett, the NAS could take credit for

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164 Rydell, *World of Fairs*, 92-98.

165 Paul Brockett to Major L. R. Lohr, 11 June 1931. Loan of Exhibits to Chicago World's Fair 1931, Executive Board Committee on Exhibits, CPF NAS-NRC.

166 *Report of the National Academy of Sciences* (Washington: Government Printing Office, 1926), 136.

167 G. K. Burgess to Frank B. Jewett, 23 July 1931. Loan of Exhibits to Chicago World's Fair 1931, Executive Board Committee on Exhibits, CPF NAS-NRC.

being the first large-scale experiment in interactive science exhibits that combined illustrations of fundamental natural phenomena with accounts of recent scholarships. After their techniques reached London, Paris, and Berlin, Brockett states that "individuals and commissions from different parts of the world arrived to study our methods of display and out exhibits."[168] He reported in 1937 that "there are now many other places where the public can perform the experiments and produce the phenomena of the early masters in research to awaken their interest in scientific research." [169] Two such institutions included Chicago's Museum of Science and Industry, which opened in 1933, and New York Museum of Science and Industry, now defunct, which opened in 1936.

Conclusion

Because the National Academy was not hindered by the traditional connotations of "museums," George Hale, Paul Brockett, Frank Schloer, and the Committee on Exhibits were able to experiment with innovative display techniques where other institutions did not. Because Hale and his colleagues approached the problem from the point-of-view of scientists and instrument makers and not museums, this allowed them to transform the traditional experimental demonstrations that scientific societies had done for centuries into operational exhibits that a visitor could interact with on his/her own, anticipating later interactive trends at science museums.

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168 Paul Brockett, "Report on Exhibits," 1940. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

169 Paul Brockett, "Report on Exhibits," 1937. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

Although they failed to create exhibits that inspired collaborative science research, they provided a channel for individual researchers and other institutions to share their work with the public in a meaningful way. Brockett went as far as to credit Dr. Hale's "live exhibits demonstrating fundamental experiments resulting from scientific research" as one of the two most important "innovations in the education of the public through the museum idea during the last half century."[170] In a role not previously recognized, the National Academy of Sciences thus contributed significantly to the creation of the modern, interactive science museum.

While the NAS may have pioneered new methods in museums, their own exhibit program was cut short. The NAS and NRC expanded activity during World War II and closed the exhibits to create more office space. Brockett reported in 1942 that all of the exhibits were returned to the contributing laboratories or had been stored. Mr. Schloer, after nineteen years of exhibition work, joined the Department of Terrestrial Magnetism of CIW to work on projects for the National Defense Research Committee.[171] The war effectively ended the exhibits program, as the galleries remained offices after the war led to the permanent expansion of the NAS and NRC. The NAS has very recently, however, returned to the exhibition idea. A renovation to the building completed in 2012 restored two of the former galleries, which now feature new exhibits on contemporary scientific research in the United States.

170Ibid. The other innovation Brockett referenced was Samuel Langley's idea for a children's museum at the Smithsonian.

171 Paul Brockett, "Report on Exhibits," 1943. Exhibits Annual Reports on 1923-1943, CPF NAS-NRC.

Chapter 5

CONCLUSION

It is possible to place the exhibit experiments at the Carnegie Institution and the National Academy of Sciences during the interwar era into larger themes in twentieth century science. The first is public engagement. As promoters of basic research tried to organize for its support, they struggled to communicate these changes to the public. Although the CIW exhibits were relatively popular, the institution never became well-known to the public outside of Washington. The NAS exhibits enjoyed modest attendance, but the agency could never compete effectively with and distinguish themselves from the magical experiences and technological utopias that large corporations promoted at the World's Fairs.

Although both institutions largely abandoned their exhibit schemes, some of the techniques with which they experimented impacted exhibition practice in museums. Museums such at the New York Museum of Science and Industry were established and looked to the CIW and the NAS for exhibit material. The interactive procedures that Frank Schloer helped to develop at the NAS became standard practice in museums after their adoption at the Chicago Century of Progress Exposition in 1933 and subsequently the Chicago Museum of Science and Industry. Science museums today continue to debate best practices in public engagement.

Another theme with which the exhibits engaged is communication amongst the scientific community. As basic research became more specialized and technical vocabularies developed, both the CIW and the NAS experimented with the use of exhibits as a communicative forum for scientists. The CIW weekend exhibits that brought together a finite institutional community proved to be the more effective of the two in this respect. Geography and limited financial resources worked against this effort at the NAS, where the goal of bringing together the nation's disparate scientists in worthwhile discussion through exhibits never came to fruition.

The best means of effective scientific communication have remained a theme in American science throughout the twentieth century. It may be possible to link the role played by exhibits at the CIW with the role poster sessions play in contemporary science conferences. While not linearly connected, both practices address similar concerns about communication within the scientific community. In a 1974 article in *Science*, Thomas H. Maugh II wrote about the first poster session to occur at a major scientific meeting in the United States. His praise of the session is quite similar to the positive qualities Robert Woodward and John Merriam attributed to the CIW exhibits in the early twentieth century. Both created informal settings to allow for personal interaction between presenter and listener, thus stimulating discussion and encouraging future collaboration. Tellingly, Maugh even associated the poster session with museum exhibits, writing that "visitors to the sessions can either wander through as in a museum or go directly to the papers that interest them."[172] Unlike the less-portable CIW exhibits, however, poster sessions have become standard practice at scientific conferences throughout the United States.

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172 Thomas H. Maugh II, "Speaking of Science: Poster Sessions: A New Look at Scientific Meetings" *Science* 184, no. 4144 (Jun. 28, 1974): 1361. The poster session was inaugurated in the United States at a June 1974 meeting in Minneapolis cosponsored by American Society of Biological Chemists and the Biophysical Society. Maugh notes that the first poster sessions were held in Europe.

The exhibits at both institutions are indicative of the struggle of scientific statesmen to reach an equilibrium between engaging with the public and engaging with fellow scientific practitioners during the interwar era. Some promoters, such as George Hale and John Merriam, regarded these audiences as complementary and thus sought to produce exhibits that could be effective for both, while others, such as Vannevar Bush, considered it best practice to leave public engagement to other authorities and allow scientists to focus solely on their research. As basic science found a large patron in the federal government during and after World War II, the scientific community perhaps no longer considered involvement with the general public to be a priority. This left museums to assume the primary role of displaying basic science to the public, at which the interactive techniques experimented with by the CIW and the NAS became mainstream museum method.

Today, only a few vestiges remain of the Carnegie Institution annual exhibitions from the interwar era. The globe with pins marking the Department of Terrestrial Magnetism voyages stands in Administration Building library, the photos in the base in need of conservation. The model of the non-magnetic ship, *Carnegie,* sits under glass in the entry hall at the DTM-Geophysical Laboratory campus. While still respected in scientific circles, few lay people are familiar with the Carnegie Institution and public engagement is no longer an institutional priority. At the National Academy, in a nod to history, a modest exhibit scheme has been reintroduced that once again highlights contemporary research themes, but the building receives few general visitors. Although the heyday of exhibits may be past, both institutions should be recognized for their contributions to the development of modern scientific museum display techniques and their engagement with issues of scientific communication.

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Appendix A

CARNEGIE INSTITUTION OF WASHINGTON EXHIBIT CATALOGUE FOR 1914

CATALOGUE OF THIRD GENERAL EXHIBIT OF WORK OF DEPARTMENTS OF RESEARCH, ADMINISTRATION BUILDING, DECEMBER 1914.

DEPARTMENT OF BOTANICAL RESEARCH.

1. The Cahuilla Basin, including the Salton Sea.
   - *a.* Map of Cahuilla basin showing position, outline, and topographic relations of the Salton Sea.
   - *b.* Model of Cahuilla basin (size 92 by 24 inches).

2. Illustrations of Modifications in Plants induced by Ovarial Treatments.
   - *a.* Diagram showing position of hollow needle in the introduction of solutions into the placenta of an ovary of Scrophularia.
   - *b.* Diagrammatic section of an ovule of Scrophularia.
   - *c.* Leaves of parental Scrophularia.
   - *d.* Leaves of derivative.
   - *e.* Venation of normal leaves of Scrophularia.
   - *f.* Venation of derivative.
   - *g.* Flowers of parental and modified form.
   - *h.* Small glass culture chamber for guarded fertilizations.

3. Soil-Temperature and Root-Habits.
   - *a.* Diagram of root-systems of Fouquieria, Carnegiea, and Opuntia, which occupy a surface layer of soil in which the temperature during the growing season ranges between 68° and 105° F.
   - *b.* Root-systems of Franseria and Prosopis occupying a deep layer of soil in which temperature during the growing season varies between 62° and 105° F.

4. Revised Map of the Vegetation of the United States, based on Physiological and Anatomical Characteristics rather than Floristic Relationships. (See key on map.)

5. Physical Factors and Distribution of Vegetation on a Desert Mountain Range.
   - *a.* Diagram to illustrate the relation of annual minimum temperatures to altitude, topography, and vegetation in the Santa Catalina mountains, Arizona. Vertical exaggeration 10 : 1.
   - *b.* Schematic representation of the incidence of rainy seasons, and of the shortening of the frostless season with increase of altitude in the Santa Catalina mountains, Arizona. (See key on diagram.)

6. Autonomic Movements of Stems of Cacti induced by Variations in Moisture.
   - *a*. Successive postures of Opuntia stems in wet, dry, and succeeding wet seasons.
   - *a*-1. A plant of Opuntia versicolor, showing positions of branches on October 22, 1912. After close of summer rainy season the water-content of the soil was high.
   - *a*-2. Same plant (*a*-1) on December 1, 1912. In the midst of the autumn dry period the water-content of the soil was low.
   - *a*-3. Same plant (*a*-1) on March 20, 1913. At the close of the winter rainy season the water content of the soil was again high.
   - *b*. Successive postures of stems of Opuntia fusicallis in desiccating soil.
   - *c*. Successive positions of shoot of Opuntia versicolor, due to increasing water content of plant.
   - *d*. Positions of shoot of Opuntia versicolor attained by diurnal movements.
   - *e*. Diagram of day and night positions of stems of Opuntia versicolor with key to water-absorption, water-loss, swelling of tissues, and acidity conditions which accompany the movements.

7. Differences in Rate of Respiration in Plants, due to the Degree of Ionization of the Atmosphere.

DEPARTMENT OF ECONOMICS AND SOCIOLOGY.

A. Books and Monographs bearing upon the work of the Department, but published under other auspices.

B. Bibliography of the Department.

C. Charts and Photographs prepared to illustrate a History of Agricultural Production from 1840 to 1860.

1. Map showing cash value of farms, 1860.
2. Map showing distribution of farms of 1,000 acres and over, 1860.
3. Map showing production of cotton, 1840.
4. Map showing production of cotton, 1850.
5. Map showing production of cotton, 1860.
6. Map showing production of wheat, 1840.
7. Map showing production of wheat, 1850.
8. Map showing production of wheat, 1860.
9. Chart showing prices of cotton, 1840–1859.
10. Chart showing prices of wheat, 1840–1859.
11. Photograph. Hussey's Reaper, 1837.
12. Photograph. McCormick's Reaping Machine, 1834.
13. Photograph. McCormick's Reaping Machine, 1848.
14. Photograph. Rugg's Reaper and Mower.
15. Photograph. Manny's Reaper and Mower.
16. Photograph. Atkins Self-Raking Reaper, 1852.
17. Photograph. Webster's Spring Beater Threshing Machine.
18. Photograph. Warren's Horse Power and Threshing Machine.
19. Photograph. Emery Horse Power and Thrasher.
20. Photograph. Steam Thrashing Outfit, 1860.

RESEARCHES IN EMBRYOLOGY.

Drawings and Photographs illustrative of studies of the Embryological Collection of the Institution under the direction of Dr. F. P. Mall.

I. Drawings and Photographs of some of the Youngest Embryos in the Collection.

1. Section showing the youngest embryo in the collection and the implantation of its chorionic sac. Probable age about 2 weeks. Enlarged 50 diams.
2. Diagram of above. The embryo is shown in red. The remainder is the chorionic sac.
3. Model of an embryo of seven pairs of somites, probably about 24 days old. Enlarged 150 diams.

4 and 6. Drawings showing the heart and vascular system in the same embryo shown in 3.

5. Photograph of an embryo (Collection No. 963), showing the attached vitelline sac and the chorion. Enlarged 10 diams.
7. Drawing of an embryo, 3 mm. long, intermediate in age between 3 and 6. Enlarged 30 diams.
8. Drawing of an embryo, 4 mm. long. Vitelline sac is collapsed. Enlarged 34 diams.

II. Series of Drawings showing Changes in External Form of Human Embryos at Different Stages of Growth.

1. Lateral view of embryo, 9 mm. long. Enlarged 11 diams.
2. Lateral view of embryo, 7 mm. long. Enlarged 12 diams.
3. Lateral view of embryo, 11.5 mm. long. Enlarged about 11 diams.
4. Lateral view of embryo, 7 mm. long. Enlarged 12 diams.
5. Lateral view of embryo, 13.5 mm. long. Enlarged $6\frac{3}{4}$ diams.
6. Lateral view of embryo, 17 mm. long. Enlarged 7 diams.

7, 10, 11, 12. Different views of an embryo, 5.5 mm. long.

8. Dorsal view of embryo, 7 mm. long.
9. Drawing of an embryo, 26 mm. long, showing its position in the uterus. Natural size.
13. Lateral view of embryo, 24 mm. long. Enlarged $4\frac{1}{2}$ diams.

III. The Surface Anatomy, the Pharynx, and the Implantation of a Human Embryo, 4 mm. long. (No. 836 of Embryological Collection, Carnegie Institution of Washington.)

1. Diagram of face showing olfactory, optic, and placodal thickenings.
2. Ventral view of face. Enlarged 50 diams.
3. Right lateral view of embryo. Enlarged 26 diams.
4. Left lateral view of pharynx. Enlarged 100 diams.
5. Water-color sketch of implanted ovum, showing fresh and extravasated blood. Enlarged 18 diams.
6. Ventral view of pharynx, from without. Enlarged 100 diams.
7. Ventral view of pharynx, from within. Enlarged 100 diams.
8. Frontal view of embryo. Enlarged 50 diams.
9. Embryo *in situ* showing implantation of ovum. Enlarged 20 diams.
10. Dorsal view of embryo. Enlarged 50 diams.

IV. Views, Section, and a Model of a Human Embryo, 21 mm. long (No. 460, Embryological Collection, Carnegie Institution of Washington).

1. Transverse section through head. Enlarged 50 diams.
2. Lateral view of embryo. Enlarged 7 diams.
3. Front view of embryo. Enlarged 7 diams.
4. Lateral view of model of head showing nervous system, muscles, and skeleton. Enlarged 20 diams.
5. Face of embryo. Enlarged about 14 diams.

V. Drawings from Wax Plate Models showing the Development of the Body-Wall in the Human Embryo.

1. Body-wall and nerves in an embryo, 20 mm. long. Enlarged 25 diams.
2. Front view of body-wall in an embryo, 20 mm. long. Enlarged 20 diams.
3. Lateral view of body-wall of same embryo.
4. Lateral view of body-wall in an embryo, 11 mm. long. Enlarged 25 diams.

VI. Drawings from Wax Plate Models showing the Development of the Limbs in the Human Embryo.

1. Muscles in left arm of embryo, 20 mm. long. Enlarged 40 diams.
2. Showing right arm and leg and their attachment to trunk of an embryo, 11 mm. long. Enlarged 30 diams.
3. Muscles of left arm in an embryo, 16 mm. long. Enlarged 40 diams.
4. Right arm and leg and their attachment to trunk in an embryo, 20 mm. long. Enlarged about 20 diams.
5. Right arm in embryo, 20 mm. long. Enlarged 40 diams.

VII. Stages in the Development of the Arm, Leg, and External Ear in Human Embryos.

1. Dorsal view of human embryo, about 5 mm. long, showing arm buds.
2. Dorsal view of hand plates of human embryo, 17 mm. long.
3. Ventral view of same.
4. Ventral view of hand of embryo, 21 mm. long.
5. Views of leg bud of embryo, 21 mm. long.
6. Ventral view of hand, 25 mm. long.
7. Ventral view of hand of embryo, 24 mm. long, further developed than preceding.
8. Posterior limbs of embryo, 24 mm. long, being the same embryo as shown in 7.
9. Lateral view of embryo, 7 mm. long, showing development of external ear.
10. Same, in embryo 13 mm. long.
11. View of plantar surface of foot of embryo, 24 mm. long.
12. External ear in an embryo, 15 mm. long.
13. External ear in an embryo, 21 mm. long.
14. Lateral view of embryo, 4 mm. long, showing site of external ear.
15. Ear in embryo, 17 mm. long.
16. Ear in embryo, 24 mm. long.

VIII. Some of the Stages in the Development of the Human Nervous System.

1. Photograph of a stained section of an embryo, 14 mm. long. Enlarged 50 diams.
2 and 3. Drawings of a model of the membranous labyrinth and its nerves of an embryo, 30 mm. long. Enlarged 50 diams.
4. Model of the brain and nerves of the same embryo shown in 1. Enlarged 30 diams.
5. Model of the peripheral nervous system of an embryo, 10 mm. long and about one month old.

IX. Pictures showing the Early Stages in the Development of the Blood-vessels in Vertebrate Embryos.

1. Capillary plexus at the caudal ends of the aortæ of the chick of 20 somites.
2. Dorsal and lateral views of the head of an injected pig embryo, 7.5 mm. long.
3, 6, and 9. Series showing development of capillary plexus in the head of chicks from 17 to 25 somites.
4. Lateral view of injected pig embryo, 6.5 mm. long.
5. Development of multiple subclavian arteries in the chick.
7. Diagram of the embryonic circulation in a chick at the 36th hour of incubation.
8. Blood-vessels in the region of the fore-limbs in a chick of 116 hours.
10. Blood-vessels in a chick embryo of 38 somites.

X. Development of the Lymphatic System in Pig Embryos, as seen in Injected and Cleared Specimens.

1. Lymphatics of the intestine of fœtal pig, 16 cm. long.
2. Developing hemal node in a fœtal pig, 23 mm. long.
3. Section of a pig, 11 mm. long, in which the blood-vessels have been injected.
4. Vascular injection of a pig, 7 mm. long, showing the neck region.
5. Lymphatic injection of a pig, 6 cm. long.
6. Jugular lymph sac in a pig, 18 mm. long.
7. Jugular lymph sac and the lymphatic vessels developing from it in a pig, 3.5 cm. long.
8. Jugular lymph sac and the lymphatics along the external jugular vein, together with the lymphatics of the shoulder in a pig, 5.5 cm. long.
9. Jugular lymph sac and the lymph nodes along the external jugular vein in a pig, 7.5 cm. long.

XI. Bone Development in Human Embryos. Four Embryos of about the Same Age (21 mm. long, 8 weeks old) belonging to different Races.

1. Ossification centers in an embryo, 54 mm. long, 11 weeks old, rendered transparent with caustic potash and glycerine.
2. Ossification centers in the hand of an embryo, 73 mm. long, about 3 months old.
3. Caucasian embryo, 21 mm. long, about 8 weeks old.
4. Filipino embryo, 21 mm. long.
5. American Indian embryo, 21 mm. long.
6. Negro embryo, 21 mm. long.

XII. Pathological Human Embryos.

1, 2, 3, and 4. Photographs of pathological embryos. Enlarged 4 diams.

5. Three views of an anencephalic monster.

6 and 7. Pathological embryos in their chorionic sacs, with accompanying photographs of sagittal sections made through them.

8. Photographs showing a pathological condition of the magma surrounding the embryo.

9. Embryo showing marked spina bifida.

10. Pathological embryo with section showing abnormal condition of brain.

11. A very young pathological embryo. Below is shown the chorion, natural size; above is shown the embryo enlarged 10 diams.

12. A pathological embryo imbedded in dense magma.

13 and 14. Sketches of a "gargoyle" monster.

15. Embryo with defective head, in its chorion. Enlarged 8 diams.

16. A very young cyclops. Enlarged 18 diams.

17 and 18. Pathological embryo, about 3 mm. long.

DEPARTMENT OF EXPERIMENTAL EVOLUTION.

1. Map of part of Long Island Sound and its Shores, showing Location of the Department and its Culture Grounds, also Goose Island, used for Isolation Experiments.

2. Photographs of the Grounds and Principal Buildings of the Department.

3. Studies on Human Heredity.
   (I) Schedules for collecting data.
   (II) Pedigree charts of families showing:
   a. Feeble-mindedness.
   b. Epilepsy.
   c. Tendency to outbursts of temper.
   d. Impulse to wander.
   e. Drink mania.
   f. Uncontrollable eroticism.
   g. Talent for singing.
   h. Histrionic ability.
   i. Scholarship.
   k. Ability as naval commanders.

4. Chromosomes in Relation to Heredity.
   a. The pairing and individuality of the chromosomes as seen in a species of Drosophila.
   b. Diagrams showing the evolution of the germ-plasm. Types of chromosomes in related species of Drosophila.
   c. The sex-chromosomes.

5. Charts showing the Relation of Characteristics of the Adult to Determiners in the Germ Plasm as worked out in the Vinegar Fly, Drosophila. (Professor Morgan.)

6. Specimens and Diagrams showing Changes of Type by "Selection."
   - *a.* In rats (Professor Castle).
   - *b.* In poultry; attempt to "create" a new "buff" race.
   - *c.* In Drosophila.
   - *d.* In garden beans.

7. Paintings showing "Control of Sex" in Pigeons.

8. Specimens showing the Influence of Secretions of the Germ-Glands on the External Sex-Characters of Poultry.

9. Diagram illustrating Sex in Bread-Molds and how it has been demonstrated.

10. Paintings and Specimens showing Control of the Formation of Pigment in Animals by Various Agents.
    - *a, b.* By chemical means.
    - *c.* By light.
    - *d.* Comparison of allied species living in caves and in daylight (see specimens in alcohol).

11. Charts showing Various Plant Abnormalities and the Inheritance of some of them.
    - *a.* Garden beans.
    - *b.* Various abnormalities in feral plants.
      1. Fascination of stem and inflorescence of Helenium autumnale.
      2. Abnormal development of the leaf of the hickory (Carya).
      3, 4, 5. Three forms of fronds in Pteris aquilina.
      6. Variation in the number of leaves to the whorl in Lysimachia (loosestrife).
      7. Variation in the number of ray flowers in Rudbeckia hirta.
      8. Variation in the number of flowers in the infloresence of Plantago.

12. Examples of Mendelian Heredity.
    - *a.* Heredity of cabbage butterflies (Professor Gerould). (See case.)
    - *b.* Four types of "rosette" of Shepherd's Purse (Bursa), exhibiting differences in leaf-form that are inherited in Mendelian fashion.
    - *c.* Inheritance of type of the capsule in Bursa.
    - *d.* Inheritance of reciprocal hybrids in the Evening Primrose (Oenothera).

13. Comparison of the Effects of Self-Fertilization and Cross-Breeding in Maize.

14. Mutation in the sexual characters of a hermaphroditic mucor.

    A dried Petri-dish culture was inoculated at four places on the outside with the normal hermaphroditic race (*y*) and at three places on the inside with the mutant (*x*). Black dots are the sexual spores (zygosphores). The normal race has a male tendency while the mutant (*x*) has a female tendency as shown by the line of sexual spores massed where the colonies of the two races meet.

14. Mutation in the sexual characters of a hermaphroditic mucor.—Continued.
   - *a.* Mucor 75*y*. A species of mucor that is producing mutants known as mucor 75*y*.
   - *b.* A dwarf mutant from the mutating species mucor 75*y* (75*T*5*i*).
   - *c.* A male mutant from the mutating species mucor 75*y* (75*x*).

GEOPHYSICAL LABORATORY.

1. Transparencies showing Exterior and Interior Views of the Laboratory and Photographs relating to recent Researches.
2. Publications of the Laboratory; bound volumes and lists.
3. Plaster of Paris Models representing the most recent Researches in Mineral Synthesis carried on in the Laboratory.
4. A Working Exhibit of the Manner of Making Thin-Sections of Lavas and Rocks for Optical Study, and a small Projection Apparatus to show these Sections on the Screen.

DEPARTMENT OF HISTORICAL RESEARCH.

1. Maps representing Phases of the Work Relative to the Preparation of an "Atlas of the Historical Geography of the United States."
   - *a.* Map showing distribution of manufacturing centers, 1910.
   - *b.* Map showing distribution of presidential votes, 1912.
2. Exhibits Relative to the Search for Materials Concerning American History in the Archives of the Indies.
   - *a.* A group of the papers from Cuba, including records of Florida and Louisiana, in their present location.
   - *b.* Photograph of a letter from Alexandro O'Reilly to Bucareli.
   - *c.* Last page of a letter from St. Ange, from the Illinois. August 4, 1766.
   - *d.* Census of St. Louis. December 31, 1774.
   - *e.* American four-dollar bill of 1776.
   - *f.* Henry Laurens, President of Congress, to Governor Navarro of Cuba. October 27, 1778.
   - *g.* Letter of George Rogers Clark. May 29, 1779.
   - *h.* Treaty of Nogales between Spanish and Indians. October 28, 1793.
   - *i.* Proclamation to the inhabitants of Louisiana announcing the sale of Louisiana to the United States. November 30, 1803.
   - *j.* Last page of articles of transfer of Louisiana from Spain to France.
3. Exhibits Relative to the Search for Materials concerning American History in the French Archives.
   - *a.* "Map of North America . . . containing the countries of New France, Louisiana, Florida, Virginia, New York, New England, Acadia, etc., the whole very faithfully drawn up, according to the observations which the author has made himself during more than 17 years . . . . by Jean Baptiste Louis Franquelin, hydrographer of the King at Quebec."

3. Exhibits Relative to the Search for Materials concerning American History in the French Archives.—Continued.

   b. "Map of the discovery of the Sr. Joliet where are seen the communication of the river Saint Lawrence with the Lakes Frontenac (Ontario), Erie, Lake of the Hurons, and Illinois (Michigan)."

   c. Early map, perhaps by Joliet, about 1673, of the Great Lakes and of the Mississippi.

4. Exhibits Relative to European Treaties bearing on American History.

   a. Bull "Inter Caetera" of Alexander VI, May 3, 1493, assigning the newly found lands to the sovereigns of Castile. (Archives of the Indies, Seville.)

   b. First page of the ratification by John II of the treaty of Tordesillas, 1494. (National Archives, Lisbon.)

   c. Last page of the ratification by Charles V of the treaty of Vittoria, 1524. (National Archives, Lisbon.)

   d. First and last pages of the ratification by Louis XIV of the Treaty of Ryswick, 1697. (Public Record Office, London.)

DEPARTMENT OF MARINE BIOLOGY.

Enlarged Photographs Illustrating the Expedition to the Coral Reefs of Torres Straits in 1913.

1. Chief of Barakan, British New Guinea.
2. Barakan, British New Guinea. The village is built over the ocean for purposes of defense.
3. Girls of Boira, Papua.
4. Servants of Governor Murray of Papua.
5. View from Wentworth Falls, New South Wales, Australia, showing the block faulting so characteristic of the Australian coast.
6. Termites' nest on Prince of Wales Island, Torres Straits, Australia.
7. Primeval forest at Kuranda, Queensland.
8. Eimeo Island, seen from Tahiti.

Tortugas Laboratory.

9. Loggerhead turtles, one day old, at Tortugas, Florida. The eggs were laid in the sand on May 28 and hatched on July 26, 1914.
10. The garden at Tortugas, Florida, in 1914.
11. The yacht "Anton Dohrn" at Tortugas.
12. Deck of the "Anton Dohrn."

Transparencies illustrating the Expedition to the Coral Reefs of Torres Straits in 1913.

13. Eimeo Island in the sunset. Seen from the Palm Groves of Tahiti.
14. Maër Island, Torres Straits, Australia.

Miscellaneous.

15 to 20. Six colored drawings made by Mr. Stanley C. Ball to illustrate Professor A. L. Treadwell's research upon the annelids of Tortugas, Florida.

Miscellaneous.—Continued.

21 to 27. Seven photographs, taken by Dr. T. Wayland Vaughan, showing the annual growth of reef corals at Tortugas, Florida.

28. Tiles upon which corals have been planted by Dr. T. Wayland Vaughan in order to determine their growth-rate.

29. Record showing the rate of nerve conduction in a jellyfish, *Cassiopea*, at Tortugas, Florida.

DEPARTMENT OF MERIDIAN ASTROMETRY.

Model of the Taurus Cluster. Representing how the sun has been passing the cluster within the last 8,500 centuries.

Transparency Box.

A. Representation of the paths on the sky of about 1,900 stars whose motions are well determined.

B. Illustrating some phases of stellar evolution.

C. The effect of stellar evolution upon the determination of the Sun's motion and upon the selective motion of the stars.

D. The Pleiades Group. All the stars are moving in the same direction.

E. The Praesepe Group. Similar to the Pleiades.

F. The position in the sky toward which the Pleiades, Praesepe, and two other groups are moving.

G. The different trend of the motions of stars in early and late stages of evolution in the region of the South Pole of the Milky Way.

H. The Meridian Circle telescope. With this instrument the positions of 26,000 stars are being determined from north to south pole.

I. The Dudley Observatory. Headquarters for the Department of Meridian Astrometry.

J. The Riefler clocks. Capable of maintaining a rate varying by no more than one-thousandth of a second per day.

K. Stacks of computations to reduce the observations taken at San Luis, Argentina.

L. The Observatory at San Luis, Argentina. Southern station of the Department of Meridian Astrometry.

M. The Photometer. Used in determining the brightness of southern stars.

MOUNT WILSON SOLAR OBSERVATORY.

Object: The study of the evolution of the stars and the structure of the universe.

The exhibit consists of two parts: photographic prints mounted in swinging frames, and glass transparencies of various astronomical subjects photographed with the instruments of the Observatory. The prints are intended to illustrate, in as connected a manner as possible, the various phases of the Observatory's work. The transparencies, on the other hand, are selected photographs, reproduced in this form in order to show delicate details which paper prints will not reproduce.

Photographs.

1. Mount Wilson from Mount Harvard.
2. Office Building in Pasadena.

Telescopes for Observation of the Sun. Snow Telescope.

Solar telescopes formerly carried short visual spectroscopes on moving tubes (No. 3). For photography a long fixed spectroscope and telescope were required (No. 5).

3. Kenwood telescope, with moving spectroscope, 4 feet long.
4. Plan and elevation of Snow telescope house.
5. Snow telescope, giving a fixed solar image.
6. Snow telescope.
7. Interior of Snow telescope, showing concave mirror.
8. Coelostat and second mirror of Snow telescope.
9. Coelostat and second mirror of Snow telescope.
10. Five-foot spectroheliograph.
11. Five-foot spectroheliograph, optical train.
12. 18-foot spectrograph of Snow telescope.

Tower Telescope.

Experience with the Snow telescope indicated that a vertical instrument, with longer spectrograph in underground chamber, would be advantageous.

13. First sketch of 60-foot tower telescope.
14. Section through upper end of tower.
15. Section through underground spectrograph chamber.
16. 60-foot tower telescope (without outer tower).
17. Upper end of 30-foot spectrograph.
18. 60-foot tower telescope in final form.

Investigations with the 60-foot tower telescope showed that great advantage should result from higher tower (larger solar image) and longer spectrograph (greater scale of spectrum).

19. 150-foot tower telescope.
20. Upper end of 75-foot spectrograph.
21. Section of tower and spectrograph chamber.
22. Section through upper end of tower.

Note that there are two skeleton towers. The inner tower carries the instruments, while the hollow members of the outer tower carry the dome and shield the inner tower from vibration by the wind.

Telescopes for Observations of the Stars.

60-inch Reflecting Telescope.

On account of the faintness of the stars, telescopes of large aperture are required to collect sufficient light.

23. 60-inch reflecting telescope, showing Cassegrain spectrograph.
24. Section of dome.
25. Arrangement of small mirrors for different classes of work.
26. 60-inch reflecting telescope.
27. 60-inch reflecting telescope.
28. Double slide plate-carrier in Newtonian focus.
29. Dome of 60-inch reflector.

Telescopes for Observations of the Stars.—Continued.

100-inch Reflecting Telescope.

The 60-inch reflector, though very powerful, does not collect sufficient light for studies of the faintest and most distant stars. Provision has therefore been made for the construction of a much larger instrument (see model).

30. Drawing of 100-inch reflector.
31. Model of mounting.
32. Polishing of the 100-inch mirror.
33. The mirror in vertical position for testing.
34. Erection of steel building on Mount Wilson.
35. 100-inch telescope building from 150-foot tower telescope.
36. Pier of 100-inch telescope.
37. Pier of 100-inch telescope.
38. Skeleton of dome (temporarily erected at steel works in Chicago).

Work of the Instrument Shop.

39. Instrument shop in Pasadena (interior).
40. Ruling machine on large planer.
41. Cutting screw of ruling machine.
42. 60-inch reflector mounting in erecting house.
43. Five-foot spectroheliograph under construction.
44. Glass disk for 60-inch reflector.
45. Polishing the 60-inch mirror.
46. 60-inch mirror in position for testing.

Transportation to Mount Wilson.

Mount Wilson rises abruptly from the San Gabriel Valley to a height of 5,886 feet, and was formerly reached by a narrow trail 9 miles long.

47. The trail before widening.
48. Widening the trail.
49. Slides brought down by winter rains, which must be cleared away annually.
50. Small truck formerly used on trail (maximum capacity 1,000 pounds.).
51. Gasolene motor electric truck.
52. Hauling material for 60-foot tower telescope.
53. Hauling material for 100-inch telescope building.
54. Erection of Snow telescope house.
55. Erection of Snow telescope house.
56. Erection of Pasadena office building.
57. Erection of Monastery.
58. Erection of building for 60-inch reflector.
59. Erection of 150-foot tower telescope.
60. Erection of pier for 100-inch reflector.
61. Wall to support 50-foot stellar spectrograph of 100-inch telescope.

Additional Buildings and Instruments.

62. Dome of 10-inch photographic telescope.
63. Dome of 6-inch refractor.
64. The Monastery: observers' quarters on Mount Wilson.
65. Power-house on Mount Wilson.

Additional Buildings and Instruments.—Continued.

66. The Pasadena Laboratory.
67. Vertical concave grating spectrograph.
68. Interior of Pasadena Laboratory.
69. Magnet for study of the Zeeman effect.
70. Electric furnace.
71. Machine shop in Pasadena.
72. Optical shop in Pasadena.
73. Library.
74. Machine for ruling large diffraction gratings.
75. Dome of 60-inch reflecting telescope.

Instruments of The Computing Division.

76. Heliomicrometer, which gives the latitude and longitude of sun-spots by inspection (without calculation).
77. Koch registering micro-photometer, for measuring spectrum photographs.
78. Large measuring machine for spectrum photographs.
79. Smaller measuring machine (16 in use).
80. Calculating machines.

All of the above instruments (except those in No. 80) were designed and constructed in the Observatory shops.

A Few Typical Observations.

Photographs Nos. 81 to 111 are intended to illustrate some of the methods of research used by the Observatory. Other photographs representing various investigations may be found in the exhibit of transparencies.

Stars, Star Clusters, Nebulæ and Spectra.

81. A field of stars—The Milky Way, by Barnard.
82. Open star cluster.
83. Globular star cluster.
84. Orion Nebula—irregular in form.
85. Spiral nebula, Messier 51.
86 to 88. Smaller spiral nebulæ.
89. Star cluster Messier 13.
90. Spectrum of Messier 13.
91. Types of stellar spectra.

The Sun—A Typical Star.

92. Direct photograph of the sun, April 30, 1908.
93. Granulation of the solar surface.
94. Sun-spots.
95. Faculæ.
96. Chromosphere and prominences.
97. Solar prominence 80,000 miles high.
98. Calcium flocculi, April 30, 1908.
99. Hydrogen flocculi, April 30, 1908.
100. Right and left-handed vertices surrounding sun-spots.
101. Photograph of a sun-spot.
102. Spectrum of sun-spot shown in No. 101.
103. Electric furnace spectrum.
104. Comparison of sun-spot spectrum with that of titanium oxide.
105. Comparison of sun-spot spectrum with spectrum of electric spark in powerful magnetic field.

Stellar Problems.

106. Spectrum of the star α Tauri, showing displacement of lines due to motion in line of sight.
107. Diagram showing that faint stars (near North Pole) are redder than brighter stars.
108. Spectra showing that distant stars are redder than nearer stars.
109. Spectra showing variation of relative intensities of spectrum lines with absolute brightness of stars.
110. Spectrum of star Lalande 1966, velocity −325 km. per second.
111. Spectrum of a spectroscopic binary star, showing alternate displacement of lines to red and to violet.

General Views from Mount Wilson.

112. Northeast from Mount Wilson. San Antonio in the distance.
113. Telephoto of Mount San Antonio from Mount Wilson. Distance 25 miles.
114. Telephoto of Pasadena from Mount Wilson. Distance 8 miles.
115. East from Mount Wilson. San Gorgonio and San Jacinto in the extreme distance, 75 and 90 miles, respectively.

Transparencies.

116. Twelve spectroheliograms of a sun-spot made on September 10, 1908, showing eruptions and other changes in the hydrogen ($H\alpha$) vapor.
117. Spectrum of a sun-spot, $\lambda 6216$–$\lambda 6360$, photographed September 16, 1914, showing the widening, strengthening, and dividing of the lines due to a magnetic field. The broken appearance of the outside components of triple or double lines in the spectrum is due to the analyzer placed over the slit of the spectrograph.
118. Sun-spot, photographed June 17, 1907. Enlarged five diameters. Diameter of earth on same scale 5-16 inch.
119. Direct photograph of the sun, April 30, 1908.
120. Calcium (H_2) flocculi, spectroheliogram of April 30, 1908.
121. Hydrogen ($H\alpha$) flocculi, spectroheliogram of April 30, 1908.
122. Hydrogen ($H\alpha$) spectroheliogram, multipolar sun-spot group, September 2, 1908.
123. Hydrogen ($H\alpha$) spectroheliogram of November 18, 1908.
124. Hydrogen ($H\alpha$) spectroheliogram of October 7, 1908, showing spots of opposite polarity in northern and southern hemispheres.
125. Portion of the sun, showing unipolar spots N and S of equator, photographed in ($H\alpha$) light.
126. Representative stellar spectra, showing the spectra of stars in the most probable order of their development. The letters refer to the types of the Harvard system of classification.
127. Stellar spectra, showing the weakening of the violet part of the continuous spectrum in the more distant and more luminous stars.
128. Stellar spectra, showing the weakening of the violet part of the continuous spectrum in the more luminous stars.
129. Stellar spectra showing the abnormal strength of the hydrogen lines in the spectra of some of the more luminous stars.

Transparencies.—Continued.

130. Stellar spectra, showing the variation of certain spectral lines with the absolute brightness of the stars. These lines furnish a criterion of brightness and so afford a means of determining stellar distances.

131. Laboratory spectrum, showing Zeeman effect for chromium in the blue.
 a. Spectrum without magnetic field.
 b. n-components.
 c. p-components.

132. Laboratory spectrum, showing Zeeman effect for chromium in the green.
 a. Spectrum without magnetic field.
 b. n-components.
 c. p-components.

133. Laboratory spectrum, showing Zeeman effect for iron in the green.
 a. Spectrum without magnetic field.
 b. n-components.
 c. p-components.

134. Laboratory spectrum, showing Zeeman effect for three strong chromium lines, λλ4254 (21 components), 4275, 4290.
 a. n-components.
 b. p-components.

135. Spectra of the east and west limbs of the sun, showing displacements due to the solar rotation.

136. Laboratory spectrum, showing Zeeman effect for iron in the blue.
 a. Spectrum without magnetic field.
 b. n-components.
 c. p-components.

137. Spectrum of iron in the arc and in the electric furnace at temperatures of 2500°, 2300°, 2000° C., respectively. λ3450–λ3700.

138. Spectrum of iron in the arc and in the electric furnace at temperatures of 2500°, 2300°, 2000° C., respectively. λ3700–λ3950.

139. Spectrum of vanadium in the arc and in the electric furnace at temperatures of 2600°, 2300°, 2100° C., respectively. λ4000–λ4500.

140. Spectrum of vanadium in the arc and in the electric furnace at temperatures of 2600°, 2300°, 2100° C., respectively. λ4500–λ5000.

141. Spectrum of chromium in the arc and in the electric furnace at temperatures of 2600°, 2300°, 2100° C., respectively. The spectrum in this region is composed chiefly of low-temperature lines which undergo little change. λ5100–λ5450.

142. Spectrum of iron in the arc and in the electric furnace at temperatures of 2600° and 2100° C., respectively. Lines strong in the furnace spectrum and remaining at low temperature are relatively strong in the spectra of sun-spots. λ5320–λ5460.

143. Spectrum of the cluster Messier 13, photographed with the 60-inch reflector, June 20–24, 1914, 30^h exposure time, enlarged 7 diameters.

Transparencies.—Continued.

144. Spectrum of Andromeda nebulæ, photographed with the 60-inch reflector, November 12 to 16, 1914, 34^h exposure time, enlarged 7 diameters.
145. Recent spectra of five Novæ.
146. *a.* Spectrum of the high velocity star Lalande 1966, velocity −325 km. per second.
  b. Spectrum of a star of normal velocity, −10 km. per second.
147. Three regions of solar spectrum with iron arc comparison, showing identification of lines in the sun.
148. Sun-spot spectra showing the Evershed effect. The displacements of the lines indicate an outflow of the vapors from the spot.
  a. Slit radial to sun and across the spot.
  b, c. Slit radial with spectra of outer and inner edges of the penumbra of the same spot juxtaposed. Spectrum of umbra appears twice.
  d. Same as *b* and *c*, except that spectrum on umbra does not appear at all.
149. Photograph of the sun-spot of June 19, 1914, also its spectrum at λ6300, photographed with:
  a. Single quarter-wave plate and Nicol prism.
  b. Compound quarter-wave plate and Nicol prism.
150. Spectrum of the center and limb of the sun. Ultra-violet, H and K, and G regions.
151. Solar spectrum λ5250–λ5320, made for the determination of the sun's general magnetic field.
152. The star cluster, M 13 Herculis. Photographed with the 60-inch reflecting telescope. Exposure, 11 hrs., June 6, 7, and 8, 1910.
153. The Ring nebula in Lyra. Photographed with the 60-inch reflecting telescope. Enlarged 22.7 times.
154. Central part of Orion nebula. Photographed with the 60-inch reflecting telescope. Enlarged 6.2 times.
155. The Crab nebula, M 1. Photographed with the 60-inch reflecting telescope. Enlarged 7.4 times.
156. The Dumb-bell nebula, M 57 Vulpeculae. Photographed with the 60-inch reflecting telescope. Exposure, 5 hrs., July 6 and 7, 1910.
157. Spiral nebula, M 51 Canum Venaticorum. Photographed with the 60-inch reflecting telescope. Exposure, 10 hrs., 45 min., April 7 and 8, 1910.
158. The spiral nebula M 33 Trianguli. Photographed with the 60-inch reflecting telescope. Exposure, 8 hrs., 30 min., August 5, 6, 7, 1910.
159. The spiral nebula, M 101 Ursæ Majoris. Photographed with the 60-inch reflecting telescope. Exposure, 7 hrs., 30 min., March 10 and 11, 1910.
160. Central part of Andromeda nebula. Photographed with the 60-inch reflecting telescope. Enlarged 7.5 times.
161. Head of Halley's comet. May 8, 1910. Photographed with the 60-inch reflecting telescope.
162. The spiral nebula, H V 24 Comæ Berenices. Photographed with the 60-inch reflecting telescope. Exposure, 5 hrs., March 6 and 7, 1910.

Transparencies.—Continued.

163. Star cluster, M 15. Photographed with the 60-inch reflecting telescope. Enlarged 5.8 times.

164. The spiral nebula, M 64 Comae Berenices. Photographed with the 60-inch reflecting telescope. Exposure, 7 hrs., 56 min., May 5, 6, 7, and 8, 1910.

165. Halley's comet. May 5 and 6, 1910. Photographed with 6-inch portrait lens at Honolulu.

166. Hydrogen ($H\delta$) flocculi surrounding sun-spots of September 10, 1909. Photographed with the Snow telescope and 5-foot spectroheliograph. Scale, Sun's diameter = 20 inches.

167. Saturn. November 19, 1911. Enlarged 2.5 diameters.
Mars. October 4, 1911. Enlarged 11 diameters.

168. Entire chromosphere showing solar prominences. Photographed with the Snow telescope and 5-foot spectroheliograph, August 20, 1909. $H\alpha$ line of hydrogen.

169. Solar prominence 80,000 miles high photographed with the Snow telescope and 5-foot spectroheliograph, August 21, 1909. $H\alpha$ line of hydrogen.

170. The Moon, region of Albategnius and Hipparchus. Photographed with the 100-foot focus combination of the 60-inch reflecting telescope. Scale, Moon's diameter = 56 inches.

171. Spectrum of Arcturus (region B to G). Enlarged about three times. Made with the 18-foot Littrow spectrograph and 60-inch reflecting telescope.

172. The Sun, direct photograph. July 30, 1906. Enlarged from a negative 6.7 inches in diameter, made with the Snow telescope.

173. Spiral nebulæ photographed with the 60-inch reflector:
a. N. G. C. 2841. Exposure 2^h. Enlargement 5.7 diams.
b. N. G. C. 4567, 4568. Exposure 6^h. Enlargement 7 diams.
c. N. G. C. 7217. Exposure $5^h\ 30^m$. Enlargement 5.7 diams.
d. H V 44 Camelop. Exposure $3^h\ 30^m$. Enlargement 2.5 diams.
e. N. G. C. 1501. Exposure 2^h. Enlargement 5.7 diams.
f. N. G. C. 5383. Exposure 6^h. Enlargement 5.7 diams.
g. N. G. C. 4736. Exposure $3^h\ 45^m$. Enlargement 5.7 diams.
h. N. G. C. 278. Exposure 4^h. Enlargement 5.7 diams.
i. N. G. C. 650, 651. Exposure 6^h. Enlargement 5.7 diams.
j. M. 82. Exposure $4^h\ 30^m$. Enlargement 4 diams.
k. N. G. C. 4449. Exposure 5^h. Enlargement 5.7 diams.
l. N. G. C. 5866. Exposure $2^h\ 45^m$. Enlargement 5.7 diams.
m. M. 97. Exposure 4^h. Enlargement 3.2 diams.
n. N. G. C. 7009. Exposure $3^h\ 30^m$. Enlargement 7 diams.
o. N. G. C. 7662. Exposure $1^h\ 30^m$. Enlargement 7 diams.
p. N. G. C. 6543. Exposure 50^m. Enlargement 7 diams.

174. Spectrum of the "Flash" (lower chromosphere) showing magnesium lines, green carbon fluting, etc. Photographed without an eclipse, 60-foot tower telescope and 30-foot spectrograph.

175. Section of preliminary sun-spot spectrum map, wave-length 5000–5200.

176. The Sun, showing the calcium (H_2) flocculi. 1906, July 30. Enlarged from a negative 6.7 inches in diameter made with the Snow telescope and 5-foot spectroheliograph.

NUTRITION LABORATORY.

A. Photographic Views of:

1. Nutrition Laboratory, exterior view.
2. Calorimeter Laboratory.
3. Calorimeter Laboratory during a series of acidosis experiments.
4. Psycho-physical Laboratory.

B. Investigations on the Variation of the Oxygen Content of Atmospheric Air:

5. Photograph of Sondén's air analysis apparatus.
6. Table showing the constancy of oxygen in the air.

C. Apparatus for Recording Muscular Activity.

7. Diagram showing method of recording muscular activity.
8. Photograph of activity-recording bed.
9. Photograph of activity-recording crib for infants.
10. Photograph of activity-recording cage for geese.
11. Collection of kymograph records showing the muscular activity of men, infants, and animals during metabolism experiments.

D. Investigations on the Fluctuations of Body-Temperature.

12. Diagram showing method of measuring the changes in body-temperature.
13. Photograph of subject on cot with rectal thermometer in position, sphygmomanometer on arm for measuring blood pressure, and observer recording body-temperature.
14. Chart showing the hourly fluctuations and the diurnal curve in the body-temperature of three subjects. (Note the low temperature in the early morning and the high temperature in the afternoon.)
15. Chart showing body-temperature curve for 22 consecutive hours of a man in the 24th and 25th days of a fast. (Note that, in spite of the absence of food, the regular diurnal change in body-temperature persists.)

E. Investigations of the Gaseous Exchange in the Animal Body.

16. Diagram showing method of determining the amounts of carbon dioxide produced and oxygen consumed by man.
17. Photograph of unit respiration apparatus connected for an experiment (early model).
18. Photograph of unit respiration apparatus for the determination of oxygen and carbon dioxide in the gaseous exchange of the animal body (latest model).
19. Photograph of unit respiration apparatus connected to a rabbit box, showing spirometer for oxygen supply and kymograph for recording muscular movements.
20. Photograph of unit apparatus connected to clinical respiration chamber for use with bedridden patients.
21. Photograph of unit respiration apparatus connected to infant's crib.

E. Investigations of the Gaseous Exchange in the Animal Body.—Continued.

22. Photograph of Tissot method for the study of the gaseous exchange.
23. Table showing the gaseous metabolism in the animal body.
24. Table showing metabolism of 18 severe diabetic patients compared with the metabolism of normal individuals of equivalent height and weight.

F. Investigations on the Relation of Pulse-Rate to Metabolism.

25. Diagram showing the photographic method of recording the pulse-rate.
26. Photograph of Einthoven string galvanometer for photographically recording the pulse.
27. Photograph of Bock-Thoma oscillograph for photographically recording the pulse.
28. Photographic record of the pulse of a man walking on a treadmill, taken with the Einthoven string galvanometer, and a photographic record of the pulse and respirations of a man, taken with the Bock-Thoma oscillograph.
29. Table showing comparison between the pulse-rate and the metabolism of an athlete.

G. Investigations on the Gaseous Metabolism of Infants.

30. Photograph of unit respiration apparatus as used for measuring the gaseous metabolism of infants.
31. Photograph of crib for registering muscular activity of infants.
32. Table showing comparison of infant's pulse-rate and gaseous exchange during periods of quiet and muscular activity.

H. Investigations on the Heat-Production of the Animal Body.

33. Diagram showing method of measuring the heat eliminated by the human body.
34. Photograph of respiration calorimeter, bed type.
35. Photograph of respiration calorimeter, muscular work type.
36. Photograph of absorber table and balances for use with the respiration calorimeters.
37. Table showing heat produced by the animal body under varying conditions.

I. Apparatus used as Sources of Exercise in the Study of Metabolism during Muscular Work.

38. Photograph of treadmill, designed by Metcalf.
39. Photograph of treadmill for dog, designed by Tangl, Budapest.
40. Photograph of unit respiration apparatus as used for the study of the metabolism of a professional bicyclist during severe muscular work.

J. Methods of Investigating the Neural and Mental Processes in Various Stages of Nutrition.

41. Photograph of method of measuring the reflex time of the knee jerk.
42. Photograph of method of measuring the quickness of reading and speaking short words.

J. Methods of Investigating the Neural and Mental Processes in Various Stages of Nutrition.—Continued.

43. Photograph of method of measuring the time of the eye-wink reflex.
44. Photograph of method of measuring the speed of individual strokes in typewriting.
45. Photograph of method of measuring the sensitivity of the finger-tips to electric shock.
46. Photograph of method of testing the auditory sensitivity.
47. Photograph of method of measuring the visual reflex time, speed, and accuracy of eye movements, and movements and pauses of the eye in reading.
48. Photograph of method of photographing the pulse and rapidity of voluntary finger movements.
49. Photograph of group of kymograph records of knee jerk, word reaction, word association, and typewriting.
50. Records of psycho-physical tests.
51. Metabolism chart of the most important factors measured on a man throughout a 31-day fast.

DEPARTMENT OF TERRESTRIAL MAGNETISM.

1. Model of Non-Magnetic Yacht *Carnegie*. On a scale of ¼ inch to the foot, mounted on a sheet of glass in representation of the water-line. The whole exterior of the vessel is reproduced from keel to truck, the details of rigging, as well as all deck superstructure and navigational appliances.

2. 30-inch Globe, showing extent of magnetic surveys of the Department, 1905 to 1914.

3. Combined Magnetometer and Earth-Inductor. One of the latest types of portable instruments designed and constructed by the Department for determining the magnetic elements on land with high precision.

4. Ion-Counter. The purpose of the instrument is to determine the number of ions per cubic centimeter of the atmosphere. The chief modification, as made by the Department from the Ebert design, consists in the adaptation of the instrument to the use of a sensitive single fiber electrometer which enables measurements to be made in a much shorter time and more accurately.

5. Views of the buildings of the Department.

6. Miscellaneous photographs and diagrams showing various designs of instruments and views typical of the observational work involved in a magnetic survey of the world.

Appendix B

THE CARNEGIE INSTITUTION OF WASHINGTON EXHIBIT PAMPHLET FOR 1925

CARNEGIE INSTITUTION OF WASHINGTON

EXHIBITS REPRESENTING RESULTS OF RECENT RESEARCH ACTIVITIES

ADMINISTRATION BUILDING
SIXTEENTH AND P STREETS

WASHINGTON, D. C.
December 1925

MAIN FLOOR

Lecture Room

MOUNT WILSON OBSERVATORY

Electric vacuum furnace.

Room 204

ROMAN BUILDING CONSTRUCTION

Esther B. Van Deman. Ancient Roman Monuments. Published plans and photographs.
Specimens of building materials.
Paintings of Roman brick-faced concrete monuments.
Photographs of wall construction and of Roman aqueducts.
Tomb decoration made of roof tile.

Room 205

MIDDLE AMERICAN ARCHÆOLOGY

Work of field expedition of 1925 at Chichen Itzá, Yucatan.
Fragments of mural paintings from Temple of the Warriors.
Photographs and colored lantern slides illustrating different phases of the excavations.

UPPER FLOOR

Library

Publications of Institution of past year.
D. N. Lehmer. Stencil device for factoring of numbers.

Room 309

GEOPHYSICAL LABORATORY

Heat measuring apparatus: Items (a) to (c) illustrate the principles of heat measurement; (d) Practical calorimeter; (e) Copper block calorimeter; (f) Twin calorimeters for use in furnace up to 1600° C.

Apparatus for determining magnetic inversion temperature of powders.

Apparatus for determining magnetism of small samples in inaccessible places.

Method of exhibiting spectral composition of interference colors.

SEISMOLOGICAL RESEARCH

Model of ocean bottom off the coast of California.
Seismograms of Santa Barbara earthquake. Fault map of Santa Barbara region.
Torsion seismometer.
Lantern slides showing effects of Santa Barbara earthquake.

DEPARTMENT OF TERRESTRIAL MAGNETISM

Exhibit relating to Heaviside Layer. Demonstration by echoes of radio waves from Naval Research Laboratory and Bureau of Standards.

Apparatus illustrating the Earth's magnetism and electricity as influenced by electric energy from the sun.

Model illustrating Earth's electric field.

Lantern slides showing equipment and operation of Department.

DEPARTMENT OF EMBRYOLOGY

CYTOLOGY

Living cultures of tumor cells growing in a drop of plasma.

Culture of living white blood cells of the frog showing their transformation into cells concerned with the healing process in tuberculosis.

Ingestion and digestion of tubercle bacilli by living white blood cells of the frog.

GROWTH PHENOMENA

Living chick embryos growing in glass dishes.

Transparencies of photographs of microscopic sections of youngest human embryo thus far observed.

Transparencies of photographs of vertebrate embryos.

LABORATORY FOR PLANT PHYSIOLOGY

Apparatus showing comparative rates of swelling in different tissues or substances.

Map and photographs illustrating history of delta of the Colorado River.

W. A. Cannon. Chart showing features of experimental studies of roots of land plants.

ECOLOGICAL RESEARCH

Behavior response of live desert animals.

Apparatus for taking census of soil animals.

Instruments for measuring volume and composition of soil air.

Demonstration of sleeping and waking movements of flowers.

Lantern slides showing life history of evening primrose flowers.

MOUNT WILSON OBSERVATORY

Transparencies and photographs illustrating results of recent investigations undertaken with telescopes on Mount Wilson and with apparatus in physical laboratory in Pasadena.

Apparatus showing spectrum of helium formed by a diffraction grating.

A. A. Michelson. Interferometer illustrating measurement of diameters of stars and distances between components of close double stars.

NUTRITION LABORATORY

Demonstration of measurement of energy consumption (food need) while performing work.

Room 301

DEPARTMENT OF GENETICS

Demonstration, by charts, by living animals, and by projection apparatus, of—

Seasonal sexual changes in pigeons.

The control of sex in water fleas.

Rate of mutation in the character "Reddish" in fruit flies.

W. E. Castle. Charts and stuffed skins illustrating linkage in rabbits.

Corridor

TORTUGAS LABORATORY

H. V. Wilson. Development of sponges from tissue cells that have been artificially separated.

DIATOM RESEARCH

Albert Mann. Microscopic demonstrations and specimens of different types of diatoms.

Lantern slides showing different types of diatoms.

DEPARTMENT OF MERIDIAN ASTROMETRY

Charts relating to effect of systematic corrections to the apparent motions of stars upon problems of direction of motion of sun through space and of northward motion of American continent.

DEPARTMENT OF HISTORICAL RESEARCH

Maps, posters, and photostats illustrating character of material developed and used in American historical studies.

Guide to Materials in Paris for American History; Letters of Members of Continental Congress; Atlas of United States History; Correspondence of Andrew Jackson; Historical Documents relating to New Mexico.

Appendix C

EXCERPT FROM THE CARNEGIE INSTITUTION OF WASHINGTON EXHIBIT PAMPHLET FOR 1939

Reprinted with permission of the Carnegie Institution of Washington.

EXHIBITION

Presenting Results of Recent
Research Activities of the

Carnegie Institution of Washington

ADMINISTRATION BUILDING
SIXTEENTH AND P STREETS
WASHINGTON, D. C.

OPEN TO VISITORS
Saturday, 7:30 to 10:30 p.m.
Sunday and Monday, 2 to 5 and 7:30 to 10:30 p.m.

December 16, 17, and 18 · · · 1939

"*To encourage in the broadest and most liberal manner investigation, research, and discovery, and the application of knowledge to the improvement of mankind.*"—PURPOSE OF CARNEGIE INSTITUTION AS STATED IN ITS CHARTER

Foreword

Each year the Carnegie Institution of Washington, at the time of its annual meetings, holds an exhibition at which are presented research results selected from the wide range of interests of the Institution. It also provides lectures and conferences on scientific subjects, which are attended by the Institution's staff and its guests. These meetings provide opportunity for exchange of ideas between scientists in various fields, and for the discussion of future research plans. They also give the Institution an opportunity to exemplify its activities to scientists and laymen generally, and in particular to many residents of Washington who follow its research efforts with keen interest.

Scientific research, of the fundamental sort which is the particular concern of the Institution, has two great objectives. The first is to lay a secure foundation of knowledge on which can be built those later applications of science which will enable man to utilize natural resources to better advantage and thus to increase his material standard of living. The second is to extend the knowledge of all those matters in which man takes a deep cultural interest: the remote past, the distant stars, the minute structure of matter, the nature of living things. The scientist can attain this second objective fully only when he shares his findings with all those who share his interest in them, whether they be fellow scientists in other fields, or laymen to whom basic science has a strong appeal.

When scientists personally present their results, as is the adopted procedure at these annual exhibits, it is felt that an especially effective means is provided for giving visitors an insight into the work of the Institution.

The exhibits on "The Earth's Magnetism," "Leukemia in Mice," and "Combustion of Carbohydrates by Man" have been prepared with the cooperation of the Museum of Science and Industry of New York; that on "Cosmic Rays," with the cooperation of the Franklin Institute, Philadelphia. It is expected that after the Institution's exhibition these four exhibits will be made available to other audiences by these cooperating organizations.

Exhibits

Upper Exhibit Hall

Lower Exhibit Hall

Public Lectures

Elihu Root Hall

SATURDAY, DECEMBER 16

8:30 to 8:50 p.m. WHAT ARE COSMIC RAYS?
T. H. Johnson

SUNDAY, DECEMBER 17

3:30 to 3:50 p.m. HOW VOLCANOES HAVE INFLUENCED HISTORY IN CENTRAL AMERICA
A. V. Kidder

4:00 to 4:20 p.m. THE VOLCANOES OF CENTRAL AMERICA AS OUTDOOR LABORATORIES FOR EARTH SCIENCES
L. H. Adams

8:00 to 8:20 p.m. THE MOTIONS AND DIMENSIONS OF OUR STELLAR SYSTEM
A. H. Joy

8:30 to 8:50 p.m. LEUKEMIA IN MICE
E. C. MacDowell

MONDAY, DECEMBER 18

8:30 to 8:50 p.m. URANIUM TRANSMUTATION OF HIGH ENERGY
L. R. Hafstad

Stereoscopic Projections

Elihu Root Hall

COLOR PHOTOGRAPHS FROM YUCATAN
THE SURFACE OF THE MOON
MONKEY AND HUMAN EMBRYOS

Saturday, December 16, 9:30 to 9:50 p.m.
Sunday, December 17, 2:30 to 2:50, 9:30 to 9:50 p.m.
Monday, December 18, 4:30 to 4:50, 9:30 to 9:50 p.m.

Appendix D

EXCERPT FROM THE CARNEGIE INSTITUTION OF WASHINGTON EXHIBIT PAMPHLET FOR 1940

Reprinted with permission of the Carnegie Institution of Washington.

EXHIBITION

Presenting

Results of Recent Research Activities

of the

Carnegie Institution of Washington

Administration Building
1530 P Street, Northwest
Washington, D. C.

Open to Visitors

Saturday, 7:30 to 10:30 p.m. Sunday and Monday, 2 to 5 and 7:30 to 10:30 p.m.

December 14, 15, and 16, 1940

"To encourage in the broadest and most liberal manner investigation, research, and discovery, and the application of knowledge to the improvement of mankind."—PURPOSE OF CARNEGIE INSTITUTION AS STATED IN ITS CHARTER

Foreword

NEARLY everyone is interested in the practical applications of science which affect his way of life, his comfort, his health, and his business. But beyond this, there is a surprisingly large number of people who have a considerable interest in the aspects of science that have no bearing on such mundane affairs, as, for example, theories of astronomy and cosmology, discoveries concerning the plants and animals of past geologic ages, or new information about the lives and customs of people of other civilizations that have long since developed, culminated, and disappeared.

These things are of purely cultural interest to the layman. He shows about such subjects that intellectual curiosity which is one of the distinguishing marks of civilized man. It is often very difficult, however, for him to obtain information on scientific work that is both accurate and understandable.

The scientist is a specialist, and he has of necessity developed a technical cant and symbolism for each of the fields of scientific endeavor. Even among scientists themselves, there are few who are familiar with the language of many branches of science. An atomic physicist can perhaps follow the conversation of a chemist, but he may be quickly lost with that of a zoologist. It is too much to expect the layman to overcome this barrier which stands between him and accurate scientific knowledge.

Rather, it is for the scientist and the popular interpreter of his work to put the material of science into such a form that this barrier of technical language is broken down, making it understandable to the layman and stimulating to his imagination. The public exhibition held by the Carnegie Institution of Washington each year at the time of its annual meeting is an attempt to do this by presenting in a graphic manner the recent work done by the staff of the Institution in the physical, biological, and historical sciences.

The exhibits on the gene and on the plant fossils of the Pacific Northwest ("Have Our Continents Migrated?") have been prepared with the cooperation of the Museum of Science and Industry of New York; that on high pressures was prepared by the Maryland Academy of Sciences, Baltimore. After the Institution's exhibition, these exhibits will be made available to other audiences by the cooperating organizations.

Exhibits

Public Lectures

ELIHU ROOT HALL

Saturday, December 14

8:30 to 9:00 p.m. Climatic Changes in the Pacific Northwest as Shown by Paleobotanical Records
Ralph W. Chaney

Sunday, December 15

3:30 to 4:00 p.m. The Gene *M. Demerec*

4:30 to 5:00 p.m. Recent Archaeological Finds in the Maya Area
A. V. Kidder

8:30 to 9:00 p.m. Supernovae *Edwin Hubble*

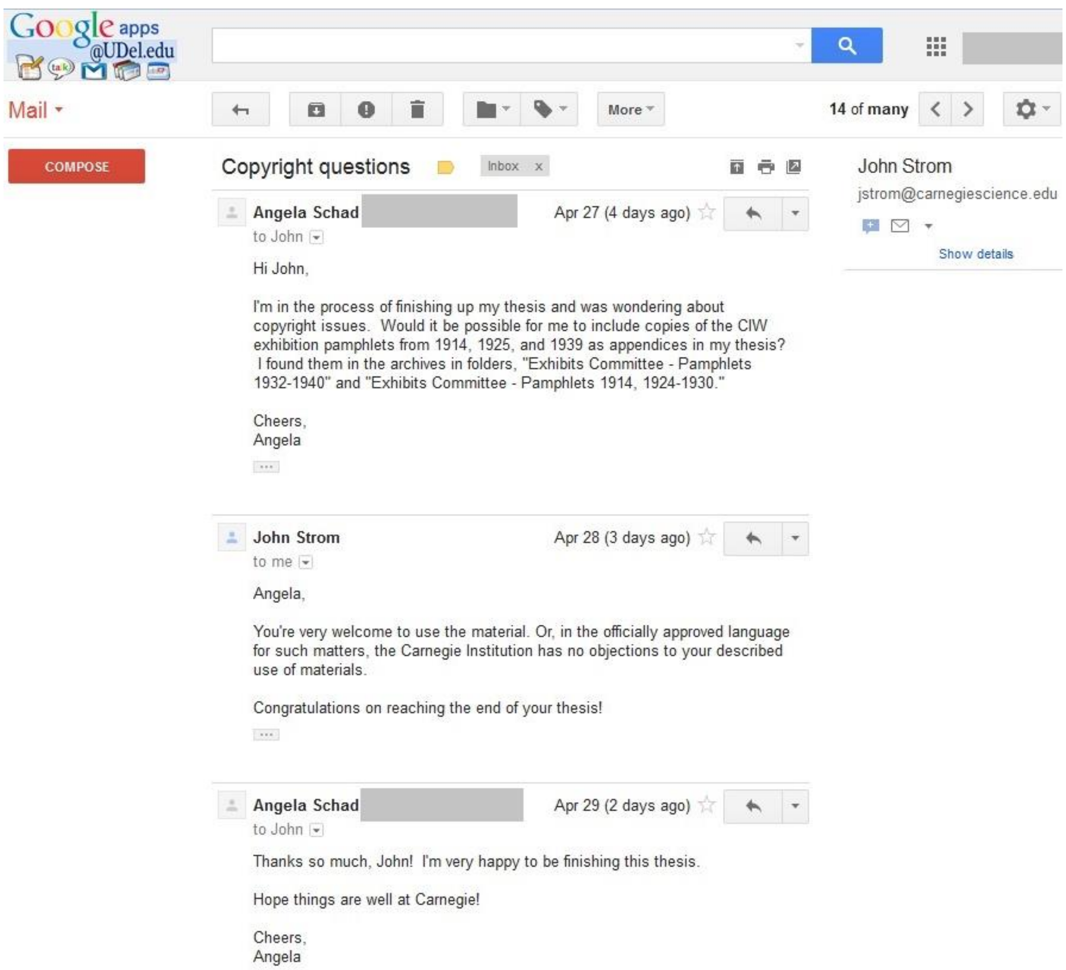
Monday, December 16

8:30 to 9:00 p.m. Apparatus for Attaining High Pressures
R. W. Goranson

Appendix E

PERMISSIONS

John Strom, Multimedia Designer and Producer for the Advancement Office, handles permission requests for the Carnegie Institution for Science.



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COMPOSE

More

14 of many

Copyright questions Inbox x

John Strom
jstrom@carnegiescience.edu
Show details

Angela Schad [redacted] Apr 27 (4 days ago)
to John

Hi John,

I'm in the process of finishing up my thesis and was wondering about copyright issues. Would it be possible for me to include copies of the CIW exhibition pamphlets from 1914, 1925, and 1939 as appendices in my thesis? I found them in the archives in folders, "Exhibits Committee - Pamphlets 1932-1940" and "Exhibits Committee - Pamphlets 1914, 1924-1930."

Cheers,
Angela

John Strom Apr 28 (3 days ago)
to me

Angela,

You're very welcome to use the material. Or, in the officially approved language for such matters, the Carnegie Institution has no objections to your described use of materials.

Congratulations on reaching the end of your thesis!

Angela Schad [redacted] Apr 29 (2 days ago)
to John

Thanks so much, John! I'm very happy to be finishing this thesis.

Hope things are well at Carnegie!

Cheers,
Angela