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# Science Fairs Before Sputnik: Adolescent Scientific Culture in Contemporary America

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# SCIENCE FAIRS BEFORE SPUTNIK: ADOLESCENT SCIENTIFIC CULTURE IN CONTEMPORARY AMERICA

by

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# ABSTRACT

"Science Fairs before Sputnik: Adolescent Scientific Culture in Contemporary America" traces the formation and evolution of science fairs in America, focusing on the ways in which adolescents established communities of practice by engaging in these competitions. Over the course of the twentieth century, generations of American children conducted their first experiments by crafting science fair projects. The dissertation evaluates this understudied phenomenon against the backdrop of American fascinations and fears of science and evolving notions of adolescence. It argues that science fairs were central to shaping an adolescent scientific culture in the United States during the early to mid twentieth century. The research is grounded in a source base that includes thousands of photographs of science fair displays, project descriptions written by students, museum collections of equipment, toys, and apparatus, scientific trade literature, popular magazines, and archival collections of sponsoring organizations. In reviewing this range of materials, the dissertation demonstrates how the meanings of science fairs were tied to widespread apprehensions regarding modern scientific advancements, negotiations between adolescents and adults over who held authority, the development of a children's consumer culture, and broader debates regarding the role scientifically inclined youth would play in shaping the nation's future.

While acknowledging the ways in which adults orchestrated the science fair movement, "Science Fairs before Sputnik" evaluates these competitions from a child's eye view, tracing how these competitions fostered the development of communities of practice. For adolescents, science fairs were a place to demonstrate their scientific acumen, develop relationships with like-minded peers, and perhaps most importantly, have fun. Science fairs also raise important philosophical questions regarding the epistemology of children's experimentation. From vibrant three-dimensional dioramas of the Progressive era to postwar argument-driven text panels, science fair displays reveal students' changing beliefs about what counted as faithful scientific evidence. Science fairs, in essence, provide an entry point for understanding how adolescents conceived of science on material, social, and epistemological terms over the course of the twentieth century.

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# INTRODUCTION

A group of biology pupils from Newtown High School in Elmhurst, Long Island won first prize for their exhibit "The Work of a Tree" at the 1931 American Institute Children's Science Fair. Shown at the American Museum of Natural History, the exhibit depicted a diorama of a large dogwood tree divided into four sections to reveal its changing foliage during fall, winter, spring, and summer (fig. Intro.1). Each branch of the tree conveyed a different part of the tree's life cycle, illustrating processes such as respiration, photosynthesis, conduction, osmosis, growth, and seed dispersal. Although the bottom of the exhibit provided written supplementary information, the display contained very little text. Instead, the tree itself stood as visual narrative that told a holistic story of the tree's subsistence to crowds of discerning onlookers.[1]

Nearly twenty-five years later, Albert H. Filskoy, a high school junior from Short Hills, New Jersey, was selected as a finalist for the 1955 National Science Fair for his project, "The Growth of Plants and Flowers in Time Lapse Photography." Like the students from Newtown High School, Filskoy was also interested in studying the life cycle of plants. Filskoy employed time lapse photography to capture the growing period of plants and flowers in shorter timeframes than he could observe through the naked eye (fig. Intro.2). Filskoy found that plants grew during both day and night, exhibited irregular growth patterns, and certain flowers opened more uniformly than

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[1] Children Viewing Display of Dogwood Tree, 1931, photograph no. 313810, Photograph Collection, American Museum of Natural History (hereafter cited as AMNH PC) ; Morris Meister, *Children's Science Fair of The American Institute: A Project in Science Education* (New York, NY: The American Institute, 1932), 9, 41.

others. Although Filskoy used photographs to make his observations, his exhibit was devoid of any images. Instead, Filskoy displayed his camera and apparatus alongside a diagram offering a detailed written explanation of each component. His corresponding text panel described the exhibit's purpose, method and results in orderly fashion.[2]

Although both projects chronicled the life cycle of plants, the exhibits shared little else in common. "The Work of a Tree" conveyed a visual narrative through the careful arrangement of a dioramic display. "The Growth of Plants and Flowers in Time Lapse Photography" offered a textual analysis of the project's main objective, methodology, and outcomes. The Newtown High School project was a collaborative endeavor. Twenty-five students ranging from fourteen to seventeen years old worked together in assembling the exhibit and collectively reaped the rewards of their forty dollar prize. Although Filskoy was inspired to work on his project based on a discussion with his teacher, ultimately he received sole recognition for his work. Newtown students were recognized for a holistic portrayal of a living system; Filskoy was rewarded for his ingenuity in building his own apparatus to conduct a specific experiment. Over the span of two decades, students' presentation of scientific evidence shifted from narrative-driven synthesis to argument-driven analysis.

As the gulf between these two projects demonstrates, scientific authority was far from a stable category in American science fairs. Rather, what constituted scientific evidence remained in flux in the years leading to Sputnik. This dissertation evaluates the underlying values and practices that fostered these epistemic divides. "Science Fairs before Sputnik" traces the formation and evolution of science fairs in America, focusing

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[2] Albert H. Filskoy, Jr. standing next to his exhibit, "Time Lapse Photography: Growth of Plants and Flowers," 1955 Science Fair Binder. Science Service Photograph Collection, Society for Science and the Public (hereafter cited as SSP).

on the ways in which adolescents established distinct communities of practice by engaging in these competitions. Over the course of the twentieth century, millions of American children engaged in their first experiments by crafting science fair projects. The dissertation traces this understudied phenomenon against the backdrop of American fascinations and fears of science and the contested landscape of adolescence. It argues that science fairs were central to shaping an adolescent scientific culture in the United States during the early to mid twentieth century. Fairs served as forums for showing off expertise, exchanging ideas with likeminded peers, articulating stories and arguments about science, and perhaps most importantly, having fun. The element of playfulness allowed participants to establish a sense of scientific authority not in spite of their youth, but by virtue of it.

The research is grounded in a source base that includes photographs of science fair displays, project descriptions written by students, museum collections of equipment, toys, and apparatus, scientific trade literature, popular magazines, and archival collections of sponsoring organizations. In reviewing this range of materials, I reveal how the meanings of science fairs were bound to widespread anxieties regarding the pace of modern scientific advancements, negotiations between adolescents and adults over who held scientific authority, the development of a children's consumer culture, and broader debates regarding the role scientifically inclined youth would play in shaping the nation's future. By demonstrating how these values reflected sociopolitical aims of science fair leaders and ultimately determined who participated, I argue that the confluence of these forces shaped the formation of a distinct adolescent scientific culture.

## **Contributions**

As a study in the history of adolescence, of science, and of popular culture, the dissertation is built upon a few key historiographical assertions. First, it views science fairs as a child-driven enterprise, where adolescents were co-creators in shaping the scientific community of which they were part. In the field of childhood studies, scholars frequently question the autonomy of children, calling into question the degree to which historians can study young people as true historical agents. To what extent can we examine the inner mindsets of children, and to what extent should we simply concentrate on what adults tried to instill in them?[3] Situated on the brink between childhood and adulthood, adolescents in particular reside in a peculiar and tenuous place within these historiographical discussions.[4] I have found that, at least in my own research, adolescents undoubtedly formed distinct sets of practices and beliefs about science in their own right. At the same time, the science fair movement was broadly conceived of and orchestrated

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[3] Some historians who have made this effort include Karin Culvert, *Children in the House: The Material Culture of Early Childhood, 1600-1900* (Boston: Northeastern University Press, 1992); Jacqueline S. Reinier, *From Virtue to Character: American Childhood, 1775-1850* (New York: Twayne Publishers, 1996); and David Nasaw, *Children of the City: At Work and At Play* (Garden City, NY: Anchor Press, 1985). For broader investigations regarding the history of childhood, see Philippe Aries, *Centuries of Childhood: A Social History of Family Life*, trans. Robert Baldick (New York: Vintage, 1962); Howard Chudacoff, *Children at Play: An American History* (New York: New York University Press, 2007); Steven Mintz, *Huck's Raft: A History of American Childhood* (Cambridge: Belknap, 2004); Paula S. Fass and Michael Grossberg, eds. *Reinventing Childhood after World War II* (Philadelphia: University of Pennsylvania Press, 2012); and David I. Macleod, *The Age of the Child: Children in America, 1890-1920* (New York: Twayne Publishers, 1998).

[4] The dissertation's discussion on adolescence is grounded in both classic investigations like G. Stanley Hall, *Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime Religion, and Education,* 2 vols. (New York: D. Appleton, 1904) and William Bryon Forbush, *The Boy Problem* (Boston: The Pilgrim Press, 1901), as well as contemporary scholarship. See, for instance, Sarah E. Chinn, *Inventing Modern Adolescence: The Children of Immigrants in Turn-of-the-Century America* (New Brunswick: Rutgers University Press, 2009); David I. Macleod, *The Age of the Child;* Joseph F. Kett, *Rites of Passage: Adolescence in America, 1790 to the Present* (New York Basic Books, 1977); David I. Macleod, *Building Character in the American Boy: The Boy Scouts, YMCA, and Their Forerunners, 1870-1920* (Madison: University of Wisconsin Press, 1983); and John Demos and Viginia Demos, "Adolescence in Historical Perspective," *Journal of Marriage and the Family* 31, no. 4 (November 1969): 632-638. For the purposes of this dissertation, I define adolescence as roughly the period when children attended junior high and senior high school (typically the ages between eleven and eighteen years old).

by adults. By taking into account the contributions of both adolescents and their adult counterparts, this project considers these competitions as key sites of negotiation over who maintained scientific authority.

Second, this dissertation contributes to scholarship on popular science by building upon the assertion that popular scientific engagement must be considered part of the scientific enterprise. As Katherine Pandora and Karen Radar have argued, knowledge production in vernacular contexts was not merely derivative of professional science. Hobbyists were not just passive consumers of scientific knowledge, but were actively producing their own forms of scientific practices, values, and beliefs.[5] Similarly, adolescent scientific activities often elided formal disciplinary distinction. Although more familiar fields like physics or biology served as popular pastimes, where did activities such as performing chemical magic tricks, writing poetry about science, or building dioramic displays reside on the disciplinary spectrum? In essence, the more holistic view of science presented in this dissertation also offers a broader vision of what constituted legitimate scientific practice.[6]

My third, related assertion juxtaposes youth culture with scientific culture, demonstrating how these groups that are typically analyzed separately were in fact interconnected. I argue that young people should be considered full-fledged contributors to the scientific community. In the process, my project calls into question the nature of expertise. Following the work of Harry Collins and Robert Evans, I relate expertise as an interactive process that requires socialization into the practices of an expert group. By considering adolescents as practitioners who developed their own communities of

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[5] Catherine Pandora and Karen A. Rader, “Popular Science in National and Transnational Perspective: Suggestions from the American Context,” *Isis* 100, no. 2 (June 2009): 346-358.

[6] David Kaiser, “Training and the Generalist’s Vision of Science,” *Isis* 96, no. 2 (June 2005): 244-251.

practice, this dissertation contributes to the understudied discussion of how scientists are made.[7] At the same time, adolescents did not simply engage in science fairs as a means of vocational training. Rather, many students joined science clubs and fairs because they were fun.[8] In this regard, "Science Fairs before Sputnik" contributes a growing number of studies evaluating amateurs and hobbyists.[9] Whereas amateur scientists during the Victorian era have received ample attention, more recently historians have also evaluated amateur communities during the twentieth century.[10] Aaron Alcorn, Sally Gregory Kohlstedt, Ruth Oldenziel, and Patrick McCray in particular have evaluated how children

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[7] In this regard, it responds to the call made by Robert E. Kohler, "From Farm and Family to Career Naturalist: The Apprenticeship of Vernon Bailey," *Isis* 99, no. 1 (March 2008): 28. See also H. M. Collins and Robert Evans, *Rethinking Expertise* (Chicago: University of Chicago Press, 2007).

[8] For more on leisure and hobbies, see Melanie Dawson, *Laboring to Play: Home Entertainment and the Spectacle of Middle-Class Cultural Life, 1850-1920* (Tuscaloosa: University of Alabama, 2005); Claude S. Fischer, "Changes in Leisure Activities, 1890-1940," *Journal of Social History* 27, no. 3 (Spring 1994): 453-475; Steven M. Gelber, "Do-It-Yourself: Constructing, Repairing and Maintaining Domestic Masculinity." *American Quarterly* 49, no. 1 (March 1997): 66-112; Steven M. Gelber, *Hobbies: Leisure and the Culture of Work in America* (New York: Columbia University Press, 1999); Kathryn,Grover, ed. *Hard at Play: Leisure in America, 1840-1940* (Amherst: University of Massachusetts Press, 1992); Richard Butsch, ed. *For Fun and Profit: The Transformation of Leisure into Consumption* (Philadelphia: Temple University Press, 1990); and Kathy Peiss, *Cheap Amusements: Working Women and Leisure in Turn-of-the-Century New York* (Philadelphia, PA: Temple University Press, 1986).

[9] The distinctions between "amateur" and "hobbyist" are often difficult to decipher. Sociologist Robert Stebbins defines amateurs as people who believe that their participation in serious leisure activities has a positive impact on their own wellbeing and the life of the broader community, often forming networks with other amateurs who share their interests. Hobbyists, on the other hand, are people who play at these activities with little personal commitment. In my research, these categories do not appear as distinct as Stebbins suggests. This project employs the term "hobbyist" to describe any student who participated in voluntary scientific pursuits, though the term "amateur" could also easily apply to many dedicated adolescent participants. Robert A. Stebbins, *Amateurs, Professionals, and Serious Leisure* (Montreal: McGill-Queen's University Press, 1992).

[10] See John Lankford, "Amateurs Versus Professionals: The Controversy over Telescope Size in Late Victorian Science," *Isis* 72, no. 1 (March 1981): 11-27; Sally Gregory Kohlstedt, "The Nineteenth-Century Amateur Tradition: The Case of the Boston Society of Natural History," in *Science and Its Public: The Changing Relationship,* ed. Gerald Holton and William Blanpied (Boston: D. Reidel, 1976), 173-190; Sally Gregory Kohlstedt, *Teaching Children Science: Hands-On Nature Study in North America, 1890-1930* (Chicago: University of Chicago Press, 2010); Elizabeth Branaby Keeney, *The Botanizers: Amateur Scientists in Nineteenth-Century America* (Chapel Hill: University of North Carolina Press, 1992); Bernard V. Lightman, *Victorian Popularizers of Science: Designing Nature for New Audiences* (Chicago: University of Chicago Press, 2007); and Iwan Rhys Morus, "Worlds of Wonder: Sensation and the Victorian Scientific Performance." *Isis* 101, no. 4 (December 2010): 806-816.

have engaged in extracurricular scientific and technical pursuits.[11]Their work complements studies that evaluate changes in curriculum and policy surrounding classroom science instruction.[12] By evaluating science fairs beyond simply their educational virtues, this dissertation focuses on the ways in which these competitions fostered new networks for exchanging ideas and expertise.

The dissertation benefits from the recent academic interest in children's engagement in extracurricular science. Two scholars in particular have produced exciting work that informed this project. Sevan G. Terzian's 2013 book *Science Education and Citizenship: Fairs, Clubs and Talent Searches for American Youth, 1918-1958* traces the advent of science fairs from their roots in New York City to their ubiquity in communities across America. Terzian's work serves as the authority on the science fair movement, and his argument that fair organizers shifted their aims from fostering a broad, scientifically minded citizenry  to a more meritocratic goal of encouraging the brightest students to pursue scientific careers both complements and informs my own

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[11] Aaron Alcorn, "Flying into Modernity: Model Airplanes, Consumer Culture, and the Making of Modern Boyhood in the Early Twentieth Century," *History and Technology* 25, no. 2 (May 2009): 115-146; W. Patrick McCray, *Keep Watching the Skies!: The Story of Operation Moonwatch and the Dawn of the Space Age* (Princeton: Princeton University Press, 2008); and Ruth Oldenziel, "Boys and Their Toys: The Fisher Body Craftsman's Guild, 1930-1968, and the Making of a Male Technical Domain," *Technology and Culture* 38, no. 1 (January 1997): 60-96. Other studies of contemporary amateur communities include: Kristen Haring, *Ham Radio's Technical Culture* (Cambridge: MIT Press, 2007) and Jack Hitt, *Bunch of Amateurs: A Search for the American Character* (New York, NY: Crown Publishers, 2012).

[12] David Kaiser, "Cold War Requisitions, Scientific Manpower, and the Production of American Physicists after World War II," *Historical Studies in the Physical and Biological Sciences* 33, Part 1 (2002): 131-159; David Kaiser, ed., *Pedagogy and the Practice of Science: Historical and Contemporary Perspectives* (Cambridge: MIT Press, 2005);  John L. Rudolph, *Scientists in the Classroom: The Cold War Reconstruction of American Science Education* (New York: Palgrave, 2002); JoAnne Brown, "A is for Atom, B is for Bomb': Civil Defense in American Public Education, 1948-1963." *Journal of American History* 75, no. 1 (June 1988): 68-90; Barbara Barksdale Clowse, *Brainpower for the Cold War: The Sputnik Crisis and National Defense Education Act of 1958* (Westport, CT: Greenwood Press, 1981); and John C. Burnham, *How Superstition Won and Science Lost: Popularizing Science and Health in the United States* (New Brunswick: Rutgers University Press, 1987).

assertion of a transformation from synthetic to analytic culture. Rebecca Stiles Onion's dissertation offers another thoughtful analysis on children's popular science in twentieth-century America by demonstrating how notions of children's enjoyment of science have "changed adult understandings of the meaning of science itself."[13] My work builds upon this recent scholarship by shifting the focus to a child's eye view. What motives compelled students to engage in science fairs?  In what ways did adolescents approach experimentation, form networks, and claim authority? How did children convey scientific evidence, and how did that standard change over time?

By analyzing the ways in which adolescent hobbyists negotiated their pursuits via their adult counterparts, my work more closely resembles the work of scholars like Aaron Alcorn in his study of young model airplane builders at the turn of the twentieth century. I demonstrate how children's engagement in science fairs were shaped by a constellation of social forces that included the materials and equipment available,[14] consumerism,[15]

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[13] Sevan Terzian, *Science Education and Citizenship: Fairs, Clubs and Talent Searches for American Youth, 1918-1958* (New York: Palgrave Macmillan, 2013); Rebecca Stiles Onion, "Science and the Culture of American Childhood, 1900-1980," Ph.D. Diss., University of Texas-Austin, 2012, 3.

[14] Following Davis Baird's "materialist epistemology" proposed in *Thing Knowledge,* I posit that objects bear knowledge as much as any written text. Davis Baird, *Thing Knowledge: A Philosophy of Scientific Instruments* (Berkeley: University of California Press, 2004). See also Lorraine Daston, ed. *Things That Talk: Object Lessons from Art and Science*. New York: Zone Books, 2004; Steven D. Lubar, and W. D. Kingery, eds. *History from Things: Essays on Material Culture* (Washington: Smithsonian Institution Press, 1993); Richard Sennett, *The Craftsman* (New Haven: Yale University Press, 2008); Joseph J. Corn, "Object Lessons/Object Myths: What Historians of Technology Learn from Things," in *Learning from Things*, ed. David Kingery (Washington, D.C.: Smithsonian Institution Press, 1996), 35-54;  Sherry Turkle, ed. *Falling for Science: Objects in Mind* (Cambridge: MIT Press, 2008); Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: University of Chicago Press, 1997); Joseph J. Corn, "'Textualizing Technics': Owner's Manuals and the Reading of Objects," in Ann Smart Martin and J. Ritchie Garrison, eds., *American Material Culture: The Shape of the Field* (Winterthur, Del.: Winterthur Museum, 1997), 169-94; and Joseph J. Corn, *User Unfriendly: Consumer Struggles with Personal Technologies, from Clocks and Sewing Machines to Cars and Computers* (Baltimore: The Johns Hopkins University Press, 2011).

[15] Jonathan R. Topham also offers important contributions on how popular science resides at the nexus between consumption and production; Jonathan R. Topham, "Introduction" *Isis* 100, no. 2 (June 2009): 310-318. For other discussions on consumerism and childhood, see Daniel Horowitz, "Cultural History and Consumer Culture." *Reviews in American History* 24, no. 2 (June 1996): 310-315; Lisa Jacobson, *Raising Consumers: Children and the American Mass Market in the Early Twentieth Century* (New York:

advice from peers and adults, persuading others about the significance of their work,[16] spatial limitations,[17] changing modes of display,[18] gender,[19] socioeconomic status, and

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Columbia University Press, 2004); Daniel Thomas Cook, *The Commodification of Childhood: The Children's Clothing Industry and the Rise of the Child Consumer* (Durham: Duke University Press, 2004); Viviana A. Zelizer, *Pricing the Priceless Child: The Changing Social Value of Children* (Princeton: Princeton University Press, 1994); and Ellen Seiter, *Sold Separately: Children and Parents in Consumer Culture* (New Brunswick: Rutgers University Press, 1993).

[16] On performance, see Michael Wintroub, "Taking a Bow in the Theater of Things," *Isis* 101, no. 4 (December 2010): 779-793; Jonathan Crary, *Suspensions of Perception: Attention, Spectacle, and Modern Culture* (Cambridge: MIT Press, 1999); Iwan Rhys Morus, "Seeing and Believing Science." *Isis* 97 (March 2006): 101-110; and Iwan Rhys Morus, "Worlds of Wonder: Sensation and the Victorian Scientific Performance." *Isis* 101, no. 4 (December 2010): 806-816.

[17] For works on space and scientific and technical practice, see Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge: Harvard University Press, 1988); Kristen Haring, "The 'Freer Men' of Ham Radio: How a Technical Hobby Provided Social and Spatial Distance." *Technology and Culture* 44, no. 4 (October 2003): 734-761; and Robert E. Kohler, "Lab History: Reflections," *Isis* 1999, no. 4 (December 2008): 761-768.. For works on domestic and children's spaces, see Clifford Clark, *The American Family Home, 1800-1960* (Chapel Hill: University of North Carolina Press, 1986); Marta Gutman and Ning de Coninck-Smith, eds., *Designing Modern Childhoods: History, Space, and the Material Culture of Children* (New Brunswick: Rutgers University Press, 2008); Amy F. Ogata, *Designing the Creative Child: Playthings and Places in Midcentury America* (Minneapolis: University of Minnesota Press, 2013); Lisa Jacobson, "Revitalizing the American Home: Children's Leisure and the Revaluation of Play, 1920-1940," *Journal of Social History* 30, no. 3 (Spring 1997): 581-596; Marilyn Ferris Motz and Pat Browne, eds., *Making the American Home: Middle-Class Women & Domestic Material Culture, 1840-1940* (Bowling Green: Bowling Green State University Popular Press, 1988); Kim Rasmussen, "Places for Children—Children's Places," *Childhood* 11 (May 1, 2004): 155-173; Steven M. Gelber, "Do-It-Yourself: Constructing, Repairing and Maintaining Domestic Masculinity," *American Quarterly* 49, no. 1 (March 1997): 66-112; Margaret Marsh, "Suburban Men and Masculine Domesticity, 1870-1915." *American Quarterly* 40, no. 2 (June 1988): 165-186; and Lynn Spigel, *Welcome to the Dreamhouse: Popular Media and Postwar Suburbs* (Durham, NC: Duke University Press, 2001).

[18] In evaluating visual sources, I have come to believe that images encapsulate a latent value system that often cannot be described sufficiently through words alone. Like objects, I posit that images depict not just aesthetics but also hierarchies of knowledge. In using images as historical evidence, I drew from Peter Burke's *Eyewitnessing: The Uses of Images as Historical Evidence* (Ithaca, NY: Cornell University Press, 2001). In analyzing evolving modes display, I was inspired by the insight of museum scholars such as Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994); Barbara Kirshenblatt-Gimblett, *Destination Culture: Tourism, Museums, and Heritage* (Berkeley: University of California Press, 1998); Steven Conn, *Museums in American Intellectual Life, 1876-1926* (Chicago: University of Chicago Press, 1998); Tony Bennett, "Speaking to the Eyes: Museums, Legibility and the Social Order" in *The Politics of Display: Museums, Science, Culture*, ed. Sharon MacDonald (London: Routledge, 1998), 22-30; Sally Metzler, *Theatres of Nature: Dioramas at the Field Museum* (Chicago: The Field Museum, 2007); and Stephen Christopher Quinn, *Windows on Nature: The Great Habitat Dioramas of the American Museum of Natural History* (Abrams, NY: American Museum of Natural History, 2006).

[19] For more information regarding women's scientific and technical training, see Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, MD: The Johns Hopkins University Press, 1982); Kim Tolley, *The Science Education of American Girls: A Historical Perspective* (New York: Routledge, 2003); Amy Sue Bix, "Equipped for Life: Gendered Technical Training and Consumerism in Home Economics, 1920-1980," *Technology and Culture* 43, no. 4 (October 2002): 728-754; Sarah Stage and Virginia B. Vincenti, eds. *Rethinking Home Economics: Women and the History of a Profession* (Ithaca: Cornell University Press, 1997); and Ruth Oldenziel, *Making Technology Masculine:*

classroom curriculum. In this regard, Alcorn and Charles Rosenberg's conception of an "ecology of practice" proves useful in analyzing not just the materials and instructions available to young hobbyists, but also the range of practices and tacit skills required to perform their work.[20] Similarly, this dissertation demonstrates the importance of media (particularly popular science magazines) in serving as network forums within the broader community that allowed adolescent hobbyists with disparate interests to develop a shared identity.[21] Although an overarching ecology shaped the broader spatial, material, and social culture of science fairs, adolescents also formed smaller communities of practice that supported their daily scientific pursuits. According to Jean Lave and Étienne Wenger, communities of practice are developed in environments built on informal interaction and motivated learning by engaging actual experience rather than meeting formal pedagogical aims. It involves not only gaining new skills but also acquiring a new identity as part of a larger community.[22] Due to its young constituency, adolescent communities of practice possessed several unique characteristics. Student clubs and

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*Men, Women and Modern Machines in America, 1870-1945* (Amsterdam: Amsterdam University Press, 1999).

[20] Charles E. Rosenberg, *No Other Gods: On Science and American Social Thought* (Baltimore: Johns Hopkins University Press, 1997); Aaron Alcorn, "Modeling Behavior: Boyhood, Engineering, and the Model Airplane in American Culture," PhD Diss., Case Western Reserve University, 2009.

[21] I am borrowing the term "network forum" from Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006). Cyrus Mody's study of scanning probe microscopists has also proven useful in understanding the formation of interdisciplinary community networks. See Cyrus Mody, *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (Cambridge: MIT Press, 2011). For more information regarding the role of media in popularizing science to American children, see Marcel Chotkowski LaFollette, *Science on the Air: Popularizers and Personalities on Radio and Early Television* (Chicago: University of Chicago Press, 2008); Marcel Chotkowski LaFollette, *Science on American Television: A History* (Chicago: The University of Chicago Press, 2013); and John C. Burham, *How Superstition Won and Science Lost: Popularizing Science and Health in the United States* (New Brunswick: Rutgers University Press, 1987).

[22] Jean Lave and Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991); Andrew Cox, "What Are Communities of Practice? A Comparative Review of Four Seminal Works," *Journal of Information Science* 31, no. 6 (December 2005): 527-540; and Etienne Wegner, *Communities of Practice: Learning, Meaning, and Identity* (Cambridge: Cambridge University Press, 1998).

groups were typically pedagogically oriented, constantly evolving (adolescents routinely grew in and out of membership), and mediated by adult leadership. Most importantly, the clubs were not necessarily motivated by profit, career status, or even formal classroom curriculum, but rather by having fun. These qualities provided adolescents with the flexibility to be more imaginative in their scientific pursuits. This confluence of forces demonstrates how children's understandings of science cannot be fully understood without taking into account a broader social context.

Finally, a careful study of science fairs serves as an optimal starting point for evaluating key questions regarding children's epistemology of science. While remaining mindful of how these science fairs were positioned within a broader social milieu, I trace what counted as scientific evidence and how these standards changed over time. Building upon Karin Knorr-Cetina's notion of epistemic cultures, I argue that these knowledge communities developed shared understandings of what constituted legitimate behavioral, material, and symbolic expressions of scientific practice. Although Knorr-Cetina limited the definition of epistemic cultures to specific scientific disciplines, this concept serves as a useful framework for evaluating the value systems underlying science fairs. I argue that children's scientific culture held distinct epistemic virtues —that is, particular sets of values, goals, and practices—that evolved over time.[23] These virtues were imbedded in how children displayed their science fair projects, their modes of expression, and the ways in which students conveyed scientific evidence.[24] My project, then, puts forth a key

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[23] I am borrowing the concept of epistemic virtues from Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2010).

[24] The nature of experiment serves as another related and important discussion in understanding adolescents' beliefs about science. See, for instance, Peter Galison, *How Experiments End* (Chicago: University of Chicago Press, 1987); Graeme Gooday, "Placing or Replacing the Laboratory in the History of Science?" *Isis* 99, no. 4 (December 2008): 783-795; David Gooding, T. J. Pinch, and Simon Schaffer, *The Uses of Experiment: Studies in the Natural Sciences* (Cambridge: Cambridge University Press, 1989);

question: what counted as science, and how did its meaning change over time? This question is not merely an insular concern over definitions, but carries with it tangible stakes. The debate over what counted as scientific also determined who could participate and for what purpose. Inasmuch as these values provided cohesion and identity to adolescent scientific communities, they also delineated who was considered suitable (and unsuitable) to take part. Tracing the evolution of these epistemic virtues allows us not only to understand the latent values of science fairs, but also how these competitions served broader sociopolitical aims in upholding a certain vision of the scientific establishment built as much around exclusion as inclusion.

## Chapter Overview

The dissertation is divided into three parts and five chapters. Part one, "Consuming Science," argues that consumer culture played a pivotal role in spurring the popularization of science among adolescents during the early twentieth century. The first chapter expands upon this assertion by describing how mass produced science and construction sets became a widespread, accessible introduction to science and technical leisure for many American adolescents. The chapter focuses on the material, spatial, cognitive, and epistemological dimensions of these outfits in order to evaluate the forms of tacit knowledge and scientific authority they promoted. At a time when educators embraced the "laboratory method" of classroom instruction, kits served as a complementary resource for extracurricular engagement by promoting a vision of science

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Bruno Latour and Steve Woolgar. *Laboratory Life: The Social Construction of Scientific Facts* (Beverly Hills: Sage Publications, 1979); James Maclachlan, "Experimenting in the History of Science," *Isis* 89, no. 1 (March 1998): 90; Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1989); and Jeffrey L. Sturchio, "Editorial: Artifact and Experiment," *Isis* 79, no. 3 (September 1988): 368-372.

as a process-based mode of thought grounded in everyday experience. Through tinkering with Erector Sets, forming science clubs, corresponding via youth magazines, and engaging in toy manufacturer competitions, students began to identify themselves as part of a larger constituency of scientific and technical hobbyists. It argues that the emergence of an adolescent consumer culture served as a critical precedent to the youth scientific culture that subsequently formed alongside the advent of science fairs.

Part two, “Narrating Science,” evaluates the virtues of synthetic culture, demonstrating how the values of narrative, collaboration, and playfulness shaped conceptions of science for clubs and fairs of the late 1920s and 1930s. Corresponding chapters two and three chronicle the genesis of the first science fairs, focusing on how this movement spread from its origins in New York City to a national phenomenon over the span of just one decade. The American Institute Junior Science Clubs and Fairs of the 1920s and 30s were caught in between two scientific traditions, moving away from progressive ideals of nature study but not yet affected by the watershed of World War II. During this moment of transition, a youth community emerged, one with its own conceptions regarding the role of science in society. Chapter two surveys the origins of science fairs by tracing the movement’s roots in progressive education and nature study, evaluating why this movement occurred in New York City and the rationale behind the sponsorship by the American Institute of the City of New York. It evaluates specific epistemic virtues tied to this movement and demonstrates how science fairs served as sites of negotiation between adults and adolescents over who held scientific authority. As the analysis of science clubs in chapter three demonstrates, the formation of science fairs also fostered distinct communities of practice where adolescents developed common modes of expression and beliefs. Shaped by a belief in the formative nature of children's play, adult organizers of the 1930s viewed science clubs and fairs as a way to cultivate a scientific habit of mind based on students' own voluntary engagement in science. These young scientists developed a distinct set of epistemic virtues that shaped what I classify as a synthetic epistemic culture, valuing a holistic view of science based on visual literacy, collaboration, and playfulness. It argues that the confluence of these forces shaped the formation of a distinct adolescent scientific culture that continued to foment over the course of the twentieth century.

By the 1940s, educators' focus on training a broad citizenry was supplanted by a more meritocratic vision devoted to finding the best and brightest adolescents in order to train them for future careers in science and engineering. Part three, "Analyzing Science," demonstrates how this shift fostered what I call an analytic epistemic culture that valued individualism, ingenuity, and argumentation, which serves as the focus of the final two chapters. Chapter four traces the formation of analytic culture by examining the contested meanings of scientific talent, professionalization, and social responsibility during the first fifteen years of the Science Talent Search (STS). Established in 1942 by the Science Service in partnership with Westinghouse Electric, STS selected forty American high school seniors showing aptitude in science or engineering to compete for scholarship money in Washington, DC. This chapter reveals how the goal of STS to expand adolescent participation in the sciences was undermined by its meritocratic methods of selection, which limited the gender, ethnic, and geographic composition of its students. Likewise, even as competition organizers touted the virtues of scientific authority in ensuring national security, surveys of former participants revealed disparate and ambivalent views of the role of science in American society at the dawn of the nuclear age. Whereas STS celebrated individual talent, most participants prized a very different reward: the formation of long-lasting relationships in a growing community network of young experimenters.

The final chapter chronicles of advent of the National Science Fair in 1950 by the Science Service. Initially established as a nationwide phenomenon, the National Science Fair quickly positioned itself as a model of youth scientific engagement that was emulated across the world. As the science fair movement achieved normative status as the benchmark in extracurricular science, adolescents also began to view themselves as serious practitioners by interacting in more notable network forums, such as the "Amateur Scientist" column of *Scientific American.* By sharing the vision of the Science Talent Search in training the next generation of scientists and engineers, the National Science Fair cemented the virtues of analytic culture as a standard for science competitions that continued to dominate in the decades that followed.

The advent of science fairs and corresponding encouragement of youth scientific engagement developed well before the fateful orbit of *Sputnik I* in 1957. Alongside these competitions, adolescents began to develop their own notions about their position in the scientific enterprise and the broader role science should play in society. By viewing science fairs from their perspective, "Science Fairs before Sputnik" provides a fuller account of young people's engagement in science in contemporary America. Science fairs, in short, provide an entry point for analyzing how adolescents understood science socially, materially, spatially, and epistemologically over the course of the twentieth century.

Figure I.1 Children viewing display of Dogwood Tree, Children’s Fair, 1931. AMNH Negative Logbook 18; Image Number 313810; American Museum of Natural History Archives.

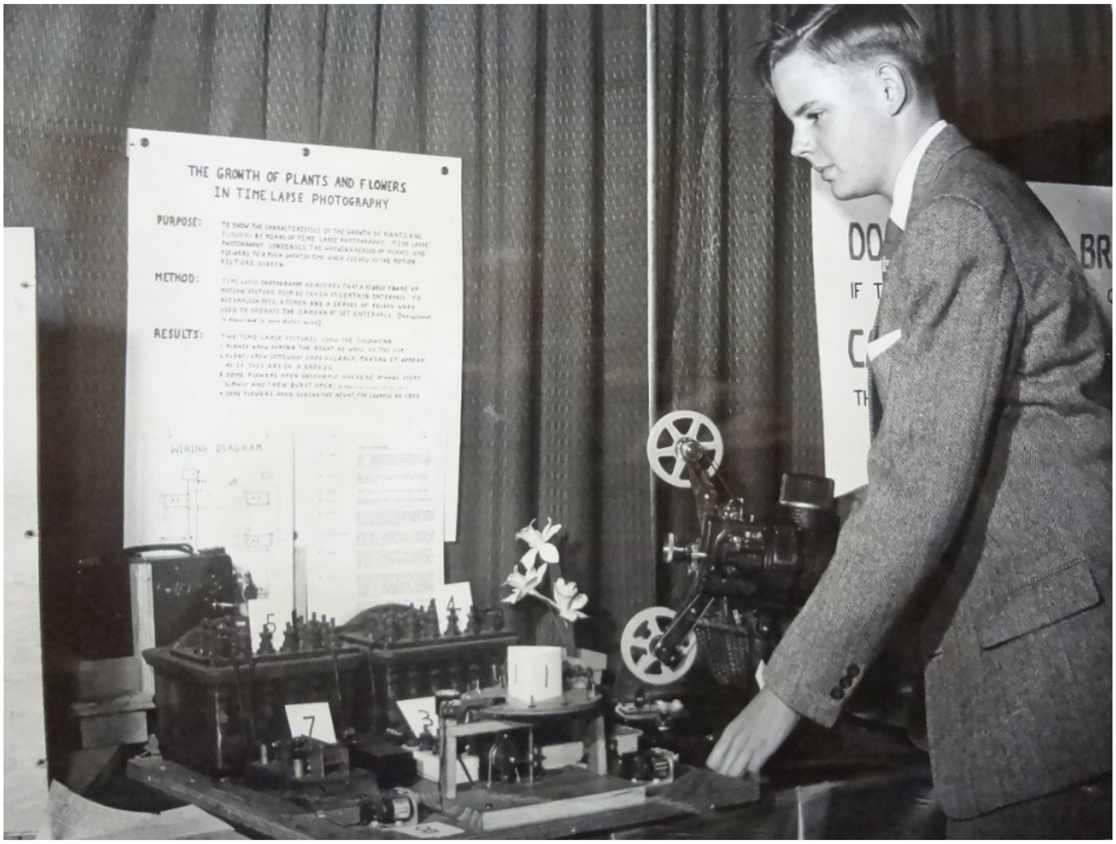

Figure I.2 Albert H. Filskoy, Jr. standing next to his exhibit,“Time Lapse Photography: Growth of Plants and Flowers,” National Science Fair, Cleveland, Ohio, 1955. Courtesy Society for Science and the Public Photograph Collection.

# PART 1

## Consuming Science

A circa 1920 stereograph by Keystone View Company entitled "Still There's No Place Like Home" depicted a contemporary American family relaxing in their suburban parlor (fig. Part 1.1). As its name suggested, the image embodied an ideal of the home as a respite from the frenetic pace of modern living where each family member could engage in their own leisurely pursuit. A father read his book as a young woman looked over his shoulder. A young man occupied himself with a quick read while a grandmother peered through a stereopticon. And under his mother's watchful gaze, a boy played with his Erector Set on the parlor floor. Although this idyllic domestic scene seemed unfettered by the influences of the industrial world, the two were in fact inexorably connected. At a time when home became a sphere increasingly distinct from the workplace, it also served as a key space for grappling with contemporary scientific and technological developments. During this period of transition, a new conception of domesticity took hold, one that positioned the home as a site of leisure and relaxation. Alongside this ideal of a modern suburban household came a new set of expectations regarding the consumer goods these spaces demanded. Science and technology were not merely the sources of amusement via stereopticons or Erector Sets, but they also provided the guidance for proper living in the industrial world.

Just as they were situated in the center of the stereograph, children served as the focal point of the modern consumer household. Children's scientific and technical hobbies spread across the nation as two key transformations occurred simultaneously in American culture at the turn of the twentieth century: the growth of consumerism and reforms in science education. The former made science both an accessible and enjoyable pursuit that also standardized the material and pedagogical dimensions of children's hobbies. The latter occurred as changes in educational philosophy coalesced with anxieties surrounding nature of boyhood in the age of modernity.[25]

The twentieth century has been classified as the "century of the child" and for good reason.[26] At the turn of the century, the growing influence of the suburban middle class changed the very conception of childhood itself. As the birthrate of children declined, their position within the household shifted accordingly. With larger amounts of resources dispersed among fewer numbers of children, parents could extend children's dependence by dedicating more time and money to their wellbeing. This conception of a sheltered childhood stood in contrast to the family-based economy that predominated rural and immigrant families still reliant on children as active contributors to the household.[27] As children's dependence on their parents expanded, so too did the timeframe in which parents attempted to exert their authority. It is no accident that a contemporary conception of adolescence also began to take hold at the turn of the century, with psychologists like G. Stanley Hall defining this interim stage between childhood and adulthood as a time of crisis that demanded greater control. When new forms of recreation and commodities entered the household, so too did heightened anxieties surrounding their questionable influence on young minds.

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[25] See Aaron Alcorn, "Modeling Behavior: Boyhood, Engineering, and the Model Airplane in American Culture," PhD Diss., Case Western Reserve University, 2009.
[26] Ellen Key, *The Century of the Child* (New York: G.P. Putnam's Sons, 1909).
[27] See David I. Macleod, *The Age of the Child: Children in America, 1890-1920* (New York: Twayne Publishers, 1998).

As adolescents came of age in a culture of consumption, how could they be properly instructed in fiscal responsibility, self restraint, and social conscience?[28] Ironically, adults' attempts at containing the allures of material goods coincided with relatively autonomous adolescent camaraderie in scientific engagement. Mass consumption offered a shared set of tools, lexicon, and social norms that provided a standard for adolescent scientific pursuits. Adolescents from across the nation could begin to identify with one another as part of a larger community of hobbyists. In this regard, science became more democratized than ever before, even as it remained limited to families with the financial means and social wherewithal to take advantage of its potential.

For their part, parents took on a new role as the financiers of children's intellectual development. The maturation of consumer culture meant that parental guidance consisted not merely of deterring children from the perils of material overindulgence but also in deciphering which goods could better serve young interests. Advertising campaigns and guidebooks aided parents in the responsibility of figuring out which goods to buy as well as how to use them properly. As the home shifted as a site from production to consumption, adults and adolescents also negotiated new spaces for leisurely pursuits. Basements, children's bedrooms, and even tabletops served as

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[28] See Lisa Jacobson, *Raising Consumers: Children and the American Mass Market in the Early Twentieth Century* (New York: Columbia University Press, 2004); Daniel Thomas Cook, *The Commodification of Childhood: The Children's Clothing Industry and the Rise of the Child Consumer* (Durham: Duke University Press, 2004); Viviana A. Zelizer, *Pricing the Priceless Child: The Changing Social Value of Children* (Princeton: Princeton University Press, 1994); and Ellen Seiter, *Sold Separately: Children and Parents in Consumer Culture* (New Brunswick: Rutgers University Press, 1993). For general studies on the rise of consumerism and modern advertising, see Richard S. Tedlow, *New and Improved: The Story of Mass Marketing in America* (New York: Basic Books, 1990); Roland Marchand, *Advertising the American Dream: Making Way for Modernity, 1920-1940* (Berkeley: University of California Press, 1985); Jackson Lears, *Fables of Abundance: A Cultural History of Advertising in America* (New York: Basic Books, 1994); Susan Strasser, *Satisfaction Gauranteed: The Making of the American Mass Market* (Washington, DC: Smithsonian Institution Press, 1989); and William Leach, *Land of Desire: Merchants, Power, and the Rise of a New American Culture* (New York: Pantheon Books, 1993).

potential sites for scientific tinkering. Parental responsibilities carried moralistic implications in shaping not just adolescents' intellectual development but also their character. Boys in particular seemed susceptible to the perils of unguided leisurely pursuits that without proper guidance could lead to a life of laziness, or worse, juvenile delinquency. Scientific toys and other purposeful hobbies served as weapons to combat idle time and fill it with meaningful endeavors that could train boys for their roles as future men.[29]

Just as parents assumed responsibility in shaping the development of their children, the organization of youth clubs and programs also worked to improve adolescent character through directing their "gang instinct" towards more positive pursuits. Founded in 1910, the Boy Scouts sought to reconnect boys with their rugged heritage and inner manliness that organizers worried had been all but lost with industrialization and the closing of the frontier. The program quickly grew in membership to 361,000 boys within just one decade. Female counterparts Camp Fire Girls and Girl Scouts likewise developed programs that worked to shape young women's characters by encouraging self-reliance and reconnection with nature. Other organizations such as 4-H and the Agassiz Association built upon the Victorian recreational traditions of nature study. These programs set the groundwork for the subsequent science club movement in providing a model for cohesive, structured youth networks across the nation.[30]

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[29] Changes in science secondary education reinforced the conception of science as a male domain, with young women directed towards more training in vocational fields or liberal arts. See Kim Tolley, *The Science Education of American Girls: A Historical Perspective* (New York: Routledge, 2003).

[30] See Sally Gregory Kohlstedt, *Teaching Children Science; Hands-On Nature Study in North America, 1890-1930* (Chicago: University of Chicago Press, 2010), 214-215; Jean-Paul Charles Dyson, "From Sermons in Stone to Studies in Science: The Transformation of Nineteenth-Century Juvenile Natural History," Ph.D. Diss., University of New York at Buffalo, 2002; David Macleod, *Building Character in the*

As consumers began purchasing amateur equipment, they relied on popular periodicals for advice on how to select and maintain their possessions. After *Popular Science Monthly* changed its focus from scholarly articles to more do-it-yourself topics in 1915, circulation doubled. Other periodicals, including *Mecanix Illustrated,* the "Amateur Astronomer" column of *Scientific American, Popular Mechanics,* and *Everyday Mechanics* similarly demonstrated how science and technology could serve as sources of entertainment while offering advice on modern living. Magazines such as *Boy's Life, Youth's Companion, American Boy,* and *Little Folks* likewise served to amuse children through stories, advertisements, and news features targeted specifically towards a young audience. As Joseph Corn has shown, these periodicals, along with the plethora of guidebooks and how-to manuals, served as a way for narrowing the gap between novice and expert even as professionals continued to gain distinguished status.[31] By encouraging readers to write in with questions or their own suggestions, these magazines fostered a sense of belonging among hobbyists. Science and technical toy manufacturers contributed to this phenomenon by creating their own club magazines that encouraged engagement among children using their products. These publications were among the first network forums to contribute to the forging of an adolescent scientific culture that would continue to strengthen over the next several decades.

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*American Boy: The Boy Scouts, YMCA, and Their Forerunners, 1870-1920* (Madison: The University of Wisconsin Press, 1983); Susan A. Miller, *Growing Girls: The Natural Origins of Girls' Organizations in America* (New Brunswick: Rutgers University Press, 2007); Thomas Wessel and Marilyn Wessel, *4-H: An American Idea, 1900-1980, A History of 4-H* (Chevy Chase, MD: National 4-H Council, 1982); and Michael Rosenthal, *The Character Factory: Baden-Powell and the Origins of the Boy Scout Movement* (New York: Pantheon Books, 1986).

[31] Joseph J. Corn, "Educating the Enthusiast," in *Possible Dreams: Technological Enthusiasm in America,* ed. John L. Wright (Dearborn, MI: Henry Ford Museum and Greenfield Village, 1992), 24. For more on how consumers grappled with household technologies, see Joseph J. Corn, *User Unfriendly: Consumer Struggles with Personal Technologies, from Clocks and Sewing Machines to Cars and Computers* (Baltimore: Johns Hopkins University Press, 2011).

In addition to the rise of modern consumer society, the second major influence that gave scientific hobbies strong social capital at the turn of the twentieth century was the profound transformation in science education. As extracurricular hobbies were popularized through consumer culture, they also served as extensions to the curricular aims of progressive reformers. Between 1880 and 1920, schools moved from a lecture-based, demonstration mode of instruction to the popularization of the laboratory method. The former was based on European (predominantly German) models of instruction that emphasized public lectures in front of large audiences. Although often successful in higher-level institutions with an informed instructor, the method proved less effective in American classrooms where teachers who had more limited training. Likewise, the European classroom equipment featuring ornate designs made of brass and marble was often too expensive (fig. Part 1.2). Faced with increased class sizes, disengaged students, and limited budgets, teachers sought out new forms of instruction.

Under the leadership of Edwin G. Hall and a team of educators at Harvard University, the laboratory method quickly became a popular alternative. Hall created a series of Baconian exercises that were dependent on careful observation. These exercises required a new set of laboratory apparatus, and American manufacturers rose to the occasion. By the end of the nineteenth century, catalogues featured more affordable, dynamic alternatives to elaborate European products. Student batteries, slate globes, St. Louis Motors, amateur microscopes, specimens, pulleys, magnets, vacuum pumps, doorbells, switches, whirling tables, and Hall’s Carriages (named after Hall himself) all could be used for multiple experiments in the newly allocated laboratory spaces (fig. Part 1.3).[32]

Educational visionary John Dewey soon expanded upon laboratory instruction by connecting it to the practicalities of modern day living. As the laboratory method fell under attack by educational advocates like physicist Charles Riborg Mann and psychologist G. Stanley Hall for being too didactic and out of touch with the interests of students, Dewey reframed the debate by describing science a process that should rationalize actual life experience. In his work *How We Think,* Dewey approached scientific thinking in terms of a series of problems that required careful consideration of potential outcomes and solutions. In effect, Dewey reframed education through a careful reconsideration of the process of acquiring knowledge rather than merely the content itself.[33] By connecting science to students' lived experiences, Dewey's educational philosophy aligned with the extracurricular aims of children's scientific hobbies.

As consumer culture merged with the aims of progressive education, it created a new set of virtues that underpinned nascent adolescent scientific culture. Because household goods served as the primary entry point for many adolescents to engage in scientific hobbies, toy kit manufacturers became the unexpected drivers for promoting adolescent scientific extracurricular engagement. Chapter one evaluates their role in promoting a conception of science with a distinct value system that aligned with both progressive pedagogical ideals and consumer culture. By mimicking the industrial world,

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[32] Steven C. Turner, "Chicago Scientific Instrument Makers, 1871-1918, Part 1: The School Science Market," *Rittenhouse: Journal of the American Scientific Instrument Enterprise* 19, no. 2 (December 2005): 65-129; Steven C. Turner, "Changing Images of the Inclined Plane: A Case Study of a Revolution in American Science Education," *Science and Education* 21, no. 2 (February 2012): 245-270; and John L. Rudolph, "Turning Science to Account: Chicago and the General Science Movement in Secondary Education, 1905-1920," *Isis* 96, no. 3 (September 2005): 353-389.

[33] John Dewey, *How We Think* (Lexington, MA: D.C. Heath & Co., 1910)*;* See also Rudolph, "Turning Science to Account."

science and technical kits encouraged problem solving to create a scientific habit of thought that could handle the demands of daily living. Likewise, these goods promoted trial and error by calling on hobbyists to perfect their technique in order to perform the associated tasks.  Toy kits of the early twentieth century also promoted a process-oriented conception of science aimed a cultivating a scientific habit of thought through direct experience. And finally, these kits promoted independence through individual play. Even as these toys were often purchased by adults, scientific and technical authority resided with children themselves. Corresponding manuals could help guide children’s pursuits, but in the end the success of the toy hinged upon the child’s ability to perform. These virtues not only promoted a distinct vision of science grounded in problem solving and individual initiative, but they ultimately shaped who was considered part of the youth scientific community. The high cost of these consumer items raised a considerable barrier to entry for children who lacked financial means. Likewise, as the perception of scientific and technical hobbies as distinctly male domains began to solidify, it curtailed the participation of young women. Chapter one demonstrates how by promoting certain values of science, toy manufacturers helped shape the values and composition of a nascent adolescent culture that would continue to develop over the course of the twentieth century.

Figure P1.1 “There’s No Place Like Home,” a ca. 1920 stereograph depicting a family enjoying leisurely pursuits in the living room, including a boy playing with his Erector Set. Image published by Keystone View Company. Courtesy of The Strong®, Rochester, New York.

Figure P1.2: European Cartesian Apparatus from the nineteenth century. Featuring an ornate brass bass large enough for performing demonstrations in lecture halls, this apparatus was great for lectures but less practical for everyday classroom use. Photo by author. Courtesy Smithsonian Institution National Museum of American History Physical Sciences Collection.

Figure P1.3 Hall’s Carriage. The simple design and inexpensive components of this American-made Hall’s Carriage made it the ideal apparatus for physics demonstrations with inclined planes. Ironically, although the carriage was developed by Edwin Hall, he designed it for acceleration experiments rather than its more prevalent use in mechanical advantage experiments. Photo by author. Courtesy Smithsonian Institution National Museum of American History Physical Sciences Collection.

# CHAPTER 1

## Constructing Character: Experiment Kits and the Formation of Adolescent Scientific Communities

Well-known slogans of the early and mid-twentieth century covered the pages of popular magazines such as *Popular Science*, *Life*, *Popular Mechanics*, and *Boys' Life:* "Experimenter today…scientist tomorrow." "Be a real engineer." "Big future opportunities for boys with knowledge of Chemistry!"[34] Showing pictures of gleaming new chemistry kits, Erector Sets, and mineralogy labs, these advertisements were ubiquitous from the progressive age through the postwar era. They depicted children working together with excitement in exploring the natural world. They highlighted the mysteries unlocked through experiments and technical constructions. Above all, these slogans emphasized that these outfits were not toys. Rather, they were miniature representations of the actual world intended to teach the next rising generation of scientists and engineers. Ranging from chemistry labs to "atomic energy" sets, these kits brought the wonders of science and technology into the home.

In order to understand changes in scientific learning occurring in the early and mid twentieth century, it is necessary to study the contours of scientific and technical play fostered by experiment kits. Targeted to children living amidst the permeation of science in mass culture, these toys reflected American faith in rationality and the promise of scientific discovery that were now accessible in children's own living rooms. By

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[34] John Tyler, *The Chemcraft Story: The Legacy of Harold Porter* (Haworth, NJ: St. Johann Press, 2003), 61; "Be a Real Engineer," *Boys' Life,* December 1931; "Chemcraft brings the fun, thrills, and adventure of a real chemical laboratory—right into your own home!" *Popular Science,* December 1946.

offering users a complex set of miniature laboratory equipment complete with classification guides, motors, gears, and sample experiments, these toys emulated the professional worlds of science and technology. Scientists and engineers added to this authority by writing in-depth instruction manuals aimed at training young minds. By allowing children to play grown up roles, these science sets aimed at inspiring a new generation of inventors, instilling hopes for an American future ruled by reason and innovation.[35]

Not only did these kits take on the task of education through emulation, but they also ushered in an unprecedented accessibility to science and technology for a generation of children raised in the industrial era. Capitalizing on parental fears and aspirations to build the character of their sons, manufacturers positioned scientific and technical tinkering as a badge of masculinity that could thwart the challenges of industrialization by capitalizing on boys' innate curiosity and constructive impulses. In the process, toy producers targeted children as veritable consumers in their own right, orchestrating cutting-edge marketing campaigns that included not just creative advertising but national competitions, club networks, and user guides and magazines. This comprehensive

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[35] A small but promising number of works have begun evaluating kits' influence on the shaping of childhood understandings of science and technology. See, for instance, John Tyler, *The Chemcraft Story;* Rebecca Stiles Onion, "Thrills, Chills, and Magic: Home Chemical Laboratories and the Culture of Boyhood Science" in "Science and the Culture of American Childhood, 1900-1980," Ph.D. Diss., University of Texas-Austin, 2012, 191-248; Kenneth D. Brown, *Factory of Dreams: A History of Meccano, Ltd, 1901-1979* (Lancaster, UK: Crucible Books, 2008); Carroll W. Pursell, Jr. "Toys, Technology and Sex Roles in America, 1920-1940" in *Dynamos and Virgins Revisited: Women and Technological Change in History,* ed. John L. Wright *(*Metuchin, NJ: Scarecrow Press, 1979); Bruce Watson, *The Man Who Changed How Boys and Toys Were Made: The Life and Times of A.C. Gilbert* (New York: Penguin, 2002); Gerard L'E. Turner, "Scientific Toys," *British Journal for the History of Science* 20 (October 1987): 377-398; Aaron L. Alcorn, "Flying into Modernity: Model Airplanes, Consumer Culture, and the Making of Modern Boyhood in the Early Twentieth Century," *History and Technology* 25 (June 2009): 115-146; Melanie Keene, "Every Boy and Girl a Scientist: Instruments for Children in Interwar Britain," *Isis* 98, no. 2 (June 2007): 266-289; and Birgitta Almqvist, "Educational Toys, Creative Toys," in *Toys, Play, and Child Development,* ed. Jeffrey H. Goldstein (Cambridge: Cambridge University Press, 1994), 46-66.

marketing strategy prompted a consequence not entirely intended by toy manufacturers: the fostering of a nascent youth scientific culture.

This chapter traces the role of consumerism in facilitating the popularization of science during the early twentieth century. It first describes how the advent of mass-produced science and construction sets became an affordable, accessible introduction to scientific and engineering principles for many American adolescents. At a time when educators embraced the laboratory method of classroom instruction, kits served as a complementary resource for extracurricular scientific engagement. As a result, these sets served as vehicles for promoting a vision of science as a process-based mode of thought grounded in everyday experience. The chapter focuses on the material, spatial, cognitive, and epistemological dimensions of these outfits in order to evaluate the forms of tacit knowledge and scientific authority they promoted. Through a careful analysis of science and construction outfits, hobbyists' correspondence with manufacturers, a 1920s report surveying how students used their sets, and children's creative submissions to toy magazines, it analyzes the ways that adolescents developed their own scientific practices and beliefs.  By tinkering with Erector Sets, forming science clubs, corresponding via youth magazines, and entering toy manufacturer contests, students began to identify themselves as part of a larger constituency of scientific and technical hobbyists. It argues that the emergence of an adolescent consumer culture served as a critical precedent to the youth scientific culture that would subsequently form alongside the advent of science fairs.

## **Consuming Science**

In the Victorian world of toys, kaleidoscopes, small clockwork toys with coiled springs, flying toys propelled by rubber bands, and steam-driven boats served as important precursors to science kits.[36] Mechanical and construction toys were commonplace during the nineteenth and early twentieth century. Log cabins emphasized American ruggedness. John Lloyd Wright (son of Frank Lloyd Wright) designed Lincoln Logs, paying homage to the former President while drawing inspiration from the American frontier (Fig. 1.1). Tinker Toys made their debut around 1914, offering a system of rods and pulleys to build abstract structures. Other construction toys, including Märklin, Minibrix, and Bildmor Blox, also appeared on the market. These toys promoted autonomous play, allowing children to determine the scale and order of construction. Interactive playthings such as sand toys and model steam engines conveyed mechanical principles. Unlike children's sets on the horizon, these mechanical toys typically performed a single function.[37]

The first chemistry sets were European in origin. These "chemical cabinets" were designed not merely as professional tools but also for popular amusement. One of the earliest known sets was designed by at the end of the eighteenth century by German chemist Johann August Göttling. Classified as a "Portable Chest of Chemistry," it contained glassware, reagents, balance, mortar and pestle, and booklet. The instructions

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[36] Sally Gergory Kohlstedt, "Parlors, Primers, and Public Schooling: Education for Science in Nineteenth-Century America," *Isis* 81, no. 3 (September 1990): 424-445.

[37] The Strong Museum of Play's trade literature collection and corresponding toys serve as strong resources for tracing the evolution of construction toys. See also the extensive collection of business ephemera in the Warshaw Collection of Business Americana, ca. 1724-1977, AC0060, Smithsonian Institution Archives Center.

listed basic experiments and also contained suggestions for “chemical tricks.”[38] By the mid-nineteenth century, manufacturers began offering an array of sets for popular audiences such as “Midgley’s Portable Chemical Museum,” “Statham’s Students’ Chemical Laboratory,” or “Kingley’s Primus Chemical Magic and Practical Chemical Cabinet.” In the 1860s, British manufacturer John J. Griffin and Sons began offering chemical cabinets specifically for classroom use. The catalogue sold apparatus specifically for elementary experimenters, claiming that “These cabinets have been prepared to suit the wants of the student of Chemistry, who wished to possess the means of performing the experiments he witness at lectures, or finds described in books.”[39] These offerings provided children with first-hand exposure to chemical apparatus while also promoting the conception of chemistry as a source of amusement.

Commercial suppliers capitalized on scientific leisurely pursuits as a potential consumer market, selling microscopes, radio equipment, electrical kits, and other apparatus specifically as products of leisure. Companies such as Bausch+Lomb provided offerings of microscopes “For the Amateur” along with how-to manuals to give “in clear and concise language all information regarding the principles, and leads to the intelligent use of the microscope.”[40] Some companies began specializing in amateur equipment specifically for children. Manufacturers like J.H. Winn claimed that it “was founded and

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[38] See William B. Jensen, “Three Centuries of the Chemistry Set, Part 1: The 18th and 19th Centuries,” unpublished lecture, n.d., PDF file, http://www.che.uc.edu/jensen/W.%20B.%20Jensen/Unpublished%20Lectures/Chemistry/02.%20Chemistry%20Sets%201'.pdf; Rosie Cook, “Chemistry at Play,” *Chemical Heritage Magazine* 28, no. 1 (Spring 2010), http://philosophyofscienceportal.blogspot.com/2010/06/old-chemistry-sets.html.

[39] John Joseph Griffin, F.C.S, *Chemical Handicraft: A Classified and Descriptive Catalogue of Chemical Apparatus, Suitable for the Performance of Class Experiments, For Every Process of Chemical Research, and for Chemical Testing in the Arts* (London: John J. Griffin and Sons, 1866), 403, http://www.archive.org/details/chemicalhandicr01grifgoog.

[40] Baush and Lomb Microscopes and Accessories Catalog A, 1900, pg. 13, Smithsonian Institution National Museum of American History Trade Literature Collection (hereafter cited as NMAH TL). Bausch+Lomb subsequently offered scholarship awards for students demonstrating an aptitude in science (resources on this program are available at the Bausch+Lomb Archive).

has grown with one thought foremost in mind—To Give Amateur Experimenters the High Quality Supplies and Equipment in the Prices That They Can Afford to pay." It offered an explanation for why boys should "monkey around" with chemistry, claiming that no matter their future vocations, "you will be seriously handicapped without a knowledge of chemistry—and there is no easier or more simple way to obtain this knowledge than by experimenting in your own laboratory."[41] Alongside its assortment of equipment, Winn also published guides like the *Book of Experiments for Junior Chemists,* offering instruction in areas such as fireworks, chemical magic, food analyses, and glass blowing.[42] These companies considered children as consumers who, given the proper guidance, could effectively manage their leisurely scientific pursuits.

Three major companies emerged as industry leaders in the foundational years of science and construction kits. British entrepreneur Frank Hornby was the first major construction set manufacturer when he patented his Meccano Set in 1901.[43] Inspired by playing with toys alongside his children, Hornby's steel girders would become one of the most popular toys in the world (Fig. 1.2). A.C. Gilbert introduced his Erector Set at the 1913 Toy Fair and was an instant sensation among American boys (Fig. 1.3). By 1920, Gilbert offered multiple outfits including chemistry sets, electrical kits, and microscopes. Coupled with his aggressive marketing strategies, Gilbert's Erector Set positioned him as the leading American toy seller in the early twentieth century.[44] Meanwhile, Lionel Porter began selling his first Chemcraft chemistry outfit in 1916, expanding to include

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[41] J.H. Winn Catalog, nd, pp. 2-3, NMAH TL.

[42] John H. Winn, *Book of Experiments for Junior Chemists* (New York: Winn, 1931).

[43] Anthony McReavy, *The Toy Maker: The Life and Times of Frank Hornby* (London: Ebury, 2004).

[44] Gilbert's background as a performer in a minstrel show, Olympic gold medalist, and successful magician undoubtedly affected his promotional strategies. For more on Gilbert's colorful life, see his scrapbooks, AC Gilbert Papers, Group 1618, Yale University Library Manuscript Collections.

different varieties of science sets by the early 1920s (Fig. 1.4).[45] Other commercial kit suppliers emerged as well, including Structo, American Model Builder, and Construments. These manufacturers paved the way for a new generation of toy tinkering, one that emphasized the potential in providing training in the influential fields of science and engineering.

As industrialization increased factory production of playthings, it also served as toys' inspiration.[46] As historian Gary Cross has demonstrated, toys modeled the excitement of the industrial world, providing realistic models for children to train for the age of large-scale construction and machines.[47]As models of industrial society, these kits also reflected the gendered roles of the modern world, focusing on men and teaching them (and, through their exclusion, women) their place in contemporary society. Whereas these home laboratories emphasized masculine virtues of science and production, girls' toys of dolls and kitchen sets embraced consumerism and homemaking. By positioning children as a veritable consumer market, these sets served as an accessible introduction to scientific and technical leisure in households across America.

The success of scientific and technical kits could be attributed in part to the aggressive advertising campaigns targeted at children. The toy industry at the turn of the century was ruthlessly competitive. Manufacturers frequently stole each other's ideas and marketed similar products.[48] To distinguish themselves on the market, suppliers and distributors turned to industry magazines like *Playthings* for advice. These columns

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[45] Tyler, *The Chemcraft Story*, 11-12.

[46] Gary Cross, *Kids' Stuff: Toys and the Changing World of American Childhood* (Cambridge: Harvard University Press, 1999) 57-58; Dan Fleming, *Power Play: Toys as Popular Culture* (Manchester: Manchester University Press, 1996), 89.

[47] Cross, *Kids' Stuff*, 66-67.

[48] See, for instance, the lawsuit over patents between Meccano and The American Mechanical Toy Company, *Playthings* 13, no. 2 (February 1915): 29.

offered information for the modern toy seller on novel store displays, industry trends, and the art of attracting customers. The articles often treated children as a profitable consumer market, offering trade secrets on "Teaching Children to Shop" or "Better Store Service for Child Customers."[49] A.C. Gilbert in particular led one of the most successful marketing strategies in the history of toys. As a trained magician, Gilbert understood the importance of showmanship. Gilbert's catchphrase, "Hello, boys! Make Lots of Toys," spoke to a generation of adolescent boys who identified with him as a fatherly figure. The onset of World War I further benefited American toy manufacturers, who filled in the gap in production left by German and British companies. While the toy manufacturing industry modernized and expanded, it garnered increasing influence over the form and composition of children's play.[50]

## <u>Building Character through Science Education</u>

As extracurricular hobbies were popularized through consumer culture, they also served as extensions to the curricular aims of progressive reformers. As part one demonstrated, the laboratory method championed by Edwin G. Hall promoted hands-on learning aimed at promoting inductive reasoning. Other reformers, such as John Dewey, would continue to champion the cause. Dewey's application of experiential learning to everyday experience aligned with the goals of kit manufacturers in preparing male adolescents for adult roles. Likewise, Dewey's conception of science as a process-

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[49] "Teaching Children to Shop," *Playthings* 7, no. 12 (December 1909): 90; "The Child Customer," *Playthings* 14, no. 11 (November 1916): 60.

[50] On the rise of modern advertising and consumerism, see, for instance, Richard S. Tedlow, *New and Improved: The Story of Mass Marketing in America* (New York: Basic Books, 1990); Roland Marchand, *Advertising the American Dream: Making Way for Modernity, 1920-1940* (Berkeley: University of California Press, 1985); Jackson Lears, *Fables of Abundance: A Cultural History of Advertising in America* (New York: Basic Books, 1994); Susan Strasser, *Satisfaction Gauranteed: The Making of the American Mass Market* (Washington, DC: Smithsonian Institution Press, 1989); and William Leach, *Land of Desire: Merchants, Power, and the Rise of a New American Culture* (New York: Pantheon Books, 1993).

oriented enterprise coincided with the methods of the trial and error and creative reasoning that the kits demanded.

As classrooms adopted new equipment and modes of instruction, kit manufacturers offered complementary products that were suitable for children's home use. At the same time, suppliers by and large did not involve themselves in the pedagogical debates. Throughout his career, Gilbert tried to keep disassociate his sets from school learning. "We were afraid that if kids saw our things in school, they'd think they were just as deadly dull….and would have nothing to do with them," Gilbert explained.[51] Though their sets often inflected many of the same values of formal classroom instruction, manufacturers' concern was less over what children learned and more over whether they had fun. Whereas manufacturers usually did not concern themselves with the pedagogical aims of classroom instruction, they did share a commitment to another debate surrounding adolescence: building character. Educational theorists, namely G. Stanley Hall and William Bryan Forbush, connected "the boy problem" of adolescence as hallmarked by the "gang age."[52] They described male adolescence as a category distinct from childhood and adulthood, defined by physical and psychological restlessness, engaging in risky behavior, and strong dependence on peer relationships. Science hobbies could harness the potential of adolescent boys by capitalizing on their innate curiosity while deterring them from more destructive pursuits.

Serving as the financiers of children's intellectual development, parents carried the burden of shaping the character of their sons. As boys became cut off from manual

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[51] Watson, *The Man Who Changed*, 74.

[52] G. Stanley Hall, *Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime Religion, and Education,* 2 vols. (New York: D. Appleton, 1904); William Bryon Forbush, *The Boy Problem* (Boston: The Pilgrim Press, 1901).

labor and the presence of their fathers who were working outside of the home, reformers feared that adolescent males lacked the masculine influences necessary to build strong men. Toy manufacturers played on the anxieties surrounding juvenile delinquency by claiming in magazines like *Popular Mechanics* that “Toys Make the Man” or “Boys Today—Men Tomorrow!”[53] An *Erector Tips* article entitled “Boy Bandit Reproaches Parents” recounted the story of seventeen year old Early Riley, a boy who turned to a life of crime because his parents refused to buy him instructive playthings. Riley warned, “Parents, if your son displays ambition for mechanical toys or tools give him all his heart desires! It may keep him from a weary term in jail later.”[54] As much as parents were encouraged to serve as the financiers of their children’s tinkering, they also could also serve as gatekeepers. Girls in particular were often overlooked or even forbidden from playing with scientific and technical toys. In a response to a letter submitted by a female enthusiast, the editor for *Meccano Magazine* wrote, “It was too bad of your mother to forbid you to join the Guild because you are a girl. There are thousands of girls who use Meccano, and very many of them are members of the Guild. We have no doubt you will shortly overcome all her objections.”[55] As parents negotiated the role of playthings in shaping their children’s character, they often determined the toys’ suitability along gender lines.

## **Tinkering with Scientific Authority**

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[53] “Toys Make the Man,” *Popular Mechanics,* November 1922; See also Carroll W. Pursell, Jr., “The Long Summer of Boy Engineering” in *Possible Dreams: Technological Enthusiasm in America,* ed. John L. Wright (Dearborn, MI: Henry Ford Museum and Greenfield Village, 1992), 34-43.

[54] “Boy Bandit Reproaches Parents: They Wouldn’t Buy Him Instructive Playthings So He Stole,” *Erector Tips* 1, no. 6 (June 1915): 4.

[55] Editorial Response, *Meccano Magazine* No. 22 (March/April 1922): 8. See also Pursell, “Toys, Technology and Sex Roles.”

Educational visionary Morris Meister was undoubtedly influenced by these programs as he conceived of cultivating boys' scientific ability through extracurricular pursuits. Meister was an immigrant born near Białystok, Russia (now Poland) who emigrated to New York City when he was seven years old. Meister recalled that his mother bribed officials in order to cross the German border in 1902, fleeing just four years prior to the infamous Białystok pogrom.  Educated by the New York City school system, Meister attended the New York City Elementary Schools before graduating Phi Beta Kappa from the College of the City of New York in 1916. After receiving his M.A. degree from Columbia University, Meister continued there for his doctoral studies. During his career, Meister served as a science teacher at Speyer Junior High School and Horace Mann School, Director of Boys' Club Work, Recreation Rooms and Settlement, New York City Board of Education Supervisor of Science Education, and President of Bronx Community College. He was the Head of Science Department and Visual Instruction at New York Training College before serving as the founding principal at the Bronx High School of Science, where he would build one of the most prestigious secondary science programs in the country.[56]

Meister was a product of the Dewey educational tradition. One of Meister's dissertation mentors (and future collaborator in initiating the science fair movement) was Otis Caldwell, a botanist who oversaw science instruction at the Dewey-inspired Chicago University High School. As a major proponent of general science education, Caldwell designed a Deweyan synthetic course curriculum built on concepts and elements that were familiar to students in order to train them in scientifically-based problem solving for

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[56] Morris Meister, "The Educational Value of Certain After-School Materials and Activities in Science." Ph.D. Diss., Columbia University, 1921; "Morris Meister," *Science Education* 50, no. 5 (December 1966): 401-405.

everyday life. Meister expanded upon these ideas to consider the role that extracurricular activities could play in establishing new forms of problem solving. Although Meister believed that ideally curricular and extracurricular instruction would appear virtually the same by both capitalizing on children's innate curiosity, as a classroom teacher he was also well aware of how the reality of classroom curriculum fell far short in achieving these goals. His research set out to determine the role extracurricular activities played in shaping students' understanding of science and technology.[57]

Meister's 1921 dissertation, entitled "The Educational Value of Certain After-School Materials and Activities in Science," analyzed the role of extracurricular activities—specifically science and technical kits, toys, and clubs—in contributing to boys' science education. His detailed study involved four years of observing approximately 500 boys ranging from nine to fifteen years old at Speyer Junior High School and Horace Mann School in New York City from around 1917 to 1921. Through detailed questionnaires, observations of boys' free play, and organizing more formalized activities through a school science club, Meister traced boys' patterns of tinkering, motivations for engaging in science hobbies, and levels of success in learning new skills. At the time, Meister presented fellow educators with a strong case for supporting extracurricular activities. For contemporary scholars, his study provides rare insight into the motives and actions of adolescents that would have otherwise disappeared from the historical record.

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[57] John Dewey, *The School and Society* (Chicago: University of Chicago Press, 1902); John Dewey, *The Child and the Curriculum* (Chicago: University of Chicago Press, 1900). For a history of the general science movement, see John L. Rudolph, "Turning Science to Account: Chicago and the General Science Movement in Secondary Education, 1905-1920," *Isis* 96, no. 3 (September 2005): 353-389; and John M. Heffron, "The Knowledge Most Worth Having: Otis W. Caldwell (1869-1947) and the Rise of the General Science Course," *Science & Education* 4, no. 3 (July 1995): 227-252.

Meister's study offered a detailed analysis of the form, composition, and pedagogical goals of different sets. Meister understood that the materials of playthings helped determine the structure of children's play. Meccano Sets proved to have the sturdiest materials for construction sets, offering around 50 to 60 standardized parts. Erector Sets were also composed of interchangeable steel components, and its girder strip served as a unit of construction that could be implemented to build a variety of models. Both Meccano and Erector offered scaffolded options so that the higher numbered outfits coincided with more varied and complex design possibilities. The most popular chemistry sets produced by Porter and Gilbert included chemicals, glass tubing, measuring spoon, filter paper, candle, funnel, and rubber stoppers. The more expensive sets offered more chemicals and experiments. In general, Meister found that the manual experiences of construction sets did not build on one another. Although the models increased in complexity, a child could just as easily complete a model at the end of the manual without completing the preceding examples. The chemistry sets offered by Porter, on the other hand, possessed a deliberate topical arrangement. By proceeding through the experiments, students gained a fuller understanding of scientific organizational structures of knowledge.[58]

A study of the composition of the kits themselves reveals the gestural knowledge required for these outfits, offering insight into the skills acquired by operating these sets

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[58] Meister, "The Educational Value," 8-40. On the evolution of materials in kit offerings, see also William M. Bean and Al M. Sternagle, *Greenberg's Guide to Gilbert Erector Sets Volume 1, 1913-1932* (Sykesville, MD: Greenberg Publishing Co., 1993); William M. Bean, *Greenberg's Guide to Gilbert Erector Sets Volume 2, 1933-1962* (Waukesha, WI: Kalmbach Books, 1998); Bert Love and Jim Gamble, *The Meccano System and the Special Purpose Meccano Sets, 1901-1979* (London: New Cavendish, 1985); and William B. Jensen, "Three Centuries of the Chemistry Set: Part II: The Twentieth Century," unpublished lecture, n.d., PDF file, http://www.che.uc.edu/jensen/W.%20B.%20Jensen/Unpublished%20Lectures/Chemistry/03.%20Chemistry%20Sets%202'.pdf.

and the visions of scientific and technical understanding they sought to promote.[59] In order to evaluate the range of skills required, I selected two of the most popular kits of the twentieth century: one construction set and one chemistry kit. The first is the model 8½ Erector Set produced by Gilbert (Fig. 1.5). Known as the "Ferris Wheel" set for its hallmark model configuration, this set served as one of the best selling Gilbert outfits of all time. The second kit is a Porter Chemcraft Senior Chemistry Set (Fig. 1.6). This outfit offered an array of chemicals, as well as a balance, weights, and litmus paper. In most respects the component parts of these sets changed little from their inception.[60] A comparison of these sets demonstrates how visions for training young minds ran along scientific and technical divides. At the same time, the shared underlying epistemic values of these sets promoted a Deweyan conception of learning grounded in problem solving, self initiative, and relevance to everyday life.

The sets' outer appearances proved markedly similar. Both sets were housed in sturdy and compact steel boxes, making them resistant to wear and easy to transport. The sets were organized in tidy compartments that served as idealized miniatures of professional labs or workshops. The Erector Set carried numerous component parts, including crankshafts, gears, wheels, and steel plates in assorted colors and sizes. Likewise, the chemistry outfit held chemicals in glass containers, glass tubing, test tube

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[59] Heinz Otto Sibum defined tacit or "gestural" knowledge as "knowledge united with the actor's performance of work," that is part of interacting with the material culture of instrumentation. When Sibum replicated Joule's paddle-wheel experiment in order to evaluate Joule's private experimental practice and tacit knowledge, however, he needed to rely on replicas. Fortunately, numerous kits from the early and mid-twentieth century are easily accessible, so I had the opportunity to use the artifacts of the original actors themselves. See Heinz Otto Sibum, "Reworking the Mechanical Value of Heat: Instruments of Precision and Gestures of Accuracy in Early Victorian England," *Studies in History and Philosophy of Science* 26, no. 1 (March 1995):76.

[60] Although Meccano and Erector Sets as well as Chemcraft Sets and Gilbert Chemistry Sets were produced by different manufacturers, these products had more similarities than differences. Due to the routine borrowing of one another's designs, the manuals and material compositions of these sets were often so similar that it can be difficult to decipher between brands.

racks, and a balance scale. The variety and quantity of items required deliberate organization from young users while providing them with a glimpse of the range of materials used by scientists and engineers.

Inasmuch as these kits shared similarities in appearance, their applications showed marked differences that reflected the different skills required for potential chemists and engineers. The chemistry set required of its users strict adherence to its guidelines. According to the manual, "For a workman to be successful in any craft…he must be able to follow the directions of others."[61] These manual instructions designated the adherence to instructions as a hallmark of professional scientists. In contrast, the Erector Set contained few written guidelines. Instead, the manual featured dozens of pictured models that illustrated the component parts but offered little advice in the way of assembly. Gilbert encouraged users to develop their own designs. He declared, "You should feel free to change them or improve them in any way you see fit. Creating models is a big part of the fun of being an Erector Engineer."[62] For Gilbert, ingenuity served as the primary part of training required for future engineers.

Likewise, the actual use of the kits demanded different forms of tacit knowledge. The chemistry set required precision. Users needed to measure accurately finite amounts of materials, calculate mathematical formulas, and use the right temperatures or pressures to achieve the anticipated results. The experiments ranged in difficulty from creating bases and testing water for iron to concocting paints and household detergents. Each experiment offered concise but concrete instructions as well as the expected results. The

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[61] Harold M. Porter, *The Senior Chemcraft Manual* (Hagerstown, MD: The Porter Chemical Company, 1950), 6.

[62] The A.C. Gilbert Co., *The New Erector: How to Make 'Em Book* (New Haven, CT: The A.C. Gilbert Co., 1951), 1.

Erector Set required vision and dexterity. Users needed to select the appropriate component parts, plan the correct order of assembly, and fasten together myriad small pieces while keeping in mind a final model. The manual's models similarly ranged from simple benches to motorized cranes and walking robots. Whereas the chemistry set trained users in experimental procedures through the adherence to guidelines, the Erector Set promoted technical creativity through its very lack of guided instruction. The differences reflected in these two sets demonstrate that the skills required for one particular kit did not always translate to a different outfit.[63]

At the same time, the sets also shared a common set of values that aligned with prevailing Deweyan wisdom. Perhaps most importantly, the sets were fun. The manuals were filled with entertaining objectives like turning water into wine or building moving carousels. By promoting playful tinkering rather than pedantic learning, these kits encouraged children's innate curiosity and self-driven learning. The kits also facilitated creative problem solving. Although some kit instructions were more prescriptive than others (chemistry manuals, for instance), ultimately the burden of responsibility lied with the student in making the outfits work. Unlike the single-purpose function of many Victorian toys, the sets could be configured for multiple experiments and models based on repeated trial and error. Finally, the outfits related to everyday experience. By emulating laboratory and workshop supplies and methods, the kits provided students with real-world practical applications that Deweyan educators sought to achieve.

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[63] Hobbies such as model airplanes required cutting, finishing, and assembling wood components. This proved a rather different skill set than prefabricated kits, even for an engineering equivalent like the Erector Set. Aaron Alcorn, "Flying into Modernity: Model Airplanes, Consumer Culture, and the Making of Modern Boyhood in the Early Twentieth Century," *History and Technology* 25, no. 2 (May 2009): 115-146.

Not only did the sets express certain epistemic goals, but they also carried latent social values. For instance, the Chemcraft magic guides that accompanied chemistry sets described in detail how to enhance the overall performance of a magic show. The young "Alchemist" was instructed to hire an assistant. According to the manual,

> "The assistant should be 'made up' as an Ethiopian slave. His costume can be similar to that worn by the Alchemist (omitting the turban) or he can wear an old burlap sack with holes cut out for his head and arms [Figure 1.7]. His face and arms should be blackened with burned cork which will wash off easily when the performance is concluded…When addressing him, he should be referred to as your slave. If you prefer the blackening of the face and arms can be omitted and the assistant can be called 'Apprentice' instead of slave. By all means assign him a fantastic name such as Allah, Kola, Rota, or any foreign-sounding word."[64]

This description raises two important points. First, it illustrates to a social function of the sets as modes for displaying scientific acumen. Even though they were intended for individual use, the promotion of staging an elaborate magic show illustrated how the playthings could be used for public performance as well. Second, it demonstrates the ways that kits expressed latent ethnic and racial stereotypes (in this case, an Orientalist "Other," a common trope for science toys of the early twentieth century).[65] The reference to a dark-skinned "slave" assistant delineated which racial group possessed more scientific and technical expertise.

Young enthusiasts often found that their outfits proved insufficient to accommodate their hobbies, and developed ways to supplement the sets' material constraints. According to enthusiast Alphonse Sagliocca of Philadelphia, "Four years ago I obtained a Chemcraft set which aroused my interest in chemistry. Since then I have

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[64] Porter Chemical Company, *Chemcraft Chemical Magic* (Hagerstown, MD: Porter Chemical Company, 1952), 19-20. These instructions were included in the manuals from the early 1920s into at least the late 1950s.

[65] For a history of Orientalism in the Western world, see Edward Said, *Orientalism* (New York: Random House, 1978).

been constantly adding equipment to my chemistry set until now it has grown in to a home laboratory. I am now able to prepare many useful things and perform many complicated experiments in my moderately equipped lab."[66] Financial limitations often hindered the adolescents' access to equipment. Meister found that parents of lesser means stopped purchasing toys for their children at an earlier age than wealthier parents.[67] Members of science clubs often overcame these limitations by combining their resources. Bob Betts of Columbus, Ohio reported that members of his club pooled together one No.5 and two No. 10 Chemcraft sets to use in their club activities.[68] Other students combined the contents of multiple sets. Figure 1.8 shows a Gilbert Chemistry Outfit dated to circa 1935. Its owner, Gilbert McCurdy, designed makeshift legs that elevated the set to operate as a miniature workspace. McCurdy's son, a teenager during the 1960s, received his own modern chemistry set, but preferred to play with his father's original outfit and manual because it contained fewer safety restrictions. The set contained five different manuals when it was donated to The Strong Museum of Play.[69] By developing creative strategies in supplementing supplies and equipment, students like the McCurdys demonstrated ingenuity in overcoming the material limitations of their sets.

The outfits raised questions not only regarding material considerations but spatial demands as well. Although the kits came in compact packages, their appearances proved deceiving. Even as the advertisements marketed each box as a complete outfit, in reality the kits required additional supplies and space. Directions for chemistry sets frequently

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[66] "Club News," *Chemcraft Science Magazine* (2 & 3 (November and December 1939): 21, GB98:09.054, Chemistry Set Paper and Ephemera Collection, Chemical Heritage Foundation (hereafter cited as CHF).
[67] Meister, "The Educational Value," 80-81.
[68] "Club New."*Chemcraft Science Magazine* 51, no. 6 (July 1940): 11. CHF.
[69] 1935 AC Gilbert Chemistry Set, 105.900 object description, The Strong Museum of Play Artifact Collection (hereafter cited as SMP).

called for procuring household items such as glue, matches, and baking soda. The chemical reactions and flames produced through experiments also needed proper ventilation and cleanup, not to mention a fair amount of tabletop space (Fig. 1.9). Likewise, the construction sets called for certain environmental and material considerations, such as wood bases for large projects, electricity to operate motors, and an expansive amount of room for assembling pieces. These requirements often demanded a specialized space for working with the outfits for any extended period of time.

## **Meister and the Contours of Children's Tinkering**

Meister considered the ways adolescents appropriated domestic spaces for their work, noting, "The experimenting and manipulatory instincts of early adolescence are far too strong to be inhibited by even the close confines of the apartment house, whether the latter be on the East Side or on Riverside Drive." Out of 141 male students that Meister surveyed, 45 had dedicated playrooms, 72 set up their bedrooms as laboratories, 32 claimed corners in the kitchen, 22 used bathroom space, and 70 boys had no designated space for their hobbies.[70] Although Meister's survey focused on home labs in urban New York City, the spatial demands of the kits were better suited for middle class suburban households. The modern suburban house was designed to promote domestic fulfillment, incorporating spaces such as workshops, playrooms, and backyards to encourage hobbies at home.[71] Certain spaces, such as garages and basements, emerged as natural domains for setting up equipment and workbenches.[72] According to Alois Dettlaff from Cudahy,

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[70] Meister, "The Educational Value," 169-171.

[71] Lisa Jacobson, "Revitalizing the American Home: Children's Leisure and the Revaluation of Play, 1920-1940," *Journal of Social History* 30, no. 3 (Spring 1997): 581-596.

[72] Kristen Haring describes, for instance, how male amateur radio operators carved out discrete locations or "shacks" for performing their hobbies. These spaces created distance between men and their families, offering a masculine refuge within the domestic sphere. Kristen Haring, "The 'Freer Men' of Ham Radio: How a Technical Hobby Provided Social and Spatial Distance," *Technology and Culture* 44, no. 4 (October

Wisconsin, “My club is located in my basement. We have it partly partitioned off with bulletin board, case for apparatus, a regular desk, and a table large enough to accommodate three or four members.”[73] The spaces available to young hobbyists, ranging from kitchen corners to full basement laboratories, reveal the negotiations that occurred between children and their parents within the household. These adult-approved spaces were intended to stimulate children’s creativity and independence. Even in dual-purpose environments such as kitchens or living rooms, children were given a certain amount of freedom in managing the parameters of their own scientific and technical pursuits. These intermediary spaces allowed adolescents to achieve intellectual autonomy while still under their parents’ spheres of influence.[74]

As Meister observed, however, not all students were fortunate enough to have domestic spaces available for conducting their hobbies. Instead, they turned to schools and other public venues. Despite the popularity of the laboratory method in science teaching, Meister’s own experience revealed the severe financial and spatial limitations many science instructors faced. At the Speyer School, Meister had no laboratory facilities or equipment to speak of. His students sought out donated equipment to start a makeshift laboratory, and soon the school’s closets were filled with discarded or broken toys, cigar

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2003): 734-761. See also Aaron Alcorn, “Flying into Modernity”; Steven M. Gelber, “Do-It-Yourself: Constructing, Repairing and Maintaining Domestic Masculinity,” *American Quarterly* 49, no. 1 (March 1997): 66-112; and Margaret Marsh, “Suburban Men and Masculine Domesticity, 1870-1915.” *American Quarterly* 40, no. 2 (June 1988): 165-186.

[73] “Club News,” *The Chemcraft Science Magazine* 51, nos. 6 & 7 (July 1939): 4, CHF.

[74] For a discussion on the spatial negotiations between adults and children, see Marta Gutman and Ning de Coninck-Smith, eds., *Designing Modern Childhoods: History, Space, and the Material Culture of Children* (New Brunswick: Rutgers University Press, 2008); Aaron Alcorn, “Modeling Behavior;” Bernard Mergen, *Play and Playthings: A Reference Guide* (Westport: Greenwood Press, 1982), 81-95; and Amy F. Ogata, *Designing the Creative Child: Playthings and Places in Midcentury America* (Minneapolis: University of Minnesota Press, 2013).

boxes, tin cans, and loaned science outfits.[75] At Horace Mann, Meister cleaned out an old junk room, and for a cost of around $250 he added library tables, books, work benches, plug-switches, saws, rulers, hammers, brushes, Bunsen burners, grindstone, hand-drill, and chemicals. He designed the workshop with group work in mind by keeping the center of the room open for large apparatus demonstrations.[76] Other student clubs received special permission to host their meetings in town halls or county commissioner offices.[77] In securing locations for their hobbies, adolescents staked a claim on public spaces as a means for maintaining their intellectual sovereignty.

## Student Motives and Engagement with Experiment Sets

What were students' motivations for engaging in these activities? Meister attempted to find an answer by surveying letters written to kit manufacturers. In addressing the question "Just what is there in these materials and activities which interests a boy?," Meister found that the largest percentage (37%) of enthusiasts were motivated by wanting to make things work. This number was significantly higher than the motive of winning a prize (23%), wanting to become an engineer or inventor (20%), or showing off to friends (9%).[78] Several boys in Meister's study reported lying in bed at night thinking about how to improve upon their projects. The main motive, then, was the process of tinkering itself—i.e., identifying problems and seeking out solutions. For Meister, this response reinforced his belief that extracurricular instruction could provide the necessary foundation for cultivating a scientific habit of thought.

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[75] Meister,"The Educational Value," 107.
[76] Meister, "The Educational Value," 167-9.
[77] "The Meccano Guild," *Meccano Magazine* no. 14 (September/October 1920), 3; "Club News," *Chemcraft Science Magazine* 2&3 (November and December 1939): 20, CHF.
[78] Meister, "The Educational Value," 88.

Despite the warnings given in the manuals to follow instructions, Meister found that only 10% of boys actually went through the manuals step by step. The manufacturers designed their manuals so that students began learning elementary techniques before moving onto more elaborate concepts. The Chemcraft guides promoted a process of learning where ideas built upon each other, requiring students to work through the manual in sequential order to comprehend the most sophisticated concepts underlying chemistry at the end. Although Erector and Meccano construction manuals contained far fewer detailed instructions, they encouraged beginners to at least learn the fundamentals in assembling square girders or operating motors. Meister found, however, that the students who did not adhere to instructions were typically more successful in school than those who diligently followed each step. These same boys would often consult the manuals later on as they developed more sophisticated ideas and concepts.[79] Meister observed what he considered to be the highest level of scientific cognition: when a student solved a problem, it often led to new, more complicated questions they needed to address.

Inasmuch as the inventiveness of hobbyists achieved the Deweyan aims of problem solving, their failures proved just as telling. One-third of the boys that Meister observed gave up when they encountered a difficult task. Although their failures were often attributed to impatience or lack of proper technique, the outfits themselves often were the source of the problem. Some of the newer electrical outfits of the early 1920s, such as the Gilbert Wireless set, were designed hastily before being put out on the market. As a result, the low quality equipment proved far less workable than simply

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[79] Ibid., 174.

purchasing individual wireless parts and assembling them independently.[80] The Erector Set models occasionally posed similar problems. The infamous 1920 Ferris Wheel required children to bend straight steel girders in order to make the round wheel. Even with the addition of curved girders in subsequent sets, elaborate Ferris Wheel models of the late 1920s proved so monstrous that they required components that could only be obtained through multiple sets.[81] Although the outfits generally prompted creative problem solving, in these instances failure was often inevitable.

At a time when educators and psychologists began measuring intelligence as a predictor of future success, the role of extracurricular activities generally remained outside of the scope of these discussions. Although Meister was concerned enough with IQ to incorporate it into his study, he ultimately found that it proved less critical for successful problem solving than forming strong habits. In fact, Meister found that students who were the most engaged in the science club had lower IQs (calculated using National Intelligence Tests) than students who were not involved in extracurricular science. However, the students who were club members performed better in constructive abilities even as several of their classmates received better marks.[82] Gilbert also argued that boys' ability to concentrate mattered more than natural talent. Gilbert often equated the process of technical training to physical fitness, asserting that excellence came through constant, dedicated practice of proper technique. "In his youth is when a boy should start training his mind, as well as his manners and muscles for the bigger things in life which are in store for him later on," Gilbert claimed. "If he acquires this training

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[80] Ibid., 51.
[81] Bean, Vol. 1, 146-147.
[82] Meister, "The Educational Value," 175; 129.

while young he need not worry about the future."[83] Although intelligence testing had begun to take hold in measuring student talent, both Meister and Gilbert believed that strong work habits and enthusiasm were far more important than raw intellect in predicting future success.[84]

Ultimately, Meister believed that the kits embodied a Deweyan form of scientific education. Rather than promoting a strict adherence to lock-step methods, they encouraged a synthetic thought process that performed comparably to the realities of formal laboratory work.[85] Meister's observations of students' motives for playing with the outfits, inventiveness through trial and error, and measurement of student performance in school confirmed his suspicions; extracurricular engagement could serve a critical function in producing a scientifically minded citizenry. As the following chapters demonstrate, these lessons would serve Meister well when he envisioned a new program of extracurricular science: the science fair and club movement.

## **Constructing a Network**

Early construction and science sets introduced users to a distinct set of values that emphasized a process of problem solving that could apply to everyday experience. These sets would also present adolescents with norms of socialization through a range of corresponding activities including clubs, competitions, and magazines. These programs went beyond supporting specific fields like chemistry or engineering to encourage a host of activities that embraced a more generalist view of science and technology. From writing poems or short stories to showing off new experiments or construction models,

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[83] "Train Your Mind for Attention," *Toy Tips* 9 no. 3 (June 1923): 28, AC Gilbert Collection, Eli Whitney Museum (hereafter cited as EWM).

[84] On intelligence testing, see John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (Princeton, NJ: Princeton University Press, 2007).

[85] John L. Rudolph, "Epistemology of the Masses: The Origins of the 'Scientific Method' in American Schools," *History of Education Quarterly* 45, no. 3 (September 2005): 341-376.

adolescents moved beyond solitary tinkering to form a network of enthusiasts across the United States and the world.

The key network forums for these communities were the magazines published by the toy manufacturers. In October 1914, Gilbert released the first issue of *Erector Tips* (also called *Toy Tips*). Chemcraft and Meccano soon followed suit, publishing *The Chemcraft Chemist* (also called *Chemcraft Science Magazine*) and *Meccano Magazine*, respectively. In the case of Meccano, the magazine was published in part due to user demand. In the introductory issue, the editor stated that "Meccano boys have been asking us for some years now to start a Meccano magazine and here it is at last."[86] Just as manufacturers emulated each others' products and marketing techniques, they also developed similar formats for their periodicals. The magazines typically consisted of short stories, club news, letters to the editor, and the introduction of new sets or products. These elaborate marketing campaigns extended beyond just selling outfits to providing new platforms of communication on a national and, at times, international scale. According to Meister, approximately one-fifth of purchasers of science or construction sets contacted either the magazine editors or the manufacturers directly with questions and comments regarding their sets. Gilbert received up to 300,000 letters a year from his buyers, many of whom connected with him personally by signing "Your loving son."[87] The Porter Company received nearly 14,000 communications in 1920.[88] The cost to the manufacturers was minimal (Meccano's Guild program reportedly comprised less than

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[86] "Our First Number," *Meccano Magazine* 1, no. 1 (September/October 1916), 1.
[87] Watson, *The Man Who Changed,* 588.
[88] Meister, "The Educational Value," 87.

1% of the total advertising budget), and in exchange, they cultivated a loyal following of children who seized these opportunities to connect with likeminded enthusiasts.[89]

Hobbyists capitalized on the support that these new forums provided. In the question and answer sections, readers could ask questions directly to the editor who published selected excerpts deemed applicable to other members. Chemcraft Science Club members wrote in with questions that reflected varied levels of expertise, ranging from simple ("What makes grass green?") to complex ("How may potassium oxide (KO) be paired with potassium nitrate (KNO3)?"). The editor of Meccano wrote personal responses back to readers who submitted questions regarding specific parts ("We shall give consideration to your suggestion for a flat and shaped radioat.") or tips for other hobbyists ("Thanks for your suggestion for Meccano boys that they use Braso for cleaning perforated strips, etc., when they get dull").[90] Through these columns, readers benefited from learning about the challenges that fellow enthusiasts faced.

The magazines also sponsored correspondence programs where members could write letters to one another. Interested students submitted their names and addresses for publication, inviting fellow members to contact them. The international Meccano program proved to be one of the most robust, with members writing one another from regions ranging from South Africa and France to the United States and Australia. In describing the rationale behind the program, the editor explained, "Meccano users have for long felt that they were members of a great brotherhood of boys, all thinking the same kind of thoughts, sharing the same pleasures and thrilled by the same ambitions." For

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[89] Brown, *Factory of Dreams*, 76.

[90] "Suggestions by Meccano Boys," *Meccano Magazine*, no. 23 (March/April 1922) : 3; "Our Mail Bag," *Meccano Magazine*, no. 23 (March/April 1922) :8.

many users, the correspondence program offered a critical lifeline to connect with fellow enthusiasts.

Not only did readers use the magazines as forums for correspondence, but they also turned to the columns for inspiration in improving their skills. The manufacturers encouraged this sort of emulation by publishing more detailed models and experiments than typically found in the manuals. According to one Meccano prize advertisement, "If you are contented to simply copy the Meccano models as you see them, you will never be successful in inventing anything new. Go to work now. See what the other fellows have done in the last two big competitions, and then go to work on something better."[91] Readers happily submitted their own successful projects and supplied their addresses so that fellow hobbyists could expand upon their work. These forms of interaction further promoted the conception of scientific and technical learning as process oriented.

Not only did students submit examples of their projects, but they also shared short stories, jokes, and poems, adding an element of playfulness that further cemented their sense of belonging. The stories offered historical, positivist accounts of "Great Men" like inventor Thomas Edison or industrialist Daniel A. Tompkins to serve as inspirations of hard work and ingenuity.[92] Other fictional accounts situated boys as the heroes, such as the story "The Hunting Trip" submitted to *Toy Tips* by John Innes. In Innes' account, "Ted Clark" embarks on a hunting trip with his father to Africa. The pair slay a series of animals before encountering a bear. After his father is unsuccessful in killing the bear, Ted successfully shoots him "right between the eyes."[93] These stories built on the

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[91] "A New £200 Prize Contest," *Meccano Magazine* 1, no. 1 (September/October 1916), 3.
[92] See, for instance, Terry Mitchell, M.E., "Daniel A. Tompkins," *Chemcraft Science Magazine* 51, no. 5 (June 1940): 6-11, CHF.
[93] John Innes, "The Hunting Trip," *Toy Tips* 9, no. 3 (June 1923): 11-12, EWM.

tradition of adventure novels such as the Tom Swift series, positioning boys as inventive, adventurous, and capable problem solvers. Other hobbyists submitted jokes to entertain fellow readers. "Teacher:--A quadruped travels on four legs and a biped goes on two legs. Give an example of a biped. Johnny:--A pair of stockings."[94] These narratives offered a creative outlet of scientific expression that added an element of whimsy to appeal to young readers.

Competitions served as another platform for young enthusiasts to exchange ideas and display their acumen. Meister found that 20-30% of his students planned on entering some sort of prize contest to present their work.[95] In 1915, Gilbert started a competition for best Erector model. The contest attracted 60,000 entrants vying for the first prize of a full-sized car. Gilbert encouraged students to create original designs, declaring "I am going to give this auto and motorcycles to some boys who make extra efforts to get them. They are not going to be given away for any common models." The successful models published in *Erector Tips* were celebrated for simplicity in design and ease of operation (such as a working swing saw), realism (such as a moving siege gun with true to life details), or ingenuity (such as adding a second spire onto a cathedral).[96] Hornby adopted a similar approach for his Inter-Club Model Competitions by offering cash prizes to both clubs and individual members. Hornby did not just reward model making, but he also honored students' presentation abilities by giving medallions to hobbyists who delivered the best papers on topics like electricity, woodworking, nature study, or collecting.[97]

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[94] David Moore, Letter to the Editor, *Toy Tips* 9, no. 3 (June 1923): 7, EWM.
[95] Meister, "The Educational Value," 68.
[96] "Winners in Prize Contest- No. 2," *Erector Tips* 1, no. 6 (June 1915): 1-2; Brown, *Factory of Dreams,* 50; Watson, *The Man Who Changed*, 54, 59; "More Prizes—Still More!" *Erector Tips* 2, no. 3 (December – Juanuary 1916): 1-3.
[97] "Special Awards for Club Members," *Meccano Magazine*, no. 14 (September/October 1920), 4; "Special Merit Medallions," *Meccano Magazine* no. 23, (March/April 1922), 4.

Students entering chemistry contests developed tricks and experiments that dazzled their audiences, such as a candle that burns with a blue flame, writing messages with invisible ink, and developing a chemical trick for catching thieves.[98] Through these interactions, children were acclimated to not just scientific and technical training but to delivering an effective presentation of their work.[99]

In addition to magazines, kit manufacturers also established membership programs to encourage hobbyists to collaborate with one another.[100] The Gilbert Engineering Institute for Boys invited hobbyists to submit papers demonstrating the models they had built in order to receive diplomas.[101] Likewise, the Chemcraft Science Club invited both boys and girls to start local chapters "for real fun, entertainment, and just lots of practical knowledge."[102] The largest and most elaborate program was the Meccano Guild. Like the *Meccano Magazine*, the guild was launched in 1919 due to hobbyist demand. Hornby deliberately chose the term "guild" to express a sentiment of camaraderie and hands-on learning. The Guild's objectives were "A) To make every boy's life brighter and happier; B) To foster clean-mindedness, truthfulness, ambition, and initiative in boys; C) To encourage boys in the pursuit of their studies and hobbies, and especially in the department of their knowledge of mechanical and engineering

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[98] "Chemistry Will Win the War," *Boys' Life*, December 1942.

[99] Other commercial contests emerged during the interwar period. For instance, in 1931 the Fisher Body Craftsman's Guild invited teenage boys to participate in a model-making contest, and *Popular Science Monthly* also held competitions offering scholarship money. See Ruth Oldenziel, "Boys and Their Toys: The Fisher Body Craftsman's Guild, 1930-1968, and the Making of a Male Technical Domain," *Technology and Culture* 38, no. 1 (January 1997): 60.

[100] Club programs also existed for other toys, such as the Hornby Railway Club and Richter Anchor Clubs. See Brown, *Factory of Dreams*, 76; and George F. Hardy, *Richter's Anchor Stone Building Sets* (Charlottesville, VA: George Hardy, 2007), 11, http://www.ankerstein.org/.

[101] "Gilbert Institute 'Live-Wires' and the Erector Models They Built," *Toy Tips* 9, no. 3 (June 1923): 15-16, EWM.

[102] The club program was established around the same time as a World War I propaganda campaign by the Chemical Foundation to encourage chemical instruction to decrease reliance on German products. "The Chemcraft Science Club," *Chemcraft Science Magazine* 51, no. 5(June 1940): 2, CHF; Jensen, Part II.

principles." Intended to cultivate both the expertise and character of its members, by 1932 the Guild boasted 100,000 members across the world.[103] The club programs quickly emerged as hubs of interaction where young enthusiasts shared equipment, expertise, and companionship.

The club programs stemmed well beyond tinkering with outfits by embracing a broader scope of scientific and technical pursuits. The Meccano Club in Wallingbrook, England held a debate on the relative merits of electricity and steam power that proved so popular that it became a regular feature of the club program.[104] The Norman Jr. High Chemcraft Science Club (location unknown) met to explore topics such as "The Miracle of Ice from Heat," fireproofing solutions, and the reactions of salts, bases, and acids. Another Chemcraft Club in Ontario, Canada collected insects and other specimens over the summer to examine under the microscope.[105] Some activities promoted an even more expansive view of scientific expression. A Meccano Guild in Leamington, England reported that it "has now its Debating Society and its Meccano Minstrel Troupe, and it is hoped shortly to organize a Library and a Bank as well as a Summer Sports Club." Like the chemical magic shows detailed in chemistry guidebooks, the club fostered a more interactional form of expertise through public performance. The Meccano editors encouraged these activities, claiming, "Many of our Meccano Clubs successfully conclude their sessions with an Exhibition or Concert. Not only does the work of organising and carrying through a good programme provide an interesting occupation, but the success of the effort gives pleasure to a large number of parents and friends, as

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[103] Brown, *Factory of Dreams*, 75; "Club Notes," *Meccano Magazine*, no. 14 (September/October 1920): 3.
[104] "Club Notes," *Meccano Magazine*, no. 14 (September/October 1920): 4.
[105] "Club New," *Chemcraft Science Magazine* 51, no. 6 (July 1940): 11-12, CHF; "Club News," *Chemcraft Science Magazine* 2 & 3 (November and December 1939): 21, CHF.

well as to the members of the Club themselves." Meccano offered a short play entitled *Nonsense Nana* to club leaders interested in arranging performances.[106] These activities offered a more expansive view of scientific expression that valued performance as a technique for hobbyists to cultivate.

Manufacturers not only promoted friendly collaboration, but they also established an inner hierarchy among members. The Meccano Guild was the most structured; each club required an adult leader as well as a boy secretary. The Gilbert Engineering Institute operated similarly to correspondence schools by offering scaffolded levels of achievement that demanded increasingly more elaborate models. To become a member, hobbyists sent in papers explaining models they have built as well as the scientific principles their projects represented. Judges then gave each submission a certain ranking of "Engineer." The Chemcraft Club designated club organizers as "Chief Scientists" in charge of informing the "junior members" of Chemcraft news and events.[107] These titles encouraged members to take on leadership responsibilities while conveying an elite status that distinguished them from their peers.

Club members were equally proud to receive tangible tokens signifying their membership. L. Predeaux of Camborne wrote, "Don't you think Meccano boys should have a little badge with the word 'Meccano' on it?" In response, Meccano supplied each Guild member with a badge, certificate, or membership card.[108] Erector Engineers received diplomas and fraternity pins, whereas Chemcraft Club members received pins

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[106] "The Meccano Guild," *Meccano Magazine,* no. 23 (March/April 1922): 4.

[107] "The Meccano Guild," *Meccano Magazine*, no. 14 (September/October 1920): 3; "Gilbert Engineering Institute for Boys," *Gilbert Annual Yearbook: 1923 Edition* (New Haven, CT: AC Gilbert Company, 1922), 64, EWM; "The Chemcraft Science Club," *Chemcraft Science Magazine* 51, no. 5 (June 1940): 2, CHF.

[108] "Each Member of the Guild Gets a Certificate," *Meccano Magazine* , no. 14 (September/October 1920): 4; "The Meccano Guild," *Meccano Magazine,* no. 23 (March/April 1922): 4.

and cards. Members opted to wear their insignia at meetings, for recruitment, or just for fun. One Meccano Guild member asked the editor if it would be okay to remove his badge for a cricket match.[109] These badges of distinction served as a source of pride for members and contributed to their sense of belonging.

Club members also developed their own rituals and codes of behavior to provide structure to the group. As Meister observed of his own club members, peer pressure often prompted students to strive for excellence. The St. Cedd's Club in London hosted model-building evenings when the Club Leader evaluated members' models. The student who received 100 marks was "top' for the evening." In one Chemcraft Club, prospective members were required to pass a test based on articles from the *Chemcraft Magazine* in order to join. Students often showed off their achievements to other clubs as well. One Chemcraft Club member boasted, "I'll bet you even money that no club has a bigger and better scrap book than we have."[110] These internal competitions and codes of conduct provided order to the group while encouraging members to keep pace with their peers.

Although the youth clubs provided a strong sense of belonging for their members, they also set up parameters for exclusion. Building upon the notion of science and engineering as distinctly masculine domains, girls were rarely mentioned. On occasion toy outfit advertisements, particularly for chemistry and microscope sets, also included girls. Chemcraft directed its some of its advertisements to both boys and girls, claiming their chemistry outfits were "for boys-and girls, too."[111] Just as the language positioned

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[109] "Our Mail Bag," *Meccano Magazine*, no. 14 (September/October 1920): 8.

[110] "Club Notes," *Meccano Magazine* , no. 23 (March/April 1922): 5; "Club News," *Chemcraft Science Magazine,* nos. 2 & 3 (November and December 1939), 4-5, CHF.

[111] I did locate a few early ads for Meccano that addressed girls. In the November 1909 issue of *Playthings*, for instance, an ad for Meccano distributor The Embossing Company declared, "Any boy or girl can make these models and numerous others with a 'Meccano' outfit." *Playthings* 7, no. 11 (November 1909): 15. These ads, however, were quickly replaced by language exclusively addressing boys. For an in-depth

girls as supplemental to boys, the corresponding imagery typically depicted girls assisting boys in their pursuits. In 1917, AC Gilbert reinforced the relegation of girls to supportive roles by releasing a Gilbert Nurses Outfit for Girls, complete with dental floss, gauze bandages, scissors, nurses cap, apron, and arm bad, and guidebook.[112] Even the more creative magazine columns often carried misogynistic undertones, such as the joke "Nature's Error" submitted by a Gilbert *Toy Tips* reader. "Mamma," said five-year-old Archie, "Come out on the lawn and play baseball with me." "I can't play baseball, dear." "Huh!" exclaimed the little fellow, "That's what comes of having a woman for a mother."[113] These messages signaled to young women that they were innately less suitable for the outfits than their male counterparts.

In reality, girls' engagement proved more complicated than the normative literature suggested. More often than not "boy" referred to the male sex, but occasionally editors conflated the term to refer to both male and female enthusiasts. In response to a poem submitted by a reader, the Meccano editor claimed, "And now we expect to have all the old nursery rhymes rewritten by Meccano boys and girls. And the boy who sends in a good one will hear of something to his advantage." Addressing readers first as "boys and girls" then simply as "boys" suggests that the term "boy" sometimes served as shorthand for all hobbyists. Female readers occasionally followed suit; Roslyn Hamilton

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discussion on how engineering and technical fields became masculinized, see Ruth Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870-1945* (Amsterdam: Amsterdam University Press, 1999); See also "Chemcraft Home Laboratory," *Boys' Life,* December 1937; Keene, "Every Boy and Girl a Scientist," 285.

[112] Klon Smith, "Gilbert Nurses Outfit for Girls," *A.C. Gilbert Heritage Society Newsletter* 13, no. 4 (December 2003): 15-17.

[113] "Gilbert Institute Clubs," *Toy Tips* 9, no. 3 (June 1923).

from Houghton, Michigan wrote, “I fully appreciate the work AC Gilbert Co. is doing for boys who are interested in the up-to-date things.”[114]

Despite these challenges, a few young women still opted to purchase outfits and join the clubs and correspondence networks. In one Chemcraft correspondence list, eight of the nine members had female names.[115] Some clubs boasted separate girls sections that performed needlework competitions or classes on making vases in lieu of the boys’ experiments or construction contests.[116] And some girls formed their own clubs entirely. The Lady Hamilton Chapter of the Chemcraft Club reported a membership of six girls who studied first aid, chemistry, and biology.[117] Although their work was rarely featured, occasionally girls submitted sample construction models. In the June 1915 issue of *Erector Tips,* Irene and Virginia Claire were shown next to their model of a Merry-Go-Round and cradle. The article claimed, “We are glad to notice that there are girls who are interested in the Erector as well as boys…Too many women are unacquainted with mechanics, although they unconsciously apply many mechanical principles  to their home work.”[118] Although girls found ways to pursue these hobbies through the channels that were open to them, these instances remained more the exception than the norm.

Even as members corresponded with a diversity of enthusiasts across the globe, hobbyist networks also excluded non-Caucasian racial and ethnic groups. Advertisements did not portray African American children playing with kits until the 1960s, at the end of

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[114] “Our Mail Bag,”*Meccano Magazine* 1, no. 7 (July/ August 1918): 4; Roslyn Hamilton, Letter to the Editor, *Toy Tips* 9 no. 3 (June 1923): 040-1. Although I am not certain that Roslyn was a girl, according to the Social Security name records for 1923, Roslyn was the 413th most popular name for girls born in the United States, and did not rank in the top 1,000 names for boys. See http://www.ssa.gov/oact/babynames/.

[115] This high ratio of girls was unusual; most correspondence lists typically had the reverse ratio between boys and girls.

[116] “Club Notes,” *Meccano Magazine,* no. 14 (September/October 1920): 3; “Club News,” *Chemcraft Science Magazine* 2 &3 (November and December 1939): 21, CHF.

[117] “Club News,” *Chemcraft Science Magazine* 51, no. 5 (June 1940): 4, CHF.

[118] “Two Girls Built These Two Models,” *Erector Tips* 1, no. 6 (June 1915): 4.

their peak in popularity. Featured contest winners, club participants, and model builders were virtually all white. And although Meccano users resided in locations across the British Empire, not all English subjects were welcome to participate. In response to a letter written by Guild member Ernest Atkins, the editor cautioned, "We want to warn you and all other Meccano boys against letters received from native boys in Africa. Most of them simply beg for presents to be sent out to them, and should be ignored."[119] Surprisingly, the fact that members received these letters suggests that some native-born African children had access to Meccano publications. But as these youth programs invited thousands of adolescents to participate in a growing network of hobbyists, they also delineated who did not belong, suggesting that only certain children possessed the prerequisite qualities to acquire scientific and technical skills.

## Conclusion: The Dawning of a Movement

Kit manufacturers' contests, magazines, and club programs facilitated a contingent of loyal customers who closely identified with the brands. These efforts stemmed beyond just mere marketing strategies. Club publications often had minimal advertising, devoting more pages instead to correspondence among readers. The Meccano Guild did not require members to own construction sets in order to join. And even outside science periodicals such as *Popular Science Monthly* became committed to producing supplementary instruction materials that could improve science education.[120] In this regard, commercial ventures coalesced with broader educational aims to encourage adolescent scientific and technical training.

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[119] "Mail Bag," *Meccano Magazine*, no. 14 (September/October 1920): 8.

[120] Coincidentally, Meister was in charge of running this program.

Adolescents capitalized on these opportunities by developing their own networks and displays of acumen. They expanded set offerings with additional materials and carved out domestic and community spaces for engaging their hobbies. They expressed their enthusiasm through writing creative stories, jokes, and poems. They formed smaller club communities that fostered a sense of belonging through holding regular meetings, establishing codes and rituals, and partnering on projects.  They sought out help and built upon the ideas of one another to develop new innovations. And in the process, they began to identify as part of a larger community of hobbyists that spanned across the nation and even the world.

At the same time, it became clear that commercial suppliers had limitations in organizing a unified youth program. Although Hornby, Gilbert, and Porter expressed similar commitments to adolescent engagement in science and technology, their position as business competitors presented a conflict of interest that made collaboration next to impossible. The continuation of the programs also depended on their ongoing financial security, a factor that was far from guaranteed given the volatile toy marketplace. And as Meister recognized, corporate motives ultimately remained devoted to generating sales, a fundamentally different aim than the broader goal of fostering a youth science network.

Both toy manufacturers like A.C. Gilbert as well as educators like Meister were aware they were on the cusp of something greater than the programs that the toy manufacturers had started. Gilbert told Meister that he perceived the greatest need in sustaining his work was developing “a central, unified, boy movement that will utilize the tendency of boys to ‘join a club’ and apply it to science activities.”[121] Meister undoubtedly agreed with this assertion. As the following chapters demonstrate, Meister

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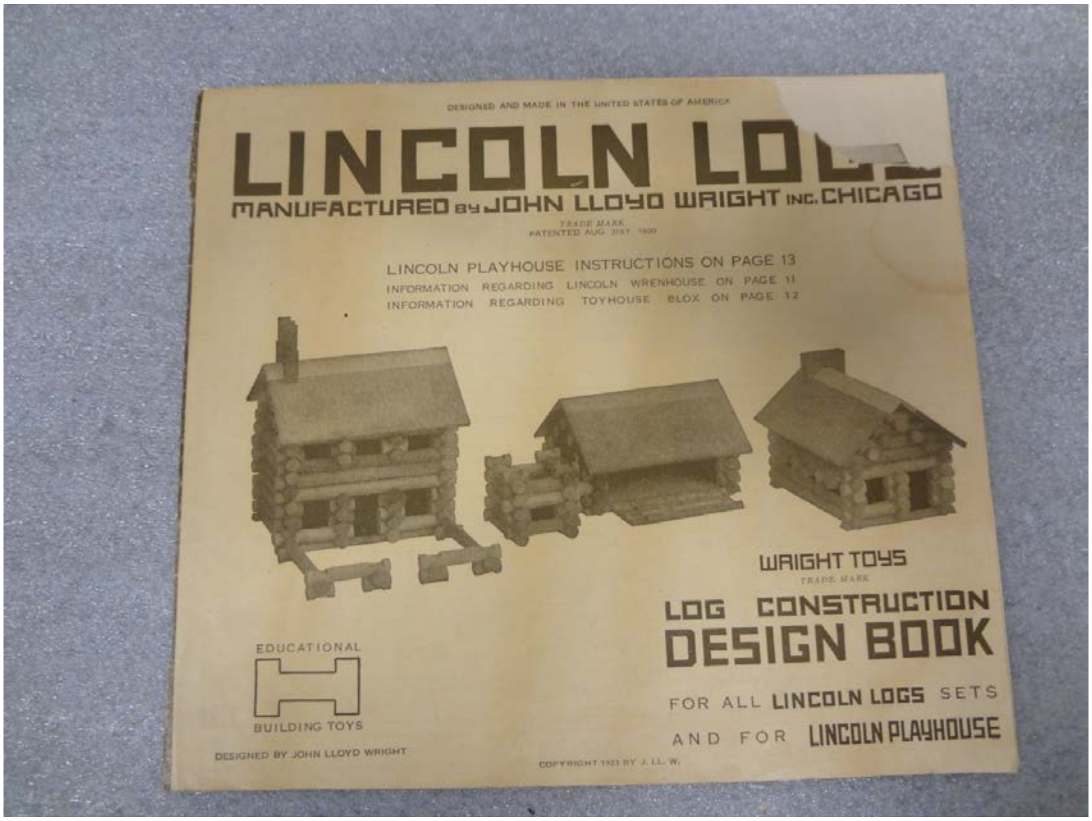
[121] Meister, “The Educational Value,” 154.

would become a central figure in organizing a national network of science clubs and fairs. Building upon the models he studied in his research, Meister and his contemporaries emulated the corporate strategies of adolescent consumer engagement in the early twentieth century to initiate a full-scale movement.



DESIGNED AND MADE IN THE UNITED STATES OF AMERICA

LINCOLN LO

MANUFACTURED BY JOHN LLOYD WRIGHT INC. CHICAGO

TRADE MARK
PATENTED AUG. 31ST 1920

LINCOLN PLAYHOUSE INSTRUCTIONS ON PAGE 13
INFORMATION REGARDING LINCOLN WRENHOUSE ON PAGE 11
INFORMATION REGARDING TOYHOUSE BLOX ON PAGE 12

WRIGHT TOYS
TRADE MARK

LOG CONSTRUCTION
DESIGN BOOK

FOR ALL LINCOLN LOGS SETS
AND FOR LINCOLN PLAYHOUSE

EDUCATIONAL
BUILDING TOYS

DESIGNED BY JOHN LLOYD WRIGHT

COPYRIGHT 1923 BY J. LL. W.

Figure 1.1 Wright Lincoln Logs, ca. 1920. Photo by author. Courtesy of The Strong®, Rochester, New York.

Figure 1.2 Meccano Set, ca. 1916. Photo by author. Courtesy of The Strong®, Rochester, New York.

Figure 1.3 6 ½ Model Erector Set with motor. Photo by author. Courtesy Eli Whitney Museum Collection.

Teaches the principles of the Science of Chemistry in an interesting and fascinating way, through many practical and harmless chemical experiments which any boy can perform many times with the contents of this outfit.

The fundamentals of Chemistry, and its application to the things we use every day, are made clear by a series of experiments which teach and amuse. All chemicals and apparatus necessary are included.

Figure 1.4  Chemcraft Chemical Outfit No. 1. Photo by author. Courtesy Chemical Heritage Foundation Collection.

Figure 1.5 Components of the 7 ½ Erector Set. Photo by author.

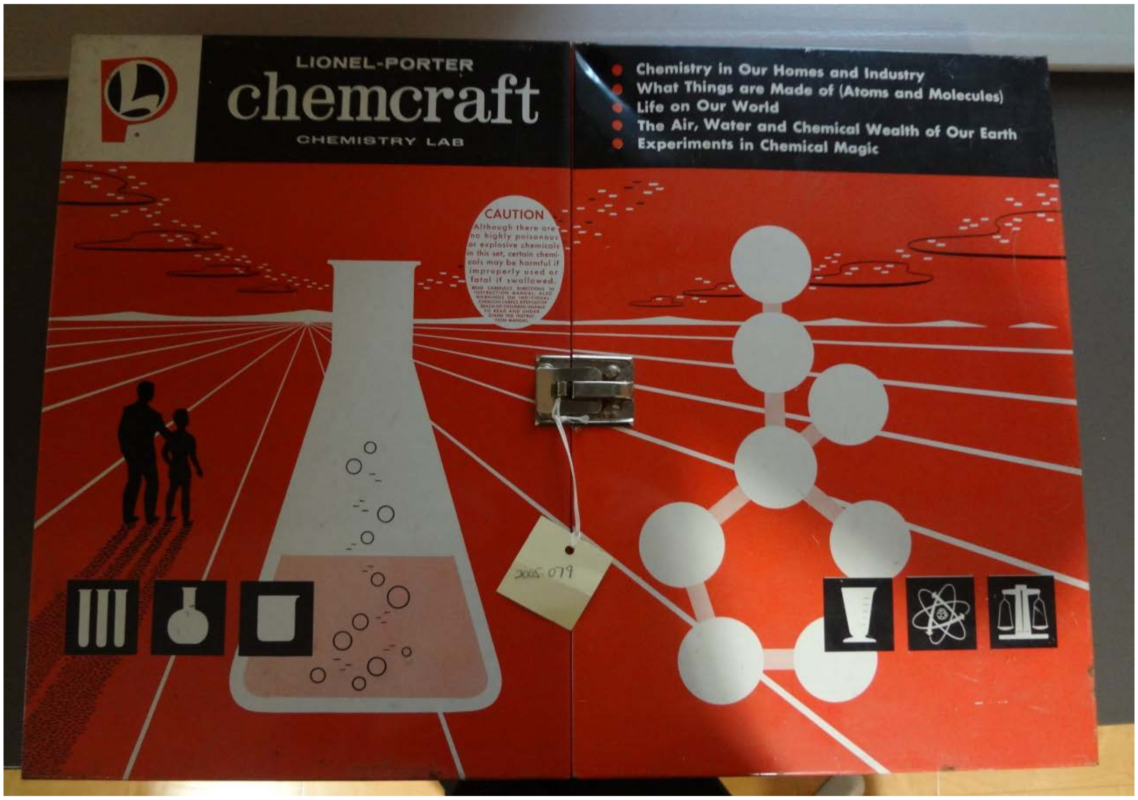


Figure 1.6 Lionel-Porter Chemcraft Chemistry Lab. Photo by author. Courtesy Chemical Heritage Foundation Collection.

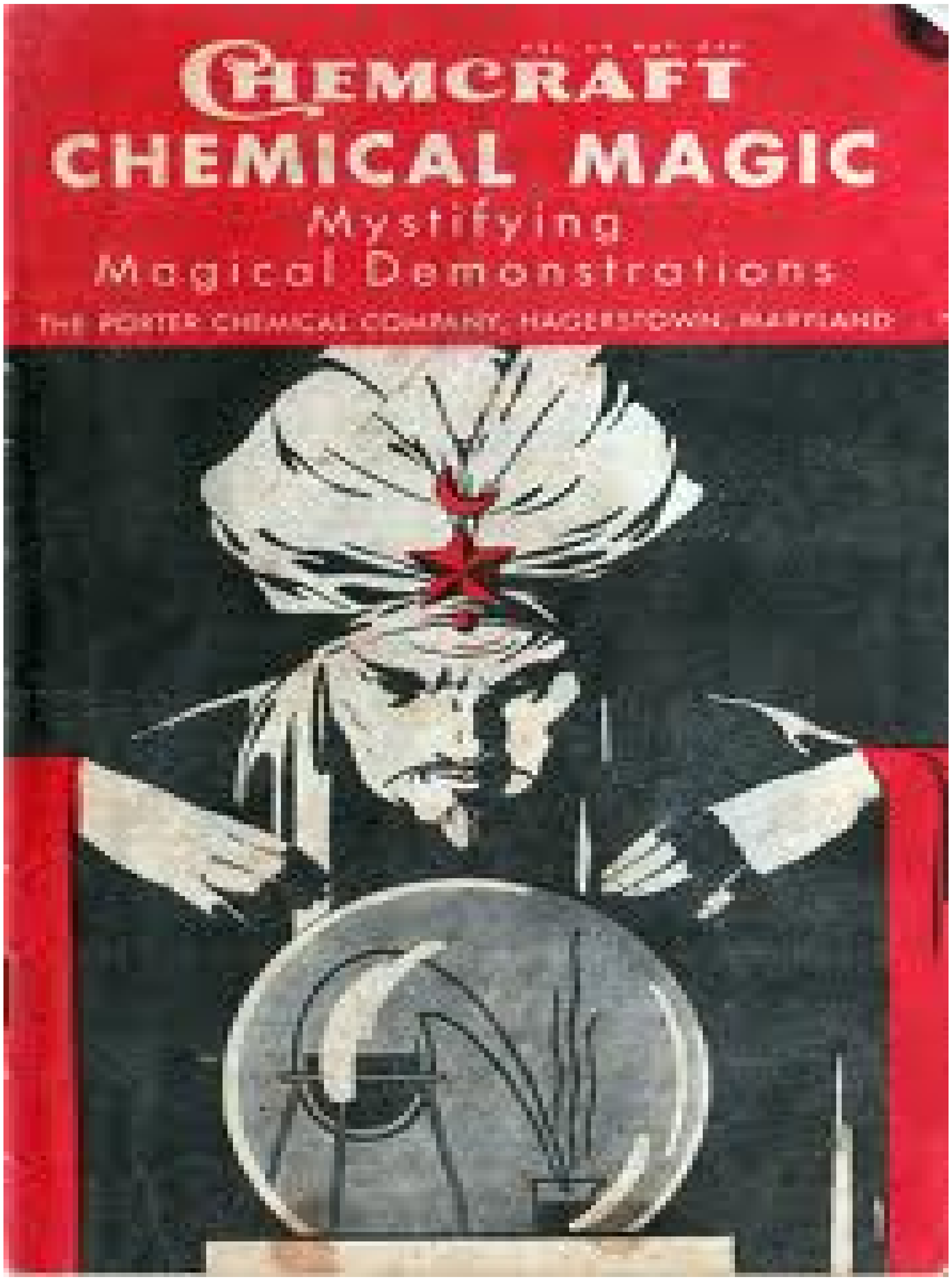
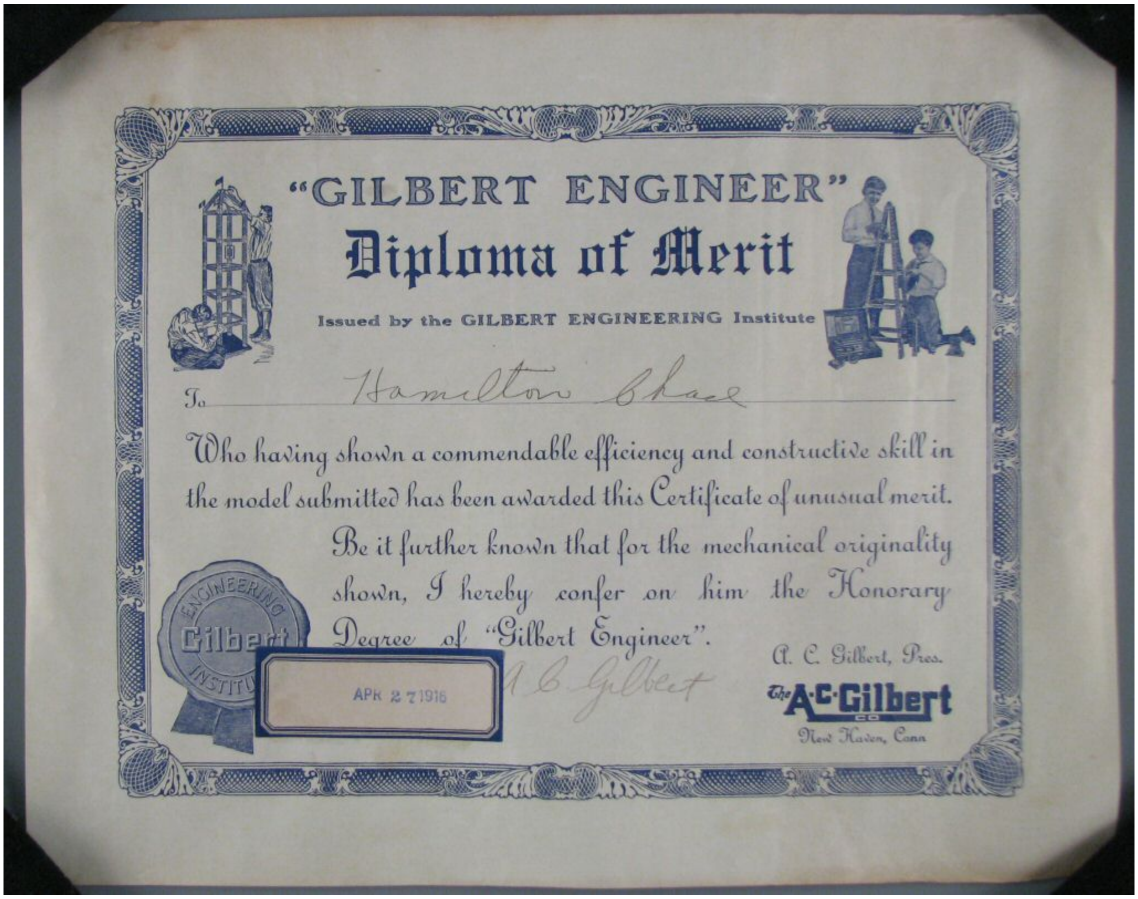


Figure 1.7 Cover of *Chemcraft Chemical Magic* booklet. Photo by author.

Figure 1.8 AC Gilbert Chemistry Set with added legs, ca. 1935. Courtesy of The Strong®, Rochester, New York.

Figure 1.9 Boy playing with chemistry set. The compact cases of chemistry sets proved deceiving. Most sets required expansive tabletop space for conducting experiments. Courtesy of The Strong®, Rochester, New York.



"GILBERT ENGINEER"

Diploma of Merit

Issued by the GILBERT ENGINEERING Institute

To Hamilton Chace

Who having shown a commendable efficiency and constructive skill in the model submitted has been awarded this Certificate of unusual merit.

Be it further known that for the mechanical originality shown, I hereby confer on him the Honorary Degree of "Gilbert Engineer".

A C Gilbert

A. C. Gilbert, Pres.

The A·C·Gilbert Co

New Haven, Conn

APR 27 1916

Figure 1.10: "Gilbert Engineer" Diploma of Merit, 1916. Courtesy of The Strong®, Rochester, New York.

# PART 2

## Narrating Science

In the December 1938 issue of the American Institute student club magazine *Science Observer*, a cartoon depicted young "adventurer" sitting at his desk surrounded by the essential tools of an amateur scientist: test tubes, books, microscope, and globe (Fig. Part 2.1). To his right loomed a stately portrait of the great empiricist Sir Francis Bacon. A vision of a bright future peered to his left, complete with modern skyscrapers and hovering aircraft. The implications were clear: caught between a remote past and an uncertain future, the responsibility for leading the nation by reason and ingenuity rested on the shoulders of the budding young scientist. The American Institute science clubs and fairs of the 1930s were also caught in between two scientific traditions, moving away from progressive ideals of nature study but not yet affected by the watershed of World War II. During this moment of transition, a youth community emerged, one with its own conceptions regarding the role of science in society. To facilitate a sense of belonging, American Institute junior members constructed stories about science that could unite students from a variety of disciplines and geographic locations. These young enthusiasts developed a distinct scientific culture that valued playfulness and collaboration, one that offered a more unreserved notion of scientific engagement.

The following two chapters evaluate a specific moment when the definition of science was in flux. It traces the genesis of the first science fairs, focusing on the movement's origins in New York City before analyzing how it spread to a national phenomenon over the span of just one decade. In tracing how the fairs originated in nature study and quickly moved to disciplinary distinctions more reminiscent of contemporary science, chapters two and three evaluate how these competitions evolved from a synthetic epistemic culture to the beginnings of an analytic epistemic culture. Shaped by a belief in the formative nature of children's play, adult organizers of the 1930s viewed science fairs as a way to cultivate a scientific habit of mind based on students' own voluntary engagement in science. These young scientists developed a distinct set of virtues that shaped synthetic culture, valuing a holistic view of science based on unity, narrative, expertise, originality, and visual mastery. By the 1940s, however, educators' focus on training a broad citizenry was supplanted by a more meritocratic vision devoted to finding the best and brightest adolescents in order to train them for future careers in science and engineering. This shift fostered an analytic culture that valued individualism, ingenuity, and argumentation.

Toy manufacturers may have initiated the youth movement at the turn of the century, but by the 1930s civic organizations championed the cause. Under the leadership of the American Institute of the City of New York, early children's fairs received enthusiastic endorsement from the School Nature League and American Museum of Natural History as well as other local educational institutions. The pedagogical origins of the first American Institute Children's Fairs stemmed directly from the nature study tradition. As Sally Gregory Kohlstedt has demonstrated, the nature study movement of the late nineteenth and early twentieth century promoted personal experiences with the natural world through careful scientific observation. Its advocates actively organized a national campaign to revise school curricula in order to incorporate student encounters with nature.[122] In this regard, nature study overlapped with broader efforts by progressive educational reformers such as John Dewey to promote hands-on, experimental, scientifically based forms of inquiry in order to train the next generation of democratic citizens.[123]

The science fair movement also developed in tandem with the profound difficulties many students and organizations faced to engage in leisurely pursuits in the shadow of the Great Depression. According to educational leader Morris Meister,

> "In school, too, the depression is beginning to exert an unhealthy influence upon the child. The urge for economy has meant crowded classrooms. Over-burdened teachers can no longer be expected to give as much of themselves as they used to for after-school activities. This is especially true in the teaching of science, where we have seen a serious reduction in the funds needed for the purchase of apparatus; so that experimentation and research on the child level is tremendously inflexible."[124]

Meister argued that the science fair movement served as a means for allowing students to engage in leisurely pursuits of science when classroom learning proved incapable of meeting these demands during a time of financial turmoil. In this regard, the science fair movement expanded in direct reaction to the challenges brought on by the Great Depression.[125]

What were the key tenets of synthetic culture? The first virtue was a belief in the unity of science. In advising students on how to craft their Children's Fair projects,

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[122] Sally Gregory Kohlstedt, *Teaching Children Science: Hands-On Nature Study in North America, 1890-1930* (Chicago: University of Chicago Press, 2010); Sally Gregory Kohlstedt, "Nature, Not Books: Scientists and the Origins of the Nature-Study Movement in the 1890s," *Isis* Vol. 96, No. 3 (September 2005): 324-352; See also Kevin C. Armitage, *The Nature Study Movement: The Forgotten Popularizer of America's Conservation Ethic* (Lawrence: University Press of Kansas, 2009); and Kim Tolley, *The Science Education of American Girls: A Historical Perspective* (New York: Routledge Falmer, 2003).

[123] John Dewey, *The School and Society* (Chicago: University of Chicago Press, 1902); and John Dewey, *The Child and the Curriculum* (Chicago: University of Chicago Press, 1900).

[124] Morris Meister, Radio Talk- WNYC, "The Children's Fair and the Junior Science Clubs Movement," January 18, 1933, American Institute of the City of New York for the Encouragement of Science and Invention Records, 1808-1983, New-York Historical Society (hereafter cited as N-YHS AI) Box 153, Folder 8.

[125] See David B. Tyack, *Public Schools in Hard Times: The Great Depression and Recent Years* (Cambridge: Harvard University Press, 1984).

Agnes Kelly of the American Museum of Natural History instructed, “Every good exhibit must have Unity…The human eye is very fussy about what it chooses to look upon…It demands attraction through color, arrangement, the bizarre, or the unusual.”[126] According to Kelly, aesthetics served as an important part of scientific training, one that aligned closely with clarity of thought and the unity of ideas. Likewise, although the projects were separated by disciplinary category, they were all encompassed under a unified conception of science. According to Morris Meister, “It is almost impossible to classify these achievements into physics, chemistry, biology or nature study. Many of the projects draw their materials from several sciences; some express the spirit and method of scientific inquiry in general; all show the relationship of a specific knowledge of life as we live it today.”[127] In this conception of science, unity mattered more than specificity.

Narrative served as a second, related virtue for science fair projects. Students employed narratives to convey a positivist account of science and its contribution to human progress.[128] Students conveyed science through cohesive narratives that entailed the careful placement of objects, images, and text. Just as science fair displays operated as visual narratives conveying a unified view of science, clubs embraced narratives as a valid medium of scientific expression. The magazines of the American Institute were coauthored and at times even edited by students themselves, serving as critical network

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[126] Agnes G. Kelly, “Points of a Good Exhibit: Children’s Science Fair,” *March of Science* 1, No. 4 (November 1932): 1 (capitalization in original). As Karen Rader and Victoria Cain describe in their forthcoming book, Kelly and her contemporaries at the American Museum of Natural History negotiated the varied (and often conflicting) roles of research, education, and outreach at their institution, conversations that ultimately affected modes of display. See, Karen A. Rader and Victoria E.M. Cain, *Life on Display: Revolutionizing US Museums of Science and Natural History in the Twentieth Century* (Chicago: University of Chicago Press, forthcoming 2014).

[127] Morris Meister, *The Children’s Science Fair of the American Institute: A Project in Science Education* (New York: The American Institute, 1931), 11-12.

[128] Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: University of Chicago Press, 1997), 784-87.

forums for exchanging ideas with other club members and sponsors. Narrative operated as a means for unifying both the youth science movement as well as conceptions of science itself.

In addition to unity and narrative, another major virtue was visual mastery. As Head of Visual Instruction at the New York Teacher Training College, Meister touted the virtues of visual learning, declaring, “The entire movement of Visual Instruction is a recognition of the evils of verbalism in teaching. An increased use of charts, pictures, slides, motion pictures and other illustrative materials is urged, because through them we bring vicarious experiences into the classroom.”[129] Considered a form of expression that coincided with the progressive educational ideal of authentic experience, thoughtful presentation served as a major component to most exhibits. Exhibitors were encouraged to keep labels “brief and to the point,” so that “each booth represents a prolonged experience in science thinking and activity.”[130] These “civilizations in miniature” were synecdochal to lived experience, using visual representation to demonstrate order and scientific habits of thought.[131]

Another key virtue of synthetic culture was a more expansive notion of expertise that included science communication. Not only did students showcase original experiments or homebuilt instruments, but they also conveyed authority by conveying stories to a general audience. This form of relational expertise considered transmitting ideas as a valid form of scientific practice in its own right. Linked to the virtue of observation, performance likewise served as a means for verifying knowledge and for

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[129] Meister, *The Children’s Fair*, 11.

[130] American Institute Press Release, April 25, 1929, American Museum of Natural History Central Archives (hereafter AMNH CA) Box 742, Folder 1268; Meister, *The Children’s Fair*, 24.

[131] The phrase “a civilization in miniature” is borrowed from the newspaper article “Pupils Rob Science of Mystery at Fair” *New York Times*, December 5, 1932. Found in AMNH CA Box 743, Folder 1268.

conveying it to a community of peers. It also encouraged more female participation at a time when science education was increasingly masculinized.[132] Although girls constituted only approximately 20-25% of individual science fair project submissions, they constituted the majority of articles authored by students in American Institute magazines. Likewise, girls constituted around 35-40% of club membership in a given year.[133] By encompassing a notion of scientific expression that included both communication and creative expression, the American Institute programs allowed for a more expansive constituency of students to participate.

These flexible notions of expertise also afforded adolescents more authority. Parents, teachers, and club leaders were encouraged to serve as facilitators who could support children's hobbies. Ultimately, however, adolescents were responsible for managing their own scientific pursuits. They designed and built their own projects, edited club newsletters, wrote jokes and plays, managed their individual prize money, and implemented club rules and constitutions. They also negotiated with adults to secure spaces for performing their hobbies, ranging from kitchen tables to local clubhouses. During the period of early science fairs, students experienced greater freedom for managing their scientific pursuits and forming autonomous communities than they would in subsequent years.

A fourth virtue celebrated by synthetic culture was originality, though the meaning of this term would change for science fairs following World War II. Originality

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[132] Regarding relational expertise, see H. M. Collins and Robert Evans, *Rethinking Expertise* (Chicago: University of Chicago Press, 2007).Regarding the masculinization of science, see Tolley, *The Science Education of American Girls.*

[133] For a more detailed gender breakdown of science fair entries, see Sevan Terzian, *Science Education and Citizenship: Fairs, Clubs and Talent Searches for American Youth, 1918-1958* (New York: Palgrave Macmillan, 2013).

served as an evaluation criterion that judges generally awarded more highly than other categories such as general educational value or clearness of objective.[134] However, the conception of originality was not limited to conducting novel experiments or designing new devices.[135] Rather, educators were more interested in promoting "originality of thought." Innovative modes of presentation were considered an equally valid form of original expression. According to an American Institute guidebook for exhibit displays, "Credit in judging the final product should be given for the devices which show resourcefulness and ingenuity. Original plans for illustrating principles and unique ways of assembling materials should be recognized."[136] Students demonstrated their originality not just through novel ideas or experiments but also through unique modes of presentation.

One of the most important epistemic virtues instilled through science clubs was collaboration. Not only did science clubs submit science fair projects as groups, but they also worked together in cleaning parks and rivers, setting up school museums, and conducting experiments. The American Institute facilitated collaboration by setting up collective meetings for club members. Across New York City, local organizations and businesses also reached out to club members by offering free lectures, tours of laboratories, and educational pamphlets. Perhaps most importantly, club members themselves began building relationships with fellow students through interclub meetings, trading of materials and equipment, and offering advice in club newsletters. These exchanges strengthened the conceptualization of science as an inherently collaborative

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[134] Minutes of Judges and Committees of 1930 Children's Fair, January 27, 1931 N-YHS AI Box 144-2, Folder 16.

[135] That said, several exhibits throughout the 1930s displayed instruments or apparatus that students constructed themselves.

[136] Meister, *The Children's Fair*, 30. Written by Ellis C. Persing, Western Reserve University.

enterprise. Finally, adolescents' distinct approach to science fostered another important epistemic virtue critical to synthetic culture: playfulness. Club members wrote poems, plays, and cartoons because they were fun. As children, they approached science from a position of playfulness with flexible boundaries of what counted as legitimate scientific practice.  Students' writings filled magazine pages with creative submissions ranging from jokes and fun facts to poetry and fictional stories.

The epistemic virtues of unity, narrative, expertise, originality, visual mastery, and playfulness served as underlying values of the synthetic culture of early science clubs and fairs. As the organizers of science fairs encouraged these values, students translated these virtues through their own work by creating dioramic, visually engaging displays. These values also reflected a transitional moment when the fairs were still grounded in progressive educational ideology as well as the tenets of nature study but began shifting towards a more disciplinary-defined notion of science. As the movement nationalized, however, so too did its underlying values. Faced with the onset of World War II, synthesis would soon be supplanted by analysis.

Chapters two and three evaluate the underlying values and practices that led up to this epistemic divide. Chapter two surveys the origins of science fairs by tracing the movement's roots in progressive education and nature study, evaluating why this movement occurred in New York City and the rationale behind the sponsorship by the American Institute of the City of New York. It then evaluates examples of student projects to illustrate the contours of synthetic culture. In analyzing how participants navigated issues such as space, materials, judging, and prizes, it evaluates science fairs as sites of negotiation between adults and adolescents over who held scientific authority. As club participation in chapter three will demonstrate, these values reflected sociopolitical aims of science fair leaders and ultimately determined who participated and for what aims. It argues that the confluence of these forces shaped the formation of a distinct adolescent scientific culture that continued to spread over the course of the twentieth century.

The American Institute Science Fairs of the 1930s served as a transformative, if fleeting, moment when children developed their own notions of the role of science in society. These young scientists developed a distinct synthetic culture that valued a narrative-driven account of science that prized unity, student expertise, originality, and visual mastery. Even as these virtues were eventually superseded by a more analytic account of science, this moment set the stage for establishing a national movement that continued to shape adolescent scientific culture throughout the twentieth century. By constructing stories about science, American Institute science fair participants pushed the boundaries of what counted as scientific during a period of great transition.

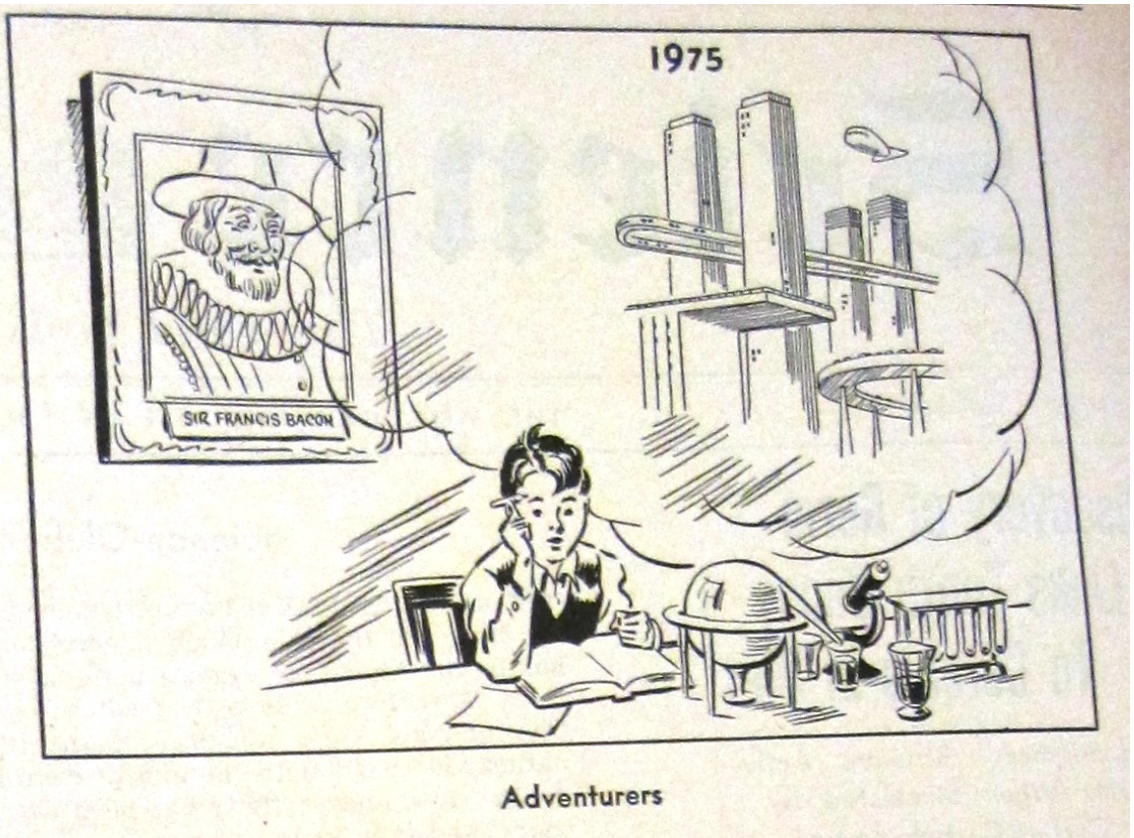

Figure P2.1 “Adventurers” cartoon. Source: *Science Observer* Vol. 1, no. 1 (December 1938): 2.

# CHAPTER 2

## Stories on Display: The American Institute of the City of New York and the Advent of Children's Science Fairs, 1928-1941

At the 1928 First Annual Children's Fair, a boy proudly presented his school's community garden project.[137] The display featured a careful arrangement of tobacco, pumpkins, beets, broom corn, and oats. The crops were grown for "observation and study" and surveyed for their annual yield. The exhibit appeared reminiscent of a typical agricultural display at a local county fair. In reality, it was a submission to the very first science fair in New York City. The only thing more surprising than the agricultural display's affiliation with a metropolitan science fair is the extent that student exhibits would change over the course of one decade. Such nature-inspired displays would become virtually nonexistent at science fairs by the dawn of World War II. This transformation is indicative of the profound changes in extracurricular science during the 1920s and 30s. Though nature study championed children's interaction with natural world at the turn of the century, it was soon supplanted by an emphasis on disciplinary distinctions more reminiscent of contemporary science fairs. As a hub of progressive science education, New York City would become a model of extracurricular engagement that the rest of the country would emulate. Chapter two traces the genesis of the first science fairs, offering a careful investigation into how this local phenomenon transformed

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[137] The original image of the 1928 agricultural exhibit can be found in N-YHS AI Box 141, Folder 6.

into a national movement. It first analyzes why the fairs began in New York City as well as the rationale behind the American Institute in initiating the fairs. It then illustrates how the nature study movement inspired the first fairs before the movement quickly shifted to a focus on scientific fields such as biology or physics. It offers a careful evaluation of the form and content of children's projects to consider the ways in which the fairs aligned with broader progressive goals in training scientifically minded citizens. In analyzing the material, spatial, and social domains of children's engagement, it considers the process of negotiation between children and adults in vying for authority. Finally, it analyzes the transformation of science fairs on the eve of World War II, when the goals of national security would introduce new cultural values that undermined the virtues of synthetic culture.

## New York City and Adolescent Culture

The fact that the science fair movement came out of New York City was no accident. As a city that boasted world class universities, museums, and civic organizations, New York was uniquely equipped to provide a network of institutional support for exposing children to science outside of the classroom. The city also developed elite public high schools specializing in science and technology such as Stuyvessant High School, Brooklyn Technical High School, and the Bronx School of Science. Not only were these schools among the most active in the early science fair movement, but they continued to be the best represented schools in national science competitions over the course of the twentieth century.

New York was also home to an enclave of immigrants where a second generation of young people was coming of age in the 1920s and 30s. By taking part in a thriving youth culture, these urban youngsters helped solidify adolescence as an identity separate from childhood on the one hand, and adulthood on the other. Historians have argued that the concept of adolescence itself was fundamentally shaped by these urban children of immigrants, who stood at the precipice between being old enough to take part in commercialized leisure but still too young to marry.[138] As adolescents engaged in popular amusements such as dance halls or nickelodeons, adults became more concerned about controlling their leisure time through purposeful play. The impulse to control leisure time served as one pedagogical underpinning for implementing the fairs. Science fair founder C.L. Hutchins noted, "Leisure is not far removed from science. The two are inseparable…Science has made our leisure. And it is going to increase it steadily. We are now aware of the fact that it is not only the child's after-school-hours which must be properly supervised, but it is the child's after-school-hours with relation to the outside-of-work-hours of the man he will be."[139] Hutchins argued that not only was leisure directly connected to scientific advancements, but it was fundamental in shaping the future character and work ethic of adolescents.

Morris Meister, who in Chapter 1 was instrumental in evaluating the effects of consumer toys on children's learning, also played a key role in developing the science fair movement and agreed with Hutchins's assessment of purposeful leisure. As head of the Science Department and Visual Instruction at the New York Teacher Training College, Meister advocated the importance of leisure time to a progressive educational agenda, and helped spearhead the growth of the youth programs offered by the American

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[138] See, for instance, Sarah E. Chinn, *Inventing Modern Adolescence: The Children of Immigrants in Turn-of-the-Century America* (New Brunswick: Rutgers University Press, 2009).

[139] Press Release, "Children's Fair Discussed at Garden Club Conference," 1933. N-YHS AI Box 154, Folder 10.

Institute.[140] According to Meister, “To the pupil, out-of-school time has always been and still is the period of freedom par excellence…His greatest activity and his greatest enthusiasm still center around the extra-curricular where are to be found problems of his own choosing and ideas born of his own inner urgings.”[141] Meister was particularly interested offering extracurricular options to adolescents. For guidance, Meister turned to the work of psychologist G. Stanley Hall, whose conceptualization of the “club instinct” and the “gang age” supported Meister’s belief that adolescent students needed to direct their focus towards collaborative, productive activities.[142] Indeed, American Institute officials were just as inspired by offsetting threats of juvenile delinquency as they were by encouraging scientific pursuits.[143]The fairs benefited from not just a thriving adolescent culture but also a citywide institutional infrastructure with the capacity to facilitate the competitions. It would be the elite learned society of the American Institute, however, that would ultimately champion the cause.

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[140] Morris Meister, *Children’s Science Fair of the American Institute: A Project in Science Education* (New York: The American Institute, 1932), Introduction.

[141] Morris Meister, “The Educational Value of Certain After-School Materials and Activities in Science.” Ph.D. Diss., Columbia University, 1921, 2.

[142] Meister, “The Educational Value,” 153. See also G. Stanley Hall, *Adolescence,* 2 Vols. (New York: Arno Press, 1969 reprint from 1904 edition).

[143] During a planning committee meeting, members argued that one of the biggest benefits of guiding student leisure time was keeping children busy and off the streets. The focus on curbing juvenile delinquency coincided with a request from Commissioner Henrietta S. Additon of the New York Police Department Crime Prevention Bureau to partner with the American Institute in developing youth programs. Additon was interested in working with the Institute to establish science clubs for children in the different precincts as measures for the prevention of juvenile delinquency. In 1933 the Institute held eight meetings for police officers to instruct them on the benefits of science clubs with the hope of establishing a long-term relationship with the Bureau. Although the relationship did not develop much further after the courses ended, it reflected the interest of the Institute in using youth activities as a mechanism for controlling adolescent behavior and grooming them into productive citizens. See Planning Committee Minutes, N-YHS AI Box 151-1, Folder 1; N-YHS AI Box 163, Folder 2. See also Sarah E. Chin, *Inventing Modern Adolescence*; Paula S. Fass, *Outside In: Minorities and the Transformation of American Education* (New York: Oxford University Press, 1989); and Kathy Peiss, *Cheap Amusements: Working Women and Leisure in Turn-of-the-Century New York* (Philadelphia: Temple University Press, 1986).

## From Learned Society to Civic Organization: The American Institute

Children's science fairs originated from a long tradition of encouraging scientific and industrial advancement by The American Institute of the City of New York for the Encouragement of Science and Invention. The American Institute was a learned society incorporated in the early nineteenth century to promote industrial development. In 1828, area leaders and entrepreneurs met in Tammany Hall and organized the American Institute "for the purpose of encouraging and promoting domestic industry in this State and the United States in agriculture, commerce, manufactures and arts, and any improvements made therein."[144] In 1828, the American Institute held its first annual fair to showcase developments in agriculture and manufacturing. It proved so popular that organizers extended the exhibition by two days in order to satisfy the demand of nearly 20,000 visitors.[145] One year later, the American Institute was chartered by the legislature. Over the course of the nineteenth century, the American Institute became a prominent advocate of scientific and industrial development, supporting the first geological survey of New York, endorsing legislative efforts for building the Erie Canal, advocating an amendment to patent law to provide greater protection to inventors, and organizing one of the first agricultural societies in the state of New York.[146] Its fairs featured such innovations as the Francis metallic lifeboat, Morse telegraph, McCormick reaper, Singer sewing machine, Bell telephone, and the Remington typewriter. [147]

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[144] American Institute, *Official Index of the Sixty-Fifth American Institute Fair, Madison Square Garden, New York, September 28th to October 29th, 1896* (New York: American Institute, 1896), 11. New York Public LibraryCollection (hereafter cited as NYPL)..

[145] American Institute, *Report of the American Institute in the City of New York on the Subject of Fairs,* 2nd Ed. (New-York: J. Seymour, 1829), NYPL.

[146] Frederic William Wile, ed., *A Century of Industrial Progress*, 1st edition (Garden City: Doubleday, Doran & Company, Inc, 1928), NYPL.

[147] Edwin Forrest Murdock, "The American Institute," in *A Century of Industrial Progress,* v-xvi.

By the turn of the twentieth century, however, popular interest in the fairs began to wane. Faced with a declining membership and overextended budget, the American Institute sought to redefine itself. In an attempt to attract new members, in the early 1920s it established an "Inventors' Section," which featured an exhibition of inventions. A disappointing turnout of 100 new members joined as a result of the new campaign. The Institute's implementation of a Flower, Fruit, and Vegetable Show proved more successful in attracting the general public, setting an important precedent for the preliminary nature-focused children's fair.[148] Ultimately, however, shifting its attention towards science proved the most viable solution for the institutional identity crisis.

After conducting a survey on how to best serve its constituents, American Institute officials concluded that the most important developments in industry were occurring not in inventors' workshops, but in the laboratory. *A Century of Industrial Progress*, a 1928 publication created in honor of American Institute's hundredth anniversary, laid out its new mission:

> "It is obvious that these results of the research laboratory must be periodically brought to the attention of the public….It would seem to be the work of the Institute to introduce these results of the research laboratory to the public, thus continuing the work which has always been its 'raison d'être' from inception. Certainly it is a job to be done, and where is there to be found an organization better fitted than the American Institute!"

In 1928, two members of the local scientific community, H.H. Shelden, a Professor of Physics at NYU and science editor at the *New York Herald Tribune* and L.W. Hutchins, a public relations executive, proposed a new purpose for the organization: "To focus the attention of the industrial public on science and scientific research, and to explain to the

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[148] American Institute, *Ninety-fifth Annual Report of the American Institute of the City of New York for the Year Ending January 16th, 1924* (New York: American Institute, 1924), 5-7.

intelligent public the current achievements of science."[149] After losing its footing as an elite learned society, the American Institute began developing a new organizational identity in educating the public about scientific developments.

Creative partnerships with local organizations not only helped shoulder the financial burdens of running the fairs, but they also directly shaped the fairs' focus on children and nature study. Throughout New York City, scores of organizations worked towards introducing nature study to children. The American Museum of Natural History (AMNH) in particular served as a leading institution in promoting children's engagement with the natural world. Since the turn of the twentieth century, AMNH supplied schools with collections, programs, and exhibits to aid in nature study. They also implemented free admission to school groups. In 1904, for instance, approximately 45,000 children engaged in educational programs at the museum, and additional 200,000 children examined specimens loaned by the museum to local schools.[150] The museum also distributed pamphlets to teachers requesting nature study materials, making it one of the premier organizations driving the nature study movement not just in New York City, but across the country.[151] The nature study room of the museum was co-coordinated by the School Nature League (SNL), a local organization dedicated to fostering nature education in public schools (fig. 2.1). Its founder, Alice Rich Northrop, a former biology teacher at Hunter College, organized the SNL as a way to engage urban children with plant, animal, and flower specimens for firsthand study. Under the leadership of Marjorie Coit, during

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[149] Quoted in Sevan G. Terzian, *Science Education and Citizenship: Fairs, Clubs, and Talent Searches for American Youth, 1918-1958* (New York: Palgrave Macmillan, 2013), 22.

[150] Sally Gregory Kohlstedt, *Teaching Children Science: Hands-On Nature Study in North America, 1890-1930* (Chicago: University of Chicago Press, 2010), 65-66.

[151] Grace Fisher Ramsey, *Project Making in Elementary Science* (New York: School Service Ser. and American Museum of Natural History, 1934), 4.

the 1920s SNL worked with school children at AMNH to encourage them to develop their own collections and exhibits on nature.[152]

Marjorie Coit worked with George H. Sherwood, Director of AMNH, to develop a fair that would feature nature study projects created by students across the city. In a letter to the American Institute, Sherwood expressed hope that the exposition would "add to the study of nature in the schools."[153] In partnership with AMNH and SNL, the American Institute, led by Hutchins, agreed to work together to establish a "Children's Fair." They decided that the American Institute would direct the overall fair and provide the prizes. In exchange, the SNL would coordinate the exhibits, and the AMNH would provide space in its Education Hall for holding the fair.[154]

The American Institute held its first Children's Fair in 1928 to a crowd of approximately 35,000 spectators. The annual Children's Fairs proved so popular that in 1932, despite facing financial strains brought on by the Great Depression, the American Institute expanded its youth offerings by initiating the Junior Science Clubs program.[155] By the spring of 1933, 118 clubs across New York City had registered. Members enjoyed taking courses at local museums, listening to Christmas lectures by professional scientists, and performing demonstrations at Science Congresses before audiences of their peers. In 1938, Westinghouse Electric and Manufacturing sponsored the American Institute youth programs, facilitating its expansion to enlist clubs from across the country. Although the Children's Fairs did not survive after Westinghouse pulled its financial

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[152] American Institute Press Release on Children's Fair, October 18-21, 1929. AMNH CA, Box 742, Folder 1268.

[153] Letter to Dr. Gustave Straubenmuller, July 3, 1928. N-YHS AI Box 140 Folder 9.

[154] William J. O'Shea, Superintendent General Circular No. 4, September 13, 1928. AMNH CA, Box 742, Folder 1268.

[155] "Institute's Children's Fair is 99th Annual," *Centurian of the American Institute* 1, no. 1 (October 1928): 9. N-YHS AI Box 468.

support in 1941, the American Institute served as the primary institutional vehicle for initiating a national network of science clubs and competitions, with programmatic descendants including the Science Talent Search, Science Clubs of America, and National Science Fair.[156] The push for focusing on children came not just from the American Institute, but it also tapped into a network of organizations that identified with the goals of educational reformers and made a concerted effort to align extracurricular activities with progressive pedagogy. Their goal was to complement formal curriculum but also remain sufficiently different from classroom studies to provide students with enough flexibility to nurture their individual talents and latent interests.

## **The Children's Fair and Nature Study**

The pedagogical origins of first American Institute Children's Fairs stemmed directly from the nature study tradition. As Sally Gregory Kohlstedt has demonstrated, the nature study movement of the late nineteenth and early twentieth century promoted personal experiences with the natural world through careful scientific observation. Its advocates actively organized a national campaign to revise school curricula in order to incorporate student encounters with nature.[157] In this regard, nature study overlapped with broader efforts by progressive educational reformers such as John Dewey to promote hands-on, experimental, scientifically based forms of inquiry in order to train the

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[156] For the history of these later programs, see Terzian, *Science Education and Citizenship;* Joseph Berger, *The Young Scientists: America's Future and the Winning of Westinghouse* (Reading, MA: Addison-Wesley, 1994).

[157] Kohlstedt, *Teaching Children Science*; Kohlstedt, "Nature, Not Books: Scientists and the Origins of the Nature-Study Movement in the 1890s," *Isis* Vol. 96, No. 3 (September 2005): 324-352; See also Kevin C. Armitage, *The Nature Study Movement: The Forgotten Popularizer of America's Conservation Ethic* (Lawrence: University Press of Kansas, 2009); and Kim Tolley, *The Science Education of American Girls: A Historical Perspective* (New York: RoutledgeFalmer, 2003).

next generation of democratic citizens.[158] These reformers were particularly interested in exposing urban youth, particularly children of immigrants, to rural America by promoting agriculture through school gardens, nature rooms, and field trips. In this regard, exposure to nature was not just achieving pedagogical aims, but it was considered part of the broader American ethos.

Although by the 1930s nature study diminished in prominence within formal education, New York City organizations continued to carry on the tradition. Early Children's Fairs received enthusiastic endorsement not only from the School Nature League and AMNH but also the New York Botanical Garden, School Gardens Association, Woodcraft League, National Plant, Flower, and Fruit Guild, Brooklyn Children's Museum, Boy Scouts, and Girl Scouts.[159] Periodicals like the *Nature-Garden Guide* provided New York teachers with additional guidance for nature education. Published by the School Garden Association of New York, its mission was "a garden for every child."[160] Teachers created curricula that embraced measures such as creating nature study rooms, collecting specimens, and growing school gardens.[161]

Funding served as another factor for the fair's emphasis on nature study. The Department of Agriculture and Markets provided financial assistance to county fairs across the state of New York, including the Children's Fair. It judged the merit of each application "based upon its contribution to the promotion of agriculture and domestic

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[158] John Dewey, *The School and Society* (Chicago: University of Chicago Press, 1902); John Dewey, *The Child and the Curriculum* (Chicago: University of Chicago Press, 1900).
[159] Letter from R. M. Jolliffe to Marjorie Coit, July 5, 1928. N-YHS AI Box 141, Folder 1.
[160] "Nature Garden Guide," October 1929. N-YHS AI Box 142, Folder 5.
[161] For more on nature study in urban environments, see Kohlstedt, *Teaching Children Science*, especially chapter three, "Framing Nature Study for the Cities," 59-76.

arts."[162] Supplementing the financing of the American Institute, the funding was dedicated primarily to providing prize money to exhibitors. Although the Children's Fair was a departure from traditional county fairs, commissioners of the Department of Agriculture and Markets understood that the urban environment of New York City necessitated a different method in attracting diverse audiences, particularly women and children. The representatives from the Department ranked the 1928 Children's Fair among the best in the state and stated that "the fair was a worthy one from the standpoint of encouragement given to the New York City school children to study and live nature in her many aspects."[163] Approaching the fairs as explorations in nature study, then, helped garner support from a key funding source that traditionally promoted agricultural expositions.

The fact that the nature study movement thrived in New York City was due to not only strong support by local institutions, but also concerns over the urban environment. Educational reformers aimed at equipping local children with a love of nature in order to offset the challenges of urban living in areas such as health, sanitation, and nutrition. The urban environment, coupled with crowded classrooms and oppressive administrative oversight, presented unique problems for teachers. Meister lamented the challenges of integrating a pedagogy focused on offering authentic "realms of experience" within the city. In his assessment of local science curriculum, Meister noted that students received instruction in nature study during the first six grades. However, teachers often lacked equipment and expertise to run their courses effectively. Whereas boys often continued to

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[162] Letter from State of New York Dept of Agriculture and Markets to Agricultural Societies, 1928, N-YHS AI Box 140, Folder 9.

[163] Letter from Assistant Commissioner C. P. Norgord to O. H. LaBarre, April 22, 1929. N-YHS AI Box 141, Folder 7.

take classes in science beyond elementary school, girls were relegated to courses in cooking and sewing. Physical science courses were an integral part of the curriculum in some schools, but they were noticeably absent in others. Meister was also dismayed that 85% of students who entered teacher training colleges had no exposure to the physical sciences.[164] Perhaps the worst deficiency, however, was the fact that the "the experiences are not real; they do not reflect the life of the city boy and girl."[165] Meister believed that the curriculum needed to reflect students' actual daily encounters in the world in order to successfully integrate nature study into their broader understandings of society.

Meister reflected a broader belief that nature study was not just an integral part of science education, but aligned with progressive goals in training citizens. Progressive educators believed that school was not just a place for learning about future expectations of adulthood, but should serve as an integral part of students' life experiences. They argued that the more that education integrated with daily routines, the more likely students would be able to produce broader generalizations about their environment and generate productive habits of thought. Aligning with Dewey's conception of education, it encapsulated a belief that learning should reflect society itself. Although education should ideally incorporate children's experiential learning seamlessly into the curriculum, Meister recognized that classroom often fell short of achieving these goals. Meister and his contemporaries at the American Institute proposed that extracurricular activities could fulfill the pedagogical gap between classroom learning and children's life experiences.[166]

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[164] Meister, *The Children's Fair*, 9-10.
[165] Meister, *The Children's Fair*, 10.
[166] Meister, "The Educational Value," 1.

The Children's Fair embodied progressive educational aims by offering an experiential form of instruction through the "project method."[167] The School Board of the City of New York enthusiastically endorsed the Children's Fair, claiming that the next generation would be better equipped to lead successful lives by adopting the ability "to acquire and foster that most desirable and productive quality—'the scientific habit of mind.'"[168] It was through learning by doing—the ability for children to engage in scientific inquiry on their own terms—that appealed to progressive educators. By providing children with opportunities to crystallize their own ideas, educational reformers hoped the fair would encourage children to serve as productive, scientifically minded citizens.

Coordinators of the science fair movement were not unique in trying to shape children's play to cultivate a scientific habit of mind. Across the country, Junior Academies of Science sprung up around the same time as the American Institute's children programs.[169] 4-H programs in agriculture and home economics had existed since the turn of the twentieth century under the slogan, "learn by doing."[170] Boy Scouts and Girl Scouts similarly promoted children's camaraderie and emphasis on character building. Starting in 1933, optical manufacturer Bausch and Lomb offered science scholarships to high school students demonstrating aptitude in science. From 1930 to

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[167] William Heard Kilpatrick developed the notion of the project method, which proposed that students guide their own learning based on their individual interests. See Michael Knoll, "The Project Method: Its Vocational Education Origin and International Development," *Journal of Industrial Teacher Education* 34, No. 3 (Spring 1997), http://scholar.lib.vt.edu/ejournals/JITE/v34n3/Knoll.html.

[168] Meister, *The Children's Fair*, 26. Excerpt written by Hugo Newman, Principal, New York Teacher Training College.

[169] Ed. M. Brogie, "History of High School Science Research in Junior Academies Associated with NAAS and "Affiliated Academies of Science and Other Science Promoters," (Unpublished manuscript, August 3, 2011), Microsoft Word file.

[170] Thomas Wessel and Marilyn Wessel, *4-H: An American Idea, 1900-1980, A History of 4-H* (Chevy Chase, MD: National 4-H Council, 1982).

1968, the Fisher Body Craftsman's Guild invited teenage boys to participate in a model-making contest for General Motors. Toy manufacturers also sponsored their own competitions. As Chapter 1 discussed, in 1915 A.C. Gilbert started a competition for best Erector set design; the first prize winner received a full-sized car.[171] Other contests also emerged for "Best Chemist" and "Expert Engineer" based on constructing experiments or models based on children's kits.[172] Although diverse in aims and motives, these programs shared a common interest in shaping the character of children through offering experiential learning.

## **From Nature Study to Science**

The first annual Children's Fair in 1928 encapsulated a distinct interest in agriculture and nature study. It featured dozens of categories ranging from topical entries in trees or mammals to thematic categories such as conservation or biological principles. Both elementary aged and older children were encouraged to apply for prizes ranging from $100 for first prize group entries to $3 to $10 prizes for individual exhibitors. According to a promotional flyer, the Children's Fair was designed to feature "exhibits which illustrate the work of New York City children in gardening and agriculture, and in nature study" for the purpose "that conservation of our natural resources may be understood and appreciated."[173] In this regard, the earliest Children's Fairs more closely resembled traditional agricultural expositions than contemporary science fairs.

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[171] Bruce Watson, *The Man Who Changed How Boys and Toys Were Made* (New York: Viking, 2002), 54, 59.

[172] Ruth Oldenziel, "Boys and Their Toys: The Body Craftsman's Guild, 1930-1968, and the Making of a Male Technical Domain," *Technology and Culture* 38, no. 1 (January 1997): 60; "Chemistry Will Win the War," *Boys' Life*, December 1942.

[173] American Institute Children's Fair brochure, 1928. N-YHS AI Box 140, Folder 4.

Early on, however, fair organizers began to question the extent to which the fair should be devoted to nature study. During a planning committee evaluation of the 1929 fair, public school educator and fair planning committee member Dr. Van Evrie Kilpatrick declared that "they must decide if the Fair is to be an agricultural, horticultural, or gardening Fair or one of the natural sciences. The two best exhibit weeks for schools are the first week in December and the last week in May; for gardens, first week in September or last week in August. If natural science is a dominant motif, it should be in one of the proper weeks."[174] The committee ultimately decided to hold the 1930 fair during December, demonstrating a distinct preference for the timing of natural science projects rather than the months that aligned best with agricultural displays.[175]

Planning committee members reaffirmed the promotion of science by changing the name of the fair. In evaluating the projects of the earliest fairs, members lamented the lack of skill in categories such as chemistry and physics in comparison to areas focused on nature study. In 1931, they approved a name change from "Children's Fair" to "Children's Science Fair." According to Meister, "this change helped to direct attention to the Fair as a means of science education."[176] The earliest fairs featured a wide array of categories including mounted insects, inventiveness in the home, school gardens, and park and roadside conservation. By 1932, the Children's Science Fair featured just ten categories, keeping older classes such as plants and animal life but also adding new fields such as physics, chemistry, and the history of science. Biology, however, remained the most popular category with approximately 30% of science fair entries between 1932 and

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[174] Summary of Children's Fair, 1929, N-YHS AI Box 141-1 Folder 1.

[175] School Nature League Children's Fair Committee meeting minutes, ca. 1930. N-YHS AI Box 141 Folder 1.

[176] Quarterly Meeting, May 7, 1931. N-YHS AI Box 144, Folder 1; Morris Meister, Report on the 1931 Children's Fair, 1931. N-YHS AI Box 144, Folder 5.

1937, followed by Physics at 23%, Industries at 12%, Astronomy at 11%, Chemistry at 9%, Health and Conservation at 8%, History of Science at 5%, and Energy at 1%.[177] With these changes, the newly named Children's Science Fair took a marked departure from more traditional nature study and agricultural expositions.

The turn towards science reflected two changing priorities. First, the American Institute began taking an even more prominent role in the planning and coordination of exhibits, isolating partners who focused more on nature study. Marjorie Coit, the Director of the School Nature League and cofounder of the children's fairs, fell ill in 1931 and could no longer carry on her work. By 1932, the School Nature League Board of Directors decided that they could no longer financially support the Children's Science Fair.[178] The disintegration of this partnership not only reflected the waning in prominence of nature study, but it also alienated the few female leaders who helped plan the fairs. The new disciplinary focus on science further masculinized the movement, both in terms of content areas and leadership.

The second shift was an appeal to older children. Planning organizers believed that adding the word "science" to the title would attract more junior and senior high school students who regarded the word "children" as too juvenile. Nature study was traditionally part of elementary curricula. By shifting the focus to physical sciences and biology, the organizers focused more on the coursework of older students. From 1930 to 1931, entries from elementary school students declined, whereas overall entries from junior and senior high school students increased (Table 2.1). In 1932, the American Institute also implemented the science club program, limiting membership to junior and

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[177] Percentages based on data from Terzian, *Science Education and Citizenship.*
[178] Letter to A. Cressy Morrison, June 15, 1931. AMNH CA Box 743, Folder 1268.

senior high school students. It was clear, then, that a shift towards science was perceived as a way to foster adolescent engagement.

Not everyone approved of new the emphasis on science. Kilpatrick asked students in his "Nature Education" class at Hunter College whether the exhibits were sufficiently representative of nature, with seven respondents replying "yes" and twenty respondents replying "no." Kirkpatrick lamented the decrease in elementary school participation, a sentiment shared by several teachers. Although no one openly questioned the loss of female authority that coincided with the decline in nature study, Executive Committee member Doris Spier Harman believed that the School Nature League, a group run predominantly by women, was not given due credit for its contributions to the fair.[179] Regardless of these complaints, the Children's Science Fair continued to focus more on general science than nature study or agriculture. As the focus of the fairs shifted, the content of children's displays changed accordingly.

## **Exhibiting Synthetic Culture**

Although the children's science clubs and fairs were quickly moving away from a specific focus on nature, they were still grounded in many of the values of the progressive nature study tradition. These fairs promoted a broader visual education in order to cultivate purposeful, aesthetic observations of the natural world. In his speech on "Pure Science" at the American Institute, behavioral scientist Dr. Ralph Gerard declared, "Science, like art, contains the beautiful and offers every more riches to him who penetrates its terrain from the frontier of dilettante interest to the hinterland of research

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[179] Children's Fair Executive Committee meeting minutes, January 13, 1932. N-YHS AI Box 150, Folder 2.

advance."[180] In his assessment of visual education, Gerard linked beauty to the purity of science, declaring aesthetic training to be an essential, elevated form of scientific inquiry. Although science fair projects differed topically and in approach, they conveyed science through a visual narrative, weaving together a unified story. Science fair officials believed that vivid reconstructions of the natural world could supplant actual physical encounters in nature, providing a form of virtual witnessing that aided visitors both in visual observation and scientific reasoning.[181] Early Children's Fair projects appropriated these dioramic forms of display to capture visual interest through the careful arrangement of objects. Building upon Victorian museum traditions of what Steven Conn calls an "object-based epistemology," students situated their exhibits within a broader visual context in order to convey a story.

The science fairs carried latent values regarding the very meaning of science itself. Ellis Persing, a researcher at Western Reserve University, conducted a study of the 1931 fair and developed a list of guiding principles underlying the exhibits. First, Persing argued that the exhibits should reflect the pedagogical aims of teaching and "should be in harmony with the philosophy and psychology of education." In this regard, Persing believed that these activities should be seamless with the overall goals of the regular curriculum. Persing also argued that group exhibits should offer opportunities for all pupils to participate, exhibits should reflect everyday life, and that "displays should be organized to tell a story to interpret the materials shown."[182] The very notion of science,

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[180] Ralph W. Gerard, "The Role of Pure Science," Address presented at the American Institute, January 11, 1938. Reprinted in *American Institute Monthly* 2, no. 5 (February 1938): 8-15.

[181] Victoria Cain, "'The Direct Medium of the Vision': Visual Education, Virtual Witnessing and the Prehistoric Past at the American Museum of Natural History, 1890-1923," *Journal of Visual Culture* 9, no. 3 (December 2010): 289.

[182] Meister, *The Children's Fair*, 29-30. Written by Ellis C. Persing, Western Reserve University.

then, supported the underlying aims of progressive education and nature study by promoting collaboration, connections to lived experience, and narrative-based interpretation. Persing's guidelines offer a useful lens for evaluating students' science displays. This section evaluates how the progressive values of the early fairs coalesced to create a distinct youth culture during the 1930s. Through an analysis of sample science fair projects, it analyzes the ways students conveyed scientific evidence and highlights several key principles that the American Institute science fair projects embraced. In evaluating these value systems, it demonstrates how both the vision of fair organizers and the practices of students themselves contributed to a shared set of beliefs over what counted as legitimate scientific expression. These values underpinned the synthetic culture of the 1930s.

Most projects presented science as unified and all encompassing. In the exhibit "Coalville," students from Public School 205 in Brooklyn provided a comprehensive display of the coal mining industry (fig. 2.2). The exhibit featured not just the operation of mechanical equipment in the coal mining industry, but also offered scenes of a mining community through the detailed recreation of a coal mine, elevator shaft, company coal office, worker huts, and a general store. The students constructed the exhibit at their school workshop by using soap for coal cars, an Erector Set for houses, and newspaper, flour, water, and sand for the terrain. A loose-leaf book titled "A Short Story about Coal" complemented the visual display.[183] As part of the exhibit category "Industry, Mining, and Farming," the display won first place by applying scientific modes of thought to provide a comprehensive synthesis of the mining industry. Its emphasis was less on

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[183] Marjorie C. Coit, ed., *Projects in Science and Nature Study Shown at the American Institute Children's Fair, 1930* (New York: American Museum of Natural History, 1931), 20-22.

demonstrating scientific principles than on the practical uses of science and its pervasiveness in daily life.

The dioramic displays also conveyed positivist accounts of science and its contribution to human progress. According to a 1934 project guidebook published by AMNH, "Let the boys and girls always keep in mind the necessity of arranging their materials in such a way that they will be not merely a collection, but will tell a story that is both interesting and true."[184] When Manfredi Bottaccini submitted his project description on the history of radio broadcasting, he stated that his exhibit was designed to show "how radio broadcasting began years ago with a leyden jar and progresses to television today." In the corresponding diagram, Bottacini proposed to incorporate an illuminated sign to capture viewers' attention, situate models at the center of his exhibit to show progressions in radio innovations, and text at the bottom of his display to provide further information.[185] As with "Coalville," the textual description was subservient to the visual display, and the exhibit conveyed a holistic story regarding an underlying theme. In presenting the narrative of radio broadcasting as a steady progression of modern technical marvels, Bottacini reinforced a positivist account of science that engendered an inherent faith in its ability to improve daily life.

Student project proposals frequently touted visual mastery when describing their exhibits. Max Benkin of James Madison High School proposed to demonstrate man's conquests of the sky and the ocean by featuring the accomplishments of explorers William Beebe and Auguste Picard.  Using a box, cardboard, paper, two half spheres, wire, and a blue balloon, Benkin created models of Beebe's bathysphere plunging two-

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[184] Fisher Ramsey, *Project Making*, 17

[185] Manfredi Bottaccini, project description. N-YHS AI Box 193, Folder 11.

hundred feet under the sea and Picard's gondola flight towards the stratosphere.[186] Rather than recreating the experiments of the explorers or challenging their findings, Benkin opted to present the explorers' accomplishments through a miniaturized three-dimensional reconstruction. Benkin's project, along with those of many other students, embodied a belief that proper visual presentation counted as scientific expertise in its own right.

The purpose of the fairs was not just to promote visual literacy for participants, but also for visitors viewing the expositions. According to one planning committee member, "The work done may be of great value to the child who made it, but unless it shows some story, idea or principle to those seeing it, it does not have exhibit value."[187] The planning committee considered ways to help the public understand what they should look for when viewing the exhibits. The committee developed guide sheets and treasure hunts to "help children observe the Fair more intelligently."[188] These guides called on students to locate exhibits that featured phenomena such as how glaciers moved, the principles behind air pressure, or how soils are formed. The guides asked age-specific questions such as "Are you a good citizen? How can you help keep your park like the pretty ones here?" for elementary students and "Forest conservation- need a pupil in New York City be interested in this problem? Why?" for high school-aged visitors.[189] These questionnaires were intended to train students in the proper techniques of observation as a means for learning not just scientific principles, but proper modes of conduct as engaged citizens.

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[186] Max Benkin, project description, November 8, 1933. N-YHS AI 157, Folder 1.
[187] 1929 Children's Fair report, ca. 1929. N-YHS AI Box 141, Folder 1.
[188] 1931 Children's Science Fair report, ca. 1931. N-YHS AI Box 141, Folder 1.
[189] Meister, *The Children's Fair*, 21-23.

Some exhibits built upon a common theme for early science fair exhibits—that of the educated consumer. Indeed, how children would enter the consumer marketplace was considered part and parcel to scientific training deemed necessary to fulfill their responsibility as educated citizens. Twenty pupils of the Science Fair Club in Bronx, N.Y. whose ages averaged 13 years old, won first prize for their exhibit entitled "How My Lassie Got Her Clothes." The display featured six vignettes on the origins of clothing, including a cotton plantation in Georgia, Japanese silkworms, Brazilian rubber plantation, and Texan cattle ranch (Fig. 2.3). The doll "Lassie" was situated in the center with cards pointing to the material origins of each garment.[190] The project conveyed comprehensive knowledge of the geographic origins of textiles as well as cultural differences in the production of the raw materials. Likewise, in a cartoon published in a science club magazine (Fig. 2.4), a car salesman attempted to sell a vehicle to a father, and his son responded, "I am taking Chemistry in high school and I can't see it from a fundamental and basic standpoint." According to the men in the background, "They have to sell the boy or the man won't buy."[191] This cartoon demonstrated a faith in adolescent scientific reasoning to make informed consumer decisions. The nature of expertise at science fairs was not limited to being a practitioner of science, but also encompassed the effective communication of scientific ideas to a general audience through what Harry Collins and Robert Evans classify as interactional expertise. Science fair prizes rewarded not just originality but also general educational value, clearness of objective, accuracy of information, general attractiveness, and effective presentation of material.[192]

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[190] "$2,124 Won by Students," *Science Observer* 2, no. 5 (July 1940): 14. N-YHS AI Box 468.

[191] Reprint by McClure Newspaper Syndicate, *Science Leaflet* 13, no. 15 (Jan 10, 1940): 39. N-YHS AI Box 468.

[192] Coit, *Projects in Science,* 6.

The presentation of the display itself was considered another form of scientific knowledge. Students conveyed originality through a careful placement of objects, images, and text. Five members of the Flushing High School Biology Club developed an innovative display showing the effects of deforestation caused by fire and careless lumbering. Before labeling the diorama, students drenched the model hills of the display with water to demonstrate how the bare hill washed away and flowed into the bed of a nearby stream. The fact that the exhibit display helped students assess the effects of water on a microscale secured the exhibit special recognition from the fair judges. Exhibits that employed unconventional display techniques or use of materials were also considered valid forms of original expression.

Science fair projects conveyed scientific authority by presenting unified narratives about the benefits of science to human society. Whether negotiating the complexities of consumer goods or demonstrating skilled observation, these projects conveyed a more flexible notion of expertise. Other virtues such as narrative, positivism, and aesthetics served as the underpinnings of synthetic culture. These values also reflected a transitional moment when the fairs were still grounded in progressive educational ideology but began turning towards a notion of science defined more by discipline than by nature.

## Negotiations over Fair Expertise

Just as the epistemic virtues of early science fairs were shaped both by organizers and student participants, discussions regarding other logistics such as the proper use of materials, space, and prizes were constant issues of negotiation between juveniles and their adult counterparts. Whereas organizers at the American Institute touted the fair as an opportunity to celebrate students pursuing science based on their own volition, they also maintained careful control over how children's work should be evaluated. The following section provides a close examination of the materials, spatial parameters, judging requirements, and allocation of prize money to reveal the ways in which students and adults negotiated the norms and standards of science fairs and, ultimately, who held scientific authority.

Although many of these negotiations took place directly between fair organizers and student participants, teachers and club sponsors often served as key brokers in the process. Every fair project required the signature of an adult teacher or sponsor authorizing permission. Adult advisors also received recognition for the success of their students through announcements in American Institute newsletters or press releases. Fair organizers envisioned teachers' roles as facilitators to guide children through the project method while students pursued their individual interests of study. According to one promotional pamphlet, "If a teacher is sympathetic and uses initiative, he can so direct the children that they can work out for themselves science projects which will illustrate fundamental ideas of science far more important to them than any textbook."[193] Teachers and club sponsors, then, were considered integral allies in facilitating extracurricular engagement, whereas students were ultimately held responsible for dictating their own scientific pursuits.

One key area of negotiation centered on the materials used in creating science fair projects. In order to exert a measure of control over how students constructed their projects, judges required students to submit forms declaring what exhibitors bought, borrowed, and built for their displays. The majority of students responded that they constructed most of their exhibits themselves. Common materials that students purchased

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[193] Fisher Ramsey, *Project Making,* 3.

included balsa wood, paint, wire, mirrors, nails, bulbs, sockets, clay, cellophane, lumber, plaster of paris, wax, enamel, cardboard, glue, celluloid, batteries, cork, crepe paper, glass, batteries, fish, film, frogs, dolls, maggots, rats, and soap for carving models. Students borrowed items such as cranks, Erector Sets, glass cases, petri dishes, specimens, tanks, electrical appliances, bottles, chemicals, vials, electric wiring, fossils, or test tubes. Typically teachers or schools lent these items, but occasionally students borrowed from local suppliers. For the most part, students built the bulk of the major project components such as telescopes, maps, miniature trees and buildings, scenery, waxed leaves, ant farms, insect models, pictures, labels, illustration books, plants cameras, slides, dissections, and photomicrographs.[194] Following the tradition of learning by doing, judges evaluated projects that students constructed themselves more highly than projects that used parts that were prefabricated.

One material that remained under constant negotiation was the use of animals. Live specimens were a constant fixture of early science fairs and often constituted their own categories, such as “Home-made Animal Cages” or “Living Insects.” Students displayed live animals as part of their exhibits to foster experiential engagement. The planning committee recognized that animals appealed to visitors attending the fair, but they also had concerns that the animals on display were neglected.[195] The American Institute partnered with the American Society for the Prevention of Cruelty to Animals (ASPCA) to instruct children on the proper treatment of animals. The ASPCA encouraged the American Institute to award prizes based on comfortable quarters for

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[194] Project descriptions, 1937. N-YHS AI Box 195, Folder 2.

[195] Children’s Fair Plan Committee meeting minutes, February 18, 1932. N-YHS AI Box 150, Folder 2.

animals that also afforded them protection from the crowds of onlookers.[196] The ASPCA also set up an exhibit during the fair and provided pamphlets with information about the temperament and housing requirements of particular breeds of household pets.[197] At the same time, projects that displayed taxidermied animals or dissections rarely received scrutiny. Even as students conducted experiments with animals through selective breeding, changes in diet, or examinations of embryos, the negotiations surrounding animals largely centered on the live specimens on display at the fair. The standard for animal treatment would change more significantly during the postwar years, but the debates at the early Children's Science Fairs demonstrates how concern over animals served as a point of negotiation from the fairs' inception.

Space was another area of negotiation between students and fair organizers. By 1929, the Education Hall at AMNH was filled to capacity. In order to meet increasing demands, fair administrators began regulating the amount of space available to each exhibitor. In 1928, exhibit spaces ranged from 4 feet by 4 feet for categories on topics like conservation or biology and 6 feet by 12 feet for displays of fruits, flowers and vegetables. In 1929, the space for individual exhibits was limited to 2 feet by 2 feet and 4 feet by 4 feet for group exhibits, with the exception of the "Gardens" category, which still allotted 12 feet by 6 feet of space. By 1932, the space allotted to groups narrowed to 3 feet by 3 feet, and requirements also limited the number of entries for each club or school (Fig. 2.5). Floor plans of the exhibit hall were carefully negotiated and adjusted to ensure a proper spatial flow of the fair.[198] AMNH added triangular dividing boards in 1931 in

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[196] Letter from Mary F. Taylor to Marjorie Coit, December 26, 1930. N-YHS AI Box 142, Folder 11.
[197] ASPCA promotional pamphlets, ca. 1929. N-YHS AI Box 141, Folder 3.
[198] See, for instance, Children's Science Fair Plan Committee Minutes, Nov 9, 1932. N-YHS AI Box 150, Folder 2.

order to delineate space between each exhibit. These spatial regulations not only imposed limitations on how exhibitors could present their findings, but they would set a precedent for the homogenous aesthetic of science fair projects that continued to develop over the next several decades.[199]

Students responded to these requirements through creatively adapting their use of space. Many exhibitors began capitalizing on vertical space to accommodate their projects. In response, by 1933 the requirements listed a strict height requirement of 32 inches for all exhibits, claiming that "no concessions to extra space or position can be made." Occasionally these requirements posed major problems for student projects. One teacher requested a corner space for a toxicology chart that was 44 inches wide and 46 inches high, claiming that the pupils created the display before the allotment of space was published. Judges responded that the project would be difficult to accommodate. At times, student negotiations proved more successful. In 1938, the requirements allowed telescopes to exceed the measurement requirements. Other students from schools with a maximum number of entries or with projects that exceeded the spatial regulations were allowed to be displayed on a noncompetitive basis.[200] Although students had limited input on the regulations set in place, they developed creative solutions that allowed them to navigate the spatial parameters set forth by fair officials.

Judging served as another point of ongoing debate among exhibitors and fair organizers. Although volunteers varied from year to year, judges were typically local science educators volunteering from local institutions such as Columbia University Teachers College, American Museum of Natural History, Brooklyn Botanic Gardens, or

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[199] Ibid.

[200] Correspondence between L. W. Hutchins and Brooklyn Technical High School, 1933. N-YHS AI Box 153, Folder 9.

area schools.[201] At times, science teacher organizations managed the judging.[202] The records of judges typically assigned ranking or point values to exhibits with little feedback. Occasionally, judges offered notes such as "Workmanship very meritorious; subject treated with understanding" or "A good idea not effectively presented; too crowded," offering additional insight into the rationale behind their decisions.[203] In most cases, exhibitors received little explanation regarding why their display received a particular ranking.

The judging criteria for the fair evolved as its priorities shifted from nature study to science. In1929, the flyer stated simply that "all exhibits will be judged on the basis of their educational value." Due to the expectations set by the State Department of Agriculture and Markets regarding prize money, the American Institute began printing the basis for judging in the promotional flyers in 1931.[204] The flyer stated that judging was based on the clearness of objective, accuracy of information given, general attractiveness, neatness, and care, originality, and effective presentation of material. Although other categories, such as importance of the idea and workmanship, were added in subsequent years, these criteria remained consistent through the late 1930s. The fair also added special awards to recognize exhibits from all categories in areas such as creative power (exhibits that "best show the creative spirit"), perfection (exhibits that "are the most effectively presented, the most readily understood, the most neatly

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[201] Children's Fair Judges List, 1929. N-YHS AI Box 141, Folder 6.

[202] C.W. Hutchins, "The Second Century…By the Director," *American Institute Monthly Bulletin* 1, no. 7 (April 1937): 4-5, NYPL. Teacher groups included the Physics Club, General Science Teachers Association, New York Association of Biology Teachers, Chemistry Teachers' Club, and Physiographers and Geographers Club of New York.

[203] Children's Science Fair judging records, 1937. N-YHS AI Box 192, Folder 11.

[204] Meeting of Judges and Committees of the 1930 Children's Fair minutes, January 27, 1931. N-YHS AI Box 141, Folder 1.

arranged, which most competently take the spectator into account"), and protection (exhibits that "are most adequately and neatly protected against breakage, tampering, and loss").[205] Aligning with the values of synthetic culture, many of these categories prized a clear narrative and unity of ideas.

One criterion that proved contentious for judging was the concept of originality. The significance of this term was in flux. In 1929, the Judging Committee reported that they judged educational value as the most important criteria, followed by accuracy of information given, originality, and appearance. By 1931, however, several members of the committee began to question that hierarchy. Committee member Dr. G. Kingsley Noble, a zoologist at AMNH, argued that originality was the most important category, whereas A. Cressy Morrison, a chemist and President of the New York Academy of Sciences, argued that "something should be done to make the exhibit tell a story in children's language."[206] These two competing notions of what was considered important reflected the rising tensions over the importance of contributing new ideas versus creating meaningful displays that engaged children. Ultimately, originality won out over other goals like effective presentation or importance of the idea.

In preparation for the 1938 fair, the committee conducted a vote on the importance of different criteria. Unlike in 1929 when general educational value was prized, originality was ranked first.[207] The committee kept the same judging criteria, but they decided to weigh originality (25 points) more heavily than other categories, including clearness of objective (20 points), accuracy (15 points), importance of the idea (10 points), effectiveness in presentation (10 points), workmanship (10 points), and

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[205] Children's Fair Flyer, 1937. N-YHS AI Box 142, Folder 2.
[206] Meeting of Judges and Committees minutes, Jan 27, 1931. N-YHS AI Box 141, Folder 1.
[207] Meeting Minutes for Judging Committee minutes, 1937. N-YHS AI Box 192, Folder 3.

general attractiveness, neatness and care (10 points). Under this rubric, aesthetic qualities such as attractiveness and workmanship diminished in importance, placing exhibits that presented a visual narrative at a disadvantage.[208] This shift marked the gradual change of values that accompanied an increasing emphasis on the applicability of science.

At the same time, the concept of originality proved elusive to define. The basis for its judging was grounded in the question, "To what extent does the presentation of this exhibit show a new approach, different from anything that has been done along this line at previous Children's Science Fairs?"[209] Unique modes of presentation as well as new ideas were considered legitimate forms of original expression. This category proved particularly challenging for exhibitors. In 1931, Fred Futterman was the only student to submit an entry in the "Inventions" class, showcasing a rudimentary swimming paddle device. Even though the device was determined to be the "result of Futterman's own inventive faculty," the judges decided not to award him a prize.[210] For many judges, originality proved too out of reach for children to successfully achieve independently.

Part of the issue was that judges feared that projects were conceptualized more by teachers than students themselves. As Meister explained,

> "Many of the pupil projects are so well conceived and so effectively executed that the question is often raised, 'Is this the child's own work?' It is almost impossible to arrive at a reasonably certain answer to such a question. It is clear that teachers take advantage of their opportunity to give assistance and guidance. This, of course, is as it should be. Only by encouraging such teacher cooperation can the Fair be integrated with and be made to supplement the school program of science teaching."[211]

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[208] Meeting Minutes, Special Committee on Judging Standards, 1937, N-YHS AI Box 192, Folder 13.

[209] Standards for Judging Committee, N-YHS AI Box 192, Folder 12.

[210] Correspondence between L. W. Hutchins and Joseph Singerman, June 1934. N-YHS AI Box 157, Folder 4.

[211] Meister, *The Children's Fair*, 15.

Although Meister recognized the role of teachers in facilitating student projects, lingering doubts remained over the originality of the work.

Prizes proved equally contentious. Prize amounts varied each year, but typical sums ranged from $5 to $25 for groups and $3 to $10 for individuals. Fair committee members feared that the prizes would not only entice adults to provide too much assistance, but that the financial rewards would dilute the overall educational value of learning for its own sake. Several teachers and community organizations shared this concern.[212] The Girl Scouts declined from participating because they did not want to compete when financial premiums were offered.[213] In 1928, Hutchins requested from Commissioner Berne Pyrke to award medals, buttons, and ribbons in lieu of money.[214] Although the Commissioner agreed that child exhibitors warranted special consideration, ultimately the request was denied. The New York State Department of Agriculture and Markets mandated that the awards were allocated in cash. Although many negotiations took place between adults and children, occasionally broader institutional pressures interceded to shape the composition of the fairs.

To compensate for the concerns over the financial rewards, the American Institute implemented regulations for the spending of prizes. The money was strictly "to be used for science, gardening, or nature study equipment or books."[215] The fair committee requested that students submit a summary of how they spent their money. Virtually all students responded that they spent the awards on educational items such as books,

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[212] Meister, *The Children's Fair*, 15-16.
[213] Letter to Hutchins from Commissioner Myers, August 30, 1928. N-YHS AI Box 140, Folder 9.
[214] Letter from Hutchins to Commissioner Pyrke, July 20, 1928. N-YHS AI Box 140 Folder 4.
[215] American Institute Press Release, October 5, 1932. N-YHS AI  Box 144, Folder 7.

instruments, or supplies for future projects.[216] Whereas one student decided to attend nature camp, another student purchased entomology tools, and one student who was "very interested in domestic science" used her winnings for a two-year subscription to *Good Housekeeping.*[217] For group winners, the money was allocated to the sponsoring teacher or organization. Group winnings were generally spent on equipment for the classroom. For instance, one teacher responded that they used part of the funds to purchase an aquarium and fernery, and the rest of the money was dedicated to the school fund for additional equipment in the school's nature room.[218] Although the American Institute held a certain set of expectations on how the money would be used, exhibitors ultimately maintained autonomy on deciding how the money could advance their own scientific pursuits.

Non-financial rewards also served as a source of honor for participants. One student hung up his certificate of award in a place where his friends could see it "as it is the only award I have ever received."[219] A project leader from the New York Plant, Flower, and Fruit Guild similarly requested a typewritten letter verifying their project's success to display in the garden so that "all the boys and girls who come to the garden may read and see it."[220] Exhibitors also received buttons and badges as a sign of their participation. Students often asked for buttons even if they were not participating in the

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[216] Prize money purchase questionnaire, N-YHS AI Box 174-2, Folder 18; "Children's Science Fair-Information in Articles Purchased with Children's Science Fair Money," 1935, N-YHS AI Box 174-2 Folder 15; Report on articles purchased with prize money, May 9-16, 1937, N-YHS AI Box 191, Folder 12; "How the Money was Spent- 1939 Fair Forms Returned, "1939, N-YHS AI Box 210-2, Folder 14.

[217] See prize money questionnaires in N-YHS AI Box 140 Folder 3; N-YHS AI Box 141, Folder 4; and N-YHS AI Box 157, Folder 3.

[218] Prize questionnaire, 1929. N-YHS AI Box 141-2, Folder 6.

[219] Radio address by Morris Meister, January 18, 1933. N-YHS AI Box 153, Folder 8.

[220] Letter from H. Munthowitz to E. F. Murdock, November 14, 1928. N-YHS AI Box 140, Folder 3.

fair. These trinkets served as tangible displays of membership that allowed students to demonstrate their elite status as participants in a prestigious competition.

Although prizes generally served as sources of pride for both exhibitors and their organizations, occasionally students came into direct conflict with their sponsors on how to use their winnings. When Helen Jones won an individual prize during the 1932 fair, she wrote a letter to the American Institute claiming that her principal mandated that Helen give the money to the school. Principal Abby Porter Leland responded that the project was more collaborative than Helen purported, and requested that the American Institute deliver all future checks to her instead of students. Helen's mother wrote a follow-up letter claiming that the family needed the $5 prize because she was unemployed and her husband worked for City Relief, a common story for many families faced with the financial turmoil brought on by the Great Depression. The American Institute ultimately decided to uphold its policy that individual awards would be given directly to the exhibitor.[221] The fact that the American Institute sided with the student rather than school reflected their expectations that children deserved to make their own decisions regarding the direction of their scientific pursuits.

The negotiations over the form and content of exhibits helped determine who participated. The flexible use of materials meant that students of limited means, including children of immigrants, still had the opportunity to enter. According to a survey of one American Institute program, 81% of students had at least one parent born outside of the United States, usually in Central and Eastern Europe. 6% of students themselves were

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[221] See correspondence (1934) in N-YHS AI Box 157, Folder 2.

also foreign born.[222] Likewise, schools and clubs were represented from Burroughs across the city and were frequently affiliated with settlement houses and other civic organizations dedicated to helping the poor. At the same time, the transformation away from nature study also alienated certain students, particularly girls who were more drawn to projects grounded in gardening and wildlife than physics or engineering. In a typical year, only approximately 20% of individual projects were submitted by girls. That said, female participation in group projects was likely much higher. Girls constituted approximately 37% of club membership in 1937, and several group projects were submitted by girls-only clubs.[223] Based on photographs of participants, racial minorities also appeared vastly underrepresented at the fairs. Whereas synthetic culture afforded a more expansive notion of expertise, it still carried limitations on who was considered a valid member of the scientific enterprise.

## **Conclusion: The Decline of American Institute Science Fairs**

This moment of synthetic culture in children's science fairs did not survive the postwar world. As Servan Terzian argues, burdened by the goals of national security, children's clubs and competitions became increasingly career oriented and meritocratic, focusing more on seeking out talented individuals than promoting playful collaboration.[224] But narrative-driven engagement began to crumble even before American involvement in World War II. In 1938, the American Institute outlined a new set of evaluation criteria. Although categories such as "clarity and dramatic value" and "artistic expression" aligned with the values of synthetic culture, other areas, such to

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[222] Based on responses by student applicants to the American Institute Laboratory, 1940-1941. N-YHS AI Box 223, Folders 1-4.

[223] Based on names of participants listed on club rosters, 1937. N-YHS AI Box 196, Folders 7-11 and Box 197, Folders 1-2.

[224] See Sevan G. Terzian, *Science Education and Citizenship.*

"develop the scientific method of thinking," "technical skill," "timeliness," and "the study and development of products, processes and principles that are of social value," prized more practical aims.[225] The committee also opted to omit the "History of Science" category from the 1938 Science Fair and instead added categories for "Aviation" in 1938 and "Engineering" in 1939. These new categories focused on areas that showcased technical skill rather than narrative expression.

The American Institute was also the victim of its own success. Across the nation, educators created science fairs modeled after the American Institute programs. In the spring of 1941, science fairs extended as far as Jackson, Michigan and Central City, Nebraska to Johnston, Pennsylvania and Rochester, New York.[226] As the American Institute opened its membership to students nationwide, its financial burdens grew accordingly. Faced with the strains of managing a program that grew in popularity quicker than the financial means to support it, the American Institute partnered with Westinghouse Electric to secure sponsorship for its programs. This corporate backing further solidified the turn towards more applied applications of science. Fittingly, the fair changed titles to the "American Institute Science and Engineering Fair." Students followed suit by designing projects that achieved more practical aims. Exhibitors began showcasing stroboscope motors, gyroscopic trainers, burglar alarms, electric guitars, and diving helmets.[227] Some projects still created dioramic displays, but focused on new wartime technologies. The Barnes Science Club of Brooklyn, New York won first prize

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[225] 1938 Children's Fair Flyer, N-YHS AI Box 201, Folder 7.

[226] "American Institute Science Fairs," *Science Leaflet* 14, no. 30 (May 8, 1941): 33-34, N-YHS AI Box 468.

[227] "Cash Grants Awarded," *Science Observer* 3, no. 6 (June 1941): 8-11, N-YHS AI Box 468; "Glass Blower in Action," *Science Leaflet* 14, no. 18 (Feb 6, 1941): 18, N-YHS AI Box 468; "Making a Full-Sized Gyroscopic Trainer," *Science Observer* Vol. 3 No. 6 (June 1941): 14-15. N-YHS AI Box 468.

during the 1939 for building a detailed model of the Momsen Submarine Escape Hatch (Fig. 2.6).[228] Although exhibits conveying visual narratives remained a prominent form of display, exhibits that featured scientific principles or practical applications began to appear with more frequency.

When its contract with the American Institute ended in 1941, Westinghouse stopped its financial support, opting instead to work with the Science Service to form the Science Clubs of America and Science Talent Search. These new programs focused less on the broad objective of promoting experiential learning and more on grooming the next generation of scientists and engineers. Lacking financial support, the American Institute programs quickly fell apart, and its coordination of science fairs ceased until after World War II. These shifts signaled a change towards an analytic culture, one that promoted individualism, ingenuity, and argumentation.

The science fairs of the American Institute reflected a holistic conception of science that underpinned the virtues of synthetic culture. The vivid dioramic displays of this period engendered a belief in science as unified and the driver of human progress. At the same time, this moment of creative expression was in constant flux, as the progressive aims of nature study were soon superseded by more disciplinary distinctions of science. The narrative-driven exhibits of the 1920s and 30s also demonstrate that the standard textual displays so prominent in contemporary science fairs were not inevitable, and moreover, what constituted scientific evidence shifted dramatically in the decades that followed. At the same time, these early fairs laid the groundwork for a movement that would ultimately serve as a model of adolescent extracurricular engagement across the nation.

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[228] Image of model shown in *Science Leaflet* 14, no. 2, (Sept 19, 1940): 8. N-YHS Box 468.

Table 2.1 Number of exhibits made by schools and organizations, 1930-1931. Source: Morris Meister, *Children's Science Fair of the American Institute: A Project in Science Education*, 1932.

| | No. of Group Exhibits, 1930 | No. of Group Exhibits, 1931 | No. of Individual Exhibits, 1930 | No. of Individual Exhibits, 1931 |
|---|---|---|---|---|
| Elementary School | 60 | 56 | 58 | 51 |
| Junior High School | 28 | 41 | 76 | 75 |
| Senior High School | 23 | 48 | 50 | 71 |
| Clubs and Organizations | 28 | 32 | 33 | 356 |
| Totals | 139 | 177 | 217 | 233 |

Figure 2.1 Boys viewing nature study exhibit, Public School 64, Manhattan. AMNH Negative Logbook 9; Image Number 280055; American Museum of Natural History Archives.

Figure 2.2 Model showing “A Short Story About Coal,” submitted by grade 5, Public School 205, Children’s Fair. AMNH Negative Logbook 18; Image Number 313562; American Museum of Natural History Archives.

Figure 2.3 “How My Lassie Got Her Clothes” by the Science Fair Club in Bronx, N.Y.
Source: *Science Observer* Vol. 2 No. 5 (July 1940): 14.

Figure 2.4 Cartoon reprint by McClure Newspaper Syndicate. Source: *The Science Leaflet* Vol. 13, No. 15 (Jan 10, 1940): 39.

Figure 2.5 Children at Children's Fair, Dec. 1932. AMNH Negative Logbook 18; Image Number 413087; American Museum of Natural History Archives.

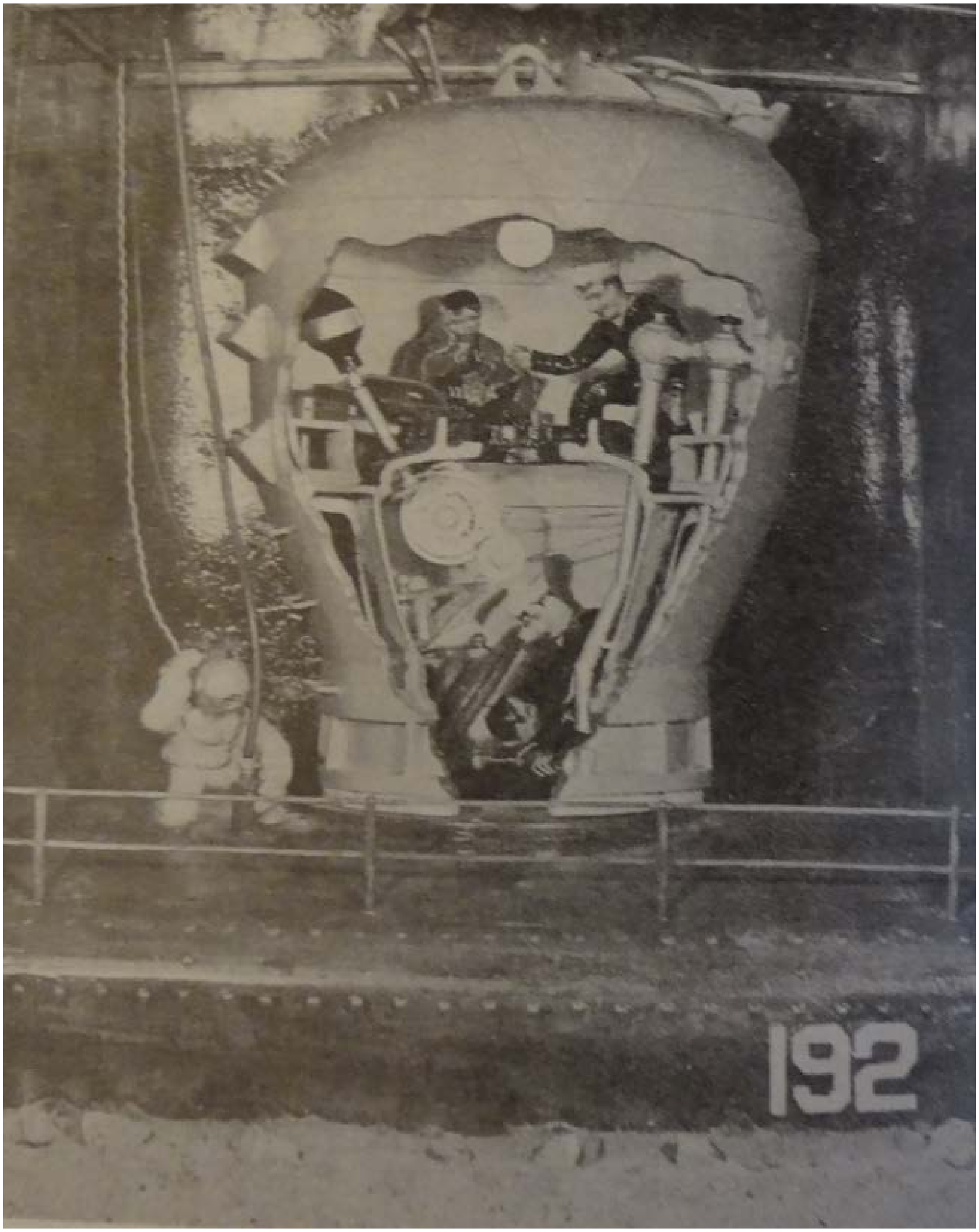

Figure 2.6 Model of the Momsen Submarine Escape Hatch made by the Barnes Science Club of Brooklyn, New York, 1940. Source: *Science Leaflet*, Vol. 14 No. 2, (Sept 19, 1940): 8.

# CHAPTER 3

## Building Communities of Practice: American Institute Science Clubs, 1932-1941

Twenty members of the American Institute Orion Club in Bellwood, Pennsylvania ground and polished an eight-inch mirror for a new telescope and developed plans to build a school observatory.[229] Alpha Sigma Chi Science Club of Shrevenport, Louisiana helped instruct elementary students on the proper use of slide rules.[230] Nature Study Club of Newark, N.J. made scrapbooks and collected images of their favorite plants and animals to create museum exhibitions.[231] Science Club of Cordoza High School in Washington, DC held a question and answer bee where members took part in six rounds of questions in the school assembly hall.[232] These sample reports from science clubs across the country were typical among the thousands of participants of the American Institute's Student Science Clubs of the 1930s. They reflected students' enthusiasm for engaging in science based on their own volition. They depicted science as a collaborative process that encouraged adolescents to work together to achieve a common goal. Above all, they emphasized a more holistic view of science, one that entailed a variety of endeavors across several disciplines. In tracing the extracurricular activities of adolescent members of the American Institute, this chapter evaluates one of

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[229] "Active Clubs Everywhere," *Science Observer* 1, no. 5 (April 1939): 7. N-YHS AI Box 468.

[230] "Alpha Sigma Chi of Centenary College or Louisiana," *Science Leaflet* 13, no. 29 (May 2, 1940): 27. N-YHS AI Box 468.

[231] "Club Briefs," *Science Observer* 3, no. 5 (May 1941): 14. N-YHS AI Box 468.

[232] "Cordoza High School Science Club Holds Question and Answer Bee," *Science Leaflet* 14, no. 1 (September 12, 1940): 28. N-YHS AI Box 468.

the most important corresponding movements to the advent of science fairs: the creation of a national network of science clubs.

The virtues of synthetic culture did not just influence the creation and display of science fair projects, but they also shaped smaller communities of practice formed through student science clubs. Clubs served as the primary forum where students exchanged ideas, demonstrated their scientific acumen, and developed distinct sets of practices and beliefs. In fact, the majority of students who entered science fair projects did so as part of a club submission. The club movement began in 1932, when the American Institute initiated the Junior Science Club program for students residing in New York City (and eventually across the nation). Membership was open to junior high and high school groups of any discipline provided that they had at least five students, an adult club sponsor, and paid annual dues.[233] Through science clubs, students began to form their own distinct communities while affiliating themselves with a larger network of adolescent scientific engagement.

According to Jean Lave and Etienne Wenger, communities of practice are developed in environments built on informal interaction and motivated learning by engaging actual experience rather than meeting formal pedagogical aims. It involves not only gaining new skills but also acquiring new identity as part of a larger community.[234] Due to its young constituency, club communities of practice possessed several unique characteristics.[235] Student clubs were pedagogically oriented, constantly evolving (adolescents routinely grew in and out of club membership), and mediated by adult

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[233] The American Institute, “Junior Science Clubs.” N-YHS AI Box 157, Folder 7.

[234] Jean Lave and Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge: Cambridge University Press, 1991).

[235] Etienne Wegner, *Communities of Practice: Learning, Meaning, and Identity* (Cambridge: Cambridge University Press, 1998).

leadership. Most importantly, the clubs were not necessarily motivated by profit, career status, or even formal classroom curriculum, but rather by having fun. These qualities provided clubs with the flexibility to be more imaginative in their scientific pursuits.

This chapter provides a careful analysis of science club activities to analyze how adolescent communities of practice formed across disciplinary and geographic divides. It argues that clubs served as an important vehicle for supporting the values of the synthetic culture of the 1930s. This chapter analyzes both the inner practices of individual club communities as well as the collective values established through the creation of a broad club network. Like science fairs, clubs maintained a distinct set of epistemic virtues that included collaboration, narrative, and performance. These values embodied a more flexible view of expertise that prized playfulness as a key component of scientific practice. It argues that adolescents created a distinct scientific culture not despite of their youth, but by virtue of it. In the process, these hobbyists established their own notions of what counted as scientific.

## Organizing the Club Movement

The Junior Science Clubs began when officers of the American Institute realized that the planning of science fair projects often occurred in extracurricular groups lacking a formal structure to guide students' scientific pursuits. As in the case of science fairs, the nexus of the science club movement initially resided in New York City, an intellectual hub of organizations, museums, and educational institutions dedicated to advancing students' intellectual development. Whereas the science fairs occurred only annually, science clubs sustained student engagement for months or even years (Fig. 3.1). The champion of the cause was none other than progressive educator and American Institute member, Morris Meister. Meister explained, "In so many instances, the boys and girls who prepared the exhibits for the Fair continued their science interests in science clubs. Often, however, such clubs did not meet the needs of children for want of effective leadership, proper programs of activities, and sufficient materials and facilities."[236] To address these concerns, in 1932 the American Institute called together a group of science educators from across New York City to organize a Plan Committee. Members included representatives from Lincoln School of Teachers College as well as area high schools.[237] The Committee decided that the aim of the club organization "shall be to encourage, assist, and guide science club activities" in New York City.[238] With this goal in mind, they deliberated on potential programs to serve the needs of science clubs, including newsletters, demonstration lectures, field trips, club competitions, roundtables, and a Junior Science Club Congress. The proposed activities were intended to build a network of clubs that would have the capacity to support students' scientific hobbies throughout the academic year.

The rationale behind the creating the Junior Science Clubs was to serve the needs of students while also cultivating a general appreciation of science. According to the Chairman of the Standing Committee John A. Clark, the aims were "not only to foster the work of the various clubs but to provide increased opportunity for pupils to develop those habits of thought so essential to citizens of a republic."[239] Like science fairs, clubs were intended to establish a scientifically minded citizenry. At the same time, the Junior Science Clubs were also designed to offer gentle guidance while also organizing a system

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[236] Morris Meister, statement prepared on American Institute Junior Science Clubs, ca. 1932. N-YHS AI Box 150, Folder 2.

[237] "The Plan Committee on Junior Science Clubs," *March of Science* Vol. 1, No. 1 (Sept 17, 1932): 4. N-YHS AI Box 468.

[238] Report by Dr. Meister on Jr. Science Activities, June 15, 1932. N-YHS AI Box 150, Folder 2.

[239] John A. Clark, Open Letter to L.W. Hutchins, *The March of Science* Vol. 1, No. 1 (Sept 17, 1932): 4. N-YHS AI Box 468.

"where clubs met together to solve their own problems."[240] Group work was considered superior to independent study in stimulating sustained engagement in science. Membership was also limited to junior high and senior high school students, aligning with the American Institute's increased emphasis on the work of adolescents rather than elementary-aged children. The Plan Committee hoped that students would develop their own independent communities where groups worked collaboratively to solve problems and nurture their mutual interests.

American Institute organizers sought out examples from other successful organizations in developing the Junior Science Clubs. The Junior Academy of Science, a student honor society affiliated with the American Academy of Arts and Science, began organizing clubs in schools to foster students' interest in science. With ten states organizing their own academies by 1931, the Junior Academy program began to spread at the same time that the American Institute developed its own youth programs.[241] Other organizations, such as the New York Electrical Society, Chemical Foundation, and 4-H also sought to organize clubs.[242] As Meister noted, "The growth of science clubs is rapidly assuming the proportions of a Science Youth Movement."[243] With the development of its club program, the American Institute began to identify itself not only as a supporter of children's education, but also as a key instigator in shaping a broader youth science movement occurring across the nation.

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[240] Planning Committee meeting minutes, June 9, 1932. N-YHS AI Box 151, Folder 9.

[241] Ed. M. Brogie, "History of High School Science Research in Junior Academies Associated with NAAS and "Affiliated Academies of Science and Other Science Promoters," (Unpublished manuscript, August 3, 2011), Microsoft Word file.

[242] Report by Morris Meister on Junior Science Activities, June 15, 1932, N-YHS AI Box 150, Folder 2; JSC Executive Committee Meeting, Nov 23, 1933. N-YHS AI Box 158, Folder 25.

[243] Morris Meister, *How to Organize a Science Club* (New York: The American Institute Science and Engineering Clubs, 1938), 3.

Club sponsors were considered key facilitators in the movement. Although American Institute organizers hoped that children would be guided by their own interests, they also acknowledged the key role that sponsors played in clubs' sustainability. According to Meister, "The success of a science club depends on the enthusiasm of the adult, and this enthusiasm is the first step in the development of a club."[244] The Plan Committee invited suggestions from sponsors on structuring the club program. Sponsors commented that they enjoyed planning the activities for their members on their own and primarily sought out resources to support those goals. They suggested supporting the particular aims of each club by coordinating exchanges between individual clubs, planning field trips for small groups rather than large gatherings, publishing newsletters with updates on the happenings of other clubs, and recognizing the individuality of clubs that varied in terms of age and discipline.[245] Club leaders also requested additional training designed especially for sponsors to keep informed on new developments in science education. In response, the American Institute set up meetings and workshops to discuss specific problems that sponsors faced, and several sponsors subsequently sat on subcommittees to assist in planning Junior Science Club activities.[246] Sponsors served as critical liaisons between the American Institute and club members, and the success of clubs often hinged on their coordination of club activities.

During the early 1930s, the Junior Science Clubs program quickly gained momentum. By 1933, 118 clubs had registered, with 61% composed of high school students and 39% composed of junior high school-aged students. Although the American

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[244] Meister, *How to Organize a Science Club,* 9.

[245] See various correspondence with sponsors in N-YHS AI Box 151, Folder 5; N-YHS AI Box 151, Folder 10; and N-YHS AI Box 157, Folder 12.

[246] : SSC Junior Activities Committee 1935-36 Minutes, 1935. N-YHS AI Box 178, Folder 12.

Institute focused its promotional campaign on public schools, 20% of clubs were affiliated with outside groups such as the YMCA, United Synagogue of America, Boy Scouts, Grand Street Settlement, or Hayden Planetarium.[247] The American Institute continually made adaptations to serve the needs of its growing constituency. With its emphasis on adolescents, the American Institute changed the name from "Junior Science Clubs" to "Student Science Clubs" in order to reduce confusion over the word "Junior" in terms of membership.[248] In 1935, the Junior Activities Committee decided to allow club membership to extend to New York suburbs to meet growing demand.[249] That same year, membership jumped to 232 clubs with 5,907 students.[250] A movement had begun.

## Forming a Scientific Network

Club activities ranged from chemistry and physics to photography and model airplanes. In 1933, for instance, 28% were general science clubs, 23% were biology clubs, 14% were chemistry clubs, and 10% were physics clubs, with other categories including airplanes, radio, electricity, photography, medicine, and microscopy (Fig. 3.2). Even within an individual club, interests and activities could vary. In a sample account of the James Monroe High School Chemistry Club, Vice President Fred Mintz wrote,

> "Much of the success of the organization is attributed to the method of conducting the meetings. Members lecture informally to the club, usually illustrating their talks with demonstrations. At least one experiment is given at each meeting. This encourages the students to conduct individual research and enables them to gain skill in setting forth their ideas…Two other worthwhile activities of the members are the presentation, each term, before the school at large, of a playlet; and field excursions by the members to various industrial plants nearby. Last December the club entered several exhibits in the

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[247] Morris Meister, statement prepared on the American Institute Junior Science Clubs, ca. 1932. N-YHS AI Box 150, Folder 2.

[248] "Junior Science Clubs to be Known as Student Science Clubs," *March of Science*, Vol. 3, No. 6 (Feb 25, 1935): 1. N-YHS AI Box 468.

[249] SSC Junior Activities Committee 1935-36 meeting minutes, 1935. N-YHS AI Box 178, Folder 12.

[250] "The Student Science Clubs," *American Institute Monthly Bulletin* 1, no. 1 (Oct 1936):15. NYPL.

Children's Science Fair…This year many members are looking forward eagerly to the fair."[251]

The plethora of activities that Mintz mentioned within his own club reflected the wide range of interests club members across the network pursued in the name of science.

In order to foster a sense of community, the American Institute organized central and zone meetings. Central meetings brought together approximately 1,000 students from across New York City to take part in lectures and workshops. The Plan Committee also divided New York City into zones so that schools and organizations could start building relationships with nearby members. The meetings proved so popular that the American Institute limited admission to a select number of tickets for each club. Students often built upon the information they gathered at meetings in their club work. After attending a talk by Dr. E.D. Merrill, Director of the New York Botanical Gardens, on "Where Our Cultivated Foods Come From," The Lincoln Botanists at Abraham Lincoln High School in Brooklyn created a similar exhibit to use in biology classroom demonstrations.[252] Other students wrote lecturers specific questions about their research. After seeing Dr. Robert Chamber, a biologist at New York University, deliver a talk on "A Device Which Enables One to Operate on Living Cells of Microscopic Dimensions," A. Hermine Klein asked Chambers how an organism such as an amoeba live after it had been enucleated, and wondered if the amoeba had the power to produce another nucleus within the cytoplasm. The American Institute sent Hermine and other students' letters to Chambers so that he could respond to their inquiries, establishing direct dialogue between

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[251] Fred Mintz, "The James Monroe Chemistry Club," *March of Science* Vol. 1 No. 3 (October 19, 1932): 4. N-YHS AI Box 468.

[252] Correspondence between Harry Rosinsky and Catherine Emig, November 1933. N-YHS AI Box 157, Folder 8.

adolescent hobbyists and the professional research community.[253] The central and zone meetings facilitated new interactions between students, sponsors, and experts that often led to forging new relationships and broadening students' avenues of research.

To establish more sustained partnerships and learning opportunities, the American Institute also developed courses for students through collaborations with local institutions. These courses represented an impressive array of institutions and disciplines that capitalized on the organizational resources of New York City. In 1936, offerings included Aeronautics at the NYU Daniel Guggenheim School of Aeronautics, Mineralogy at the Brooklyn Children's Museum, Nature Handicraft at AMNH, Wild Animals at the New York Zoological Park, Physics, Biology, and Chemistry at NYU, Washington Square, Engineering at the Columbia University School of Engineering, Telescope Making at the Hayden Planetarium of AMNH, and Radio Engineering by the RCA Institute.[254] Courses offered by area institutions were in high demand. The American Institute limited the number of participants from each club, but unregistered students still arrived spontaneously with the hope of attending. Other courses proved so popular that instructors stayed behind answering individual questions or even held extra sessions because "the children were most anxious to work."[255] Participants embraced these courses as opportunities to hone their leisurely pursuits while learning from local practitioners.

In order to facilitate relationships between institutions and individual clubs, the American Institute also established the Speakers' Bureau, a program that fulfilled requests from clubs for guest speakers and visits to local institutions. The American

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[253] Letter from Hermine Klein to Robert Chambers, January 16, 1933. N-YHS AI Box 159, Folder 8.
[254] "The Student Science Clubs," *American Institute Monthly Bulletin* 1, No. 1 (October 1936): 15. NYPL.
[255] Letter from William H. Carr to Catherine Emig, December 12, 1933. N-YHS AI Box 158, Folder 17.

Institute once again called on its vast connections with local universities, museums, and industries to support club projects. In one instance, E. M. Spotkov, a biologist from New York University, spoke to thirty-five students of the Natural Science Club about mitosis and stayed afterward to continue the discussion with a group of students who had additional questions.[256] Other clubs made arrangements to visit science facilities. The James Madison High School Physical Science club viewed the Astronomical Observatory at Columbia University, whereas the Haaren Camera Club visited the Photography Department of the Daily News.[257] The Speakers' Bureaus and related programs supported the needs of individual clubs while allowing members to establish partnerships with area institutions.

Although the American Institute provided field trips and courses to members in New York City, several students opted to collaborate on a more individualized level by meeting with clubs sharing similar interests. The American Institute frequently received requests from members for lists of other clubs that they could visit.[258] Some clubs also offered summaries of their programs and invitations for neighboring clubs to visit and trade programs.[259] Students at Stuyvesant High School entertained fellow science club members by hosting an inter-club meeting at their school. They developed a demonstration on light and crystals to highlight the mechanical principles behind electronics, a glass-blowing display featuring the characteristics of ancient glass, and an

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[256] Letter from Lucile Sargent Mac Coll to Catherine Emig, May 3, 1934. N-YHS AI Box 158, Folder 3.

[257] Correspondence between Albert Bicknell and American Institute, 1933. N-YHS AI Box 159, Folder 1; Correspondence between Harold Schwartz and the American Institute, April 3, 1933. N-YHS AI Box 159, Folder 1.

[258] See, for instance club correspondence in N-YHS AI Box 158, Folder 7; N-YHS AI Box 158, Folder 7; and N-YHS AI Box 151, Folder 5.

[259] "Science Club Section," *Science Leaflet* 14, no. 11 (Dec 5, 1940): 35-39. N-YHS AI Box 468.

interactive telegraph system that visitors could operate themselves.[260] Each demonstration was led by two students who responded to questions from their peers about their work. These kinds of exchanges allowed members to learn about the practices of their fellow students, promoting collaboration and communication across the club network.

Students also called upon fellow club members for help on specific experiments or apparatus order to work through those projects themselves. When Herbert Reese encountered difficulties in reproducing the formula for building a chemical garden published in the newsletter's "Laboratory Notes," he wrote a letter to the editor asking for advice from other students interested in hydroponics. The editors responded with suggestions of materials he could examine as well as a call for other students to contact him directly with any suggestions.[261] Other students were inspired by the work of fellow members presented at science fairs. When Bob Ross of Bellingham, Washington requested more information on a tin can auto engine presented at the Children's Science Fair, the students responded that they would send him their work plans.[262]

These examples illustrate the ways in which collaboration was at the heart of synthetic culture. Students employed the club network to build relationships with professionals, learn about ongoing scientific developments, and try new activities. Not only did the American Institute encourage interactive engagement through its programs, but members took it upon themselves to reach out to one another to seek out advice and

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[260] Bernard Osbahr, Jr, "Stuyvesantians Entertain American Institute Science Clubs," *March of Science* 5, no. 2, (Nov 13, 1936): 3. N-YHS AI Box 468.

[261] Herbert J. Reese, letter to the editor, *Science Observer* 1, no. 12 (December 1939): 2. N-YHS AI Box 468.

[262] Correspondence between Bob Ross and American Institute, May 1933. N-YHS AI Box 152, Folder 3.

commiseration. In the process, collaboration became a critical component of scientific practice writ large.

## Experimenting with Adulthood

Like the expertise of science fairs described in chapter two, science clubs embraced a more flexible notion of what constituted scientific authority. In the process, they emulated adult scientific engagement while still claiming ownership over their pursuits. One key area of expertise for student science clubs was experimentation. The meaning of experimentation and its counterpart, the scientific method, would change as science clubs and fairs matured in the postwar world. In the context of the American Institute, however, experimentation served as an important tool for training scientifically-minded citizens that relied on faith in children's abilities. American Institute official and progressive educational leader Otis Caldwell perceived children as "natural experimenters." Caldwell argued that "children are always putting questions to nature, then trying to answer their own questions by inquiry and by experiment. Too often their inquiry when addressed to their adult associates is met with belittling discouragement, or worse still by unsatisfying answers. Few things are more important than saving children's natural inquiry and helping them toward honest and engaging answers to these questions."[263] For Caldwell, the American Institute programs encouraged children's innate inclination towards experimentation by providing them with the gentle guidance to seek out answers for themselves, sustaining their wonder of the natural world.

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[263] Otis W. Caldwell, "The Children's Science Fair," radio program script November 5, 1931. N-YHS AI Box 144, Folder 11. For more on Caldwell's role in progressive education, see John L. Rudolph, "Turning Science to Account: Chicago and the General Science Movement in Secondary Education, 1905-1920," *Isis* 96, no. 3 (September 2005): 353-389; and John M. Heffron, "The Knowledge Most Worth Having: Otis W. Caldwell (1869-1947) and the Rise of the General Science Course," *Science & Education* 4, no. 3 (July 1995): 227-252.

Although experimentation served as a way of addressing the goal of training young citizens in scientific inquiry, adolescents also pursued experimentation to gain status among peers. Several clubs required members to present a sample experiment or lecture during meetings to gain feedback from fellow students (Fig. 3.3). The Electron Science Club of Walton High School held a "resourcefulness contest" where members were shown an apparatus and tried to conceive of the proper method for using it. The members who made correct guesses received points.[264] Other clubs requested sample experiments from the American Institute, inspiring the Planning Committee to create a Library of Experiments featuring sample projects available upon request to any club member. The Science Juniors developed a series of questions asked of each experiment, including "What are you trying to find?" "What are you going to use?" "How are you going to do it?" "What did you see especially?" "And last but not least. How does it apply to your everyday life?"[265] By setting up parameters of experimental inquiry, students defined for themselves the importance of experimentation through open dialogue with fellow club members.

Proper experimentation also required skills in visual literacy. According to one club newsletter article, "It is a simple thing to conduct an experiment according to the precepts handed down in a standard textbook; it is another matter to develop a new system or a new method for arriving at a desired result. The former requires careful adherence to written instructions—the latter is based upon keen observation and an understanding of the problem at hand, which, when solved, spells invention and fame."[266] The Photography Salon served as one of the biggest celebrations of observational

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[264] "Do You Know That," *March of Science* 1 no. 6 (January 4, 1933): 2. N-YHS AI Box 468.
[265] "Our Experiments," *Science Leaflet* 13, no. 2 (September 21, 1939):16. N-YHS AI Box 468.
[266] "Learn to Observe," *Science Observer* 2, no. 2 (February 1940): 2. N-YHS AI Box 468.

expertise. The Salon was established in 1938 through a partnership between the American Institute and the Camera Club at Stuyvesant High School, whose students accepted primary responsibility for coordinating the event. Students from across the country submitted photographs they had both taken and processed to be featured in the Education Hall at AMNH.[267] In evaluating the observational expertise as part of the skills necessary to become a skilled photographer, the Photography Salon served as a creative outlet for amateur photographers to showcase both their technical skill and aesthetic talents. Whether through careful observation or commiseration among peers, experimentation served as an important expression of scientific authority.

## **Science in the Household**

Household science served as another field of club activities that embraced a more flexible notion of expertise. Defined as the "field of science as it is related to the home" that also included units on "Consumer Education," household science applied scientific methods to everyday domestic activities. The proposed activities and newsletter columns dedicated to household science prepared students for grappling with the industrialization of the home as well as their role as consumers in the market. Like club activities grounded in observation, the goals of the newsletter sections devoted to household science intended to "go far beyond the possibilities of the textbook"[268] by fulfilling demands by teachers and club members on learning more about "science as related to home making."[269]In this regard, household science encompassed not just home

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[267] "The American Institute First Scholastic Salon of Photography," pamphlet, 1938. N-YHS AI Box 215, Folder 6.
[268] "What is Household Science?" *Science Leaflet* Vol. 14, No. 1 (Sept 12, 1940): 21. N-YHS Box 468.
[269] "Note from the Editor," *Science Leaflet* 13, no. 1 (September 14, 1939): 3. N-YHS AI Box 468.

economics, but also biology, chemistry, technical mastery, and consumer literacy.[270] Household science embraced a range of scientific expertise that transcended disciplinary divides.

Activities included under the umbrella of household science also considered American homes as technological systems.[271] In perceiving the home not as an independent entity but as an integral part of a larger system of technologies and social practices, household science offered opportunities for considering the myriad ways scientific habits of thought could produce a better and more efficient domestic life. Some projects emphasized consumer literacy to discern faulty products or fraudulent claims. One proposed activity encouraged students to observe manufacturer brands, prices, and labeling by comparing and contrasting similar consumer products on the market.[272] Other activities promoted technical skill, such as lesson plans on “managing the refrigerator” or “plumbing in the home.” Additional activities offered information about producing and testing household products. These activities shared a common goal in training students systemically for household management.

Of course, household science carried gendered implications as well. The majority of science projects in this field were created by female students. Indeed, household science served as a welcoming entry point for young women expressing an interest in

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[270] To see how this view of household science coincided with home economics curricula, see Amy Sue Bix, “Equipped for Life: Gendered Technical Training and Consumerism in Home Economics, 1920-1980,” *Technology and Culture* 43, no. 4 (October 2002): 728-754; Sarah Stage and Virginia B. Vincenti, eds. *Rethinking Home Economics: Women and the History of a Profession* (Ithaca: Cornell University Press, 1997); and Megan J. Elias, *Stir it Up: Home Economics in American Culture* (Philadelphia: University of Pennsylvania Press, 2008).

[271] I am borrowing this term from Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York: Basic Books, 1983), 13.

[272] Dorothy Jebb, “Cosmetics and the Consumer: Methods of Approach,” *Science Leaflet* 14, no. 3 (Sept 26, 1940): 29-32. N-YHS AI Box 468.

science. Students often framed their interest in chemistry or physics as a critical skill in discerning household products, one of the many areas of expertise young women needed as they entered the marketplace. Although many of the projects centered on the skill sets of young women, boys were occasionally the focus of household training. In the column “Another Note on Home Economics for Boys,” the author encouraged instructors to consider topics that addressed issues relevant to male students, such as simple mending and sewing, studying the implications of the Pure Food and Drug Act, and managing household finances.[273] However, the work of female students far outnumbered the few references aimed at young men. More commonly, household science served a form of expertise that served as a viable introduction to science for many girls Household science embraced an expansive notion of expertise that coincided with progressive aims in applying scientific methods to everyday experience.

## **Narrating Science**

The spectrum of activities and disciplines represented by Junior Science Clubs presented a unique set of challenges. What activities could unite adolescents with interests that ranged from photography and model airplanes to physics demonstrations and nature study? How could, say, radio hams identify with amateur chemists? Science fairs and related club activities served as critical network forums that allowed groups with disparate interests and practices to develop a shared scientific culture. The magazines published by the American Institute served as mediums for sharing

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[273] “Another Note on Home Economics for Boys,” *Science Leaflet* 14, no. 30 (May 8, 1941): 20, N-YHS AI Box 468.

information among different clubs.[274] These magazines provided an informational lifeline by notifying members with updates regarding other clubs, upcoming events, and suggestions for activities. A critical component to synthetic culture, these network forums also expressed a shared set of values across the club community.

Just as science fair displays operated as visual narratives conveying a unified view of science, clubs embraced narratives as a valid medium of scientific expression. The publications of the American Institute, including *Science Observer, March of Science, Amateur Scientist,* and *Science Leaflet,* served as critical network forums for exchanging ideas with other club members and sponsors. These magazines provided an informational lifeline across the club network by notifying members with updates regarding other club achievements, upcoming events, and suggestions for activities. These publications positioned stories about science as a form of scientific mastery in its own right.

From the onset, the American Institute welcomed narrative expression by inviting students to submit articles about their activities and accomplishments. The Plan Committee distributed tickets for club events to editors of school newspapers and created a press box at central meetings. Editors at the American Institute encouraged students to create their own newsletters, claiming that they served as "a club activity which the Junior Science Clubs believes to be of highest value."[275] Student journalists responded to the call by establishing publications such as *Bio* at Evander Childs High School, the James Monroe High School *Physical Digest,* and *What Stars Are Made Of* by the Junior Astronomers at Hayden Planetarium. These publications promoted interactional expertise

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[274] I am borrowing the term "network forum" from Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).

[275] "Club Publications," *March of Science*, 2, no. 3 (Feb 8, 1934): 4. N-YHS AI Box 468.

where students disseminated information on important club happenings and current events in science.

Club members also negotiated for additional authority by requesting to serve on editorial committees for American Institute publications. In December 1936 a group of students from various New York high schools met at the American Institute headquarters to form their own group, The Science Writers Club. The club was composed of about 50 boys and girls who served as newspaper editors at their respective high schools. The club met weekly to expand the American Institute's publications by including additional articles written by students themselves.[276] In 1937, the American Institute announced that moving forward, the *March of Science* "will be edited, not by the Institute, but by boys and girls in the schools and clubs who are interested in science writing. News of the Institute's activities will still be presented, but the point of view will be that of the student reporter."[277] The Institute called on students to "start your journalistic career now" by serving on the publication staff.[278] The Science Writers Club also created the *Amateur Scientist,* a magazine written, edited, and managed entirely by students themselves. For members of the Science Writer's Club, writing about science served as an important medium for conveying scientific ideas to a broader constituency.

Members both in New York City and eventually across the United States considered these publications a critical lifeline of the club community. As club sponsor Margaret Murley from Sumner, Iowa declared, "Enclosed you will find a slip for my

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[276] Arnold W. Ravin, "The Science Writers Club," *The March of Science* Vol. 5, No. 4 (Feb 23, 1937): 4; C.W. Hutchins, "Seeing is Believing…By the Director," *American Institute Monthly Bulletin* Vol. 1, No. 8 (May 1937): 5-6, N-YHS AI Box 468..

[277] "An Explanation about this Issue of the March of Science," *March of Science* Vol. 5, No. 4 (Feb 23, 1937): 1,. N-YHS AI Box 468.

[278] "Help Wanted—Male and Female," *Amateur Scientist* 2, no. 1 (October 1937): 2. N-YHS AI Box 468.

renewal for your paper *Science Observer.* It has been a great help and inspiration to me and is used by my 7th graders. We are pretty much alone in our science endeavors in this town and it is good to have a paper come enlightening us on the many recent happenings in science."[279] Other members turned to the newsletter to facilitate club activities. The Busy Molecules of Schuyler Lake Union School, New York, used the crossword puzzle of the *Science Observer* as the objective of a race each month.[280] Club sponsor S.M. Constance noted, "My club members haunt me until the *Observer* is placed in their hands. We read every item and reread, comment, and suggest among ourselves."[281] For many clubs, the publications were vital in maintaining a sense of belonging to a broader community of adolescent hobbyists.

The narrative structure of students' submissions varied from standard reports and sample experiments to jokes and playlets. Like many nascent scientific communities, club members fostered a sense of belonging by crafting a history that connected their work to a broader scientific tradition. Clubs paid homage to their disciplinary heritage with official names such as the Gregor Mendel Science Club, Louis Agassiz Club, Mystic Association of Alchemists, and Aristotle Science Club. Club members also submitted research articles featuring stories about the achievements of well-known historical figures like Louis Pasteur, Marie Curie, Joseph Lister, or Charles Goodyear. Writers demonstrated their knowledge by showcasing their prize-winning projects from the Children's Science Fair or providing diagrams of equipment and apparatus they built themselves. Club members expressed whimsy by writing reports connecting science to

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[279] Margaret Murley, Letter to the Editor, *Science Observer* 3, no. 5 (May 1941): 18. N-YHS AI Box 468.

[280] "Active Clubs Everywhere," *Science Observer* 1, no. 5 (April 1939): 7. N-YHS AI Box 468.

[281] S. M. Constance, "Pestered! Letters to the Editor," *Science Observer* Vol. 2, No.5 (July 1940), 12.

leisure, such as Griffith Davis's report on "Sir Isaac Newton at the Races."[282] As students fostered a scientific culture, these imaginative narratives demonstrate how the community's shared values were established from a distinctly adolescent frame of reference.

These stories were not just run of the mill accounts about science; they also embodied a spirit of playfulness. Adolescents wrote poems, jokes, and plays because they were fun. As children, club members possessed flexible boundaries of what counted as legitimate scientific expression. In the poem "Atomic Sonata in B1," student Mary Kelly wrote:

"Atom, little atom
You are so very small
I sometimes sit and wonder
If you are there at all

When Dalton first discovered you
I'll bet he nearly dropped
As tinkering in the Lab, one day
Right up at him you popped…"[283]

Club members also shared jokes, such as "What animal has more lives than cats? Frogs, because they croak every night."[284] Students submitted quizzes, riddles, and crossword puzzles as a playful challenge to fellow club members. One biology club shared a song used to open its meetings: "The Biology Bug will bite you if you don't watch out. If he ever bites you, you will sing and shout, O you gotta get out and find a snake or worm or other bug. That's the study Biology."[285] The enthusiasm captured in this song and other

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[282] Griffin J. Davis, "Sir Isaac Newton at the Races," *Science Leaflet* 13, no. 11 (November 30, 1939): 21. N-YHS AI Box 468.
[283] Mary Kelly, "Atomic Sonata in B1," *Science Leaflet* 14, no. 29 (May 1, 1941): 39. N-YHS AI Box 468.
[284] "Si Ant's Colyum." *Science Observer* 2, no. 4 (June 1940): 16. N-YHS AI Box 468.
[285] "Biology Club Song," *Science Observer* 3, no. 3 (March 1941): 12. N-YHS AI Box 468.

submissions illustrate the playful nature of adolescent club activities that were a critical feature of synthetic culture.

Playlets written and performed by students served as some of the most compelling examples of playfulness. Playlets served as a key activity of science clubs across disciplines, and club magazines featured dozens of sample scripts written by students themselves. The epistemic theme of unity described in chapter two transcended disciplinary divides. According to an anonymous contributor in the *Science Leaflet*, "The best minds of the times in the education field are convinced that the different subjects taught in the secondary schools should be related more closely to each other than they usually are—not taught as distinctly separate disciplines, each to occupy a unique cubicle in the student's mind for all future times."[286] For many clubs, cooperation between English and science departments afforded some of the best opportunities for coordination across fields. Through writing and performing playlets, students shared their beliefs about science by engaging in creative pursuits that crossed disciplinary divides.

A typical trope of these stories placed an emphasis on children's expertise. The playlet "Leeuwenhoek and His Discoveries," for instance, offered a fictional account of Leeuwenhoek and his daughter, Maria. As Leeuwenhoek worked on developing his microscope, Maria served as his active assistant, and it was Maria who in fact encouraged Leeuwenhoek to submit his findings to the Royal Society.[287] Other plays emphasized issues of particular concern to adolescents. In the play "Replacement: A Comedy Romance," grandmother "Mrs. H." Halogen looked after her granddaughters Chlorine, Flourine, Bromine, Postassium, and Sodium as they tried to find appropriate "matches:"

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[286] "Dramatization in Science," *Science Leaflet* 13, no. 2 (Sept 21, 1939): 20. N-YHS AI Box 468.
[287] Violet Brabec, "Leeuwenhoek and His Discoveries," *Science Leaflet* 13, no. 27 (April 19, 1940): 32-36.

Mrs. H.: It's mostly your younger sister who worries me.
Chlorine: Iodine, why?
Mrs. H.: Well, haven't you noticed how susceptible she is to Alcohol?
Chlorine: Why, I had noticed some weakness for him. Do you think it serious?
Mrs. H.: It's just that I believe he is a bad influence. Certainly no good companion for so young a girl!
Chlorine: I admit he has a poor reputation.[288]

These plays valued playfulness as a means for promoting science as both wondrous and within the grasp of student expertise.

Other plays and demonstrations aimed to inspire awe and wonder. Science club newsletters featured articles on putting shows of a "Headless Helena" or "Strong Man," showing illusions of magic or supernatural strength.[289] Students assembled performances such as a "House of Magic" or a "Magic Troupe" to convey the mystical wonders of science while also demonstrating their own scientific abilities.[290] The featured plays provided counsel not just on learning the magic tricks but also staging the performance. In the playlet "The Al-Chemist" performed by the Chemistry Club of Hastings, Nebraska, the lead "Al-Chemist" was encouraged to dress in a "black robe with a tall, peaked hat and with a long peaked beard. The other chemists who perform the tricks are dressed in black robes with black turbans." Building on the Orientalist themes such as those featured in the magic show programs of chemistry sets, the "Al-Chemist" demonstrated his mastery of the elements by turning water into wine, making artificial milk, and bringing ice from infernal flames. Although the written script provided detailed instructions for creating the experiments, the scientific principles behind the spectacles were never

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[288] "Replacement: A Comedy Romance," *Science Leaflet*, 14, no. 4 (Oct 3, 1940): 36-38; "Replacement- a Comedy Romance Continued from Last Issue" *Science Leaflet* 14, no. 5 (Oct 10, 1940): 40-41, N-YHS AI Box 468.
[289] "You, Too, Can be a 'Strong Man,'" *Science Observer* 2, no. 3 (March 1940): 11. N-YHS AI Box 468.
[290] See, for instance, "Club Briefs," *Science Observer* 2, no. 9 (December 1940): 15. N-YHS AI Box 468.

revealed to the audience.[291] Even as science club newsletters frequently featured articles discrediting mystical variations of science by debunking beliefs in superstitions, telepathy, or astrology, students still approached these topics as a playful outlet for conveying their scientific authority.[292]

## Staging Performance: The Science Congress

The dramatic value of students' playlets also reflected a critical element of interwar science clubs: performance. Science club activities such as playlets or science congresses promoted not just learning about science, but expressing it to a wider audience. Linked to the virtue of observation, performance served as a means for verifying knowledge and for conveying it to a community of peers. The American Institute Science Congress served as most prominent example of student performance. Modeled after the professional meetings of the American Association for the Advancement of Science, Science Congresses invited students to share their research with fellow club members. In explaining the importance of the Science Congress, Meister declared, "We must recognize the appeal which adult activities make to the adolescent mind. The Congress is like the meeting of the American Association for the Advancement of Science. The true scientist does not hide his discoveries from the world. He seeks full and free discussion by his colleagues."[293] The Science Congress, then, operated as an exercise in socialization whereby students learned how to express their

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[291] P.W. Evans, "The Al-Chemist," *Science Leaflet* 13, no. 20 (February 14, 1940: 32-40. N-YHS AI Box 468.

[292] See, for instance, "Astrology," *Science Observer* 3, no. 5 (May 1941): 2. N-YHS AI Box 468.

[293] Morris Meister, "Why a Science Congress?" *March of Science* 2, no. 5 (May 8, 1934): 1. NYHS Box 468.

ideas to an audience and receive feedback on both the quality of their work and their powers of persuasion.

The Science Congress served as the annual capstone event for science clubs that was guided by the expertise of students themselves. In order to present their work, students first submitted proposals to a panel of adult judges. The judges vetted the projects based on a series of criteria evaluating both the demonstrations' content and dramatic value. The judges then set up a series of panels by grouping projects according to theme. The program itself, however, was conducted primarily by students themselves. After each demonstration, a student leader (under the guidance of an adult facilitator) fielded questions and guided discussion.[294] Although the demonstrations were not ranked like science fair projects, adult judges occasionally selected the best demonstrations for prizes, such as a trip to General Electric Schenectady plant and research laboratory.[295] This format brought clubs together to learn and evaluate the work of fellow members with the presumption that students learned better from one another than from programs led primarily by adults.

Students enjoyed the Science Congresses as a means for observing the creative work of their peers. In 1934, almost 7,000 students across New York City attended the Science Congress.[296] Student demonstrations reflected the range of specialties of different club members. Inspired by a lecture by John A. Clark, Chairman of the Physics Department at Alexander Hamilton High School, Mariam Gold demonstrated a series of experiments with a Bunsen flame. Seymour Lewis of the Agassiz Club of Lafayette High

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[294] "Junior Science Clubs of the American Institute Holds Science Congress," press release, ca. 1934. N-YHS AI Box 158, Folder 20.

[295] "Don't Forget the Science Congress: Entries Due November 21st," *March of Science* 5, no. 2 (November 13, 1936): 1. N-YHS AI Box 468.

[296] Meister,"Why a Science Congress?"

School in Brooklyn showcased live reptiles for his presentation entitled "Snakes, Unloved Friends of Man." Charles B. Miller and Gordon Van A. Graham of Newton High School demonstrated a new commercial method for the preparation of white lead.[297] Presentations generally featured a range of interactive materials such as sample experiments, collections of specimens, charts and graphs, or demonstrations of equipment and apparatus. The Planning Committee noted that student-led congresses generally resonated better than talks by adult scientists. At one school, there was so much interest that organizers called the police to help send students home.[298] Science Congresses served as a popular forum across the club network where students could show off their skills and commiserate with likeminded peers.

Judges' notes and selection criteria of Science Congresses similarly reveal the importance of performance as a scientific virtue. The emphasis of what counted as the key elements of performative expression evolved as Science Congresses matured. In 1933, the selection committee judged projects based on questions such as: "What is the nature of the paper or demonstration? What is its merit? What equipment will be needed? How much time will be required for an effective presentation? Is the demonstrator a good speaker?"[299] These criteria emphasized the abilities of the presenter, focusing on their scientific acumen and the merit of their work. By 1939, judges evaluated projects based on questions like: "Was the exposition clear to the audience? Was the demonstration scientifically accurate? Was the demonstration original? Were the demonstration materials adequate? Was the audience interested?" Although several of these parameters

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[297] For examples of student projects, see N-YHS AI Box 163, Folder 19; Box 224, Folder 36; and Box 163, Folder 19.

[298] Junior Science Clubs Plan Committee, meeting minutes, June 12, 1933. N-YHS AI Box 151, Folder 1.

[299] Science Congress, judging requirements, 1933. N-YHS AI Box 159, Folder 14.

overlapped with earlier criteria, the questions focused more on the anticipated reactions of the audience.

Judges' evaluations of projects reflected this shifting priority. Some comments focused on the content or originality of the proposed presentation. One judge wrote on Grover Cleveland High School student Christine Treuner's talk on "Methods of Vegetative Propagation" that she should "return next year with something more unusual and original."[300] However, in general judges focused more on the performance skills of presenters, making comments such as "lucid and thorough and logical, but so technical and full of formulae that many parts of it were too for 'above' audiences" or "hesitation marked…timbre good…slight stammering, use of 'ah.'"[301] In these instances, the mode of delivery was valued as highly as the content of the demonstration itself. In this regard, Science Congresses served as an introduction to the performative nature of science and the role of effective presentation in conveying evidence.

Performance, alongside narrative, expertise, collaboration, and playfulness, served as the key set of tenets of synthetic culture for youth science clubs during the 1930s. Whether through writing creative playlets, setting up interclub meetings, or facilitating student-led demonstrations, club members shaped the underlying beliefs and practices of their nascent scientific community. Although club members' interests ranged across an array of disciplines, these common values unified their disparate interests under a common vision that valued students as legitimate scientific practitioners. Ultimately, these virtues both demarcated and expanded the notion of what counted as scientific at a

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[300] Science Congress, judging records, 1939. N-YHS AI Box 217, Folder 16.
[301] Ibid.

moment when club members began to view themselves as part of a larger movement of student scientists.

## Communities of Practice

Although the club network shared several underlying values, students' broad range of interests and activities required more nuanced practices, beliefs, and expressions of science that were particular to each club. The following section analyzes the inner workings of individual clubs and the contours of these distinct communities of practice. In evaluating the ecologies of clubs through a careful analysis of their spatial, material, and regulatory domains, it argues that these distinct communities of practice shaped adolescents' understanding of science as a collaborative process, one they helped define for themselves.[302]

Individual club practices depended on organizing an overarching structure and establishing leadership roles for students. The American Institute encouraged clubs to set up a system of rules and officer positions. Club presidents served as liaisons for sharing information with their clubs and were frequently consulted by the American Institute for their opinions on ongoing programs. The American Institute also held meetings where student officers planned events, learned about ongoing programs, and informed officials about the needs and challenges facing their clubs.[303] The American Institute also offered model club constitutions, suggesting possible goals and aims, eligibility for membership, election of officers, and sample rules and regulations.[304] Clubs employed constitutions as

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[302] The notion of "ecologies of practice" described in the dissertation introduction serves as a useful starting point for situating these scientific communities within a broader social, material, and spatial context.

[303] President's meeting- November 6, 1937, N-YHS AI Box 196, Folder 4; "AISAE Club Presidents Meet," *Science Observer* 1, no. 12 (December 1939): 7. N-YHS AI Box 468-3.

[304] "A Model Constitution for Junior Science Clubs with Alternative Suggestions," ca. 1933. N-YHS AI Box 160, Folder 2.

a means of identifying the key objectives of the group while maintaining an organizational structure.

Clubs also created rewards systems and modes of distinction for their members. The Futurians Science Club of West Tampa Junior High School restricted membership to students who attained a "B" average or higher in science classes.[305] The Engineers Club of Central High School, Kansas City, Missouri presented a gold watch to the most successful student of its 100-member club.[306] Club initiations also served as a common ritual (in spite of the American Institute's discouragement of humiliating new members). The Xenon Science Club of Evanston, Wyoming submitted their new recruits "to humorous indignities in order to become members of the club, which up to then had twenty-seven members enrolled."[307] The American Institute also suggested that students develop a point system for evaluating participation.[308] The American Institute presented pins to all new members and added exclusivity to club events by requiring students to present tickets or membership cards.[309] Members of the science club in Keokuk Iowa appreciated the club pins, membership cards, and charter that they received as part of their membership. Even though they were located in a remote area, according to club sponsor Sister Mary Gertrude, "At present we feel like we really *belong* to your club."[310] Badges of distinction for American Institute members fostered a sense of belonging across the club network.

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[305] "Active Clubs Everywhere," *Science Observer* 1, no. 6 (May 1939): 7. N-YHS AI Box 468.

[306] "Science Club Notes: Merry Molecules Play Chemical Games," *Science Leaflet,* 14, no. 5 (October 10, 1940): 40. N-YHS AI Box 468.

[307] "Active Clubs Everywhere," *Science Observer* 1, no. 4 (March 1939): 7. N-YHS AI Box 468.

[308] Morris Meister, "Organization of a Science Club," ca. 1933. N-YHS AI Box 160, Folder 2.

[309] See, for instance, "Bell Laboratories Demonstration," *March of Science* 3, no. 2 (October 19, 1934): 1. N-YHS AI Box 468.

[310] Sister Mary Gertrude, "Letter to the Editor," *Science Observer* 3, no. 1 (January 1941): 17. N-YHS AI Box 468.

Students also met the needs of their clubs by exchanging materials using the "Barter and Exchange" and "Let's Swap" sections of club newsletters. Members placed ads asking for specimens or equipment they lacked as well as offering items they could provide to other clubs. Sample items included wood, reptiles, rats, bones, rocks and minerals, insects, and mice.  Members also made invitations for guest student speakers to present at their school or organization. In these cases, students were just making requests for goods and services, but they also served as experts who were willing to share their supplies and expertise with fellow members.

Space served as another area that club communities negotiated to meet the particular demands of their hobbies. Club members built darkrooms, aviaries, museums, herbariums, and amateur weather stations to facilitate their activities. Students often needed to develop creative solutions for securing necessary space and equipment.  The Catholic Boy's Brigade transformed a small brick storeroom into a "woodland hut, furnished like the cabins of old, where they could hold their meetings and woodcraft studies."[311] By covering the walls in burlap and building rustic shelving out of logs, the club members created a headquarters that served as a nature-inspired oasis standing apart from its urban surroundings. School spaces in particular proved challenging for club members. Three ham radio operators at Bayside High School in Bayside, New York gathered information about radio operations at other schools to build a case for creating a station for their club. They convinced their high school science teacher to provide a space for their rig of transmitters and receivers in the science classroom as well as rooftop

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[311] Major George W. Sommer, "Catholic Boy's Brigade of the U.S. St. Michael's Company," *March of Science* 1, no. 4 (Nov 9, 1932): 4. N-YHS AI Box 468.

access for positioning their antennae.[312] In this regard, spatial negotiations provided opportunities to not only meet the demands of specific club activities, but they also served as opportunities for members to articulate the value of their scientific endeavors to outside authorities.

Safety served as another key area where clubs developed their own sets of regulations. Some sponsors worried about the safety of their members more than others. The use of explosions, handling of toxic chemicals, or tinkering with industrial equipment served as common practices for clubs (Fig. 3.4). The Science Club of Fort Plains High School in Fort Plains, New York decided to raise money by inviting students to visit the laboratory of chemical performances and demonstrations. Club members dazzled audiences through dry ice demonstrations of bursting balloons, hydrogen soap bubbles, disappearing pennies (by immersing them in nitric oxide), and a miniature volcano. For inspiration, the club relied on suggestions in the *Science Leaflet,* such as the demonstration of “Cold Fire” whereby students added a solution onto their hands and lit them on fire to produce the illusion of burning limbs. The performance concluded when the words “The End” on a paper with a saturated solution of yellow phosphorus in carbon disulphide suddenly burst into flames.[313] The presentation contained warnings for students regarding the proper technique of each experiment. However, the element of danger remained a key component of the dramatic value of the presentation itself. Safety was considered an essential part of scientific training, but students and sponsors navigated flexible boundaries over what constituted proper safety measures on an individual club basis.

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[312] George Raney, “Calling ‘CQ,’” *Amateur Scientist* 2, no. 4 (Jan 1938): 8-9, 16. N-YHS AI Box 468.

[313] “Putting on a Show in the Chem Laboratory,” *Science Observer* 3, no. 5 (May 1941): 16- 17. N-YHS AI Box 468.

Animal testing served as another area with flexible boundaries where the rules depended upon each club community. By and large, the American Institute offered little instruction on the appropriate usage of animals in experimentation. The American Institute's Library of Experiments, for instance, provided clubs with an experiment to see how white mice fail to grow without Vitamin A without information regarding the proper care and treatment of animals. According to the instructions, "The animals receiving the [vitamin A] supplement should grow nicely whereas the controls on the vitamin free diet only will lose weight and eventually die."[314] Without much guidance from the American Institute, clubs took part in a range of activities involving live organisms. Several clubs worked on genetics and animal development through experiments such as crossing guinea pigs or observing the development of live chicken embryos.[315] The Bronx House in New York City built a refrigeration unit to study the effect of "frozen sleep" upon animals to gauge if artificial hibernation can relieve pain or disease.[316] Raphael Miller of the Biology Project Club at Grover Cleveland High School presented a project at the Science Congress on "The Effect of Drugs on the Live Frog Heart."[317] In each instance, the decisions regarding the appropriate treatment of animals were left to the judgment of individual club members. Animal experimentation and other inner club activities illustrated how individual clubs established internal structures of values and beliefs. These communities of practice shaped how students systematically established their own parameters of proper scientific engagement.

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[314] "Vitamin A Free Diet for Experimental Work on White Mice," sample experiment, ca. 1933. N-YHS AI Box 152, Folder 3.

[315] "Wilson High School Science Club, Rock Rapids, Iowa," *The Science Leaflet* 14, no. 2 (Sept 19, 1940): 37; "Science Club Corner," *Science Leaflet* 13, no. 18 (January 31, 1940): 38. N-YHS AI Box 468.

[316] "Club Briefs," *Science Observer* 3, no. 4 (April 1941): 16. N-YHS AI Box 468.

[317] "Science Club Corner," *Science Leaflet* 13, no. 22 (February 28, 1940): 36. N-YHS AI Box 468.

Ultimately, the underlying values of synthetic culture shaped who participated in science clubs and fairs and for what purpose. The gender makeup of both science fairs and clubs remained predominantly male throughout the 1930s. Female students typically only constituted 20% of individual science fair projects. When evaluating the composition of club entries, however, female participation jumped to between 35% and 40%, suggesting that the virtue of collaboration proved particularly appealing to female students.[318] In addition, the vast majority of poems and plays (over 75%) were written by girls, serving as an outlet that celebrated a more interpretive form of expertise. In addition, the majority of students were second generation immigrants. According to a survey for one American Institute children's program, 81% of students had at least one parent born outside of the United States, and 6% of students themselves were also foreign born. Most parents were born in European countries such as Germany, Poland, Hungary, Austria, or Italy.[319] Students of Jewish descent were particularly drawn to participating in science clubs and fairs. At the same time, I have found few examples of African American students or children from other ethnic groups participating in the American Institute programs. If synthetic culture embraced a broader conception of scientific expertise, it still carried limitations on who envisioned themselves as belonging to this community.[320]

## **Conclusion: Westinghouse and Science Clubs of America**

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[318] Based on names of participants listed on club rosters, 1937. N-YHS AI Box 196, Folders 7-11 and Box 197, Folders 1-2.

[319] Based on responses by student applicants to the American Institute Laboratory, 1940-1941. N-YHS AI Box 223, Folders 1-4.

[320] On different kinds of expertise, see Harry Collins and Robert Evans, *Rethinking Expertise* (Chicago: University of Chicago Press, 2007). On the scientific education of girls and women in the early twentieth century, see Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: The Johns Hopkins University Press, 1982); Tolley, *The Science Education of American Girls.*

On the eve of World War II, the synthetic culture of the Junior Science Clubs program began to deteriorate. As the nation turned its attention to securing its safety, the goal of encouraging leisure for its own sake began to be supplanted by the mission of seeking out the most talented students for future careers in science and engineering.[321] The Junior Science Clubs program was also the victim of its own success. In 1938, the American Institute opened membership to clubs outside of New York. As the program attracted a national constituency, the number of participants tripled from 6,000 students in 1938 to over 18,500 students in 1939 (Fig. 3.5).[322] Faced with the strains of managing a program that grew in popularity quicker than the financial means to support it, the American Institute partnered with Westinghouse Electric to secure sponsorship for its programs. The collaboration formed just in time to make plans for the 1939-1940 World's Fair, fortuitously held in New York City. The theme of the World's Fair, "Building the World of Tomorrow," symbolized the optimism that Americans could overcome economic and social turmoil to create a future of peace and prosperity.[323] To celebrate this theme, Westinghouse arranged a working laboratory at its fair pavilion for science club members to conduct experiments and display their scientific acumen to crowds of onlookers. The underlying philosophy of the laboratory hung prominently on

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[321] See Sevan G. Terzian, *Science Education and Citizenship.*

[322] "Membership in the A.I.S. & E. Clubs Was Trebled During Year," *Science Observer* 1, no. 11 (November 1939): 1. N-YHS AI Box 468.

[323] See Joseph J. Corn and Brian Horrigan, *Yesterday's Tomorrows: Past Visions of the American Future,* ed. Katherine Chambers (Baltimore: The Johns Hopkins University Press, 1984); Helen A. Harrison and Joseph P. Cusker, *Dawn of a New Day: The New York World's Fair, 1939/40* (New York: Queens Museum and New York University Press, 1980); Rosemarie Haag Bletter, *Remembering the Future: The New York World's Fair from 1939 to 1964* (New York: The Queens Museum, 1989).

the wall: “Westinghouse believes in the boys and girls of today. They are the men and women of tomorrow.”[324]

This tagline captured the changing character of youth science programs during the late 1930s and 40s. When its contract with the American Institute ended in 1942, Westinghouse stopped its financial support, partnering instead with the Science Service to form the Science Clubs of America and Science Talent Search. These new programs focused less on the broad objective of promoting experiential learning and more on grooming the next generation of scientists and engineers. This shift signaled a change towards an analytical culture, one that promoted individualism, ingenuity, and argumentation.

Facing mounting economic pressure, in 1941 the American Institute announced that its science clubs program would be taken over by the Science Service, a nonprofit science news organization located in Washington, DC. “The program met with unparalleled success and resulted in the organization of over 800 clubs. Indeed, the movement expanded beyond the present capacity of the Institute to service all of the Clubs and foster their related activities,” American Institute President Dr. H.C. Parmalee declared. "Speaking for The American Institute, I commend the joint plan as a step in the achievement of common objectives; and I believe that both working together can accomplish more than each separately."[325] Whereas the Science Service would operate the club program under the new title Science Clubs of America, the American Institute would continue to manage the youth activities in New York City. The two organizations

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[324] “Until A.D. 6939,” *Science Observer* 2, no. 8 (Nov. 1940): 3-4; “Editorial,” *Science Leaflet* 14, no. 20 (Feb. 20, 1941): 3-4, 37-38. N-YHS AI Box 468.
[325] “Science Service Backs Science Clubs Movement,” *Science News-Letter* 40, no. 13 (September 27, 1941): 204.

planned on forming a joint committee to oversee the transition. The Science Service's publication *Science News-Letter* temporarily featured articles in the tradition of the American Institute's *Science Observer.*[326] By the mid-1940s, however, the partnership had all but dissolved. With the financial backing of Westinghouse, the Science Service continued to expand its youth programs nationwide. The American Institute, on the other hand, was forced to stop its science fair programs until after World War II. Within a few short years, the American Institute was replaced by the Science Service as the leading organization of youth science engagement in America.

The Science Service kept many of the same guidelines of the American Institute club program while expanding membership opportunities beyond adolescents. For a fee of $2, members received a certificate of affiliation, membership cards, how-to booklets, bulletins, and news updates. The Science Service did not limit participation to children. Instead, it encouraged intergenerational exchanges brought about by adult membership, declaring in one promotional article, "Young scientists need the guiding spirit of college men and graduates; they in turn, find affiliation with specialists desirable and helpful."[327] The Science Service also encouraged science engagement within families. According to Science Service Director Watson Davis, "Age or youth is no barrier to such useful activities. In fact, fathers and sons and mothers and daughters often become members of the same club on a plane of equality in interest and effort."[328] Some parents organized clubs for their own children. Ira J. Laufer's father sponsored the Junior Research Society,

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[326] The last mention of the *Science Observer* appeared in the November 13, 1943 issue of the *Science News-Letter.*

[327] "Even in War, Science Saves More Than it Destroys," *Science News-Letter* 41, no. 1 (January 3, 1942): 3-4.

[328] Watson Davis, "Science for Everybody," *Science News-Letter,* 40, no. 17 (October 25, 1941): 262-263.

a group of boys who studied living organisms on Ira's dining room table.[329] Although the Science Service still regarded teachers as key facilitators of science clubs, its elimination of age requirements and invitation for parental involvement also invited other adults to take part in the movement.

Initially, Science Clubs of America still advocated in training a broad-based citizenry. In comparison to the more meritocratic programs of the Science Service such as the Science Talent Search or National Science Fair, science clubs were intended to encourage all students to engage in science. According to Davis,

> "For every club member who will become a professional scientist there are hundreds who will not. For most of the school science hobbyists, science will remain a hobby throughout life, whether they become lawyers, merchants, housewives or some other variety of the great public. For these non-professional scientists of tomorrow, the serious fun they have in science clubs is one of the richest experiences of their youth. They will be better equipped to live in a scientific world and control the results of science so that civilization will progress rather than be wiped out."[330]

With the continued objective of encouraging students' broad scientific interests, many club activities remained consistent with the programs of the 1930s. Science congresses, school plays, museum exhibits, and chemistry shows continued to make the headlines of the *Science News-Letter* during the early 1940s (Fig. 3.6).[331] These activities embodied the playfulness of the original American Institute programs.

At the same time, American involvement in World War II fundamentally altered the tone and direction of science clubs activities. According to Davis, "Scientific hobbies can be much more than mere leisure time activity, amusement or recreation. They can even aid materially professional science research programs. In the organization of home

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[329] "Science Clubs of America," *Science News-Letter*, 41, no. 6 (February 7, 1942): 92-93.

[330] Watson Davis, "Youth Learns Science," *Science News-Letter* 52, no. 14 (October 4, 1947): 218-219.

[331] See, for instance club correspondences in *Science News-Letter* 40, no. 20 (November 15, 1941); *Science News-Letter* 40, no. 21 (November 22, 1941); and *Science News-Letter* 40, no. 22 (November 29, 1941).

defense now underway, science club members can take a leading part in the more technical phases of protecting America."[332] No longer simply a leisurely pursuit intended for self-fulfillment, youth science engagement transformed into a national imperative. The Science Service called on students to support the war effort by building scale-model airplanes to assist the Navy in aircraft recognition, "Invent for Victory" by submitting innovative suggestions to the National Inventors Council, or by conserving energy, paper, and other resources.[333] Clubs responded to the call with vigor (Fig. 3.7). Students of the Bio Club at Chapman College in Los Angeles, California offered public demonstrations on restricted diets for food rations.[334] The Agassiz Club of Great Neck, New York developed a victory garden at their school.[335] Students across the nation responded to the War Administration's request for collecting milk-weed floss by gathering over 1,700,000 pounds for use in life preservers.[336] By supporting the war effort, science clubs moved beyond avocational pursuits to serving the needs of the nation.

Clubs' engagement in national security coincided with the rapid expansion of SCA. Between 1942 and 1943, membership increased 300%, with over 2,500 clubs in all 48 states as well as international members residing in Cuba, Puerto Rico, Canada, and Portugal.[337] In 1946, Bloom Radio Club in Chicago, IL became the 10,000th club to secure affiliation with SCA.[338] Witnessing the program's success, UNESCO officials invited Watson Davis to speak on the American club movement in hopes of using SCA as

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[332] Watson Davis, "Science for Everybody," *Science News-Letter* 40, no. 17 (October 25, 1941): 262-263.

[333] "Science Clubs of America to Cooperate With Navy," *Science News-Letter* 41, no.7 (February 14, 1942): 104; and Joseph H. Kraus, "Amateur Scientists Can Help America," *Science News-Letter* 41, no. 2 (January 10, 1942): 24-25.

[334] "Science Clubs of America," *Science News-Letter* 41, no. 14 (April 4, 1942): 221.

[335] "Science Clubs Help Win War," *Science News-Letter* 43, no. 14 (April 3, 1943); 220.

[336] "Boys and Girls Exceed Milkweed Floss Quota," *Science News-Letter*, August 4, 1945.

[337] "Young Scientists Work," *Science News-Letter* 44, no. 16 (October 16, 1943): 254-255.

[338] "Science Club No. 10,000," *Science News-Letter* 50, no. 3 (July 20, 1946): 36-37.

a potential starting point for establishing a network of international clubs. Although science youth initiatives were already forming in countries like Czechoslovakia, Denmark, Holland, Latin America, and the Soviet Union, the well-established programs of the Science Service served as a model to the rest of the world.[339] The SCA eventually eliminated its membership fee, further boosting enrollment. By 1949, the SCA boasted 15,000 clubs located both domestically and abroad.[340] Although the Science Service continued to allow adults to join, the vast majority of members remained adolescents. The club network had grown exponentially from its origins at the American Institute. In its place, an international movement reflecting the national objectives of the postwar world had begun.

From its origins in New York City to its postwar position as an international model of youth engagement, the American Institute Science Clubs program facilitated a movement of students who began to identify as part of a growing network of adolescent hobbyists. In promoting self-guided learning, the clubs offered a space for adolescents to engage in sustained scientific engagement that was driven by their own volition. The clubs served as individual communities that maintained distinct practices and beliefs surrounding the material, spatial, and social parameters of scientific expertise. At the same time, the club movement facilitated network forums that brought students from different disciplines and geographic locations to identify as part of a larger community of enthusiasts. By promoting virtues such as collaboration, playfulness, and narrative, the

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[339] "Science Clubs Abroad," *Science News-Letter* 56, no. 6 (August 6, 1949): 85; Science Service Records, ca. 1910-1963, RU 7091, Smithsonian Institution Archives (hereafter cited as SSR) Box 273: Folder 2; SSR Box 305, Folder 1; SSR Box 418, Folder 13; SSR Box 418, Folder 14; SSR Box 446, Folder 33.

[340] Margaret E. Patterson, "Clubwork Makes Science Fun," *Science News-Letter* 56, no. 12 (September 17, 1949): 186-188.

club network served as a critical component to the synthetic culture of adolescent scientific communities during the 1930s. With the onset of World War II, however, these values began to shift. As the final two chapters demonstrate, the programs and fairs of the Science Service promoted a different vision of scientific expertise. In effect, it would transform adolescent synthetic culture to an analytic culture by bringing forth a new set of scientific norms and values.

Figure 3.1 Mr. Carr’s Junior Science Group, December 1933. AMNH Negative Logbook 18; Image Number 314307; American Museum of Natural History Archives.

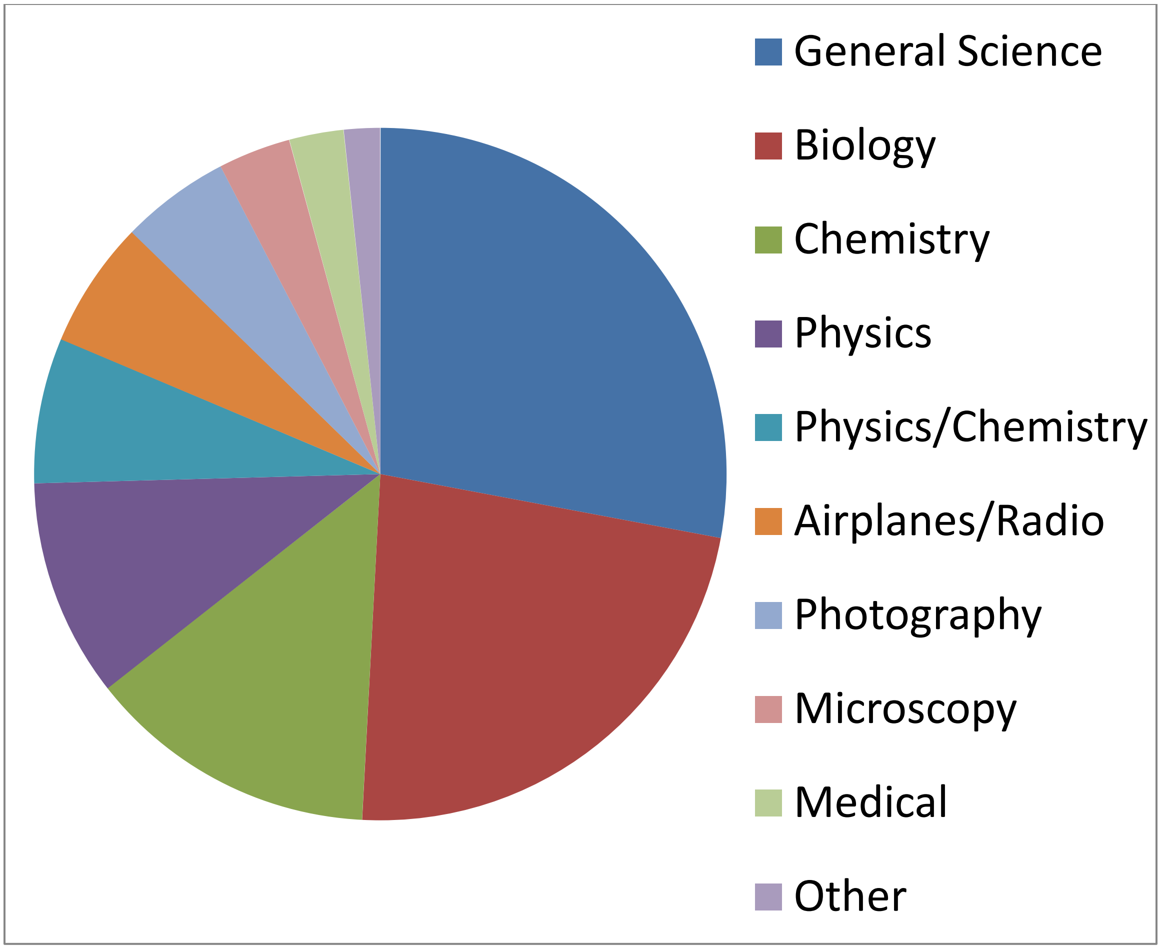


Figure 3.2 Distribution of science clubs by category, 1933. Figure made by author.

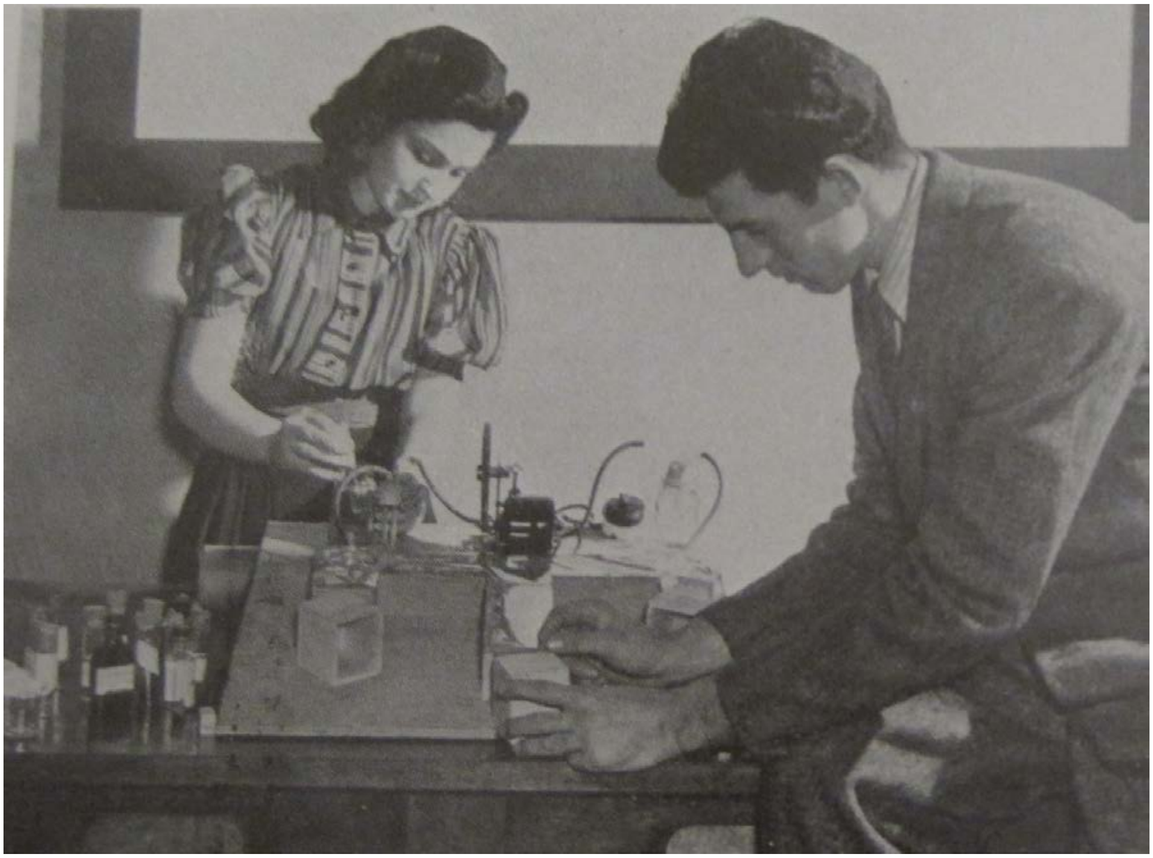


Figure 3.3 Selma Friedman and Nicholas Sanmartano of Evander Childs High School. The students conducted an Odoermeter experiment to determine the most attractive scent to insects. Source: *Science Observer* 3, no. 3 (February 1941): 19.

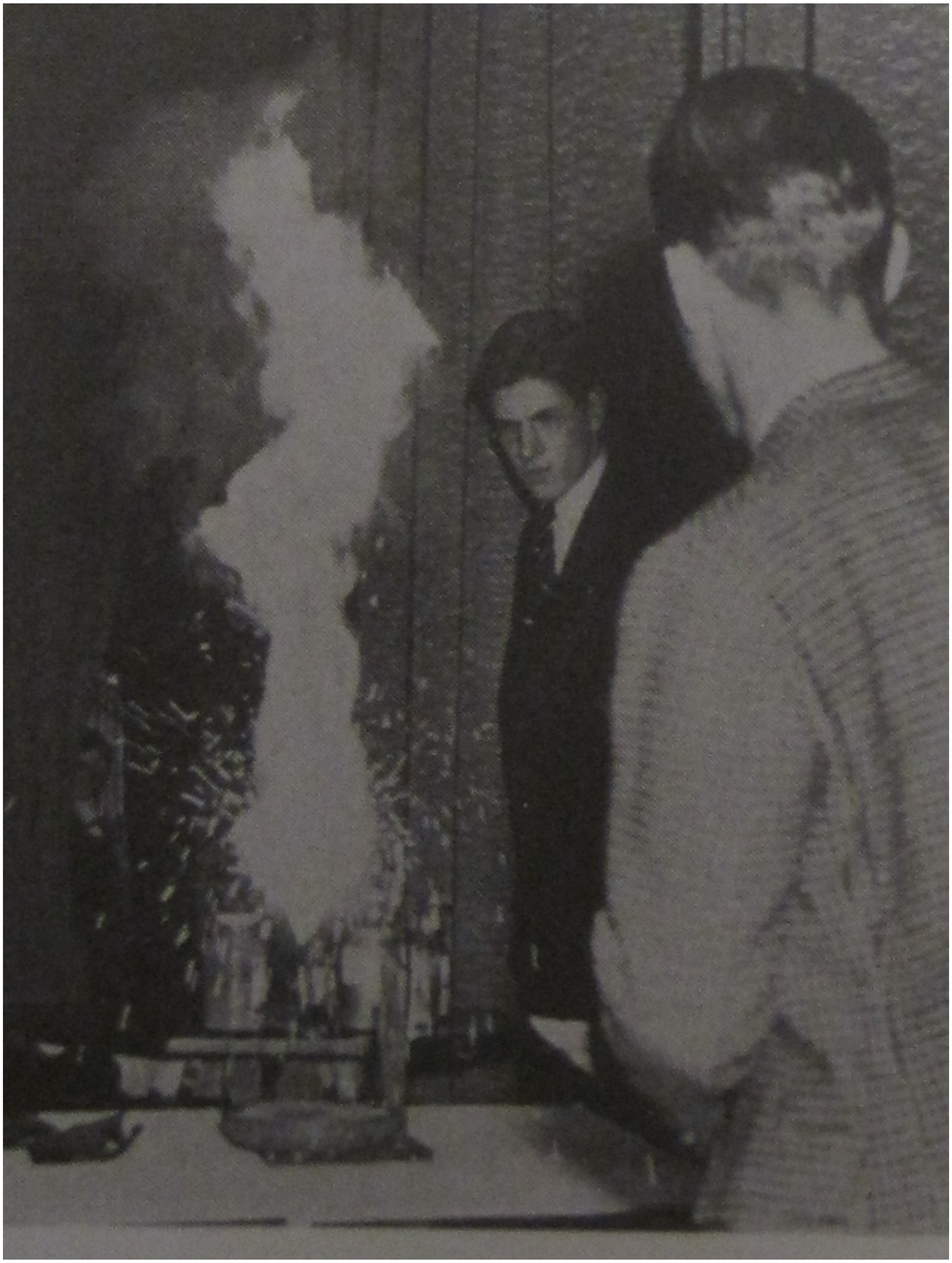
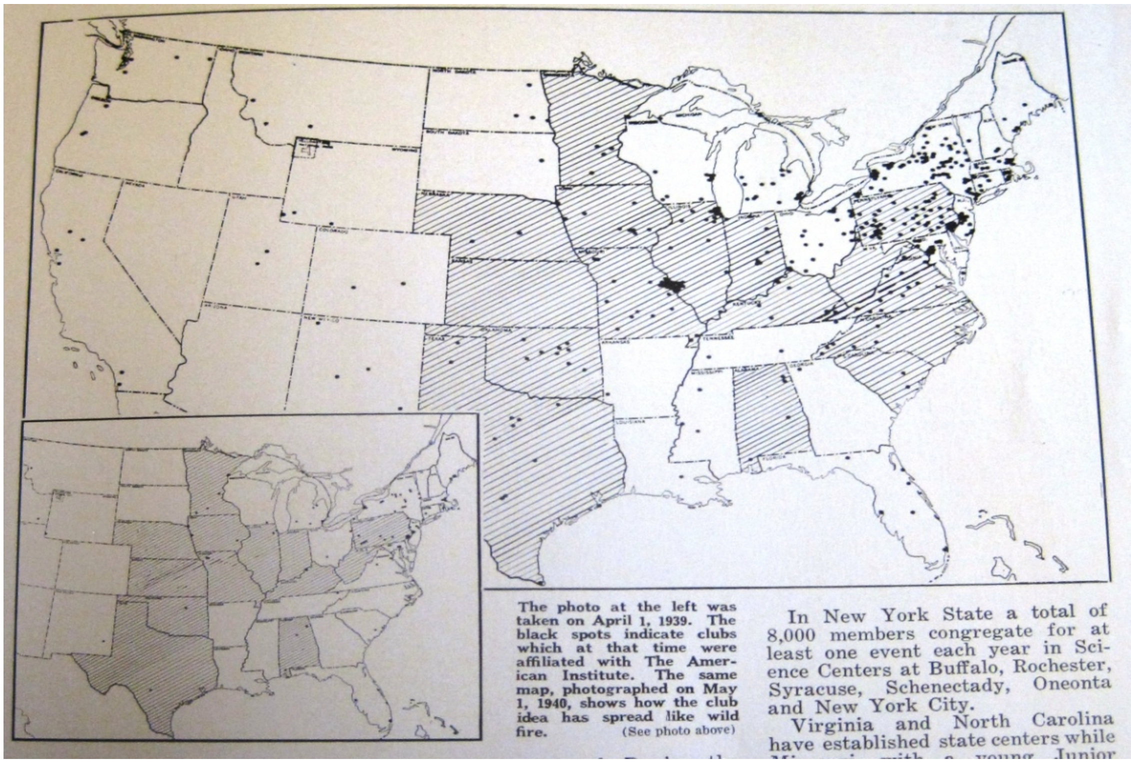


Figure 3.4 Leon Goldman and William Coombs of Franklin High School. The students delivered the lecture “What is Back of Incendiary Warfare” at the Rochester Science Center Congress. Source: *Science Observer* 3, no. 3 (February 1941): 15.



The photo at the left was taken on April 1, 1939. The black spots indicate clubs which at that time were affiliated with The American Institute. The same map, photographed on May 1, 1940, shows how the club idea has spread like wild fire. (See photo above)

In New York State a total of 8,000 members congregate for at least one event each year in Science Centers at Buffalo, Rochester, Syracuse, Schenectady, Oneonta and New York City.

Virginia and North Carolina have established state centers while

Figure 3.5 Club membership expansion between 1939 (left) and 1940 (right). Source: *Science Observer* 2, no. 6 (August-September 1940): 19.

Figure 3.6 Student presentation at the 1947 Oneonta Science Congress. Courtesy Society for Science and the Public Science Photograph Collection.

Figure 3.7 Members of the Kenwood High School Science Club. The Baltimore, Maryland-based club purchased three jeeps for the Sixth War Loan Drive, 1944. Courtesy Society for Science and the Public Photograph Collection.

# PART 3

## Analyzing Science

Forty high school finalists arrived in Washington, DC to compete in the 1948 Seventh Annual Science Talent Search (STS) (Fig. Part3.1). Sponsored by Westinghouse Electric, the Science Talent Search sought out the country's brightest high school seniors via a rigorous selection process that evaluated students' intellect and academic accomplishments. Not only did participants have a chance to compete for scholarship money, but they joined an elite alumni network. Raymond Schiff, winner of the 1943 STS Grand Science Scholarship, spoke to the participants regarding his perspective as a recent Harvard graduate who started a career working as an engineer at Westinghouse. "The scientist must be a functioning citizen if he is to survive as a scientist," Schiff asserted. "The scientist's fellow-citizens are now in the mood to defend and promote science, but they cannot be reasonably expected to do much on behalf of science unless the scientist himself participates in their efforts."[341] Schiff argued that these talented students' role as future scientists entailed not just performing their jobs in the laboratory but in applying science for the good of the nation.

Schiff's position that students needed to consider the broader ethical considerations of their work reflected a sentiment that resonated with many adolescent hobbyists who came of age in the atomic era. The science competitions of the 1940s and 50s operated in a different sociopolitical landscape than their Depression-era

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[341] "Science Talent Institute," *Science News-Letter* 53, no. 10 (March 6, 1948): 150.

predecessors. Extracurricular science was less an expressive outlet of free play and more a mechanism of socialization that prepared students for the postwar world. In the years leading up to *Sputnik*, adolescent scientific culture itself changed accordingly. Chapters four and five investigate this transformation through an analysis of the programs of the Science Service: the Science Talent Search and National Science Fair. These competitions would galvanize the science fair movement to serve as a national and international standard for scientific extracurricular engagement. The students who participated in the Science Service programs developed a set of values that differed from the synthetic culture of the 1930s American Institute clubs and fairs. The competitions were intended to introduce students to the norms of the professional scientific community while also establishing a set of values that adolescents should adhere to in their independent scientific pursuits. Rather than celebrating the virtues of playfulness, collaboration, and narrative, this new value system prized experimentation, individualism, and persuasion. In the process, adolescents began to view themselves as serious practitioners who developed their own, often ambivalent, perspectives on the position of science in society.

Americans began to question the value of science after witnessing the devastation of a global cataclysm. World War II was a watershed not just in terms of the scale of death and destruction but also in the mobilization of science for the war effort. The coalescence between science and national security spurred new projections for the role science should play in the polity. The advent of big science—the vast increase in cost, scale, and complexity of scientific ventures —led to large-scale organizational structures spanning industry, government, and academia.[342] The growth of the scientific establishment led to anxieties regarding the amount of manpower required to maintain American intellectual and technological superiority. Was the next generation prepared to carry on the cause?

Although professional science underwent unprecedented expansion, it did not lead the way in taking on the challenge in educating America's youth. As in earlier decades, the drivers of adolescent extracurricular science came from outside formal educational and industrial channels. In the years preceding the National Defense Education Act, the Science Service, a nonprofit news organization, championed the cause. At a time when science was headline news, science fairs offered comforting stories of the promise of young geniuses in ensuring the security of the nation. Headlines written by the Science Service emphasized the students' outcomes rather than the learning process. The sensationalism of these stories set forth a worldview that adolescents were not only capable of great achievements but that they bore responsibility for ensuring the progress of the country.[343]

In this politicized climate, parents and teachers also took on new roles for ensuring national security. To enlist adult support, the Science Service published articles such as "Junior Scientists Start Early," "Scientists for Tomorrow," and "How to Be a

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[342] For a discussion on the advent of big science, see Peter Galison and Bruce Hevly, eds., *Big Science: The Growth of Large Scale Research* (Stanford: Stanford University Press, 1992); James H. Capshew and Karen A. Rader, "Big Science: Price to the Present," *Osiris* 2nd Ser. 7 (1992): 2-25; Catherine Westfall, "Rethinking Big Science: Modest, Mezzo, Grand Science and the Development of the Bevalac, 1971-1993." *Isis* 94, no. 1 (March 2003): 30-56.

[343] See John C. Burham, *How Superstition Won and Science Lost: Popularizing Science and Health in the United States* (New Brunswick: Rutgers University Press, 1987).

Space-Age Santa."[344] The features offered advice on the latest scientific research, gadgets, and activities targeted at adolescents. Parents and teachers were considered critical allies in the cause; it was their duty as citizens to help identify the nation's most talented youth and encourage them to pursue scientific and technical pastimes.

As extracurricular scientific engagement garnered additional adult support, it also carried higher stakes. In the process, students lost a certain level of autonomy that they had enjoyed in the interwar period. The imaginative, narrative expressions of science were superseded by an emphasis on achievement. The rules and regulations for science fairs changed accordingly, with restrictions increasingly determining the size, structure, and content of student displays. These higher stakes also shaped who was targeted as a potential future scientist. Although boys had long been considered the superior sex in scientific pursuits, the disappearance of nature study and replacement by physics and vocational skills in school curricula further isolated girls, despite the Science Service's active attempts to recruit young women.[345] Likewise, ethnic and racial minorities (with the notable exceptions of first and second generation immigrants and students of Jewish descent) remained vastly underrepresented in Science Service programs. Even as the country called for a greater number of scientists and engineers, the assumed face of these professionals remained markedly limited.

Although children lost a certain level of independence, they also capitalized on the opportunities that science fairs afforded them. Students used their projects as steppingstones for gaining entry into college, securing scholarship money, and acquiring

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[344] "Junior Scientists Start Early," *Science News-Letter* 72, no. 3 (July 20, 1957): 42-43; Alan Waterman, "Scientists for Tomorrow," *Science News-Letter* 69, no. 21 (May 26, 1956): 333; and Shirley Moore, "How to Be a Space-Age Santa," *Science News-Letter* 76, no. 20 (November 14, 1959): 326, 328, 332.

[345] See Kim Tolley, *The Science Education of American Girls: A Historical Perspective* (New York: Routledge Falmer, 2003).

field experience. They also sought out new network forums that supported their professional aspirations. Rather than reading magazines featuring amusing plays or trivia, students turned to more prestigious publications that considered them as intellectual equals. “The Amateur Scientist” column of *Scientific American*, for instance, treated adolescents as competent practitioners by featuring detailed descriptions of projects based on the assumption that amateurs could replicate or adapt the concepts. Most importantly, adolescents continued to establish independent scientific communities by joining clubs, commiserating with their peers at competitions, and engaging in alumni networks.

As students increasingly employed science fairs as forums for professional socialization, the underlying values of these competitions shifted. Unlike focus of the synthetic culture of earlier science fairs on process, narrative, and a holistic view of science, postwar analytic culture prized specificity and solutions to contemporary problems. Conducting original research served as one of the most common approaches for gaining entry into the national competitions. Scoring systems rewarded ingenuity, problem solving, and systematic experimentation. Rather than emphasizing the process of scientific principles, student projects became more concerned with analysis and experimentation. Students conceptualized their projects not in terms of a story but as a problem that they intended to solve. As a result, projects often highlighted more technical skills such as building instruments and apparatus. The emphasis on “technique” that concerned 1930s educators now translated to more practical applications. Indeed, students strove to demonstrate the applicability of their work, at times even working with industrial and government agencies or applying for patents. Finally, virtually all of the projects represented the success of lone individuals. Participants could not submit projects as groups, and even though several finalists recognized the outside assistance they received from teachers, family members, or fellow students, ultimately they received sole credit for their work.

These analytic values engendered new ideals of citizenship that manifested in visual displays as well as words.  Narrative modes of display were superseded by a systematic focus on procedures and results. Judging criteria prioritized creativity and results over synthesis and aesthetic value. Visual qualities mattered less than expressing a clear purpose. As a result, the dioramic displays of the 1930s were supplanted by text panels that explained through words and charts rather than models and imagery. Like synthetic culture, analytic culture embodied a faith in science as a vehicle of progress. However, these newfound virtues conveyed science as a results-oriented enterprise more invested in securing international superiority than in cultivating a scientifically minded populous.

Although analytic culture promoted the virtues of science to a rising a generation of scientists and engineers, student science fair finalists often developed disparate, even ambivalent views on the value of science in society. The evaluation of the Science Talent Search in chapter four demonstrates how coming of age during the atomic era profoundly shaped the ways that student finalists perceived their social obligations as they began their careers. As student participants grew up to become practitioners, they started to question whether the virtues of individualized merit mapped onto their own experiences in the profession. Chapter five then examines how the National Science Fair established itself as a standard for adolescent scientific engagement. As the fair movement began to spread to the international stage, so too did its entanglement with the interests of national security. By emphasizing a bright future ruled by reason and innovation, science fairs served to demonstrate the nation’s intellectual superiority—first to fellow Americans, then across the globe. By setting a standard both domestically and abroad, the National Science Fair carried out a broader mission that encapsulated not just the goal of preparing future scientists and engineers, but also exerting American scientific dominance in the postwar world. What started as an extracurricular pastime became a mark of American global scientific authority at a time when that position was in question.

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Figure P3.1 1948 Science Talent Search Finalists. The finalists are joined by First Lady Bess Truman in front of the White House. Courtesy Society for Science and the Public Photograph Collection.

# CHAPTER 4

## A Meritocratic Mission: Origins of the Science Talent Search, 1942-1957

High school senior Paul Erhard Teschan of Shorewood, Wisconsin, won first place in the 1942 First Annual Science Talent Search for his response to the essay prompt "How Science Can Help Win the War." Out of nearly 10,000 applicants, the Science Service selected Teschan and thirty nine of his peers to compete for scholarship money in Washington, DC and participate in a five day institute filled with lectures by prominent scientists, visits to national laboratories, and commiseration with fellow participants. Organizers of the Science Talent Search broadcasted these students' success across national radio airwaves, touting them as the great talents of their generation who could help lead the nation through a time of international crisis. For his part, Teschan demonstrated unbridled faith in the ability of scientists to ensure American success in the war effort. In his prize winning essay, Teschan enthusiastically wrote, "I believe that, because their ingenuity has always had unlimited exercise in the field of free thought, the scientific men of the United Nations and particularly of America will ultimately outstrip the regimented researchers of the Axis powers in the development of those processes and inventions that will enable the fighters for freedom to emerge victorious!"

Just nine years later, Teschan's response to an STS alumni questionnaire showed a marked departure from the optimism of his high school essay. "Since scientists will probably have to continue as members of communities, society, and civilization, I believe more emphasis should be placed on the consequent responsibilities and implications," Teschan wrote. “There is no question that, at a time when our civilization is being threatened with annihilation, these considerations become tremendously important. I would place special responsibility on the STS to present these things clearly and forcefully.” Serving as a 1st Lieutenant in the US Medical Corps during World War II, Teschan experienced firsthand the realities of war and the frustrations faced by scientists of his generation. Teschan believed that the Science Talent Search bore a special obligation not only to seek out talented youth, but to inform these students of the ethical challenges that awaited them as they entered scientific professions.

In tracing the professionalization of the first decade of Science Talent Search participants, this chapter responds to Robert E. Kohler’s call for more attention by scholars on “how scientists are made.”[346] Historians of Cold War science have demonstrated how scientists ensnared in the nascent military-industrial-academic complex navigated the moral complexities of their work.[347] This chapter seeks to expand upon this robust literature by capturing this how critical moment played out in the lives of adolescents on the brink between childhood and their professional careers. Growing up in the shadow of World War II, these young experimenters were just beginning to develop their own mindset about the place of science in society at a time when such a role was being questioned by the broader populous. STS helped socialize its participants into scientific careers by providing a community network where they could establish not only

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[346] Robert E. Kohler, “From Farm and Family to Career Naturalist: The Apprenticeship of Vernon Bailey,” *Isis* 99, no. 1 (March 2008): 28.

[347] See, for instance, Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill: The University of North Carolina Press, 1999); Jessica Wang, “Scientists and the Problem of the Public in Cold Ear America, 1945-1960,” *Osiris*, 2nd Ser. 17, (2002): 323-347; Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993); Peter Galison and Bruce Hevly, eds., *Big Science: The Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992); and David Kaiser, “The Postwar Suburbanization of American Physics,” *American Quarterly* 56, no. 4 (December 2004): 851-888.

the standard practices of their respective disciplines but also the ethical responsibilities of scientists during a moment of national uncertainty.

The mission of the Science Talent Search to identify the next generation of scientists and engineers placed adolescents at the center of a web of postwar interests aimed at ensuring American security and intellectual superiority. The Science Service took on this objective with vigor. Indeed, the accounts of STS educational leaders reveal a near desperation in ensuring that the forty students they selected were indeed the most elite and talented of their cohort. How could STS attract and identify the nation's most talented students? In what ways could the competition celebrate their successes and present the finalists as inspirational examples of American ingenuity? And most importantly, how could STS mobilize these students to capitalize on their innate abilities to serve the nation through careers in science and engineering?

To carry out its mission, the Science Service approached STS as a giant social experiment in its own right by carefully tracking participants during the competition's initial years. Officials measured multiple factors, including geography, gender ratios, where participants went to college, when they got married, their eventual careers, and their changing ideas about science. An analysis of these rich records reveals that considerations for talent were not always as democratic as the Science Service purported. The same factors that Science Service tried to ameliorate through its meritocratic aims tended to favor certain students rather than level the playing field. Likewise, these records also suggest that the goals and expectations of STS did not map neatly onto the mindsets of participants. Rather, STS participants' views on the value on science in society were disparate and often ambivalent. Even as STS celebrated individual talent, most finalists prized a very different reward: the formation of a community network and long-lasting relationships that extended into college and their professional careers.

This chapter traces the solidification of analytic adolescent scientific culture by examining how students navigated the goals of STS officials as well as public perceptions of the scientific enterprise with their own conceptions regarding the role of science in society. First, it traces the origins of the Science Talent Search back to the same progressive impulse behind the American Institute programs before examining how its mission ultimately departed from these goals by seeking out the best and the brightest students. Through a careful analysis of student projects, it then evaluates how this meritocratic system operated and the ways in which it fostered a new set of epistemic virtues. It then considers the limits of this meritocratic order by uncovering the inequities among participants as well as students' ambivalence over their role as potential scientists in shaping the nation's future. It concludes by evaluating how students ultimately formed a new scientific community with former participants that persisted as they began their careers. These developments signaled a shift from the synthetic culture of the interwar period to the advent of an analytic culture that would define the science fairs of the postwar world.

## **Origins of the Science Talent Search**

Founded in 1920 by journalism mogul E.W. Scripps, the Science Service (now called the Society for Science and the Public) was a nonprofit news foundation dedicated to improving public understanding of science. Perhaps inspired by his own upbringing working on his parents' farm in Illinois, Scripps valued an apprenticeship model of learning that promoted sustained interaction with the natural world.[348] Like his progressive contemporaries at the American Institute, Scripps believed that scientific innovation was not inspired merely from classroom learning, but through active engagement in scientific activities. Though not formally trained as a scientist, Scripps viewed scientific principles as the foundation of a successful democracy. He believed that making science both accessible and comprehensible to the public would ultimately lead to a more informed, rational citizenry.[349] His views complemented the educational vision of reformers like John Dewey that prized process oriented, inquiry-based learning, calling for a restructuring of school curriculum to allow students to cultivate their full potential.[350] Like Morris Meister, Scripps argued that children and adults alike should develop experimental, scientifically based forms of inquiry to perform their social responsibilities as citizens in a participatory democracy. At the heart of his educational framework was a belief in learning by doing—that is, allowing students to build their education based on lived experience.[351]

When journalist Watson Davis assumed directorship of the Science Service in 1933, he continued to uphold this educational vision. By the early 1940s, Watson devoted much of his attention to youth-oriented initiatives by establishing the Science Clubs of

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[348] For more information on an apprenticeship model on learning, see Kohler, "From Farm and Family to Career Naturalist."

[349] William E. Ritter, "Science Service as One Expression of E.W. Scripps's Philosophy of Life," SSR Box 443, Folder 9. For more on Scripps's journalism efforts, see Duane C.S. Stoltzfus, "A Paper for the People: E.W. Scripps's Chicago Experiment in Adless Journalism," PhD Diss., Rutgers University, 2001.

[350] Process-oriented learning also extended into popular scientific and technical hobbies at the turn of the twentieth century. See Sally Gregory Kohlstedt, *Teaching Children Science: Hands-On Nature Study in North America, 1890-1930* (Chicago: University of Chicago Press, 2010); Aaron Alcorn, "Flying into Modernity: Model Airplanes, Consumer Culture, and the Making of Modern Boyhood in the Early Twentieth Century," *History and Technology* 25, no. 2 (May 2009): 115-146; and Steven M. Gelber, *Hobbies: Leisure and the Culture of Work in America* (New York, NY: Columbia University Press, 1999), especially pp. 193-254.

[351] John Dewey, *The School and Society* (Chicago: University of Chicago Press, 1902); John Dewey, *The Child and the Curriculum* (Chicago: University of Chicago Press, 1900).

America, one of the first national networks of youth science clubs. As chapter three described, the genesis for the Science Clubs of America (and subsequently the Science Talent Search) emerged from the American Institute of the City of New York for the Encouragement of Science and Invention, an organization that served as the institutional vehicle for mobilizing science clubs and competitions in New York and subsequently across the nation. When the American Institute faced financial difficulties brought on by the Great Depression, G. Edward Pendray, a member of the American Institute as well as an executive at Westinghouse, pressed the company to provide funds to support the Institute's science competitions during the late 1930s. Soon after, Watson Davis from the Science Service teamed up with Westinghouse to take over stewardship of the Institute's national network of youth science clubs, establishing the Science Clubs of America in 1941 and Science Talent Search in 1942.[352] By the time it held its first National Science Fair in 1950, the Science Service had established itself as one of the leading promoters of youth engagement in science and technology in America.

In most of its youth-oriented programs, the Science Service sought to nurture scientific talent while also providing education to the general populous. Though Davis believed that few participants would actually emerge as national scientific leaders, he also believed in the inherent value of teaching science to America's youth regardless of their future careers. "Most of these thousands of young enthusiasts will never become professional research workers. But their lives and the service they will give to the world are immeasurably enriched by the actual undertaking of science projects," Davis

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[352] Sevan G. Terzian, *Science Education and Citizenship: Fairs, Clubs, and Talent Searches for American Youth, 1918-1958* (New York, NY: Palgrave MacMillan, 2013); Joseph Berger, *The Young Scientists: America's Future and the Winning of the Westinghouse* (Reading, MA: Addison-Wesley Publishing Co., 1994).

declared. “They discover faster and more surely than they could from a thousand textbooks the methods and usefulness of science. That is important. They will have more chance of conducting their own lives rationally and, with their votes, of helping to mold American democracy in this scientific age.”[353] The Science Service also produced numerous periodicals for public consumption, including the weekly magazine *Science News-Letter*, the radio show “Adventures in Science,” hands-on kits and experiments via *Things of Science,* and the monthly journal *Chemistry.* Through promoting scientific play and exploration, the Science Service viewed its mission not just as teaching students how to become scientists and engineers, but also how to serve as scientifically principled citizens. By the time it held its first National Science Fair in 1950, the Science Service had established itself as one of the leading promoters of youth engagement in science and technology in America.

In many regards, Davis shared the same educational vision of his American Institute predecessors. Davis viewed the goals of the Science Center as inherently different from those of classroom education, which he considered too didactic to foster a general interest in science. According to Davis, “Our students are taught how to learn to read but not always how to read to learn. They look *at* a book instead of looking *through* it. This is what a child does when a microscope or telescope is first put in his hands. His attention is absorbed in the instrument, not in what it is designed to reveal.”[354] Rather than teaching scientific facts, the youth-oriented programs of the Science Fair aimed at cultivating a “scientific habit of mind,” one that taught children not just reciting answers, but how to formulate thoughtful questions.

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[353] Watson Davis, “Science Teaching and Science Clubs Now and Postwar,” SSR Box 444, Folder 6.
[354] “Adult Education in Science,” SSR Box 443, Folder 9.

At the same time, Davis also considered this broad-based educational vision as only part of a larger objective in seeking out America's most talented youth. Although Davis believed in the inherent value of general education, he also held the conviction that children possessed innate differences in their abilities. According to Davis, "One of the important recognitions in modern times is that, while men should have equality of opportunity, they are not except in their right to such opportunity, created equal. Their hereditary endowments given them by their biological origins, plus their experience and training in life, markedly affect the quality of performance by individuals."[355] Debates about the role of innate abilities in differentiating a democratic citizenry stem as far back as the Enlightenment, when conceptions of talent helped inform a new social order to justify social distinctions among a populous no longer set apart by birthright. This meritocratic vision was "not an expression of, but an alternative to, a more egalitarian society."[356] John Carson argues that by the early twentieth century, American conceptions of talent were increasingly framed in terms of a singular characteristic: intelligence. The development of the "Intelligence Quotient" by Stanford-Binet and the proliferation of mental testing reinforced the belief that intelligence was innate, hierarchical, and immutable.[357] Children served as a primary target for the impulse to cultivate talent. As the next generation of citizens, children not only served as the

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[355] Watson Davis, *The Century of Science* (New York: Duell, Sloan and Pearce, 1963), 265.

[356] Jerome Karabel, *The Chosen: The Hidden History of Admission and Exclusion at Harvard, Yale, and Princeton* (Boston, MA: Houghton Mifflin Company, 2005), 4. This chapter is informed by Karabel's definition of meritocracy as "a society in which advancement is based, not on the prerogatives of birth, but on talent and performance" (pg. 5).

[357357] John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (Princeton, NJ: Princeton University Press, 2007); John Carson, "Differentiating a Republican Citizenry: Talents, Human Science, and Enlightenment Theories of Governance," *Osiris*, 2nd Ser. 17 (2002): 74-103. See also Gordon S. Wood, *The Creation of the American Republic, 1776-1787* (Chapel Hill: University of North Carolina Press, 1969).

upcoming cohort of scientific professionals entering the workforce, but they also symbolized a broader vision of a nation ruled by reason and innovation.[358]

The Science Talent Search built upon this legacy by offering a meritocratic system for seeking out America's best and brightest adolescents. During the 1940s and 50s, orchestrators of the Science Talent Search focused their efforts on two complementary goals: to seek out scientifically talented youth in order to publicly celebrate their successes as inspirational examples of American ingenuity; and to encourage these adolescents to pursue careers in science or engineering.[359] According to Davis, "One of the most important tasks of our civilization is to try to put our collective finger upon those rare and few creative geniuses who are truly the revolutionists of the future."[360] STS promoted encouraged students to take initiative in their own learning through sustained voluntary activities ranging from conducting household experiments and building instruments to making astronomical observations and assembling collections of specimens. Although STS educators supported hands-on tinkering, their biggest objective remained the cultivation of seemingly innate abilities.

## Measuring Talent

In order to seek out the next generation of scientists and engineers, the Science Service set up elite parameters for qualification (Table 4.1). During the1940s, the Science Service would send an average of 16,000 applications to high school seniors across the nation. All student applicants were required to take a science aptitude test and submit

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[358] For a thoughtful evaluation of how notions of childhood embodied republican ideals in the nineteenth century, see Catherine Pandora, "The Children's Republic of Science in the Antebellum Literature of Samuel Griswold Goodrich and Jacob Abbott," *Osiris* 2nd Ser. 24 (2009): 75-98.

[359] See Sevan G. Terzian, "'Adventures in Science': Casting Scientifically Talented Youth as National Resources on American Radio, 1942-1958." *Pedagogica Historica* 44, No. 3(June 2008): 309-325.

[360] Watson Davis, "The National Program for Science Talent," SSR Box 446, Folder 37.

their high school record. This process eliminated all but three hundred semifinalists. Students who qualified to the next round were then evaluated based on writing essays. The first annual essay posed the topic of "how science can help win the war," but in subsequent years, students were asked to provide a synopsis of their science projects. These essays were then judged by specialists in the field to select the final forty students who would go to Washington, D.C. to compete for scholarship money.[361] The sequence of this evaluation system, then, privileged the testing of seemingly innate talents by using an aptitude exam as a vetting process before considering other factors such as students' research, work ethic, or leadership roles.

The aptitude test served as the preliminary and most important funneling system for evaluating potential candidates (Fig. 4.1). The test typically contained a range of questions designed to test different forms of intellect, including vocabulary ("a prefix meaning hardness is…"), mathematical thinking ("a decigram equals .5432 grains. How many grains are there in ten grams?"), analysis and reading comprehension of a sample essay, knowledge of current scientists' research ("For each scientist in Column III, put the number of his field of science (Column IV)"), and analysis of spatial imagery ("Through what minimum distance will rope A have to be pulled to raise weight B a distance of 1 meter?")[362] The tests were difficult by design because the questions were intended to evaluate students' raw intellect as well as their perseverance in completing the exam. According to STS promotional brochures, "It won't do much good to rehearse your students on this test. It is not a test of a knowledge of science both rather one

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[361] Harold A. Edgerton "The Third Annual Science Talent Search." *Science* 99, no. 2573 (April 21, 1944): 319-320.

[362] "How You Can Search for Science Talent Search," Book of Facts brochure, ca. 1947. SSR Box 446, Folder 17.

designed to measure the student's ability to read, understand, and think in terms of concepts and techniques of science."

As historian JoAnn Brown notes, the goal creating of talented leaders grounded in scientific training was identified as a matter of national importance well before the orbit of *Sputnik I* in 1957.[363] Though historians have rightly characterized the subsequent passage of the 1958 Defense Education Act as an educational milestone for increasing science rigor and funding in public schools, the case of the Science Service demonstrates that within the realm of popular science learning, this push came much earlier.[364] In a 1946 address to the Central Association of Science and Mathematics Teachers, Davis declared, "There must be thousands of boys and girls being given the opportunity of becoming tomorrow's scientists, capable of doing the fruitful scientific research upon which tomorrow's progress will be based. We must be confident that there will be a scientific way to prevent atomic wars of the future which will negate progress. We must be confident that science provides the strength and the foundation for a better world, just as it has provided deadly weapons of offense and defense in times of need."[365] Watson classified America's youth as the nation's most powerful defense of democracy in the volatile postwar world.

The work of the Science Service complemented other initiatives like Atoms for Peace, the American Museum of Atomic Energy, and Walt Disney's *Our Friend the*

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[363] JoAnn Brown, "A Is for Atom, B is for Bomb": Civil Defense in American Public Education, 1948-1963," *Journal of American History* 75, no.1 (June 1988): 68-90; See also Terzian, "'Adeventures in Science,'" 325.

[364] John L. Rudolph, *Scientists in the Classroom: The Cold War Reconstruction of American Science Education* (New York: Palgrave, 2002); Barbara Barksdale Clowse, *Brainpower for the Cold War: The Sputnik Crisis and National Defense Education Act of 1958* (Westport, CT: Greenwood Press, 1981); Andrew Hartman, *Education and the Cold War: The Battle for the American School* (New York, NY: Palgrave MacMillan, 2008); Wayne J. Urban, *More than Science and Sputnik: The National Defense Education Act of 1958* (Tuscaloosa: The University of Alabama Press, 2010).

[365] Watson Davis, "Tomorrow's Scientists," SSR Box 446, Folder 14.

*Atom* in attempting to both educate and ameliorate the public anxieties surrounding advancements in postwar science.[366] Its sponsorship by Westinghouse Electric provided a direct link to the world of industrial research which faced its own set of ethical concerns regarding the relationship between science and national defense. During World War II, Westinghouse supplied approximately 8,000 products to support the war effort such as radar and radio equipment, turbines for military ships, and naval ammunition and artillery. This wartime partnership would help cement the relationship between Westinghouse and the federal government well into the Cold War, when it would continue to secure large-scale government contracts and form collaborations with military research labs at universities like Stanford and MIT.[367] Westinghouse officials viewed STS as a mutually beneficial program where sponsorship could help them cultivate a strong public relations campaign while also identifying future potential employees. A Westinghouse article for the *Science News-Letter* promoted Science Talent Search scholarships as rewarding youth possessing "the native skill and talent that have made America great and will make it greater."[368] This linkage to postwar industrial research not

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[366] Arthur Molella, "Exhibiting Atomic Culture: The View from Oak Ridge," *History and Technology* 19, no. 3 (June 2003): 211-226; John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence," *Osiris* 2nd Ser., 21 (2006): 161-181; Heinz Haber, *The Walt Disney Story of Our Friend the Atom* (New York: Simon and Schuster, 1956). For more on the role of media (including the Science Service) in popularizing science, see Marcel C. LaFollette, *Science on the Air: Popularizers and Personalities on Radio and Early Television* (Chicago: University of Chicago Press, 2008).

[367] Patrick Vitale, "Wages of War: Manufacturing Nationalism During World War II," *Antipode* 43, no. 3 (2011): 783-819; Thomas C. Lassman, "Industrial Research Transformed: Edward Condon ant the Westinghouse Electric and Manufacturing Company, 1935-1942," *Technology and Culture* 44, no. 2 (April 2003): 306-339; Stuart E. Leslie, *The Cold War and American Science.* Of course, such military-industrial research programs were not limited to Westinghouse. For examples of other large-scale research, see Jon Gertner, *The Idea Factory: Bell Labs and the Great Age of American Innovation* (New York: Penguin Press, 2012)*;* Leonard S. Reich, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876-1926* (New York: Cambridge University Press, 1985); and David A Hounshell and Kohn Kenly Smith, Jr., *Science and Corporate Strategy: Du Pont R&D, 1902-1980* (Cambridge: Cambridge University Press, 1988).

[368] Terzian, *Science Education and Citizenship,* 90.

only provided the funding necessary for the operation of STS, but it also shaped the very forms of experiment that its adolescent participants pursued.

## **Displays of Scientific Acumen**

In honor of their achievements, the forty finalists attended the Science Talent Institute in Washington, DC, an intensive five-day series of field trips, presentations, and interviews. They met the President of the United States, toured sites near Capitol Hill, spoke before the Senate, gave interviews for the Science Service "Adventures in Science" radio program, and visited nearby science facilities (Fig. 4.2). They heard talks from leading scientists of industrial and academic laboratories such as Westinghouse, Harvard University, and the Rockefeller Institute for Medical Research. Former STS participants spoke to current finalists about their lines of work, providing an introduction to the robust alumni network that would continue to support finalists as they entered college and their professional careers (Fig. 4.3). As students enjoyed these intellectual exchanges, they actively competed for scholarship money. Each participant underwent an intensive interview process regarding their academic achievements and research interests (Fig. 4.4). In this regard, the Science Talent Institute served as the final vetting process for selecting the winners, socializing participants into the national scientific community while evaluating their potential as future scientists.[369]

Students presented their research during a project exhibition night that served as the pinnacle event of the Institute. The showcase originated as an informal "Hobby Show" and quickly transformed into a sensation that attracted thousands of annual visitors. Although students were not formally evaluated on their exhibits, the evening

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[369] For a description of the Science Talent Institute, see "Science Talent Institute," *Science News-Letter* 51, no. 10 (March 8, 1947): 149-151; "Science Talent Institute," *Science News-Letter* 53, no. 10 (March 6, 1948): 149-151.

served as an opportunity to display their scientific acumen and exchange ideas with fellow peers. During the event, students wandered over to each other's sections and engaged in conversations that often extended into their hotels rooms at night. Judges and visitors could also question finalists about their work and witness their projects in action. Unlike the science fairs of the 1930s, the event promoted ongoing interaction between students and their audiences.

The initial exhibits of the Hobby Shows showed great variety and lacked any standard mode of display. Unlike the American Institute, the Science Service did not initially impose any size requirements. As a result, participants were only limited by their ability to transport their work to Washington, DC. Some students capitalized on this freedom by featuring multiple text panels, bulky equipment, or large collections. Betty Porter even brought in the full skeleton of a mule that she cleaned, cataloged, and reassembled (Fig. 4.5).[370] Like the Children's Science Fairs, animal experimentation remained a common feature that lacked many restrictions. Carolyn Hansen, for instance, brought in rodents to showcase her experimental work on the functions of endocrine glands through experiments of male and female castration (Fig. 4.6).[371] Other exhibits proved more modest, featuring just a lab notebook or a simple piece of apparatus. The vivid dioramic exhibitions of the 1930s were noticeably absent. Instead, the Hobby Shows of the 1940s featured a plethora of displays that lacked any real sense of cohesion.

Because finalists remained next to their exhibits during the showcase, students depended less on the aesthetic qualities of their displays and more on their skills as presenters. Students convinced visitors of the merit of their work not just through visual

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[370] Betty Porter project photograph. SSP Science Talent Search 1950 Box .

[371] Carolyn Hansen project photograph. SSP Science Talent Search 1956 Binder.

cues but also through live demonstrations and in-person conversations (Fig. 4.7). Research scientists in students' fields of study often attended the Science Institute and provided finalists with detailed feedback on their work. Robert Handschmacher, whose essay on petroleum granted him entry to the Science Talent Institute, commiserated with petroleum expert Ralph K. Davies to discuss his research.[372] Performance, then, remained a key scientific virtue of the Science Talent Search, though it now emphasized students' ability to persuade others of the importance of their work.

Students became increasingly adept at engaging their audiences. David Smith prepared a series of experiments to demonstrate his homemade Geiger counter (Fig. 4.8). Rosemary Och built a mechanically actuated computer designed to solve an old Chinese puzzle (Fig. 4.9). The heading of her display enticed visitors by asking, "This is the 'ROMAC'- Can You Outsmart It?"[373] Even finalists presenting in more abstract areas such as mathematics developed creative strategies for explaining their findings. Robert Solovay presented his work in higher mathematics through a series of "Logical Paradoxes" designed to confound his audiences (Fig. 4.10), such as "The barber shaves everyone who does not shave himself. Who shaves the barber?"[374] Jonathan Glogower arrived prepared with a giant notepad to write down formulae as he explained his work on vapor pressure measurements for the analysis of ideal solutions (Fig. 4.11).[375] The success of the showcases often resided more in the presentation abilities of the participants than the aesthetic quality of their displays.

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[372] Science Talent Search photograph. SSP Science Talent Search 1945 Binder.
[373] Rosemary Och project photograph. SSP Science Talent Search 1956 Binder.
[374] Robert Solovay project photograph. SSP Science Talent Search 1956 Binder.
[375] Jonathan Glogower project photograph. SSP Science Talent Search 1957 Binder.

Carefully staged representations of student achievement extended to the promotion of the Science Talent Search itself. By the mid-1940s, the Science Service moved beyond simply photographing finalists' portraits to posing each participant next to their project. The images framed students skillfully interacting with their exhibits by demonstrating equipment, pointing at their displays, or observing phenomena such as a petri dish under a microscope. Science Service officials also collected images of alumni actively at work in their new careers. The images submitted by former finalists, such as operating the Oak Ridge Camera at Harvard College Observatory, controlling the atom smasher at Westinghouse, or conducting experiments at the Army Medical Department, served as success stories that illustrated the widespread influence of STS alumni (Fig. 4.12). By capturing students and alumni adept in scientific practice, both series of images situated participants as authoritative experts who were masters of their craft.

Science Service officials extended this promotional campaign even further by visiting select STS participants at home. The photographs depicted students not just as engaged scientists but as well-adjusted teenagers. Science represented only one in a series of interests that shaped Alan Haught's character, a high school senior at Bethesday-Chevy Chase High School near Washington, DC. Haught was depicted not just studying chemical reactions with a homemade spectroscope but also listening to records with his friends (Fig. 4.13).[376] These portrayals of participants' home life showed marked gendered distinctions. Whereas boys were featured tinkering with cars or shooting rockets, girls were almost always depicted taking part in some sort of domestic pursuit. When Carol Hawkins was not busy developing innovative eye-dropper feeding methods

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[376] Science Service promotional photograph. SSP Science Talent Search 1954 Box.

for newborn puppies, she worked on her seamstress skills.[377] Merry Margolish did not just conduct experiments on color blindness, she also enjoyed baking pies (Fig. 4.14).[378] These images reflected the mixed signals young women received regarding their roles as both professionals and as future homemakers. Whereas STS actively encouraged young women to participate, it did not question the gendered expectations placed on women in the home.[379]

Although standard modes of display never fully materialized during the first two decades of the Science Talent Search, text-based analysis became an increasingly predominant feature of student exhibits. In 1945, only 24% of projects featured any form of text panels. By 1955, over 60% of projects featured at least one large text panel as part of student displays.[380] Students began to employ the scientific method in describing the problem, hypothesis, and conclusion of their projects as a schema for organizing information, although it remained far from standard. Considering that students were selected as finalists based on written reports of their research, this transformation is perhaps not surprising. However, it also signaled to a new set of values in conveying scientific evidence, one that relied more on textual persuasion than visual narrative.

## The Emergence of Analytic Culture

Changing modes of display reflected the shift in epistemic values that began to take shape in postwar adolescent scientific culture. Although the vetting process of STS valued aptitude testing and academic records more highly than student research, the

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[377] Science Service promotional photograph. SSP Science Talent Search 1955 Box.

[378] Science Service promotional photograph. SSP Science Talent Search 1957 Binder.

[379] For more on media depictions of female scientists, see Sevan Terzian, "'Science World,' High School Girls, and the Prospect of Scientific Careers, 1957-1963," *History of Education Quarterly* 46, no. 1 (Spring 2006): 73-99; and Marcel C. LaFollette, "Eyes on the Stars: Images of Women Scientists in Popular Magazines," *Science, Technology, & Human Values* 13, no. ¾ (Summer-Autumn 1988): 262-275.

[380] Based on an analysis of science exhibit photographs from SSP Science Talent Search 1945 Binder and 1955 Binder.

projects that students developed ultimately served as the crown jewel of the competition. After months and sometimes years of preparation, the forty finalists showcased their projects in Washington, DC to thousands of visitors, including many scientists who regarded students' work as a gauge for the future of the profession writ large. The range of fields represented each year proved impressive, ranging from anthropology and botany to physics and engineering. The previous section described the virtue of performance as an important quality in mid-century science competitions. This section will continue to examine the underlying values of student projects. These virtues reflect the emergence of a burgeoning analytic culture that would come to replace the synthetic values of the 1930s.

Conducting original experiments served as one of the most common approaches for gaining entry into STS. Kurt William Kohn of Bronx, New York, secured his position as a finalist in the 1948 Science Talent Search by investigating the ability of ants to distinguish members of their own colony. He conducted his experiment by digging out an ant colony and setting it in between two plates of glass. He then painted the abdomens of "stranger" ants and immersed them into the foreign colony. (Fig. 4.15) Kohn observed how the strangers were spotted and thrown out within three hours by native ants that were able to sense the invaders.[381] He concluded that there is a quality (he guessed an odor or other sensory ability) inborn in ants that helps them distinguish their own colony. Some experiments displayed mastery in observation. However, unlike the visual education touted in earlier fairs, the STS valued the observational expertise of students in gathering data rather than their ability to create a visual narrative. Millicent Margaret Sawyer conducted a detailed study of a twenty-acre tract of forest that her family purchased

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[381] "Adventures in Science," radio program script, February 14, 1948. SSR Box 394, Folder 7.

outside of Terre Haute, Indiana. Sawyer surveyed soil conditions, landscapes, and tree growth in order to produce a topographical map of the area (Fig. 4.16).[382] Other experiments produced more theoretical contributions. James Alexander Hummel of Los Angeles, California conducted a mathematical study of interplanetary flight. “Men will soon reach for the stars, and when he tries to bridge the gap between the planets, the principles of spatial navigation will become all important,” Hummel explained. “It will be necessary to find a method of setting up a course which will take the space voyageur from the planet earth to the goal with the least possible expenditures and time.”[383]

Other projects highlighted more technical skills such as building instruments and apparatus. The emphasis on “technique” that concerned 1930s educators now translated to more practical applications. Nicholas Allen Wheeler of Oklahoma City earned an honorable mention at the 1952 Science Talent Search by constructing a homemade Wilson Cloud Chamber. In order to build the expansion chamber, he attached one Bakelite cylinder on top of another. Wheeler then sealed the lower cylinder, connected it to a vacuum tank, and mounted the entire apparatus onto an aluminum frame to allow him to tilt the chamber at any angle. Wheeler also designed an electronic control unit to keep track of the ions passing through as well as a camera to photograph their tracks. Through trial and error, he concluded that the complete expansion of the chamber must occur in about .02 of a second in order to attain an accurate measurement.[384] Joel Dean Finnegan built a homemade telescope in his basement. According to the media photo description, “The family wash waited while he ground” (Fig.4.17).[385] The projects

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[382] Ibid.

[383] “Adventures in Science,” radio program script, February 16, 1946. SSR Box 392, Folder 3.

[384] Helen Miles Davis, *Scientific Instruments You Can Make* (Washington, DC: Science Service, 1956).

[385] Science Service promotional photograph. SSP Science Talent Search 1950 Box.

exemplified technique, ingenuity, and resourcefulness in constructing complicated equipment using inexpensive materials.

Several students demonstrated originality by developing practical applications for their research. While working for a telephone company, Douglas Page Baird of Whitesboro, New York met a woman who was hard-of-hearing and whose hearing aid did not operate sufficiently when she used the telephone. To resolve this issue, Baird designed a compact audio amplifier that could fit on a standard phone set in order to assist hearing-impaired telephone users (Fig. 4.18).[386] Collecting served as another means for gaining recognition. Richard A. Bideaux of Tucsan, Arizona surveyed mineral specimens from an old lead mine near Yuma. Over the course of fourteen field trips, he collected over 300 specimens for his investigation. His project helped Bideaux prepare for a career in mining engineering by allowing him to study how lead ores were produced in nature.[387]

Although the projects featured at STS represented a range of fields and skill sets, they also shared several commonalities. All of the projects encompassed some sort of material or theoretical output. Students could not advance as a finalist if they merely synthesized other people’s work; they needed to conduct a first-hand investigation. Finalists’ projects were also highly field specific. The more students could demonstrate how their project made an original contribution to their discipline, the more likely they would move forward in the competition. At the same time, student projects needed to demonstrate strict adherence to the underlying practices of their respective fields. Projects that made small, measured contributions proved more successful than those adopting

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[386] “Adventures in Science,” radio program script, February 16, 1946. SSR Box 392, Folder 3.

[387]“Adventures in Science,” radio program script, February 16, 1952. SSR Box 401 Folder 4.

unconventional methods. Perhaps most importantly, each project needed to present a straightforward analysis about the merits of the student's work. Rather than conveying a visual narrative, the project descriptions embodied a clear, written argument.

Finally, virtually all of the projects represented the success of lone individuals. Participants could not submit projects as groups, and even though several finalists recognized the assistance they received from teachers, family members, or fellow students, ultimately they received sole credit for their work. For instance, in 1945 Edward Kosower won the Science Talent Search when he was just fifteen years old by organizing a chemical manufacturing business and supplying rare chemicals from his basement laboratory to the U.S Army, university labs, and private businesses. Although he developed his company alongside two friends, ultimately Kosower served as the sole recipient of his first place prize. Science Talent Search officials praised Kosower's ingenuity and entrepreneurial spirit. Rather than providing a visual narrative, his detailed report provided a verbal description of the processes involved in making the chemicals, how his project built upon existing scholarship, and potential practical uses of his research (Fig. 4.19). By demonstrating how his work could serve the pressing needs of industry through his text-based analysis, Kosower embodied several of the characteristics valued by the emerging analytic culture.

Such individual recognition also carried great responsibility. At the First Annual Science Talent Search dinner, Dr. Harlow Shapley of the Harvard College Observatory cautioned finalists not to get too conceited about their success. "Don't forget that this distinction of being a winner in the Science Talent Search should be a source for sympathy rather than congratulations because upon you a heavy burden has been placed," Shapley warned. "You have no escape now from the necessity of hard work, persistent thinking, and sincerity in scientific activity. We expect great things from you."[388] Their success identified these students as the necessary brainpower to keep American democracy intact during a time when its position was threatened—both externally by fascist and communist regimes as well as internally by a scientifically ignorant citizenry. This highly individualized system of recognition underscored the competition's underlying intention to reward students based on inherent ability rather than their gender, ethnicity, or geographic background.  As the next section will demonstrate, however, this system often proved more difficult in practice.

## **The Limits of Meritocracy**

The meritocratic vetting process of STS was intended to level the playing field. STS prided itself on seeking out students from across the nation, publicizing that the location of high schools had little to do with winning in the Science Talent Search and that "promising young scientists appear to be almost anywhere in the U.S."[389] However, the geographic makeup of finalists proved otherwise. Areas to the South and Southwest generally performed below expectancy, whereas states in the Northeast, Midwest, and Northwest typically performed above expectancy. As of 1946, 18 states had never had a student finalist in STS. On the other side of the spectrum, in the first six years of the competition, New York had 54 finalists and 235 honorable mentions.[390] This overrepresentation is perhaps less surprising when recalling that New York was the first state to organize statewide science fairs and served as the direct precursor to the

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[388] Hardlow Shapley, "Scholarship Winners Told Beware of Bumptious Vanity," *Science News-Letter* 42, no. 4  (25 July 1942): 52.

[389] "Awards Wait Young Scientists," *Science Page* 2-8 October 1949. Located in SSR Box, 444, Folder 6.

[390] Harold Edgerton, "Is Your State Discovering its Scientific Talent?" *Science Education* 28, No. 4 (October 1944): 228-231. Located in SSR Box 444, Folder 6.

competitions sponsored by the Science Service. These disparities varied from school to school as well. In the 1950 competition, for instance, only 22 finalists came from schools with no previous representation in STS. In contrast, by that same year Bronx High School of Science already had 15 participants in the competition, averaging nearly two finalists per year. Part of these disparities could be explained by the fact that STS did not take location into account when determining finalists. Due to the lack of restrictions and the fact that judges did not know the location of applications, any school or state could be represented any number of times. The competition made no adjustments for geographic disparities even as organizers recognized that such inequities existed.

In contrast, STS officials were adamant about recruiting young women. As other youth competitions such as the Fisher Body Craftsman's Guild prevented females from participating, the Science Service aggressively tried to recruit high school girls. It selected the number of STS finalists of each gender in proportion to their percentage of applicants, and until 1948 appointed one male student and one female student each year as winners. Promotional materials also celebrated female finalists who eventually pursued full-time employment as scientists and cited examples of women who successfully balanced homemaking with their careers.[391] These promotional messages never challenged the notion of women's domestic responsibilities, but rather suggested that it was possible for women to be successful both at home and in the workplace.

In spite of their efforts, however, in the first ten years the proportion of female applicants consistently hovered at around 20%. Perhaps this is due to the fact that STS's strict meritocratic objective often overlooked the unique challenges female participants

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[391] Margaret E. Patterson, "Young Scientists Make Good," *Science News-Letter* 55, no. 2 (January 8, 1949): 26-27.

faced. Female STS alumni reported getting paid significantly less than their male counterparts. They also entered chemistry in much higher numbers than pursuing the more lucrative careers in physics or engineering. Likewise, the pressures of pursuing a career while balancing familial responsibilities proved challenging for many women. Alum Jean Rose Towle declared, “This business of combining two careers—marriage and chemistry—is interesting, entertaining, and above all, time consuming. I am still doing ultraviolet work for Sinclair Research Labs and have the honor of being the only female in the labs with my name on my lab door.”[392] As the opportunities that attracted young women to scientific engagement during the 1930s—such as collaborative projects and creative writing—disappeared, so too did female participation.

Disproportions in participation were not just limited to gender or geographic location. According to a study of male contestants who participated in the first three years of the Science Talent Search, the applicants classified as more scientifically inclined also had a higher percentage of professional fathers. The rankings also showed a deficiency in Catholics as well as an excess of Jews, and only one African American was considered part of the successful “Honors” group. [393] Though these statistics demonstrate the inequity among contestants, the fact that the Science Service actively collected and analyzed this data demonstrates its commitment to ensuring that it was comprehensive in seeking scientific talent from across the nation. Science Service positioned talent as the

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[392] Margaret E. Patterson, ed. “Science Talent Search Light,” 7 no. 1, December 1949. SSR Box 444, Folder 28.

[393] Ralph David Norman, “A Study of Scientifically Talented Boys, with Special Reference to the Early Validity of Selections Made in the First Talent Search.” SSR Box 444, Folder 6.

common denominator that allowed anyone with aptitude to excel in science, regardless of background.[394]

In some cases, the lack of distinction worked contestants' favor. Jewish students, a group that was discriminately denied entry to many prestigious Ivy League programs well into the mid-twentieth century, were disproportionately represented at STS.[395] The Science Service also ensured that students from a variety of backgrounds—children of Jewish descent, immigrants, and young women—were prominently featured in their media outlets. For instance, Edward Kosower, the student who organized his own chemical manufacturing business, appeared on Davis's radio show "Adventures in Science" alongside his father, a Brooklyn cab driver. Davis asked the Kosowers to "find out how to train the potential scientists of tomorrow," using them as an example of a working class family who made the time and effort for their child to pursue scientific hobbies.[396] At the same time, the Science Service did not address the distinct challenges facing minority students. 1944 STS finalist Sister Julia Mary Deiters recalled how African American finalist Nancy Durant was not allowed entry into several restaurants in Washington, DC. The group of students ended up eating at the YWCA.[397] As the only African American student to become a finalist during the first decade of the Science Talent Search, Durant's challenging experience during the five-day institute reflected a broader issue regarding the strict focus on innate talents fostered by STS. For many students, the Science Talent Search may have provided them with amazing opportunities, but many students questioned its very spirit of competition.

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[394] Patterson, "Young Scientists Make Good."
[395] Karabel, *The Chosen.*
[396] Davis, "Scientists of Tomorrow."
[397] Laura Vanderkam, "Sister Julia Mary Deiters: Planting Seeds for Science Education," *Scientific American,* 13 October 2008.

## **Reactions from Finalists Regarding the Science Talent Search, Scientific Communities, and Social Responsibility**

A careful analysis of alumni surveys reveals that just as student demographics did not neatly align with STS's vision, students also possessed disparate and often conflicting views of the competition at large. Certainly, many students were appreciative of the opportunities that STS afforded them. In a questionnaire about how STS affected their lives, finalist Leonard Taylor replied, "The welcome back at school has truly surprised me. Apparently the news of my winning caused a sensation at Webb School not unfavorably comparable to the San Francisco earthquake. The entire faculty went wild, and behaved in a most undignified manner. As the intelligence spread, almost everyone had hysteria…At school the entire faculty and the whole student body was massed to greet the new 'hero.'"[398] John T. Hopkins was killed by lightning just a few months after attending the 1946 Science Talent Institute. When officials visited Hopkins's improvised apartment laboratory, they found Hopkins's STS portrait hanging prominently on the wall (Fig. 4.20).[399] Others supported the meritocratic mission of STS, with alums responding, 'The STS has proven to be a great and far sighted contribution to our national welfare." Another student claimed that "As a whole it is beneficial to the national interest to recognize such talent."[400] The Science Talent Search often served as a source of pride for both finalists and their communities.

Other students proved more skeptical of the success of STS and the worthiness of its overall mission. One alum stated," Hoping to seem not ungrateful for the benefits I

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[398] Margaret E. Patterson, ed. "Science Talent Search Light," 7 no. 1, December 1949. SSR Box 444, Folder 28.

[399] Photograph of Hopkins's apartment. SSP Science Talent Search 1946 Box.

[400] Margaret E. Patterson, ed. "Science Talent Search Light," 8 no. 1, August 1951. SSR Box 444, Folder 28.

have received through STS, I seriously question the value of searching out and stimulating those persons who, by very virtue of the fact that they complete the gamut of STS requirements, indicate they need no stimulation.” For many students, the mission of celebrating individual talents did not align with their experiences working in the profession. One former finalist claimed, “Science is complex and deep but not as esoteric and mysterious as some would believe. It requests a great deal of hard work but there is nothing in it which is innately beyond the understanding of the diligent student.” Another alum replied, “Most of the important new developments [in science] are made possible through teamwork rather than by individual genius.”

The participants also engaged in a rousing debate over why more students opted to pursue careers in the physical sciences rather than in the biological sciences. During the 1930s, despite the decline in nature study, the most popular science fair categories remained in areas such as biology, preservation, and plant and animal life. However, the projects of Science Talent Search participants diversified to areas in engineering, physics, and a growing number of projects in mathematics. This shift reflected an impulse in higher education to increase the enrollments of students in the physical sciences. As David Kaiser has shown, the number of American PhDs in physics after World War II doubled every seven years at a rate twice as fast as the first half of the twentieth century. Universities, government officials, and private industry advocated for the education of future physicists as a measure of national security. Other fields such as biology or chemistry did not achieve nearly the same growth rate.[401]

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[401] David Kaiser, “Cold War Requisitions, Scientific Manpower, and the Production of American Physicists after World War II,” *Historical Studies in the Physical and Biological Sciences* 33, Part 1 (2002): 131-159.

Former STS finalists were well aware of physics' disciplinary primacy. Some students believed in the innate superiority of the physical sciences. Kenneth Ford attributed the success of physics to "the excessive respect for, or even fear of, physical sciences and physical scientists, which the great strides of the past half century have been occasioned." Other students believed that the Science Talent Search itself was structured to favor the physical sciences. Kirby Dwight, Jr. responded that "the method of selection of STSers favors the type of mind which prefers precise problems with definite answers. The biological sciences do not offer such people as much satisfaction as the physical sciences," whereas Herbert Radack asked, "Do the STSers in this instance represent a true cross section of the interests of American science students? Perhaps the STS exams have stressed math and scientific logic more than imaginative speculation upon multitudes of 'illogical' observations."[402] By assuming that biological sciences were less logical or precise than the physical sciences, Radack and Dwight demonstrated an implicit bias toward the physical sciences that many STS finalists shared. Finalists also considered the gendered implications of this shift. Female former finalist Ursel Blumenheim asked, "Could it be because most of them [finalists] are boys and are more interested in physical sciences than in biological sciences?"[403] Like the decline of the nature study movement during the 1920s and 30s, the shrinking interest in the biological sciences further alienated young women who were more drawn to these fields.

This discussion was also illustrative of the conscious choices students made in planning their careers when considering the professional rewards system in place. As future physics Nobel Laureate and 1947 STS alum Leon Cooper explained,

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[402] Margaret E. Patterson, ed. "Science Talent Search Light," 7 no. 1, December 1949. SSR Box 444, Folder 28.
[403] Ibid.

> "Originally interested in physics as well as biochemistry and bacteriology, I now lean toward physics because there is only limited opportunity in the biological sciences except medicine. The salaries are pitifully low in the biological sciences and there are few opportunities to do research on problems in which one is interested unless one is fortunate enough to get into a foundation or get a fellowship. In physics on the other hand opportunities have greatly expanded because of the development of atomic energy and subsequent government-supported research projects."

Although 1944 Finalist Ben Mottelson decided to pursue a career in the physical science, he was ultimately skeptical of the hype. Mottelson claimed, "It's a fad. Interest in the 'atomic age' will certainly make phys. sc. more active and interesting." He also explained that work in the physical sciences offered greater incentives via "Government subsidies—graduate fellowships."[404] Mottelson held a prestigious fellowship from the Atomic Energy Commission and would go on to receive a Nobel Prize in 1975 in physics for his work on asymmetrical atomic nuclei.[405] The responses of Cooper and Mottelson reflected the practical concerns of students in navigating their careers at a time when certain scientific fields were valued more highly than others.

Although STS showcased students' skills in specific fields, alums often embraced a more generalist perspective as they entered their professions. According to one finalist, "The greatest error [in science] is not just too few scientists, but too few with training which transcends the classical visions of learning." Other former participants reflected that "too many scientists are too narrow" and that "the real inspirations come through outside your immediate field."[406] Although many STS participants continued to support science as the most valuable contribution to society, others believed that scientists should

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[404] Ibid.

[405] Margaret E. Patterson, ed. "Science Talent Search Light," 6, no. 1, February 1948. SSR Box 446, Folder 20.

[406] Margaret E. Patterson, ed. "Science Talent Search Light," 8 no. 1, August 1951. SSR Box 444, Folder 28.

seek out additional training in other fields or even other disciplines in order to gain a broader perspective of their work.

Indeed, many students began to express doubt on whether or not the larger goals of STS matched their understandings of science itself. The downside of celebrating individual talent for many students was that even among finalists, several students felt that they did not belong as one of the rare geniuses deserving of such recognition. Joseph Ousley described STS as “a noble venture but I shouldn’t be grouped with these geniuses,” whereas finalist Mary Ann Williams claimed, “I can truthfully say that I have never met such an aggregation of talent in one place. So much so, that on further analysis, I am all the more certain that the judges must have mixed me up with someone else in the first place.”[407] Indeed, STS’s singular focus on the lone genius not only created a sense of inferiority among many STS finalists, but it also overlooked the fact that what many alums valued most from the program was not its recognition of their individual achievements. Rather, it was the sense of community that many participants felt with one another.

STSers held reunions, invited new cohorts of finalists to visit their universities, and even assisted each other academically and professionally. Alum Richard Milburn explained, “The unique circle of fellowship which STS has generated will, I am confident, endure for our lifetime. Through STS I have met many new friends. I am also grateful to STS for standing as an introduction to other friends whom I have not as yet met, or may never meet. It is a welcome feeling to have something in common with a

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[407] Margaret E. Patterson, ed. “Science Talent Search Light,” 7 no. 1, December 1949. SSR Box 444, Folder 28.

small group of people with related interests, who by this time have scattered themselves all over the country."[408]

This formation of a network is particularly apparent when evaluating where participants decided to attend college. Certain universities such as MIT, Harvard, Cornell, Columbia, and CalTech became hubs of STSers. This was no accident. In evaluating the distribution of annual cohorts, several students opted to attend the same institution. For instance, in 1948, 13 of the 40 finalists, or 25%, attended Harvard.  Many of these finalists reported becoming roommates or taking classes together. As one Harvard student claimed, "There are so many STSers here at Harvard it seems like another Washington. I've very grateful to STS for the number of friends I have made through it."[409]

Perhaps it was this sense of community, just as much as the public recognition through the competition itself, that helped STS achieve its intended goals of encouraging talented students to pursue careers in the sciences. The first decade of finalists led to 27 students working in mathematics, 31 in medicine, 33 in chemistry, 34 in engineering, and 50 in physics. Several students reported that STS gave them the confidence to pursue these lines of work. At the same time, several former finalists also moved beyond thinking about the pursuit of science for its own sake to ask broader questions about the role of science in society.

When evaluating where students attended college and eventually landed careers, there was a clear connection to national defense research. Finalists listed positions at Oak Ridge, U.S. Civil Aeronautics Administration, Office of Naval Research, Radar Communications with the U.S. Air Force, Radiation Lab at U.C. Berkeley, Westinghouse

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[408] Ibid.
[409] Ibid.

Atomic Power Division, the Jet Propulsion Lab at CalTech, U.S. Army Electronics Warfare Center, or simply "classified." Four of the top five schools chosen by finalists—MIT, CalTech, Harvard, and Columbia—also received the largest R&D contracts in the nation. Alongside these entanglements with sponsored research, these academic institutions also established cultures of self-reflection, whereby students and faculty posed questions regarding the larger place of science in society. As Stuart Leslie notes in his study of MIT, these research communities "challenged the administration *and themselves* to reexamine their own priorities in light of questions about social responsibility of scientists and engineers as well as MIT's proper role 'in the nation's service.'"[410]

It is perhaps not surprising due to STS's connection to Westinghouse Electric, a company with its own entanglements in national defense, that STS surveyors did not ask alums questions about the ethical implications of science. Yet, many former finalists framed their responses in ethical terms. One former participant claimed, "Science alone won't solve the world's problems." And finalist William Kohn, declared, "No view of science is adequate unless it takes into account the society in which the science is perpetuated." These alums challenged the idea that the scientific enterprise was an inherent good in its own right, calling on members of their profession to take into consideration of the broader ethical implications of their work.

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[410] Stuart Leslie, "Times of Troubles for Special Laboratories" in David Kaiser, *Becoming MIT: Moments of Decision* (Cambridge: MIT Press, 2010), 123-138. For other examples of how universities grappled with the politics of the Cold War, see Ellen W. Schrecker, *No Ivory Tower: McCarthyism and the Universities* (New York: Oxford University Press, 1986); and Rebecca S. Lowen, *Creating the Cold War University: The Transformation of Stanford* (Berkeley: University of California Press, 1997).

## Conclusion

Now sponsored by Intel Corporation and run by the Science for Society and the Public (formerly the Science Service), the Science Talent Search continues to serve as a premier science scholarship competition that recognizes talented high school seniors across the nation. In reflecting upon its legacy, the first decade of the Science Talent Search proved markedly successful at achieving its aims in cultivating the next generation of leading scientists. Out of these early finalists, four would go on to become Nobel Laureates (Leon Cooper, Walter Gilbert, Sheldon Glashow, and Ben Mottelson), two would win the National Medal of Science (Ronald Breslow and Paul Cohen) one would win a Fields Metal (Paul Cohen), and one would become a MacArthur Fellow (Richard Berry).[411] A recent special column of *Scientific American* called "Where Are They Now?" profiled former finalists to see how STS ultimately affected their careers. Sister Julia Mary Deiters (formerly Rosemary Deiters) responded that being a 1944 finalist was "very affirming. I guess it convinced me that I did want to go into [the] sciences."[412] Likewise, 1947 finalist Leon Cooper believes that the scholarship was the reason he was admitted to Columbia University, where he obtained a PhD in physics before going on to receive the 1972 Nobel Prize in Physics for developing the theory of superconductivity.[413]1952 finalist Alice Beck Kehoe stated that, "On the one hand, I realized that I didn't have the same kind of brilliance some people had." On the other

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[411] "Alumni Honors," SSP. http://www.societyforscience.org/sts/alumnihonors#fields Accessed 20 April 2013.

[412] Laura Vanderkam, "Sister Julia Mary Deiters: Planting Seeds for Science Education," *Scientific American*, 13 October 2008.

[413] Laura Vanderkam, "From Biology to Physics and Back Again: Leon Cooper," *Scientific American*, 15 July 2008.

hand, “It was exciting to think I was counted, literally, in this company. For a girl in the 1950s, that really helped.”[414]

Beck Kehoe’s statement reveals a familiar ambivalence towards the notions of talent that has coincided with the Science Talent Search since its inception. This glimpse into the lives of student scientists in the 1940s and 50s reveals that although the Science Talent Search promoted individual talent to instill the values of scientific authority to a rising a generation of scientists and engineers, STS student finalists often developed disparate, sometimes even ambivalent views on the value of science in society. The meritocratic vision of STS to seek out students based on innate ability proved more challenging in practice, where certain groups of students were privileged or excluded based on gender, geography, or high school education. These inequities led to broader questions regarding what constituted talent as well as anxieties over whether such abilities could be measured or discovered. As student participants began their careers, they started to question whether the virtues of individualized merit mapped onto their own experiences in the profession. Indeed, coming of age during the atomic era profoundly shaped how these budding scientists and engineers perceived their social obligations as they began their careers.  For many students, it was the sense of connection and the building of relationships that they valued most, both in STS and in their careers. STS did not just serve as a celebration of individual talent- rather, it helped form a community of young scientists who developed their own notions of the role and value of science in the polity.

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[414] Laura Vanderkam, “Alice Beck Kehoe: Overturning Anthropology Dogma since the Tender Age of 16,” *Scientific American*, 16 December 2008.

Table 4.1 The selection process of the Science Talent Search. Made by author.

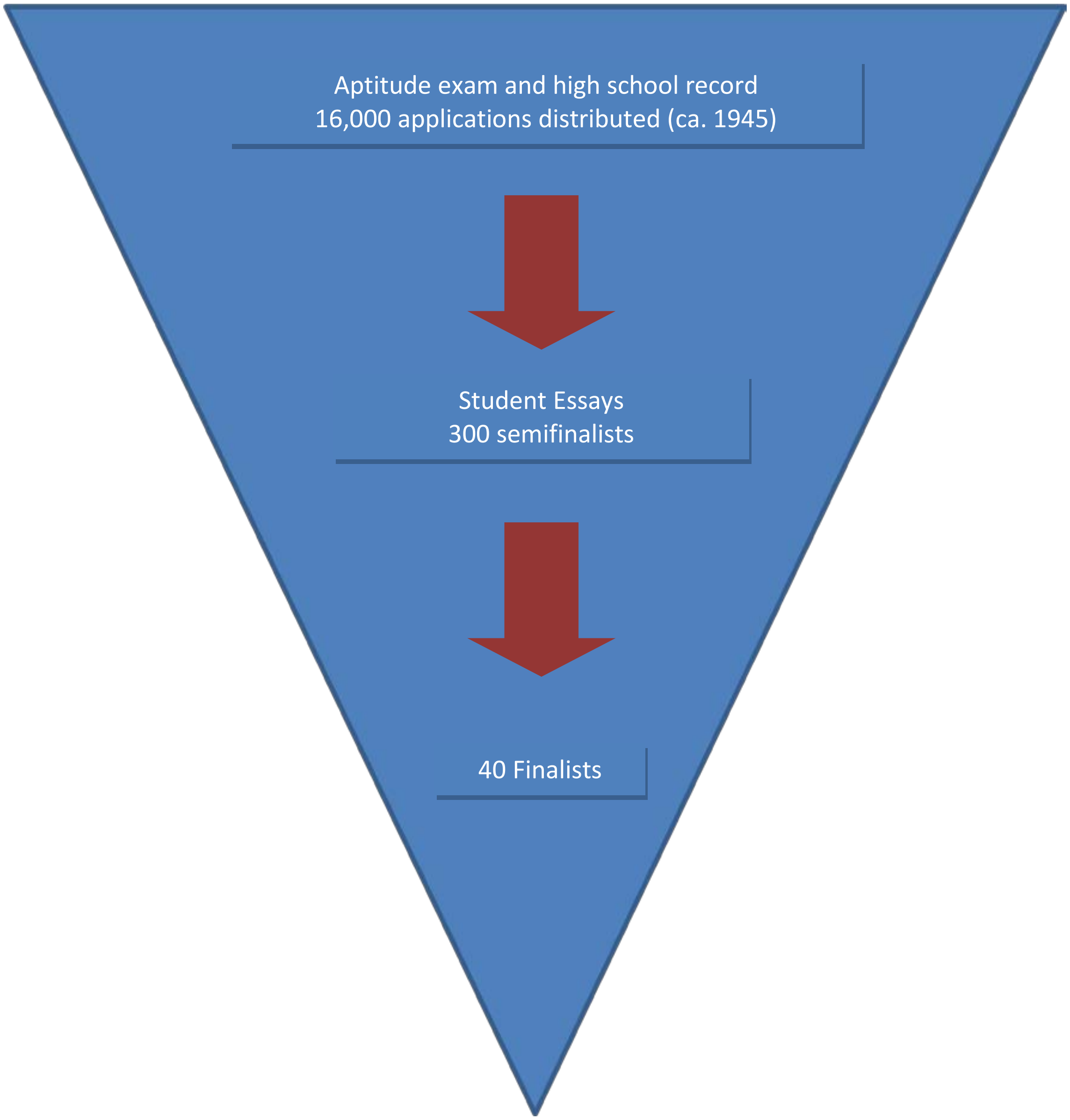

Figure 4.1 Examination during the first annual Science Talent Search, 1942. Courtesy Society for Science and the Public Photograph Collection.

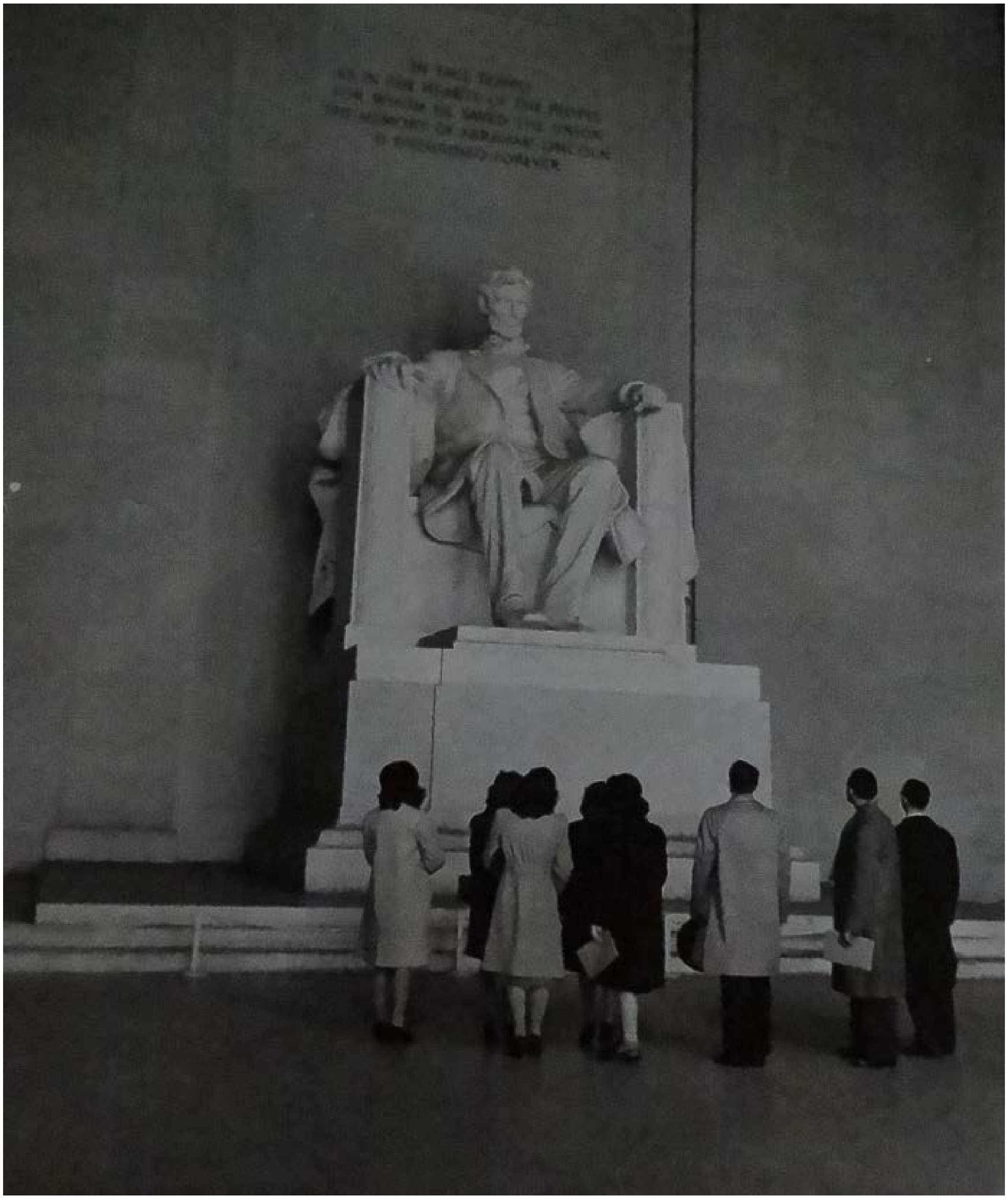

Figure 4.2 Science Talent Search finalists in front of Lincoln Memorial. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.3 Former finalists talking to current STS participants about their careers. Marina Prajmoysky discussed her study of DDT at Harvard, and John W. Michener delayed college training to do research related to the atomic bomb. He then pursued a Ph.D. in physics at Carnegie Tech. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.4 STS Finalist Nan Honour interviewed by Dr. Harold Edgerton, 1944. Courtesy Society for Science and the Public Photograph Collection.

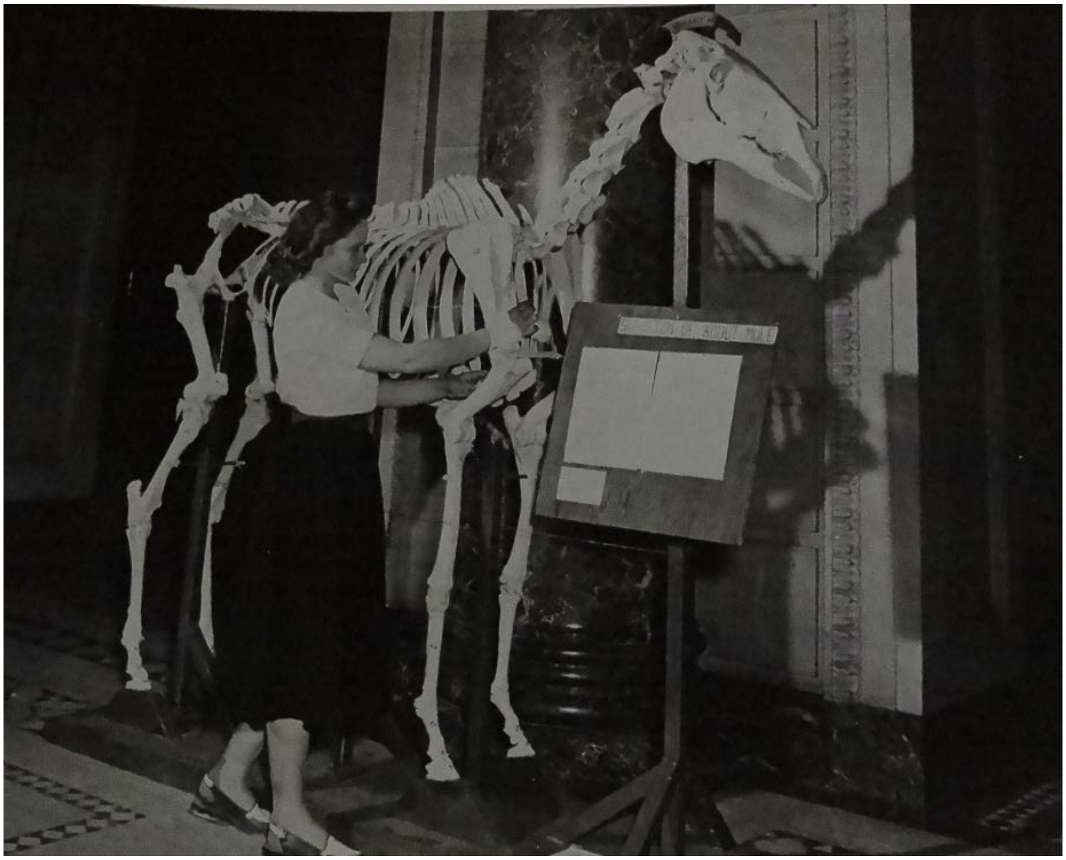

Figure 4.5 Betty Porter standing with the skeleton of a mule that she reassembled. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.6 Carolyn Hansen’s project on endocrine glands in rodents. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.7 Leon Bush telling Gerald Ludwig about his work on paramecium. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.8 David Smith demonstrating his Geiger counter. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.9 Rosemary Och with her mechanically actuated computer, “ROMAC.” Courtesy Society for Science and the Public Photograph Collection.

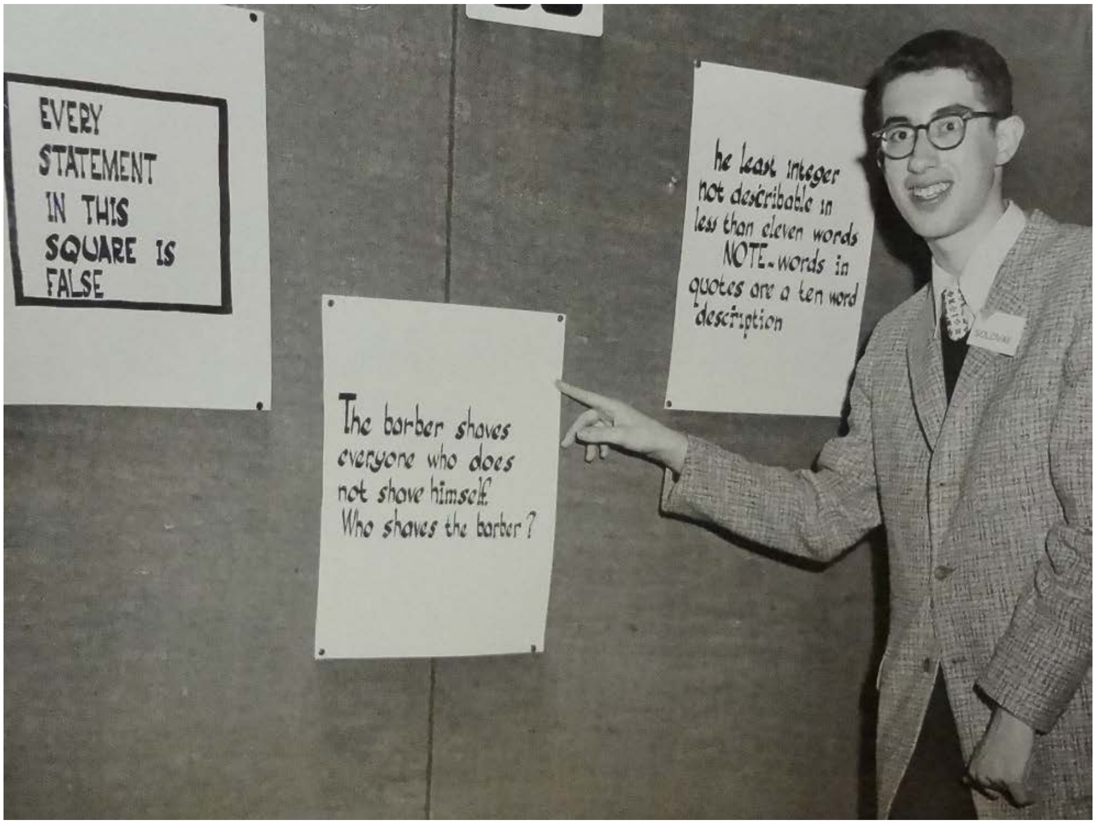

Figure 4.10 Robert Solovay with his display on logical paradoxes. Courtesy Society for Science and the Public Photograph Collection.

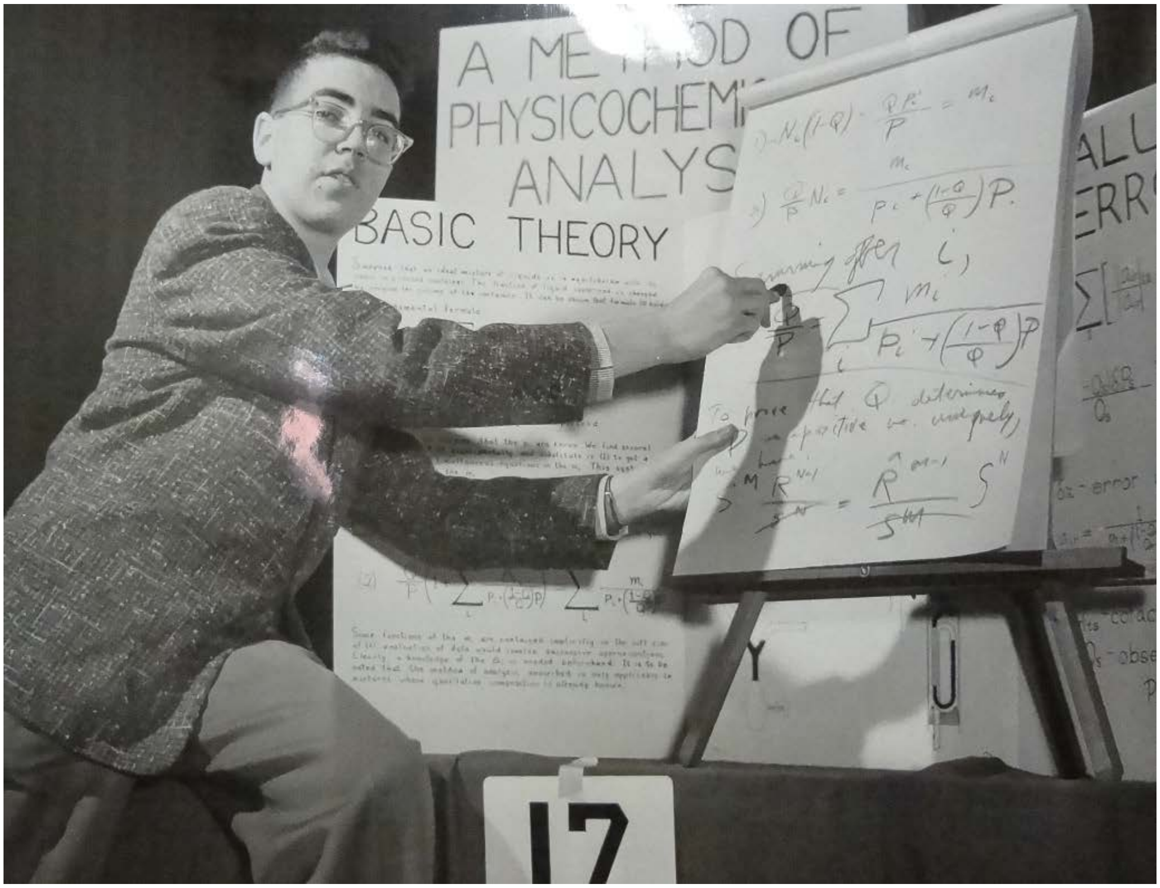

Figure 4.11 Jonathan Glogower with his presentation analyzing vapor pressure measurements for an analysis of ideal solutions. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.12 Joyce Marrison (1944 alum) and Gordon Newkirk, Jr. (1946 alum) setting the Oak Ridge Camera at Harvard College Observatory. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.13 STS finalist Alan Haught looking at records with friends in his living room. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.14 STS finalist Merry Margolish posed baking in her kitchen. Courtesy Society for Science and the Public Photograph Collection.

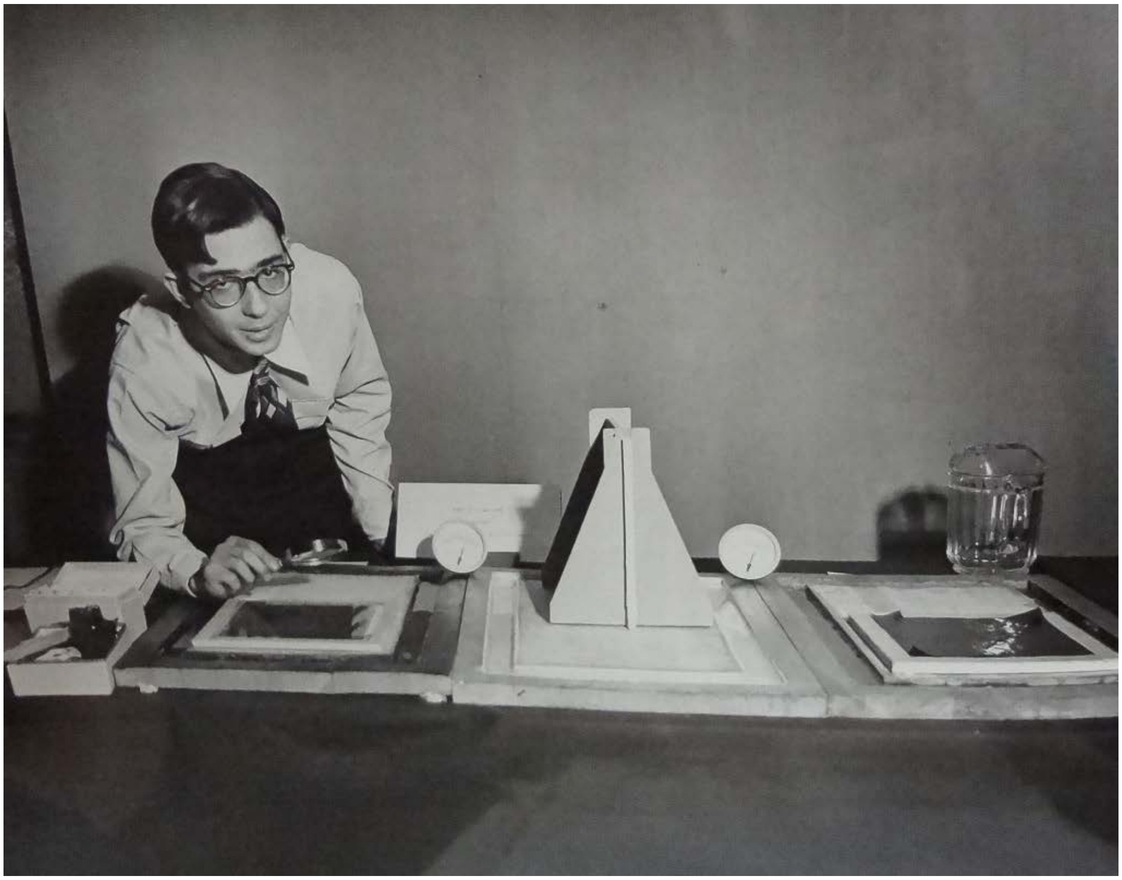

Figure 4.15 Kurt William Kohn of the Bronx School of Science shown with his ant colony. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.16 Millicent Margaret Sawyer of Wiley High School in Terre Haute, Indiana with her collection of pressed flowers and leaves. Courtesy Society for Science and the Public Photograph Collection.

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Figure 4.17 Joel Dean Finegan grinding his telescope mirror on his mother’s washing machine. According to the photo description, “The family wash waited while he ground.” Courtesy Society for Science and the Public Photograph Collection.

Figure 4.18 Douglas Baird showcasing his telephone amplifier for the hard of hearing. Courtesy Society for Science and the Public Photograph Collection.

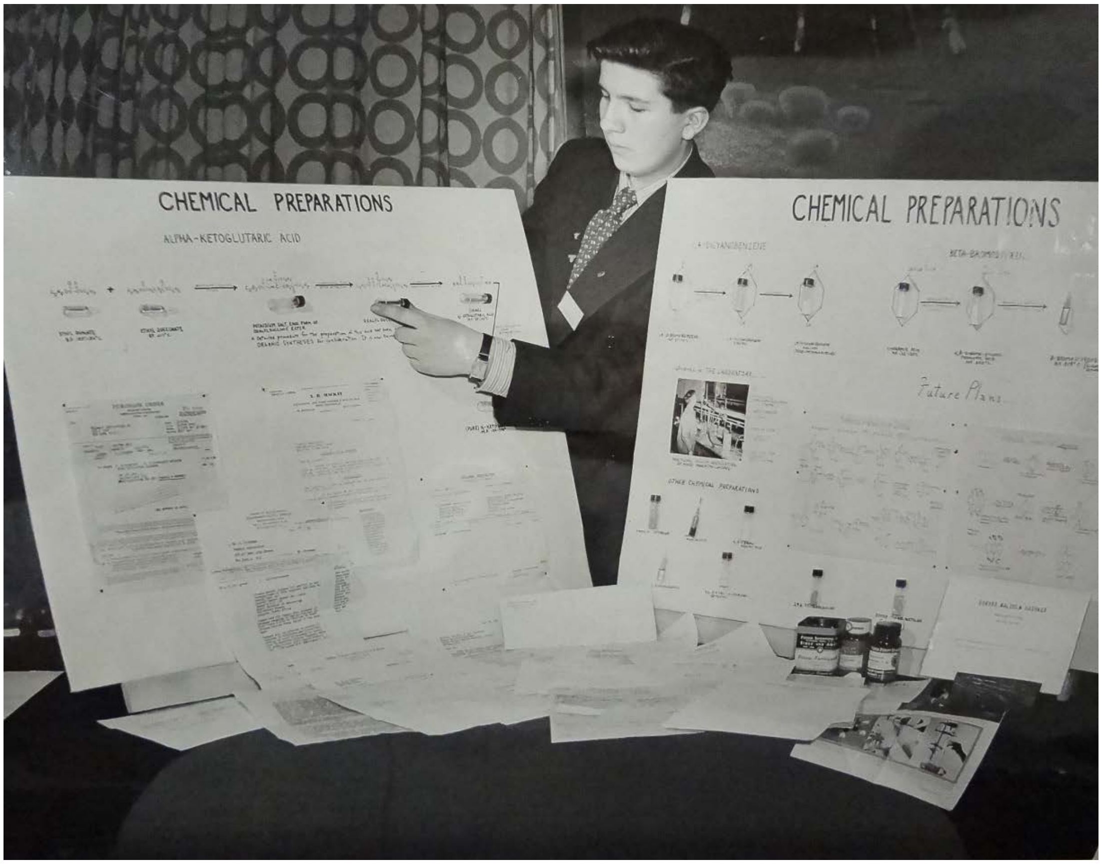

Figure 4.19 Edward Kosower of Stuyvesant High School with his display of chemical preparations. Courtesy Society for Science and the Public Photograph Collection.

Figure 4.20 John T. Hopkins's apartment chemistry lab with his Science Talent Search picture hanging on the wall. Courtesy Society for Science and the Public Photograph Collection.

# CHAPTER 5

## From a National Movement to an International Standard: The National Science Fair, 1950-1965

Japanese high school student Mizue Mori gained entry to the 1961 National Science Fair-International for her study on cuprammonia silk. Mori joined 384 American and international students to attend a three-day competition in Kansas City, Missouri to demonstrate their scientific abilities. In her exhibit, Mori described preparations for different varieties of pulp, methods for dissolving the pulp cellulose, differing spinning speeds of threads, and the results of her treatments in preparing silk. Her neat trifold display provided a detailed description of each step of the preparation process, test tubes featuring sample pulp and threads, and diagrams of her results. In front, Mori carefully positioned her lab equipment, notebook, and project report. Mori's exhibit earned her a Fourth Award for its experimental design and craftsmanship, and yet it resembled the hundreds of thousands of science projects displayed both domestically and abroad.[415] The science fair movement was no longer confined to American borders. Rather, it had become a standard for youth scientific engagement emulated across the world.

This chapter chronicles of development of the National Science Fair (NSF) by the Science Service. Initially organized in 1950 at the local level, the National Science Fair quickly positioned itself as a model of adolescent scientific engagement that spread

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[415] Mori's project is shown in Ronald Benrey, *Ideas for Science Fair Projects* (New York: Arco Publishing Company, Inc., 1962, 1970), 83.

internationally. As the science fair movement achieved normative status as the benchmark in extracurricular science, adolescents began to view themselves as serious practitioners by interacting in more notable network forums, such as the "Amateur Scientist" column of *Scientific American.* By sharing the vision of the Science Talent Search in training the next generation of scientists and engineers, the National Science Fair cemented the virtues of analytic culture as a standard for science fairs that continued to dominate in the decades that followed.

The chapter begins by tracing the advent of NSF from its grassroots origins to a national phenomenon, demonstrating how science fairs encouraged local community involvement to support students' scientific pursuits. As the Science Service provided a platform for students to compete at the national level, it also claimed authority over the content and composition of science fairs. The chapter then provides a detailed overview of the 136 projects featured at the 1955 NSF. By focusing on a single year of participants, this section offers insight into students' socioeconomic backgrounds, inspiration for their work, and how they conveyed scientific evidence through their displays. It evaluates how the virtues of analytic culture became engrained in students' work while also illustrating how their participation in science fairs affected their future college and career choices. The following section likewise evaluates the ways in which the values of analytic culture manifested through a new forum for conveying student expertise, "The Amateur Scientist" column of *Scientific American.* The magazine served as a mark of prestige for the fair participants who published their projects while operating as a platform for professional socialization by allowing students to share their findings with a broader scientific community. The chapter concludes by evaluating the spread of science fairs across the globe. Just as the creation of the National Science Fair established a domestic standard, the international movement conveyed a specific vision of youth scientific engagement that served American interests. In the years immediately following *Sputnik's* orbit in 1957, science fairs served as a form of cultural diplomacy that shaped the contours of adolescent scientific cultures worldwide.

## From Local Engagement to a National Standard: Origins of the National Science Fair

When science fairs first nationalized in 1950, the scientific values underlying the competitions were in flux. Prior to the first National Science Fair in 1950, students across the country entered local and regional fairs. Following its hiatus during World War II, the American Institute continued offering science fairs at Madison Square Garden, attracting thousands of visitors. Other organizations such as the Buffalo Museum of Science in New York, the Buhl Planetarium in Pittsburgh, Pennsylvania, and the Department of Commerce in Washington, DC, served as sites for exhibitors to showcase their work.[416] Considering that several of these programs began in the 1930s and 40s, the expositions built upon the fair tradition established by the American Institute. What form would they take to meet the new realities of the postwar world?

Although the Science Service organized postwar science fairs at the national level, ultimately fairs remained heavily localized, grassroots efforts. Newspapers served as typical sponsors by devoting sections for promoting the fairs and financially supporting student travel to the national fair. Likewise, institutions of higher education, local businesses, civic organizations, and science societies often helped organize the fairs by providing judges, space, and financial backing. The general public showed their

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[416] "State Science Fairs and Searches," *Science News-Letter* 52 no. 4 (July 26, 1947): 61.

support by attending the expositions. One city reported that 16% of its local population attended, and another fair boasted 30,000 visitors.[417] Committees that formed to organize the fairs often worked beyond their initial scope by coordinating with teachers to shape science curricula, providing guest speakers, or organizing field trips.[418] When they attended the National Science Fair, students relied on the financial support of local organizations to sponsor their trips. Science fairs served as a common goal that brought community groups together and in turn fostered public support of science at a localized level.

Science Service officials recognized the potential of local fairs in supporting the youth movement. Science fairs built upon the familiar American pastime of county fairs by fostering local pride and a sense of community. Claiming that the National Science Fair was "aimed at encouraging interest in science at the grassroots level," the Science Service capitalized on preexisting community efforts by affiliating NSF with its Science Clubs of America program.[419] This partnership proved mutually beneficial. In 1948, there were approximately 15,000 clubs affiliated with the Science Clubs of America; one decade later, the number had expanded to 25,000. Likewise, local fairs underwent a major boom in popularity. The Lehigh Valley Science Fair in Allentown, PA, for instance, expanded from 14 projects in 1947 to 822 projects in 1958.[420] The fairs provided the Science Service with a direct connection to local community organizations

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[417] Joseph H. Kraus, "The National Science Fair: Purposes and Program," *Science News-Letter* 69, no. 5 (February 1956): 265-269.

[418] "Science Youth Program Grows," *Science News-Letter* 76, no. 15 (October 10, 1959): 231-232.

[419] "National Science Fair Expected to Double," *Science News-Letter* 65, no. 12 (March 20, 1954): 184.

[420] Ron Ross, "Work of Young Scientists," *Science News-Letter* 54, no. 20 (November 13, 1948): 314-315; "Science Youth Program," *Science News-Letter* 75, No. 10 (September 5, 1959); and Shirley Moore, "Science Fairs Grow Up," *Science News-Letter* 73, no. 18 (May 3, 1958): 282-283.

and audiences, allowing the national agency to wield greater control over the form and direction community fairs would take.

The Science Service exerted its authority over the science fair movement by providing a national platform for students to aspire to attend. The first National Science Fair was held on May 19-21, 1950 at the Franklin Institute in Philadelphia. It featured 30 finalists from 13 fairs across the country. Student exhibitors spent three days meeting with world famous scientists, visiting local laboratories and research centers, and commiserating with one another. Finalists listened to Nobel physicist Dr. Robert A. Millikin as he challenged them to use science "so to understand the world that there may be peace and plenty for all peoples."[421] The national fair introduced students to the professional scientific community while also establishing a set of values that they should adhere to in their own scientific pursuits.

Why did the Science Service, a well-established news agency with multiple successful youth programs already in place, take on the cause of science fairs? Unlike the Science Talent Search, which garnered the financial support of Westinghouse, the Science Service lacked corporate sponsorship for the National Science Fair program. Instead, it relied on local sponsorships to subsidize student travel and for promotion. The Science Service implemented NSF at a moment when children's science garnered headline news. At a time when science news stories were dominated by sensationalism, science fairs offered pithy headlines of young geniuses that captured readers' attention. By playing on adult anxieties regarding the security of the nation, the Science Service offered comforting stories about the promise of American youth in overcoming

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[421] "First National Science Fair," *Science News-Letter* 57, no. 21 (May 27, 1950): 326-327; "First National Science Fair to Be Held," *Science News-Letter* 57, no. 16 (April 22, 1950): 245.

international conflict. In this regard, the Science Service did not just publish news stories, but presented a worldview expressing an inherent faith in scientific advancements.[422]

The affiliation with grassroots science campaigns meant that early National Science Fairs were in flux between local traditions and the emerging analytic culture that would eventually dominate the overarching values of the expositions. The Science Service afforded a certain amount of flexibility to local fairs. It offered advice and publications on the logistics of coordinating fairs but ultimately left the planning to local authorities.[423] Unlike at the national level, local fairs could invite students of all age groups. In addition, the Science Service suggested that the local fairs allow group submissions. Even as local fairs maintained a certain measure of autonomy in coordinating their competitions, students needed to meet the standards set forth by the Science Service to compete at the national level. The rules and regulations dictated that only students in 10th, 11th, or 12th grade may submit projects. Even as the Science Service suggested that local fairs allow group submissions, only individual projects were allowed entry to the National Science Fair. Each affiliated fair was entitled to send two finalists, typically one boy and one girl. At the national level, boys and girls would be evaluated separately to allow for both male and female prize winners. Local fair officials were responsible for sponsoring the winners' trip to the national competition, and often relied on local news agencies for financial support.

Fair rules and regulations were in flux during the early years of NSF and reflected the evolution from the autonomy of local fairs to the standardization set forth at the national level. Although the science fairs and congresses of the 1930s featured dazzling

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[422] See John C. Burham, *How Superstition Won and Science Lost: Popularizing Science and Health in the United States* (New Brunswick: Rutgers University Press, 1987).
[423] Helen Miles Davis, ed. *Exhibit Techniques* (Washington, DC: Science Service, 1951), 12-13.

fire and chemical displays, at NSF chemicals, open flames, and explosives were prohibited.[424] Animal testing served as another area under constant negotiation. Initially, officials were hesitant to allow any animals to be entered due to the difficulty of feeding and transporting the organisms. The rules then permitted live animals as long as they were properly fed and had their cages cleaned daily. By the late 1950s, the Science Service declared that "the basic aim of scientific studies that involve animals is to achieve an understanding of, and a deep respect for, life itself and for all that is living."[425] Students were required to work under the guidance of an adult supervisor and needed a trained biologist, physician, dentist, or veterinarian to oversee experiments involving anesthesia, surgery, radiation, or pathogenic organisms. The Science Service also called on the expertise of the American Veterinary Medical Association, Animal Care Panel and the Institute to review the regulations for experiments involving live organisms.[426] Spatial requirements also gradually became more restrictive for science fair exhibitors at the national level. Initially, any exhibit gaining entry to the National Science was accepted regardless of size. By 1955, the space was confined to 36 inches by 48 inches, and by 1959 to 30 inches by 48 inches. In 1964, the Science Service also implemented a height limit of 12 feet which was reduced to 11 feet the following year.[427] As the National Science Fair solidified its rules and regulations, it also set a national standard that delineated the form and content of student projects.

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[424] Helen Miles Davis, ed. *Science Exhibits* (Washington, DC: Science Service, 1955), 10.

[425] "Science Youth Program," *Science News-Letter* 75, No. 10 (September 5, 1959).

[426] "Veterinarians Play Vital Science Fair Role," *Science News-Letter* 83, no. 3 (January 19, 1963): 47.

[427] Miles Davis, *Exhibit Techniques*, 6; Miles Davis, *Science Exhibits*, 9; "Fairs: National—Local," *Science Newsletter* 75, no. 10 (September 5, 1959); "Fairs: National—Local" *Science News-Letter* 86, no. 8 (August 22, 1964): 127; "Fairs: International—National—Local," *Science News-Letter* 88, no. 11 (September 11, 1965): 174.

The categories for judging remained consistent throughout the 1950s and early 1960s, setting an analytic standard. The scoring system prized ingenuity, problem solving, and systematic experimentation. Out of 100 points, creative ability counted for 30 points. Judges evaluated how much the project "appears to show originality in approach or handling." Scientific thought also counted for 30 points, and judges were asked to consider, "Does the exhibit disclose organized procedures? Is there a planned system, classification, accurate observation, controlled experiment?" Both creative ability and scientific thought emphasized originality and thoughtfulness behind the project's conceptualization. The remaining criteria of thoroughness, skill, clarity, and dramatic value each accounted for 10 points. These categories took into account both the project design as well as modes of display. In spite of the criteria to evaluate the overall attractiveness of an exhibit through its dramatic value, judges were warned, "Do not be influenced by 'cute' things, lights, buttons, switches, cranks, or other gadgets which contribute nothing to the exhibit."[428] Aesthetic qualities mattered less than expressing a clear purpose. One key difference between the National Science Fair and either the Science Talent Search or the Science Congresses of the 1930s was the lack of interaction with judges. Even as exhibits served as students' primary and often only medium for communicating their research, the judging criteria prioritized creativity and results over synthesis and aesthetic value.

The system of prizes also encouraged students to think about their role as scientists in a consumer society. Just as Americans were instructed to fulfill their duty as citizens by being dedicated consumers, students were instructed to be good consumers in

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[428] Miles Davis, *Science Exhibits*, 8-9.

order to be good scientists.[429] One science fair guide written by Ronald Benrey, a former National Science Fair finalist, included an entire chapter on "Shopping." Benrey advised, "These is a big a big difference between *buying* and *shopping.* Buying is easy; you just put your money on the counter. Shopping requires more effort. You must carefully consider each purchase before you make it."[430] The rewards structure for the National Fair encouraged students to make conscious choices regarding their prize money. Like the prizes of the American Institute, the Science Service provided students with a cash reward that was intended to be spent on scientific publications or equipment. Students made "Wish Lists" that specified how they would spend their awards in the event that they won first, second, third, or fourth place. The rewards system encouraged students to consider the purchasing of consumer goods as an important part of their work as scientists.

These analytical values were also reflected in the suggestions of assembling exhibit displays. Initially, the Science Service co-opted the synthetic vision of the American Institute by declaring, "An exhibit of scientific work tells a story. When you build and show such an exhibit you are striving to tell your audience how some part of the world around you has come to have special meaning for you."[431] In contrast, by the early 1960s students were encouraged to think about their projects not in terms of a story but as a problem that they intended to solve. "Begin with a problem," advised Dr. John. R. Dunning, dean of Columbia University School of Engineering and Applied Sciences. "Once you have tackled your problem, give your curiosity and theorizing impulses full

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[429] Lizabeth Cohen, *A Consumer's Republic: The Politics of Mass Consumption in Postwar America* (New York: Knopf, 2003).
[430] Benrey, *Ideas for Science Fair Projects*, 65.
[431] Miles Davis, *Exhibit Techniques*, 1.

scope. Do not be too severely practical. Be prepared to turn sharply and pursue the unexpected. But do not become too theoretical. The creation and manipulation of symbol-systems is great fun—but it can be sterile, if it is an end in itself. If it is to be fruitful, it must remain in contact with the real world."[432] This transformation was also reflected in the techniques students were encouraged to employ when designing their displays. Helen Miles Davis, chemist and wife of Science Service Director Watson Davis, encouraged students to turn to museums and even store windows for inspiration on developing an effective mode of display.[433] By the 1960s, however, students were advised to follow a "Presentation Check List" that included criteria such as a description of their topic, the project's importance to the field, how they tackled the problems they intended to solve, documentation of procedures, and conclusions they reached.[434] The narrative modes of display were again superseded by an analytic focus on procedures and results.

The value of specificity was reinforced by the narrowing of scientific categories featured at the fair during the early 1960s. The *Science News-Letter* informed students that when designing their projects, "The point is to be specific. This cannot be over emphasized."[435] This recommendation advocated for narrowing in on a particular field of inquiry rather than providing a synthetic overview of a discipline. Throughout the 1950s, NSF featured just two categories—Physical Sciences and Biological Sciences—with each category awarding one male and one female first prize winner. In 1962, the Science Service further divided the fair into the fields of botany, chemistry and biochemistry,

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[432] Forrest L. Snakenberg, "Beginning a Science Project," *Science News-Letter* 88, no. 14 (October 2, 1965): 218-219.
[433] Miles Davis, *Exhibit Techniques,* 7.
[434] Benrey, *Ideas for Science Fair Projects,* 81-82.
[435] Forrest L. Snakenberg, "Beginning a Science Project," *Science News-Letter* 88, no. 14 (October 2, 1965): 218-219.

earth and space sciences, medicine and health, physics, mathematics and computers, and zoology.[436] Specificity was no longer merely a recommendation, but now served as the norm.

Although the science fair movement began as a grassroots campaign, the establishment of the National Science Fair quickly set a national standard that was cemented by the end of the 1950s. By dictating rules and regulations, modes of display, judging criteria, and disciplinary categories, the Science Service had the authority to oversee the form and content of students' work. Their recommendations reinforced the virtues of analytic culture by prizing specificity, ingenuity, and problem solving over narrative expression or aesthetics. The following section analyzes the way students negotiated these values in their own projects. By zeroing in on a single year of science fair participants, it demonstrates how students' inspiration for their work, socioeconomic backgrounds, career aspirations, modes of display, and project design conveyed their own vision for the future of science in the postwar world.

## **Negotiating Analytic Culture: Student Projects at the 1955 National Science Fair**

On May 12, 1955, 136 boys and girls descended on Cleveland, Ohio to participate in the Sixth National Science Fair. The students served as the top winners from more than 65 local and regional fairs across the country. They spent three days sightseeing and learning about each other's research while competing for more than 40 awards worth over $2,000. Just two years before Sputnik, these students engaged in a movement that was booming across the country. During the 1955-6 academic year, more than 1,500,000 people attended science fairs to view approximately 187,000 exhibits. Science fairs were

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[436] "Honors at Science Fair," *Science News-Letter* 81, no. 20 (May 19, 1962): 309.

an opportunity for students to display their scientific acumen to their local communities while competing for national recognition. The following section focuses on the participants of the 1955 National Fair to capture the ways students envisioned their position in the scientific enterprise through the construction of their projects. Using surveys conducted by the Science Service as well as photographs of finalists' projects, this section analyzes students' socioeconomic backgrounds, hobbies, motives and inspiration, modes of display, project descriptions, college enrollment, and career choices. It argues that although the localized nature of science fairs provided a small measure of flexibility in how students conceptualized their work, ultimately the virtues of analytic culture predominated the ways that they conveyed scientific authority.

With financial support provided more by local communities than by corporate sponsorship like Westinghouse, the National Science Fair showed greater diversity in terms of students' geographic backgrounds, gender, and race. Whereas only seniors were eligible to compete in the Science Talent Search, students in 10th, 11th, and 12th grades were encouraged to participate in the National Science Fair. In 1955, 26 students were in 10th grade, 34 students were in 11th grade, and 76 students were in 12th grade. Participants' ages ranged from 14 to 20, with most students between 15 and 18 years of age. Although New York dominated STS every year, there were no students from New York represented at the 1955 fair.[437] Instead, the three states with the highest representation at NSF were Indiana, California, and Tennessee, with 15, 12, and 10 student finalists, respectively. Female students were also better represented at the

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[437] Although I am not certain why New York did not engage in the early years of the National Science Fair, I suspect that there was lingering animosity between the American Institute and the Science Service due to the transfer of Westinghouse support in the early 1940s. By 1957, students from New York participated in the National Science Fair.

National Science Fair; 35% of participants were young women, compared to the 20-25% ratio typical of most Science Talent Search cohorts. During the 1955 fair, approximately three students were African American. Although still underrepresented commiserate with their proportion of the total student population, this number was still higher than STS, which had only two African American participants during the first two decades of competition. Both competitions featured several children of immigrants. At NSF, numerous students reported that their parents were immigrants from Russia and other eastern European countries, and one student's parents moved to the United States from Japan. Local authorities' control over choosing the top finalists in their region contributed to more diverse student representation at the national level.[438]

Students also came from a range of socioeconomic backgrounds. In citing their parents' professions, 33 students out of the 136 participants reported that their fathers worked in blue collar positions such as famers, electricians, miners, welders, and textile workers. 61 students' fathers worked in white collar careers unrelated to science in areas such as law, teaching, accounting, and sales. 29 students' fathers worked in fields related to science, medicine, and engineering as chemists, dentists, physicians, researchers, science teachers, pharmacists, or engineers. 43 students, or 32%, stated that their mothers were employed. Although the majority of these women worked as teachers, nurses, and secretaries, they also worked in positions such as lab assistant, physician, college professor, and pharmaceutical sales representative. In addition, 41 students mentioned that their mothers had some form of college or post-secondary training. The range of parents' careers coincided with the overall diversity of student participation at NSF.[439]

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[438] Project photograph descriptions. SSP National Science Fair 1955 Binder.
[439] Ibid.

Students who participated in the National Science Fair were typically involved in science clubs and other activities. 63 students, or 46%, mentioned that they were members of the Science Clubs of America. 61 students stated that they had participated in previous science fairs. Eight students were finalists or semifinalists in the national Science Talent Search, and an additional three students were involved in STS at the state level. Seventeen students had participated in the Junior Academy of Science. Other popular honors and civic organizations included the National Honor Society (19 students), 4-H (11 students), and Junior Achievement (5 students). Students were also involved in several activities not related to science, such as Student Council, Boys and Girls Scouts, drama, music, sports, and church-related programs. Several students also held summer jobs related either to their parents' professions (such as farm hands or store clerks) or to their hobbies (as technicians or lab assistants). National Science Fair finalists were among the most actively engaged students in their schools and communities.[440]

Although students came from a variety of backgrounds, the majority still desired to pursue careers in science, engineering, or medicine. 47 students wanted to major in a science-related field, 32 in engineering or electronics, and 27 in medicine. Only twelve students planned on pursuing a major not related to science. Students' career ambitions were similarly predominant in science and engineering, with 50 students citing a professional goal related to science or mathematics, 32 related to engineering or electronics, 28 in a field of medicine, and only 14 listing fields unrelated to science. Chapter four demonstrated how most Science Talent Search participants enrolled in the nation's most prestigious universities such as Harvard, Caltech, Columbia, or MIT. In contrast, the majority of National Science Fair participants (68%) who reported their

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[440] Ibid.

plans for college planned on attending an in-state institution. Students who aspired to go out of state for college were attracted to elite institutions like MIT, University of Chicago, or Harvard, but several students also cited smaller liberal arts colleges or flagship state universities like Mt. Holyoke, Oberlin, Georgia Tech, Hamilton College, or the University of Michigan. Even as the majority of National Science Fair participants desired to continue their education, they were also inclined to accomplish these goals closer to home.

Students of the 1955 fair were also required to submit a list of the items they would purchase with their prize money. In order to ensure that their "Wish Lists" were appropriate to the prize amounts, students needed to know how to calculate the costs of their proposed materials. Their role as amateur scientists, then, required skills of consumer literacy.[441] Students referred to educational trade catalogs like Ward's, Fisher, and Welch as well as catalogs geared towards amateurs such as Edmund Scientific to make their selections. Students' desired prizes reflected the sophistication and professional aspirations of their work. Unlike the chemistry sets, summer camp visits, and general reference books purchased by science fair participants of the 1930s, National Science Fair finalists requested spectroscopes, atomic scales, dissecting sets, Geiger counters, science journal subscriptions, and amplifiers. The most common requests included microscopes, oscilloscopes, and slide rules (Figs. 5.1, 5.2, and 5.3). These objects all required a certain level of prerequisite knowledge for proper use. Items such as slide rules, which during the early twentieth century were used primarily by professional engineers and carpenters, served as marks of distinction that indicated a level of

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[441] This concept is inspired by Lizbeth Cohen's notion of a "purchaser as citizen" in postwar America. See Lizabeth Cohen, *A Consumer's Republic*, 8-9.

mathematical savvy not all high school students possessed.[442] The financial prizes complemented engraved medals and certificates given to finalists and their schools as tangible indicators of prestige and belonging.[443]

In addition to listing their desired prizes, students also disclosed the inspiration behind their science projects. The number one influence, cited by 27% of the students who responded, was magazine articles and other publications. One student cited a book they purchased at a previous fair, whereas another student attributed their project to an ad in a Welch trade catalog. The second greatest source of inspiration came from hobbies or longstanding interests in a particular field of science. Most students who listed hobbies as their source of inspiration had been cultivating their interests for years. Teachers ranked third as the inspiration for approximately 15% of finalists, followed by miscellaneous activities such as summer jobs or encountering real world problems (12.5%), classes at school (10.5%), presentations or previous science fairs (8.6%), clubs (3.8%), and parents and siblings (each accounting for 1.9% of respondents). The results reveal that the most common inspirations cited by students (publications and personal hobbies) were more individual in nature than more collaborative activities such as clubs and courses.[444]

The range of student inspirations was also reflected in the variety of their displays. Students at the 1955 National Science Fair exhibited projects ranging from poisonous snakes and heated horticulture to rocket propulsion and a liquid scintillator. Photographs of student projects along with project descriptions demonstrate how students conveyed scientific evidence. A close study of both project content and modes of display

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[442] Peggy Aldrich Kidwell, Amy Ackerberg-Hastings, and David Lindsay Roberts, “The Slide Rule: Useful Instruction for Practical People” in *Tools of American Mathematics Teaching, 1800-2000* (Washington, DC: Smithsonian Institution and The Johns Hopkins University Press, 2008), 105-122.
[443] Miles Davis, *Exhibit Techniques,* 4.
[444] Project photograph descriptions. SSP National Science Fair 1955 Binder.

reveals the underlying values behind students' conceptions of science. By and large, these values aligned with the professional virtues of postwar analytic culture. In this regard, science projects operated as a form of socialization that allowed students to convey their expertise in ways that were of value to the postwar professional world of science.

Some projects sought out solutions to everyday problems. Joanna Hackman conducted a nutritional study after reading that chlorella can serve as a source of food for starving populations. She began testing the nutritive value of spirogyra, a variety of fresh water algae that was more easily accessible that chlorella. Her project won first prize in the girls biology category. Whereas Hackman turned to current research for inspiration, other students' projects were based on problems they encountered firsthand. Nancy de cou Cowell built a vertical bed after the death of her sister from asthma. Her invention won a prize for best commercial possibility (Fig.5.4). Of the two exhibits in the field of home economics, both projects took an experimental approach to addressing issues related to the household. Carolyn Kirkpatrick tested rayon and cotton to test the quality of soap and detergents in the cleaning process.[445] All of these projects capitalized on science fairs as a platform for addressing social problems.

Other projects demonstrated different forms of ingenuity. Some students adopted cutting edge research or techniques. Winston Stanley Marshall, also a Science Talent Search finalist, won a fourth place prize for employing paper chromatography to his research on alkaloid drugs, demonstrating knowledge of a relatively novel method. Other projects employed innovative use of materials. Charles Jay Schwartz designed and constructed a refracting equatorial telescope using salvage parts such as 22 caliber shells, paper towel tubs, and curtain rods (Fig. 5.5). Student projects also demonstrated

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[445] Project photographs. SSP National Science Fair 1955 Binder.

innovation by developing new laboratory techniques. Richard Jorandby won third place for developing his own method for preparing mammalian skulls to show the relationship between teeth and the foods animals eat. Finally, some projects presented theoretical concepts in new ways. Philip Pochay used a light, electromagnet, vacuum, and a photoelectric cell to ascertain whether or not a magnetic field is due to special curvature. Pochay's project earned him an award for most creative thinking.[446] Although they varied by discipline and methodology, these projects all demonstrated the key analytic value of ingenuity.

One of the most common underlying values of science fair projects was trial and error. Unlike the Science Talent Search, students could enter science fairs multiple times. Several students were previous regional or national science fair finalists, and a few students were finalists in both the National Science Fair and Science Talent Search at the same time. Charles Canada reported rebuilding his exhibit three times in order to perfect his system for auto-controlled lighting at home (Fig. 5.6). Other students were inspired by outside projects and sought to improve their designs. Haruo Sasai built upon plans for an electrical hygrometer he saw in an article in *Scientific American,* which offered instructions on constructing a homemade hygrometer using pieces of a flower pot.[447] The emphasis on trial and error also accommodated for failure. R. Gary Kirk attempted to send sound with light by converting sound into light ways and converting them back with sound using a "photophone," or a phonograph, photocell, amplifier, and speaker. Gary admitted to "failing in some plans for his proposed exhibit."[448] These projects revealed

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[446] Project photograph descriptions. SSP National Science Fair 1955 Binder.
[447] Albert C. Ingalls, "About a Hygrometer Made from a Flower Pot," *Scientific American,* May 1, 1954.
[448] Project photograph descriptions. SSP National Science Fair 1955 Binder.

the arduous process of perfecting one’s work, a value encouraged by the National Science Fair’s acceptance of projects over multiple years.

Several underlying values were common among most of the projects. The projects focused on results, outlining a set of procedures and the subsequent outcomes. Small, measured contributions often received higher praise than a large synopsis of a field of study. And several of the projects showcased a measure of ingenuity, whether through trial and error, building upon current debates in the field, or demonstrating practical applications. Unlike the focus of earlier science fairs on process, narrative, and a holistic view of science, postwar science projects prized specificity and solutions to contemporary problems.

These analytic values also affected the ways students displayed their information. Unlike the Science Talent Search, students could not rely on the ability to verbally describe their work while standing alongside their exhibit. Although the judges could interview finalists, their initial impression was informed by evaluating the display itself. Generally, students’ presentations emphasized procedures and results based on measurable outcomes. Projects that were more descriptive or process-oriented still made appearances at the fair, but they proved the exception rather than the norm. A typical fair exhibit of the mid-1950s featured a single, double, or (most frequently) trifold display with text explaining the goal, methods, and results of the project. Students often supplemented the textual information with equipment, specimens or examples of their work, and laboratory notebooks. For instance, Yvonne Nasser described her experiment in producing penicillin broth (Fig. 5.7). The headers of her display—“Protecting,” “Producing,” and “Processing,”—offered a step-by -step explanation of her technique along with its potential commercial value. In front, Nasser displayed her microscope along with sample slides. Although Nasser included images and diagrams, ultimately the information of her project was conveyed through textual analysis and equipment rather than the visual aesthetics of the display itself.[449]

One common exception to this analytic standard was the display of collections, which remained relatively stable in its mode of presentation over time. Donald Barnhart (Fig. 5.8) began collecting insects for 4-H projects. His display featured eight boxes of 410 insects organized by orders and life cycles. In showcasing a distinct series of animals, minerals, or other specimens in a systematic order, students demonstrated knowledge of their subject matter through showing relationships between objects. In this regard, the display itself communicated knowledge in a manner more reminiscent of fairs during the early twentieth century.[450]

Another form of display where the visual supported the aims of the project objective was in showcasing technique. Unlike the fairs of the 1930s, technique was not valued in the construction of the display, but rather in mastering a form of tacit knowledge relevant to experimental design or the construction of equipment. Robert Ballinger's exhibit on photomicrography (Fig. 5.9) involved photographing biological slides through a microscope. He showcased several images of specimens alongside his

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[449] A fascinating comparison could be made with Steven Conn's analysis of contemporary museum displays in *Do Museums Still Need Objects?* (Philadelphia: University of Pennsylvania Press, 2010). Conn argues that museums during the early twentieth century were dedicated to educating visitors through unencumbered visual engagement with objects. As the missions of museums expanded to incorporate educational, recreational, and commercial interests, the centrality of objects in museal displays declined.

[450] Project photograph, SSP National Science Fair 1955 Binder. The collections-based method of scientific display is more reminiscent of the object-based epistemology described by Steven Conn in *Museums in American Intellectual Life, 1876-1926* (Chicago: University of Chicago Press, 1998).

setup of microscope and camera. Rather than telling a story, however, Ballinger's images conveyed his expertise in using laboratory equipment.[451]

Even though dramatic value only counted for 10% of presenters' final score, an effective mode of display often made a difference in judges' overall scores. Two finalists, Alvin Fields and Jon Peterson, created nearly identical projects of thermal engines showing the contraction of rubber through the application of heat. Whereas Fields (Fig. 5.10) displayed his engine alongside a clear text panel describing "What Makes it Work?," Peterson presented a more modest display (Fig. 5.11) that lacked a large panel, opting instead to feature just the demonstration apparatus and a report of his findings. Fields won a fourth place prize for his project; Peterson did not place. Although the presentation of equipment or other objects served as an important component of an exhibit display, the quality of presenters' textual analysis could determine their overall score.[452]

These analytical forms of display posed a challenge to presenters: how could they create an enticing exhibit without relying on aesthetics? In response, students developed innovative forms of presentation to capture viewers' attention. Anne Lugar (Fig. 5.12) showcased a homemade chicken incubator in hopes of featuring chickens hatching at the fair, allowing viewers to see her results in action. Some presenters added buttons, sounds, drawers, or levers that encouraged more sensory engagement. James Bertschi (fig. 5.13) incorporated lights from two scrapped pinball machines to demonstrate the operations of a triode vacuum tube. Another common technique was to frame the project around a compelling statement or question. In showcasing her project of a "Mechanical Brain,"

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[451] Project photograph. SSP National Science Fair 1955 Binder.
[452] Ibid.

physical science first place prize winner Rosemary Och (Fig. 5.14) asked visitors, “Do mechanical brains think?” and “Can you outsmart this robot?” Although these projects relied on textual analysis more than visual narrative, students developed imaginative tactics to create enticing modes of display illustrating their work.[453]

The majority of finalists from early National Science Fairs continued to pursue science in college and into their careers. In 1960 G.L. Daniels, an associate professor of science at the University of Montana, completed a doctoral study of National Science Fair finalists that was submitted to the Teachers College of Columbia University. His dissertation, entitled “Occupational Choices of Former National Science Fair Exhibitors,” evaluated questionnaires of 295 respondents who participated in the National Science Fair from 1950 to 1955.[454] Daniels studied respondents’ socioeconomic background, birth order, gender, choices of colleges and careers, inspiration for pursuing science-related work, and hobbies and other interests. Daniels did not evaluate racial, religious, or geographic factors. Of the 295 respondents, 225 were boys and 129 were girls. Their ages ranged from 20 to 27 years old and all were at least sophomore standing in college.[455] Like Morris Meister’s doctoral research on scientific and technical toys described in chapter one, Daniels evaluated the role of extracurricular activities in influencing adolescent engagement in science. However, Meister was primarily interested in the development of scientific habits of thought that children acquired through unguided play. Daniels, on the other hand, focused on “whether these particular students in their later

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[453] Ibid.

[454] Shirley Moore, “Origin of the Scientist,” *Science News-Letter* 78, no. 10 (September 3, 1960): 154-155.

[455] Gert L. Daniels, “Occupational Choices of Former National Science Fair Exhibitors,” Ph.D. Diss., Columbia University, 1960, 2, 45.

career development have continued on the science path."[456] Whereas Meister focused on the learning process, Daniels' study emphasized outcomes.

In evaluating the responses of early National Science Fair finalists, Daniels discovered that socioeconomic background played a significant role in students' decisions to pursue science-related careers. More than half of the respondents came from privileged backgrounds. Half of all participants had at least one parent who finished college. 20.7% of respondents were only children and an additional 44.1% were the first born children in their families.[457] Students also typically came from larger high schools, with 68.9% of respondents attending high schools with over 300 students.[458] Socioeconomic status also affected students' eventual career decisions. Daniels reported that engineers, mathematicians, physicians, psychologists, and botanists generally came from upper-class backgrounds whereas nurses, technicians, chemists and biologists came more often from lower-class backgrounds.[459]

Daniels also found that future career choices often broke along gender lines. More men chose careers in engineering, physics, and mathematics (all mathematicians who responded to the survey were male). Women were more likely to work as nurses, technicians, and biologists.[460] Daniels found that in high school, boys were more likely to take higher level math and physics courses than girls, which likely contributed to gender disparities in eventual career choices. Daniels measured how marriage affected women's career decisions. 61% of female respondents were still single and 38% were married. Of the married women, approximately 25% stayed in their career field after marriage, 50%

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[456] Ibid., 1.
[457] Ibid., 60.
[458] Ibid., 86.
[459] Ibid., 62-63, 98.
[460] Ibid., 56-63.

had given up their professions temporarily, and 25% permanently left their occupations to stay at home.[461]

The vast majority of respondents pursued higher education. 96.9% of men and 91.5% of women attended some college after high school. Ultimately, 75.5% of National Science Fair finalists (82% of male respondents and 63% of female respondents) chose to enter scientific, technical, or related occupations. However, the responses were mixed regarding the impact of students' science fair projects on their career decisions. 17.6% of respondents reported that they were strongly influenced by their science fair projects, 39.4% reported that they were mildly influenced, and 43% reported that their projects had no influence in their choice of occupation.[462] Although Daniels' study revealed the correlation between gender, socioeconomic status, educational backgrounds and students' eventual career decisions, his work provided only limited insight into whether or not students' engagement in extracurricular science had a major influence on their future careers. However, the findings provide a compelling glimpse into the future college and career choices of 1955 finalists and other participants of the first National Science Fairs.

A careful analysis of the 1955 participants' backgrounds, project inspirations, experimental design, modes of display, and college and career choices illustrate the ways in which the National Science Fair served as a mechanism of socialization that positioned students as the future problem solvers of the postwar world. At the same time, students conceived of themselves full-fledged practitioners of the scientific enterprise. As the National Science Fair set a standard for the country in scientific engagement, students' projects conveyed analytic values such as ingenuity, trial and error, and applicability to

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[461] Ibid., 94-95.
[462] Ibid., 74-75.

real world commercial problems. In the years leading up to *Sputnik,* finalists used the National Science Fair as a means for conveying scientific authority as well as a stepping stone for pursuing future careers in science and engineering.

## **“The Amateur Scientist”: A Forum for Professionalization**

As adolescent amateurs engaged in science fairs to demonstrate their expertise, they also turned to new forums for gathering inspiration and establishing a sense of community. Although the Science Service featured club and fair information in the *Science News-Letter,* the magazine did not fulfill the same purpose as the publications of the American Institute. By and large, students served as the topics of news stories rather than the authors and editors. The needs of students similarly changed as the fairs transitioned into platforms of professionalization. Rather than seeking out playful jokes or fictional playlets, students sought publications that could provide them with prestige and treat them as intellectual equals. “The Amateur Scientist” column of *Scientific American* would serve as a new network forum that could serve students’ needs in postwar analytic culture.

“The Amateur Scientist” was a column intended specifically for lay audiences with an interest in science as an avocation. It originated in 1928 as a column written by Albert G. Ingalls for amateur astronomers, but expanded its scope in 1952 to include a broader range of scientific and technical hobbies. Following Ingalls’ retirement in the mid 1950s, Clair L. Stong took over the section. An electrical engineer by trade, Stong worked for Western Electric prior to his position at *Scientific American.* Despite his professional background, Strong strongly identified with the amateur community, which had accumulated an estimated readership of more than 100,000 laymen. Stong described himself as a ham radio enthusiast who "teethed on *Scientific American*" as a teenager growing up on a farm in Iowa.[463] He appreciated the work of amateur scientists who he described as "introverts, compulsive tinkerers that relax by doing, not talking." Under Stong's leadership, the column quickly established itself as the authority on amateur science.[464]

As Stong managed the column, he sought to distinguish "The Amateur Scientist" from other publications attracting lay audiences. According to Stong, "Unlike the so-called popular 'science' publications which are designed primarily for appeal to amateur craftsmen, *Scientific American* has become a medium through which the professional scientist reports his work to professionals in fields other than his own, both scientific and non-scientific, and to students of science."[465] The column featured several projects that were both timely and challenging, ranging from gas lasers and homemade atom smashers to Moire patterns and gravitation simulators. The column treated its readers as competent practitioners, and featured detailed descriptions of projects based on the assumption that fellow amateurs could replicate or adapt the concepts to suit their own interests.

Adolescents recognized the column's reputation as a well-established publication read by professional and lay audiences alike. Likewise, Stong recognized the potential of students in contributing to the publication. In order to acquire material to his columns, Stong sought out the work of Science Talent Search and National Science Fair finalists (in fact, he was friends with Charles Fry of Westinghouse who helped direct the Science

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[463] Letter from CL Stong (hereafter referred to as Stong) to Dr. RA Moses, February 2, 1955. C.L. Stong Papers, 1952-1976, Collection No. 12 Smithsonian Archives Center (hereafter cited as Stong), Box 4. Folder November 1954.

[464] In 1960, Stong published a collection of projects featured in the column in a book entitled *The Amateur Scientist.* Although the book went out of print in 1972, it is still a popular resource among contemporary amateurs. C. L. Stong, *The Scientific American Book of Projects for the Amateur Scientist* (New York: Simon and Schuster, 1960). Many of the projects described here were reprinted in Stong's work.

[465] Letter from Stong to Carol De Decker, February 10, 1951. Stong Box 1, Folder June 1952.

Talent Search). Stong could not offer the young contributors money. Instead, he appealed to students' ambitions for recognition. In a letter to a potential adolescent contributor, Stong wrote, "It occurs to us that much worthwhile scientific work has been performed by gifted amateurs. Some of these, like yourself, are still in school, although others are well established in professional careers they also make science an avocation. We believe the amateur scientist deserves the encouragement that comes with publication."[466] Students eagerly contributed their work and often contacted Stong with ideas for potential columns. Even as "The Amateur Scientist" was focused on science as an avocation, students recognized its potential for establishing themselves as full-fledged members of the professional scientific community.

NSF participants also turned to "The Amateur Scientist" column for ideas in creating projects. The number one inspiration for projects cited by finalists of the 1955 fair was publications. *Scientific American* was also consistently ranked one of the top requests by science fair participants on their "Wish Lists" for prizes.[467] Noel Elliott (Fig. 5.15) was sought out by Stong to feature his project from the 1950 Science Talent Search called "A Tick-Tack-Toe Machine."[468] The electrical automaton could calculate and transfer information from one circuit to another in order to play a human opponent in a game of tick-tack-toe. Elliott's project appeared in the May 1953 issue of *Scientific American.*[469] In 1955, National Science Fair finalist Joel Brown created a "Tick Tack Toe Machine" for his project (Fig. 5.16). Claiming that he was inspired by "literature,"

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[466] Ibid.

[467] Shirley Moore, "Science Youths Start Younger," *The Science News-Letter* 84, no. 11 (September 14, 1963): 170-171, 173.

[468] Project photograph. SSP Science Talent Search 1950 Binder.

[469] Correspondence between Stong and Noel Elliot, 1951-1953. Stong Box 2, Folder May 1953.

Brown's electrical device appeared markedly similar to Elliott's work.[470] By providing instructions for replicating project designs, "The Amateur Scientist" column allowed students to build upon each other's ideas without even contacting their fellow peers.

*Scientific American* encouraged amateurs to replicate and improve the work featured in "The Amateur Scientist." Following the instructions for building a cloud chamber, the magazine offered to send radium glued to the head of a pin to provide amateurs with the material they needed to conduct experiments with their own apparatus. So many readers requested the material that the magazine repeated its offer. Science fair participants from across the country thanked the editors for offering the sample. Pat Schultze of St. Louis, Missouri wrote, "Following the instructions given in your September 1952 issue of *Scientific American,* I constructed the more elaborate chamber and entered it in the annual Greater St. Louis Science Fair. As a result of this work, I was awarded a four-year full-tuition scholarship offered jointly by Monticello College in Alton, Illinois and Washington University in St. Louis. The project was also a deciding factor in my winning the Bausch and Lomb Honorary Science Award."[471] Schultze's success story showed how students eagerly utilized *Scientific American* to their own advantage. It also reflected the magazine's commitment to supporting children's autonomous explorations of science of the atomic age.

"The Amateur Scientist" column also facilitated new forms of interaction between professionals and amateurs. Richard C. Sinnott worked with three friends on building a cyclotron at El Cerrito High School in Berkeley, California. They were inspired by taking a tour of the cyclotron at the University of California-Berkeley Radiation Laboratory.

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[470] Project photograph description. SSP, National Science Fair 1955 Binder.

[471] Letter from Pat Schultze to Stong, May 23, 1953. Stong  Box 1, Folder September 1952; , Response from Stong to Schultze, June 3, 1953. Stong Box 1, Folder September 1952.

During the tour, they met Benjamin Siegel and Louis Wouters, two scientists at the lab who offered to serve as their advisors in constructing the project. According to Sinott, "They did not discourage us nor doubt our sincerity; they assisted us as best they could, both morally and financially, and the complex project of building a cyclotron was launched with great enthusiasm and great hopes by four very young men."[472] Sinnott went on to graduate from the University of California-Berkeley with a degree in Engineering-Physics. Upon graduation, he was offered a position as a physicist at the Radiation Lab, and credited his work on the cyclotron for getting the job.[473] Although many students like Sinnott began engaging in science as amateurs, their extracurricular projects facilitated a direct tie to the professional world.

However, not all professional disciplines were as welcoming to amateur scientists. Specialists in fields such as paleontology and archaeology proved particularly hostile to amateurs engaging in fieldwork. When a father and son took up the hobby of collecting dinosaur bones, or a club of high school amateur archaeologists worked on excavating a Native American site, their work was received with criticism and backlash by the professional community.[474] In a book chapter titled "Should the Amateur Dig?," Stong recognized the inherent tension between amateurs and professional scientists that erupted in these fields, pointing to the fact that improper excavations could permanently destroy that record of information by neglecting to account for the environment in which the artifacts were found.[475] One archaeologist stated that by publishing the work of amateurs,

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[472] Richard C. Sinnott, "The El Cerrito Cyclotron," February 25, 1953. Stong Box 2. Folder September 1953.
[473] Letter from Richard C. Sinott to Stong, February 27, 1953. Stong Box 2, Folder September 1953.
[474] See various correspondence in Stong Box 9, Folder February 1959; Stong Box 10, Folder January 1960; Stong Box 24, Folder December 1967.
[475] Stong, *The Amateur Scientist*, 85-89.

the *Scientific American* “appears to condone the work of a group of vandals.”[476] Stong responded to the controversies by largely defending the work of his contributors. In responding to the complaint of an archaeologist, Stong wrote to one of his teenage authors, “I am sure that most non-archaeological readers enjoyed it. On the other hand, I am certain that the professional archaeologists did not. They have an unwritten code—NEVER MENTION THE WORD AMATEUR IN AN ARTICLE ABOUT ARCHAEOLOGY.”[477] Whereas the physicists at UC-Berkeley welcomed teenage amateurs into their professional community, archaeologists expressed more concerns about the damage amateurs could cause to their professional field.

Safety served as another concern that raised questions over the autonomy of adolescent amateurs. Parents, educators, and practitioners all wrote letters of complaint about the dangers of experiments featured in the column. After publishing instructions for building an inexpensive x-ray machine, Stong received a letter from a medical doctor declaring, “I shudder to think of some bright high school youth constructing a workable x-ray & playing with it without proper supervision & with only the warning at the end of the article to ‘resist the temptation to make x-ray examinations of the bones in the hand---etc.’” Stong staunchly stood in defense of adolescent amateurs, claiming that he had “irrational confidence in the good sense of kids.”[478] Stong replied, “Whether any printed warning can protect the innocent and uninformed is problematic, of course, but bright boys have been doing dangerous experiments of all sorts for centuries and the population still exhibits biological vigor. Hence, from the evidence, it would appear that we are in no

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[476] Letter to Editor from Jesse D. Jennings, February 5, 1960. Stong Box 10, Folder January 1960.

[477] Letter from Stong to Terrence Jay O’Neal, December 28, 1967. Stong Box 24, Folder December 1967.Emphasis in original letter.

[478] Letter from Stong to Lewis J. Grant, March 3, 1958. Stong Box 8, Folder August 1958.

immediate danger of extinction."[479] Adolescents also stood up in their own defense for performing their hobbies. In response to a complaint over the dangers of rocketry, a thirteen-year-old amateur responded, "This 'sport' as you put it is not as dangerous as it may seem….Chances are that more people are hurt, both seriously and 'minor cuts and bruises,' falling off bicycles every day than are in rocket experiments."[480] Although "The Amateur Scientist" added safety warnings to several of its columns, it did not stop publishing articles showcasing projects deemed potentially dangerous. "The Amateur Scientist" expressed a faith in adolescents and other amateurs to take charge of their own safety.

Columns of "The Amateur Scientist" also encouraged interaction between adults and children, particularly fathers and sons. As the country turned inward toward promoting home and family life, fatherhood became a new "badge of masculinity."[481] One father mentioned purchasing a *Scientific American* subscription for his son that he secretly wanted for himself.[482] David and August and David Raspet, father and son, submitted an article on "Bathtub Aerodynamics" demonstrating modifications to toy airplanes for illustrating how their behavior in water is similar to the motions of full-sized planes in the air. In the coauthored report, thirteen-year old David was referred to as the "senior author" and his father, a member of the Aerophysics Department at Mississippi State College, was referred to as the "junior author."[483] The story emphasized the authority of David in developing his own scientific interests under the gentle guidance of

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[479] Letter from Stong to Edgar L. Dimmick, July 14, 1956. Stong Box 5, Folder July 1956.
[480] Response letter to Steve on the safety of rocketry, author unknown, December, 20, 1957. Stong Box 7. Folder June 1957.
[481] Elaine Tyler May, *Homeward Bound: American Families in the Cold War Era* (New York: Basic Books, 1988), 129.
[482] Letter from R.A. Moses to Albert G. Ingalls, November 20, 1954. Stong Box 4, Folder November 1954.
[483]David and August Raspet, "Bathtub Aerodynamics," May 1953. Stong Box 3, Folder April 1954.

his father. It also alluded to the critical role of parents, particularly fathers, in training children, particularly sons, as future scientists and engineers.

For many students, “The Amateur Scientist” operated as a platform for professional socialization. Robert Detenbeck was a finalist in the 1950 Science Talent Search who presented his research on constructing a scintillation counter (Fig. 5.17). When Stong approached Detenbeck to feature his project, he was a freshman at the University of Rochester majoring in physics. According to Detenbeck’s mother, his interest in science began by experimenting with chemistry sets, setting up the breakfast room as a workshop, and scaring children on Halloween by rigging the doorbell with electrical sparks and noises. Detenbeck eventually created a laboratory in the family basement where he worked on building a Geiger counter and dismantling radios before he came across the idea of a scintillation counter through a book at the library.[484] Detenbeck’s personal story reveals the ways children evolved from playful hobbyists to serious amateurs. Other students employed “The Amateur Scientist” as means for jumpstarting their professional careers. High School student Stephen Fry built a gas laser using the September 1964 column as inspiration. Fry went on to earn a PhD in Physics and wrote his dissertation on lasers. “The Amateur Scientist” provided an accessible entry point for students to foster their scientific interests that could assist them in all stages of professional socialization.

For high school students from less privileged socioeconomic backgrounds, “The Amateur Scientist” could provide the opportunity they needed to attend college and enter a professional career in science. High School student Harry Rudloe, a semifinalist in the 1955 Science Talent Search, designed a mechanical mouse circuit and submitted not just

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[484] See correspondence between Stong and the Detenbeck family in Stong Box 2, Folder March 1953.

the plans of his design but also the shorthand notation, a rare feat for amateurs of his age.[485] Despite his accomplishments, Rudloe was uncertain if he could attend college because he came from an impoverished background. Stong wrote letter of recommendation to the Director of Admission at Harvard on Rudloe's behalf, stating that "in my 21 years as a science journalist I have never met a more promising young man."[486] Rudloe attended Harvard on a full scholarship. Rudloe also received more than 1,000 letters of inquiry from industrial manufacturers such as Bell Labs and IBM regarding his work. "The Amateur Scientist" column not only helped facilitate Rudloe's entry into college, but it also brought his work to the attention of the broader scientific and engineering community.

"The Amateur Scientist" column served as an important network forum for science fair participants and other adolescent hobbyists in the postwar world. Far from just a column that fostered avocational interest, it was a platform that carried tangible educational and professional ramifications. The column operated as a forum for exchanging ideas between adolescents and professionals, a source of inspiration for potential projects, and a mark of prestige for adolescent contributors. Above all, it treated adolescents as intellectual equals by considering them as full-fledged members of the amateur scientist community. By supporting the process of professional socialization for adolescent amateurs, "The Amateur Scientist" served as a critical messenger of the virtues of analytic culture.

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[485] See various correspondence regarding Rudloe in Stong Box 2, Folder November 1954; Stong, *The Amateur Scientist*, 34

[486] Letter from Stong to Harvard Director of Admission, April 25, 1955. Stong Box 4, Folder November 1954.

## **Setting an International Standard: Science Fairs Serving National Security**

As science fairs cemented the virtues of analytic culture domestically, the phenomenon also began to spread beyond American borders. The following section analyzes the ways in which science fairs standardized extracurricular science across the world. The goals of the science fairs officials were two-fold: first, to assert American superiority internationally; and second, to prepare American students for potential careers in the emerging military-industrial complex. Following the orbit of *Sputnik I* in 1957, the National Science Fair opened its eligibility to international students and began showcasing American student projects across the world. In the United States, governmental agencies began providing financial support to the science fair movement through providing prizes and offering internship programs. By partnering with the Atomic Energy Commission, science fair officials sought to export their vision of extracurricular science by initiating student fairs in developing countries. In this regard, science fairs served as a form of cultural diplomacy that set an international standard for adolescent scientific engagement. What started as an extracurricular pastime became a mark of American global scientific authority at a time when that position was in question.

The entanglement between the National Science Fair and the interests of civil defense began virtually from the competition's inception. In 1953, the Science Service hosted the National Science Fair in Oak Ridge, Tennessee. Students visited military installations across the city, were treated as guests of the Oak Ridge Institute of Nuclear Studies and the Union Carbide and Carbon Corporation, and presented their projects at the American Museum of Atomic Energy.[487] Internationally, the Science Service also showcased the ingenuity of American youth by sending seven projects from the Eighth National Science Fair to Japan. These projects served as an example of American scientific authority, with a Japanese geology professor reportedly commenting that a student's fossil collection was "better than most of our university students can classify."[488] In 1957, Japan started its own "Science Festival" and Puerto Rico initiated plans to implement a national science fair modeled after the programs of the Science Service.[489] Likewise, the Philippines sent two delegates to the National Science Fair to study the movement. They called on Science Service officials to help them find a delegate to initiate a science club network in their country.[490] By the mid-1950s, NSF not only served as a national standard but began to operate as an international model of adolescent scientific engagement.

When the Soviet Union launched *Sputnik 1* in 1957, it galvanized not only formal science education but the science fair movement as well. John L. Rudolph has demonstrated that within classroom education, scientists worked in coordination with the National Science Foundation and other governmental agencies to revise secondary pedagogy in order to suit the new intellectual landscape of big science.[491] The National

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[487] "Fourth Science Fair," *Science News-Letter* 63, no. 12 (March 21, 1953): 182. For more on the cultural legacy of Oak Ridge, see Arthur Molella, "Exhibiting Atomic Culture: The View from Oak Ridge," *History and Technology* 19, no. 3 (June 2003): 211-226.

[488] "Japanese Teachers See Science Fair Exhibits," *Science News-Letter* 72, no. 15 (October 12, 1957): 229; "Puerto Rico to Hold Fair," *Science News-Letter* 72, no. 21 (November 23, 1957): 325. Other countries, such as India, requested to showcase American student projects as well. See "Winning Science Fair Exhibits Travel to India," *Science News-Letter* 78, no. 24 (December 10, 1960): 376.

[489] "Japan Starts Combines Science Search and Fair," *Science News-Letter* 71, no. 19 (May 11, 1957): 303; "Puerto Rico to Hold Fair," *Science News-Letter* 72, no. 21 (November 23, 1957): 325.

[490] "Philippines Aids Science Talent, Understanding," *Science News-Letter* 72, no. 15 (October 12, 1957): 233.

[491] John L. Rudolph, *Scientists in the Classroom: The Cold War Reconstruction of American Science Education* (New York: Palgrave, 2002); On the relationship between education and big science, see also

Defense Education Act of 1958 provided financial backing for these reforms by offering financial assistance to states to improve instruction in mathematics, science, and other areas deemed important to national security.[492] Within the realm of science fairs, the impact proved equally significant. Rather than scientists spearheading reform, however, news agencies took on the call to spread the gospel of American science both domestically and abroad. "Without resorting to the methods that we are confident will eventually ruin the fruitfulness of Soviet technology, America must increase the flow of its talented youth into the fields of mathematics, physical and other sciences and engineering so necessary to our future," Science Service Director Watson Davis warned. "The science club and the science fair are prime devices for doing this."[493] Students across the nation heeded his call. In 1957, around 250,000 students participated in local and national fairs; by 1962, the number had quadrupled to approximately one million participants.[494] In 1958, the National Science Fair welcomed international students to participate for the first time. Two Japanese representatives from the Second Japan Student Science Awards traveled to the United States to compete in the Ninth National Science Fair in Flint, Michigan.[495]

Domestically, governmental agencies began offering programmatic support and financial incentives to science fair participants. The U.S. Army, Navy, Air Force, NASA,

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David Kaiser, "Cold War Requisitions, Scientific Manpower, and the Production of American Physicists after World War II," *Historical Studies in the Physical and Biological Sciences* 33, Part 1 (2002): 131-159.

[492] See Wayne J. Urban and Jennings L. Wagoner, Jr., *American Education: A History* (New York: McGraw-Hill, 1996), 335-8; Barbara Barksdale Clowse, *Brainpower for the Cold War: The Sputnik Crisis and National Defense Education Act of 1958* (Westport, CT: Greenwood Press, 1981); Wayne J. Urban, *More than Science and Sputnik: The National Defense Education Act of 1958* (Tuscaloosa: The University of Alabama Press, 2010).

[493] "Science Youth Movement," *Science News-Letter* 68, no. 1 (July 2, 1955): 13.

[494] "Million Science Projects Shown in Science Fairs," *Science News-Letter* 81, no. 19 (May 12, 1962): 295.

[495] "Fair Goes International," *Science News-Letter* 73, no. 10 (March 8, 1958): 150.

and Atomic Energy Commission, as well as professional organizations such as the American Medical Association, American Heart Association, and Optical Society of America, offered special awards and excursions to students working in areas related to their respective fields. Other agencies and companies, such as the National Bureau of Standards , Westinghouse Research Laboratories, American Chemical Corps, and U.S. Weather Bureau, implemented summer employment programs for "student scientists" to serve as scientific manpower.[496] These programs aimed at nurturing students' skills in order to prepare them for careers in science and industry that could support civil defense and other national interests.

The Science Service promoted its international focus by unveiling a new name for its science fair program in 1961: National Science Fair-International. The name change coincided with its presence at the Seattle World's Fair in 1962. Just as the 1939 New York World's Fair promoted the "world of tomorrow," the Seattle World's Fair turned toward the future through its emphasis on "living in the space age." Like New York, science fair participants were featured as symbols of American promise and ingenuity as 387 finalists of the National Science Fair-International presented their projects at the World's Fair Display Hall.[497] "I am honored to open the Seattle World's Fair today. What we show is achieved with great effort in the fields of science, technology, and industry," President John F. Kennedy declared. "This exemplifies the spirit of peace and cooperation with which we approach the decades ahead." Kennedy's opening speech

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[496] Shirley Moore, "Laboratories Train Scientists," *Science News-Letter* 73, no. 13 (March 29, 1958): 202-203; "Young Summer Scientists," *Science News-Letter* 81, no. 25 (June 23, 1962): 386.

[497] "Science at World's Fair," *Science News-Letter* 81, no. 15 (April 14, 1962): 231; SSP Science Fair Brochure Binder.

promoted science, technology, and industry as the vehicles that could usher in an era of international peace and prosperity.

But the realities of the post-Sputnik world proved more volatile. In the midst of the Bay of Pigs and Cuban Missile Crisis, American officials sought out more interventionist strategies to protect their own backyard. By 1962, the Atomic Energy Commission began partnering with the Science Service to employ science fairs as a mode of cultural diplomacy that could support the AEC's objective in facilitating scientific and technical training in Latin American countries.[498] Through financial support by the AEC, the Science Service worked with international leaders to initiate science fair programs in countries such as Mexico, Chile, Uruguay, Spain, Colombia, Portugal, El Salvador and Guatemala.[499] The Science Service capitalized on its position as an international leader in extracurricular science by seeking out federal support. In 1958, Congress passed Public Law 85-875 to promote youth interest in science through clubs, fairs, and other extracurricular activities. Although a bill to support the Science Service in fulfilling this mission was introduced twice before Congress, the measures ultimately failed.[500] In spite of the financial setback, the Science Service continued to promote the science of the

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[498] For other examples of cultural diplomacy in American history, see Richard Pells, *Not Like Us: How Europeans Have Loved, Hated, and Transformed American Culture since World War II* (New York: Basic Books, 1997); Richard T. Arndt, *The First Resort of Kings: American Cultural Diplomacy in the 20th Century* (Dulles, VA: Potomac Books, 2005)*;* Ruth Oldenziel and Karin Zachmann, *Cold War Kitchen: Americanization, Technology, and European Users* (Cambridge: MIT Press, 2009)*;* and Victoria de Grazia, *Irresistible Empire: America's Advance through 20th-Century Europe* (Cambridge: Belknap Press of Harvard University Press, 2005).

[499] "Science Program Spreads," *Science News-Letter* 82, no. 17 (October 27, 1962): 271; "Mexican Science Exhibits," *Science News-Letter* 81, no. 9 (March 3, 1962): 134; "Uruguay Holds First National Science Fair," *Science News-Letter* 84, no. 18 (November 2, 1963): 280-281; "Science Fair in Spain," *Science News-Letter* 85, no. 18 (May 2, 1964): 279; "Costa Rica Prepares National Science Fair," *Science News-Letter* 88, no. 14 (October 2, 1965): 219; "Teen Science Brain Force," *Science News-Letter* 87, no. 2 (January 9, 1965): 21.

[500] "Charter Youth Activities," *Science News-Letter* 81, no. 21 (May 26, 1962): 334; "Science Service Charter Bill Passes House," *Science News-Letter* 81, no. 26 (June 30, 1962): 406; "Science Service Charter is Considered by House," *Science News-Letter* 83, no. 6 (February 9, 1963): 86.

atomic age through continuing its partnership with AEC. In this regard, science fairs operated as a de facto intellectual arms race by seeking to dominate science extracurriculum in the Western Hemisphere.

In the battle to demonstrate American scientific authority, science fair participants were recruited as cultural ambassadors to tout the virtues of analytic culture abroad. In Europe, students were invited to showcase their work at the West Berlin Industries Fair and participate in emerging European youth science programs such as the European International Camp, London International Youth Science Fortnight, Camp of the Jeunesses Scientifiques in Belgium, and a science camp organized by the Mouvement Jeunes-Science in France.[501] In the early 1960s, the Science Service continued to maintain strong ties with Japanese science fair authorities by sending American students to the Japan Student Science Awards. In a program eventually called "Operation Cherry Blossom," three Science Fair finalists were sponsored by the U.S. Army, Navy and Air Force to serve as "special representatives" of the armed forces.[502] While students showcased their projects, they spent time visiting with Japanese students and families. In these instances, American students were not merely symbols of American ingenuity, but served as ambassadors who could speak directly to the pedagogical aims and analytic values behind American fairs.

In 1965, Watson Davis commented on the success of the science fair movement at home and abroad. Davis declared that participants in clubs and fairs served as the "brain force" that would continue to advance civilization. "They are viewing the world with

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[501] "Fair Winners Go to Berlin," *Science News-Letter* 78, no. 6 (August 6, 1960): 95; "European Science Camp Open to American Teens," *Science News-Letter* 87, no. 23 (June 5, 1965): 360.

[502] "Armed Forces 'Operation Cherry Blossom,'" *Science News-Letter* 85, no. 21 (May 23, 1964): 335; "Operation Cherry Blossom Participants Selected," *Science News-Letter* 87, no. 21 (May 22, 1965): 327.

fresh and enlightened minds that will give advanced knowledge of facts and theories when they join the research ranks," Davis remarked.[503] The Seventeenth National Science Fair-International now boasted representatives from 227 fairs, including 11 from foreign countries such as West Germany, the Philippines, Costa Rica, Canada, Japan, Sweden, and Puerto Rico.[504] That same year, the Science Service changed the name of the National Science Fair-International once again, this time to International Science Fair.[505] The name aptly reflected the impressive scale of the science fair movement. What had started as a grassroots pastime had now grown into a worldwide sensation.

During the first fifteen years of the National Science Fair, the Science Service set in motion a standard for adolescent scientific engagement that served as a model for the rest of the world. Employing science fairs in the service of national security reflected how American officials took these projects seriously. American students who engaged in these programs not only received training for their future role in the scientific careers of the postwar world, but they also served as ambassadors who carried out the message of American ingenuity both at home and abroad. No longer were science fairs merely showcasing student work; they now symbolized the advancement of American science, and by extension, the nation's position of authority in the Cold War world.

## Conclusion

Building upon the grassroots efforts of local educators, the National Science Fair quickly established itself as a standard for adolescent scientific engagement in the United States. Once its position of authority was recognized, the Science Service shaped the

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[503] "Teen Science Brain Force," *Science News-Letter* 87, no. 2 (January 9, 1965): 21.

[504] Shirley Moore, "On to Dallas for Science Fair!" *Science News* 89, no. 14 (April 2, 1966): 216-218.

[505] "International Science Fair New Name Adopted," *The Science News-Letter 8*7, no. 21 (May 22, 1965): 324.

form and content of science fair exhibitions by promoting results-oriented, headline-grabbing projects. As the National Science Fair endorsed the values of analytic culture, it also served national interests. By emphasizing a bright future ruled by reason and innovation, science fairs demonstrated the nation's intellectual superiority—first to fellow Americans, then to the rest of the world.

For their part, students took advantage of their position as emerging professionals who could lead the nation in the atomic era. As students showcased their projects through neat text panel displays, they also conveyed an inherent faith in scientific advancement. Their science projects demonstrated ingenuity, adaptation, and real-world applicability. Students shared their work with fellow adolescents as well as adults through network forums like *Scientific American*, which treated them as intellectual equals. As a result, science fairs and "The Amateur Scientist" column helped socialize students into the broader professional world of science.

As the fair movement began to spread on the international stage, so too did its entanglement with the interests of national security. The Science Service's collaboration with the Atomic Energy Commission promoted science fairs as a means for controlling scientific engagement in developing countries whose loyalties to American interests were in question. For their part, students served as cultural ambassadors by sharing their work with peers across the globe. By setting a standard both domestically and abroad, the National Science Fair carried out a broader mission that encapsulated not just the goal of preparing future scientists and engineers, but also exerting American scientific dominance in the postwar world.

Figure 5.1 Bausch+Lomb Microscope Set, 1950. Not only were Bausch+Lomb microscopes popular among adolescent amateurs, but the company also sponsored a high school scholarship competition. Photo by author. Courtesy Bausch+Lomb Archives.

Figure 5.2 Heathkit Laboratory Oscilloscope, ca. 1960. Heathkit served as one of the most popular home electronics kit manufacturers in the country, offering affordable, well-crafted equipment to amateur tinkerers. Photo by author. Courtesy of The Strong®, Rochester, New York.

Figure 5.3 Pickett Log Duplex Slide Rule, ca. 1962. Pickett slide rules were popular with both engineers and students alike. Photo by author. Courtesy Smithsonian Institution National Museum of American History Physical Sciences Collection.

Figure 5.4 1955 National Science Fair finalist Nancy du Cou Cowell with her project, “Vertical Bed.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.5 1955 National Science Fair finalist Charles Jay Schwartz with his project, “Design and Construction of a 3 ¼-Inch Refracting Equatorial Telescope.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.6 1955 National Science Fair finalist Charles William Canada with his exhibit, “Automatic Light Control with an Automatic Demonstrator.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.7 1955 National Science Fair finalist Yvonne Nasser with her exhibit, “Penicillin- Protecting, Producing, Processing.” Courtesy Society for Science and the Public Photograph Collection.

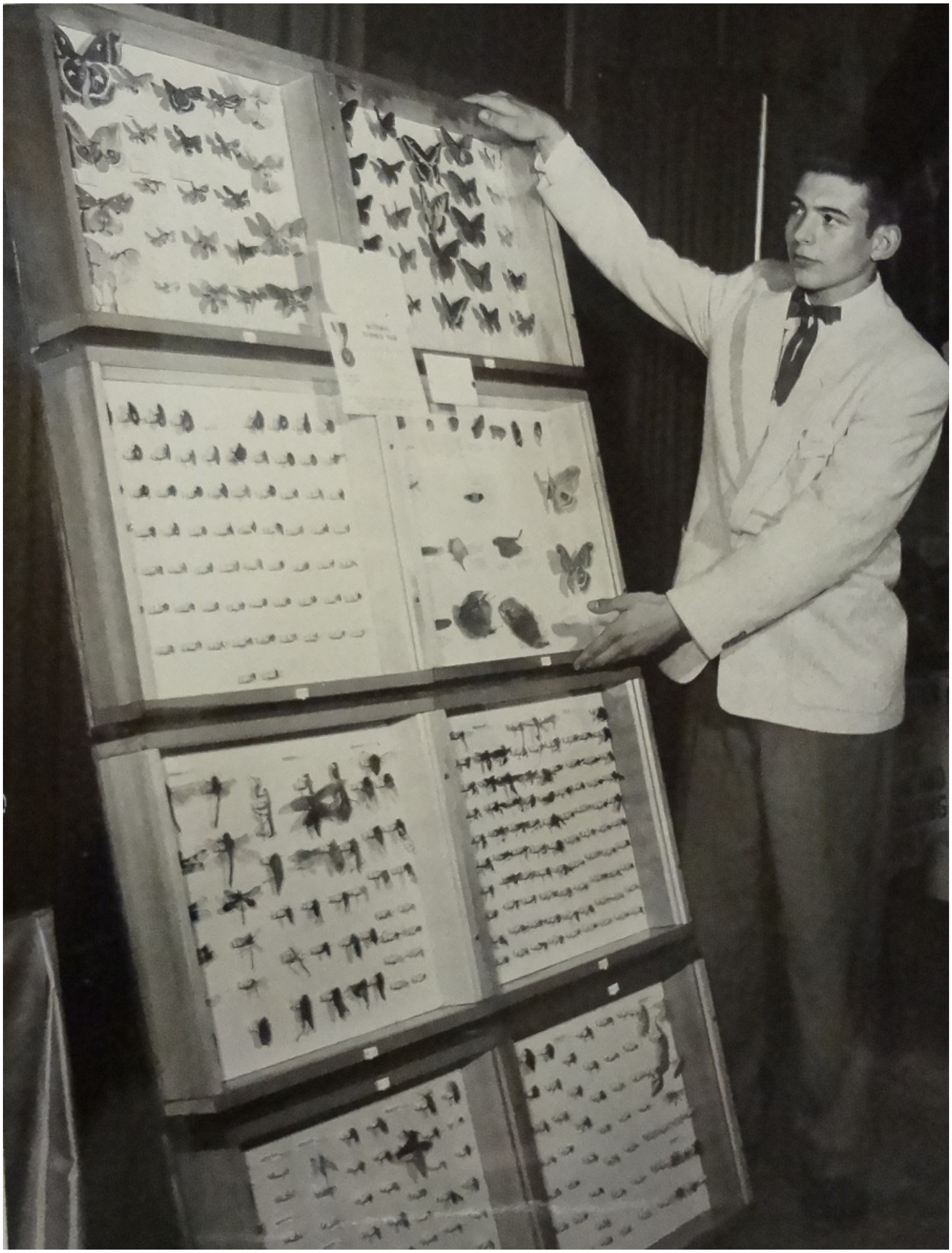

Figure 5.8 1955 National Science Fair finalist Donald William Barnhart with his exhibit, "Study of Insects and their Life Cycles." Courtesy Society for Science and the Public Photograph Collection.

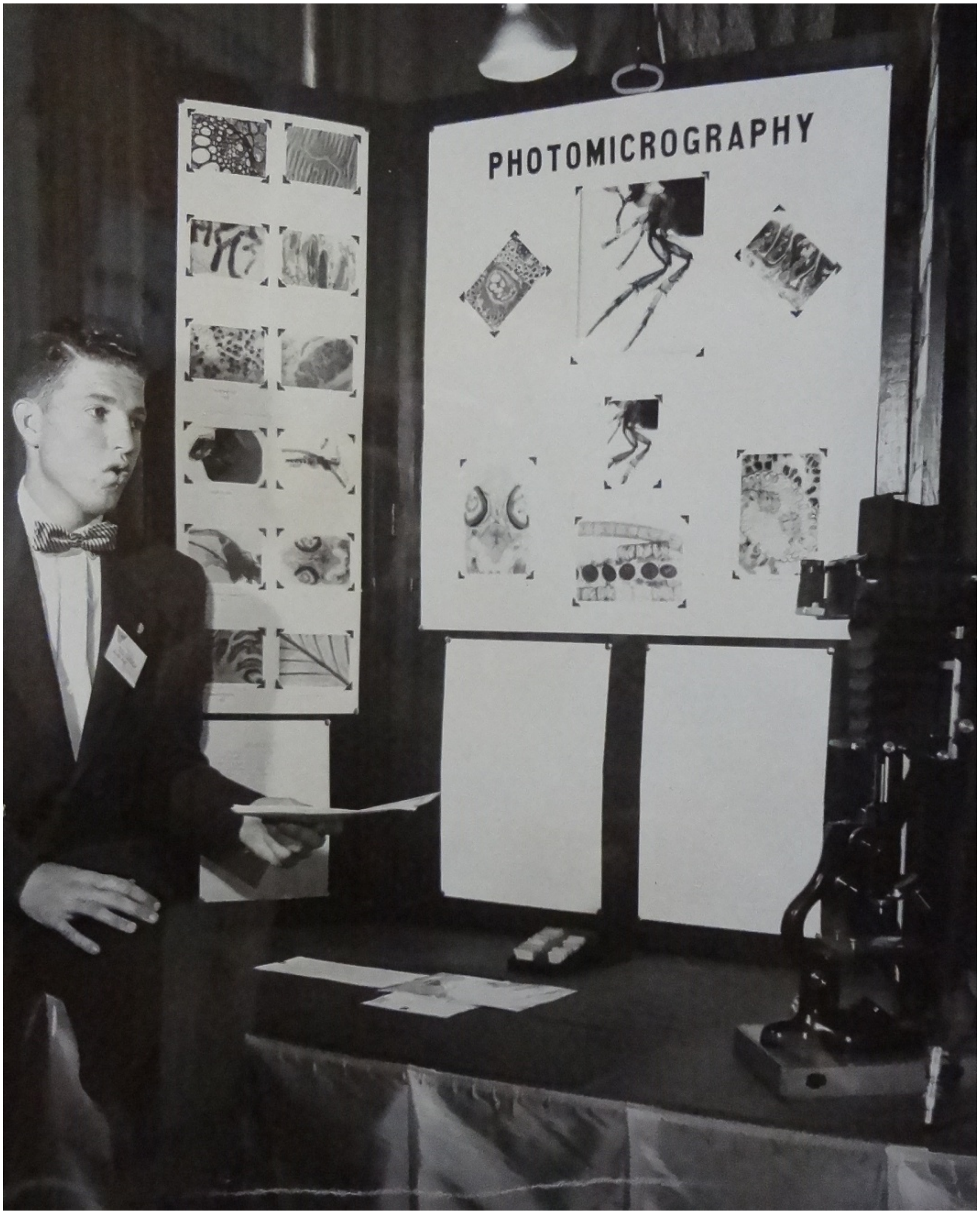

Figure 5.9 1955 National Science Fair finalist Robert Lewis Ballinger with his exhibit, “Photomicrography.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.10 1955 National Science Fair finalist Alvin McKinnon Fields with his exhibit, “Macro-Molecular Thermal Engine.” Courtesy Society for Science and the Public Photograph Collection.

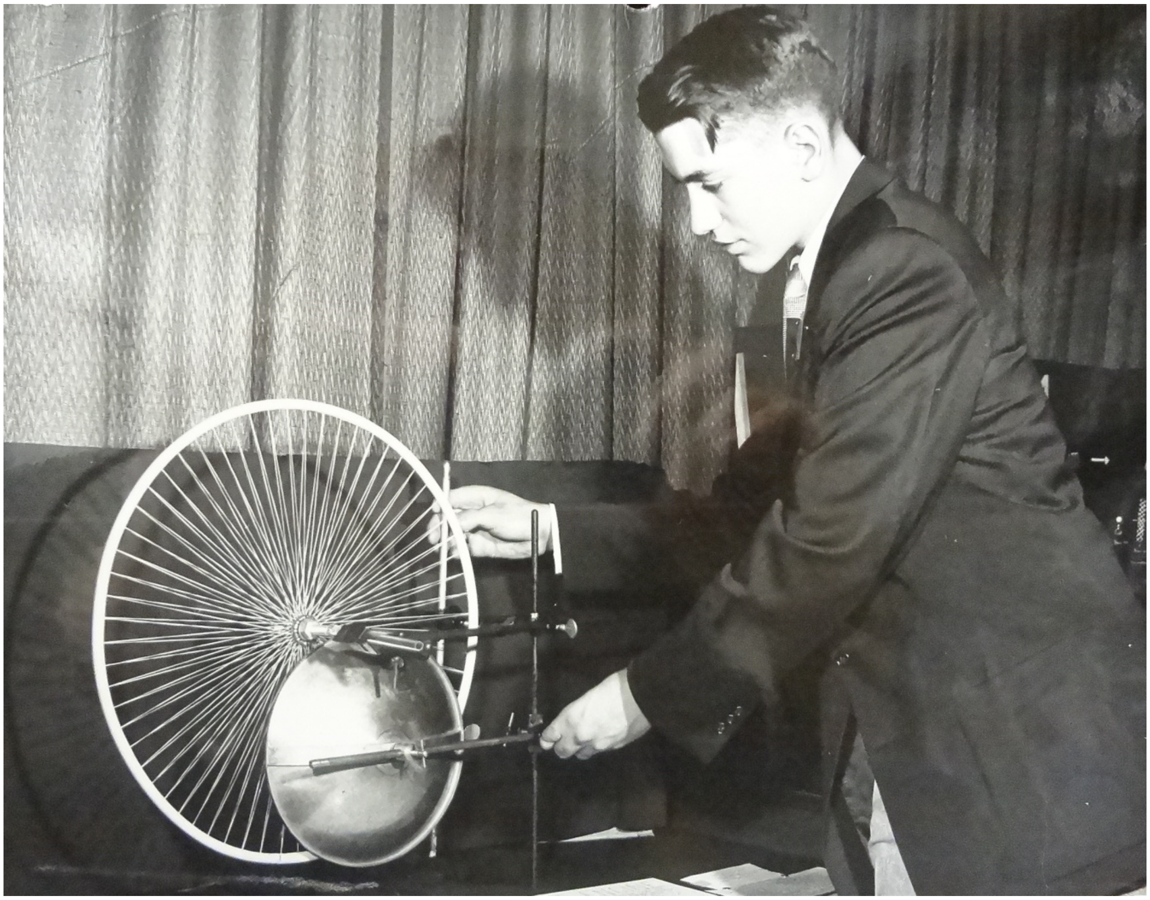

Figure 5.11 1955 National Science Fair finalist Jon Earl Petersen with his exhibit, “Rubber Band Heat Engine.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.12 1955 National Science Fair finalist Anne Hoereth Lugar with her exhibit, “Development of a Chicken Using a Homemade Incubator.” Courtesy Society for Science and the Public Photograph Collection.

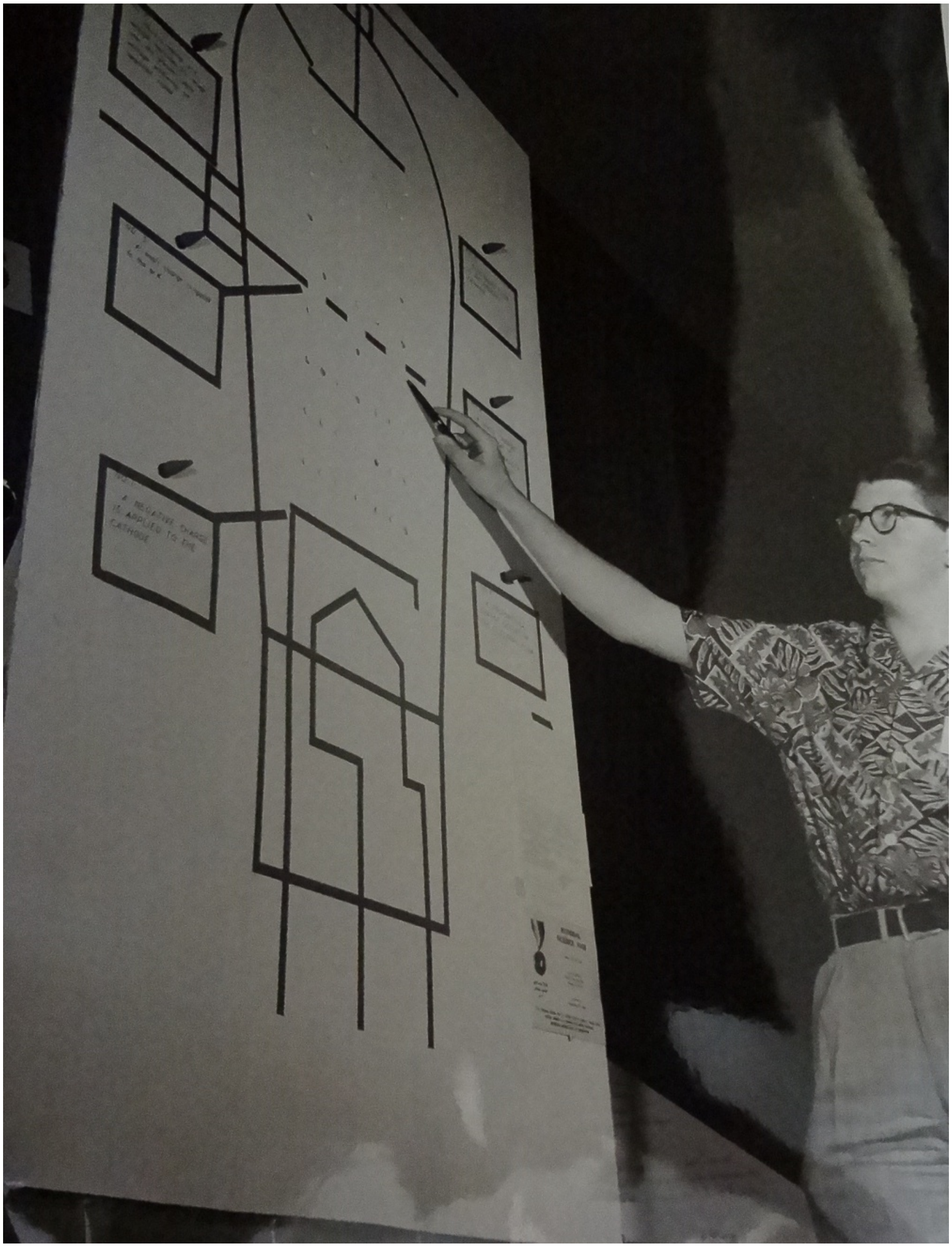

Figure 5.13 1955 National Science Fair finalist James D. Bertschi with his exhibit, “Simple Vacuum Tube.” Courtesy Society for Science and the Public Photograph Collection.

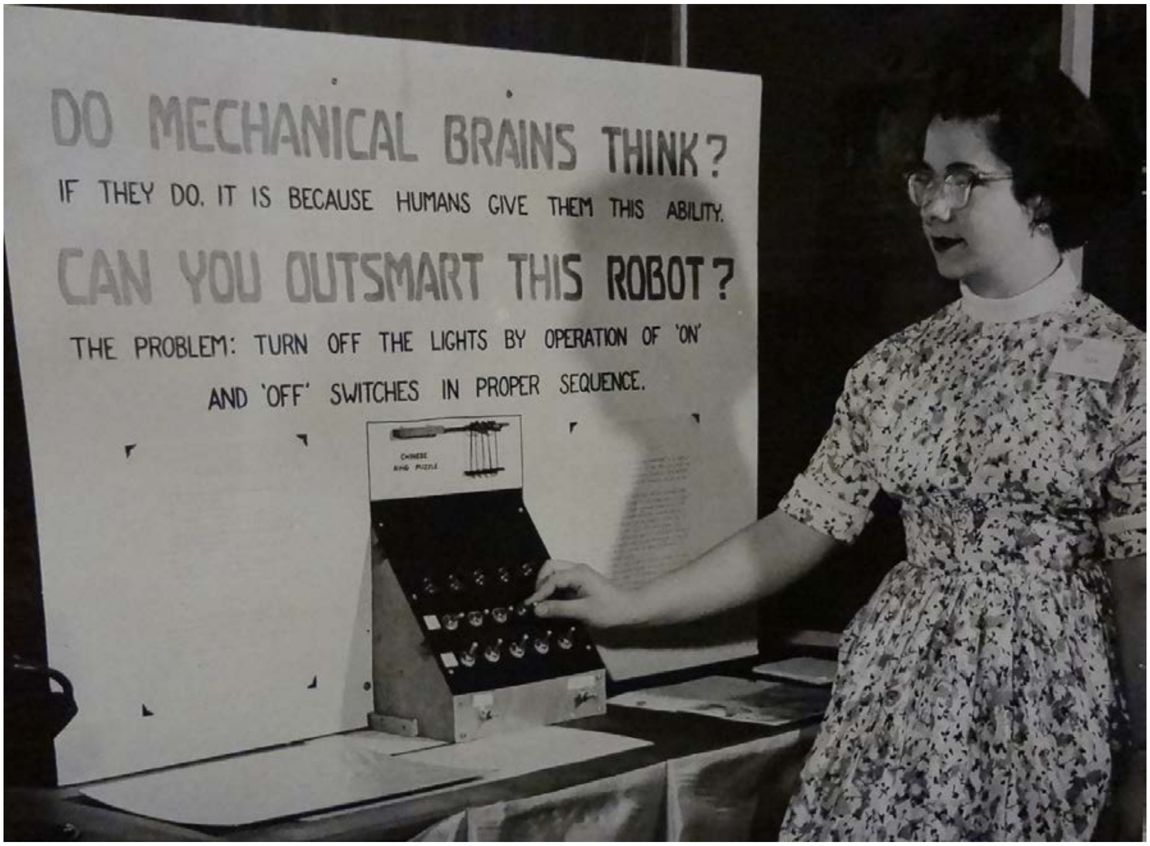

Figure 5.14 1955 National Science Fair finalist Rosemary Patricia Och with her exhibit, “Mechanical Brain.” Courtesy Society for Science and the Public Photograph Collection.

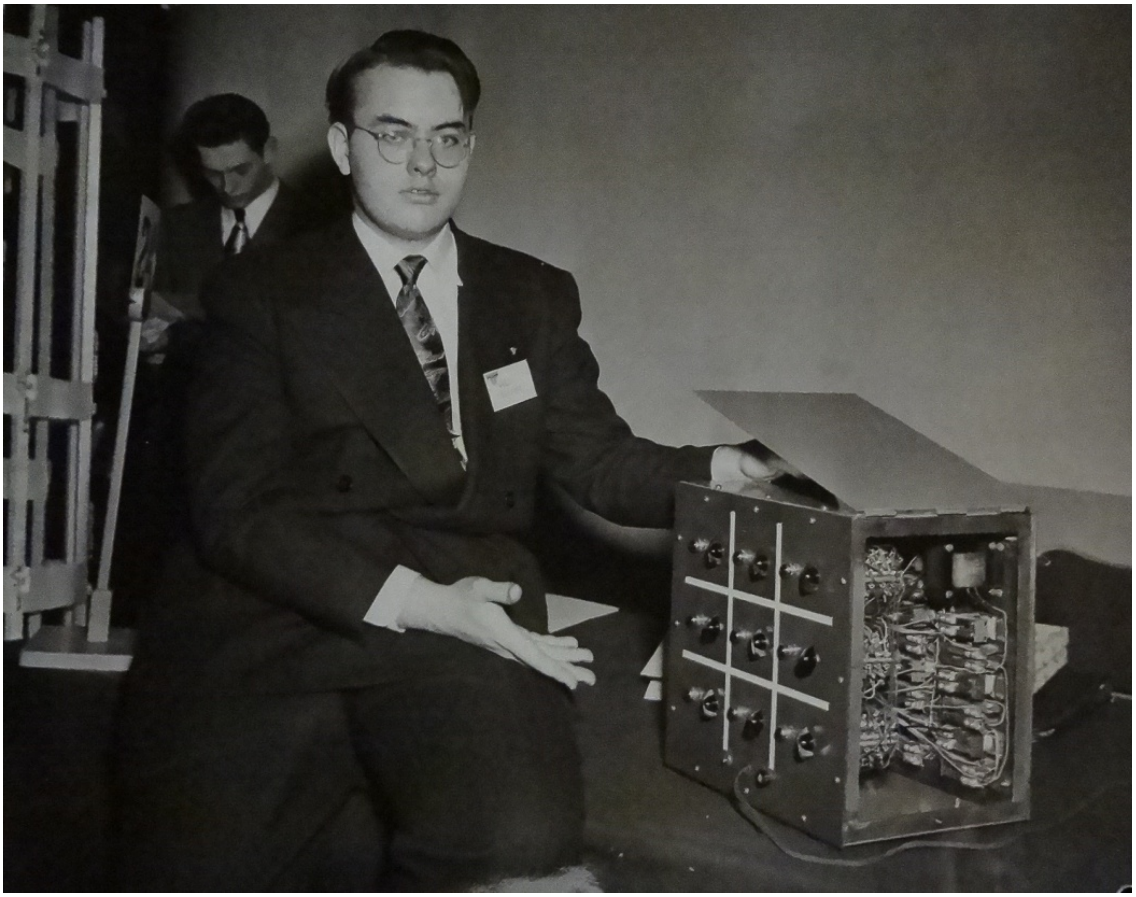

Figure 5.15 1950 Science Talent Search finalist Noel Penney Elliott with his exhibit, “Tick-Tack-Toe Machine Takes the Place of One of the Humans in the Game.” Courtesy Society for Science and the Public Photograph Collection.

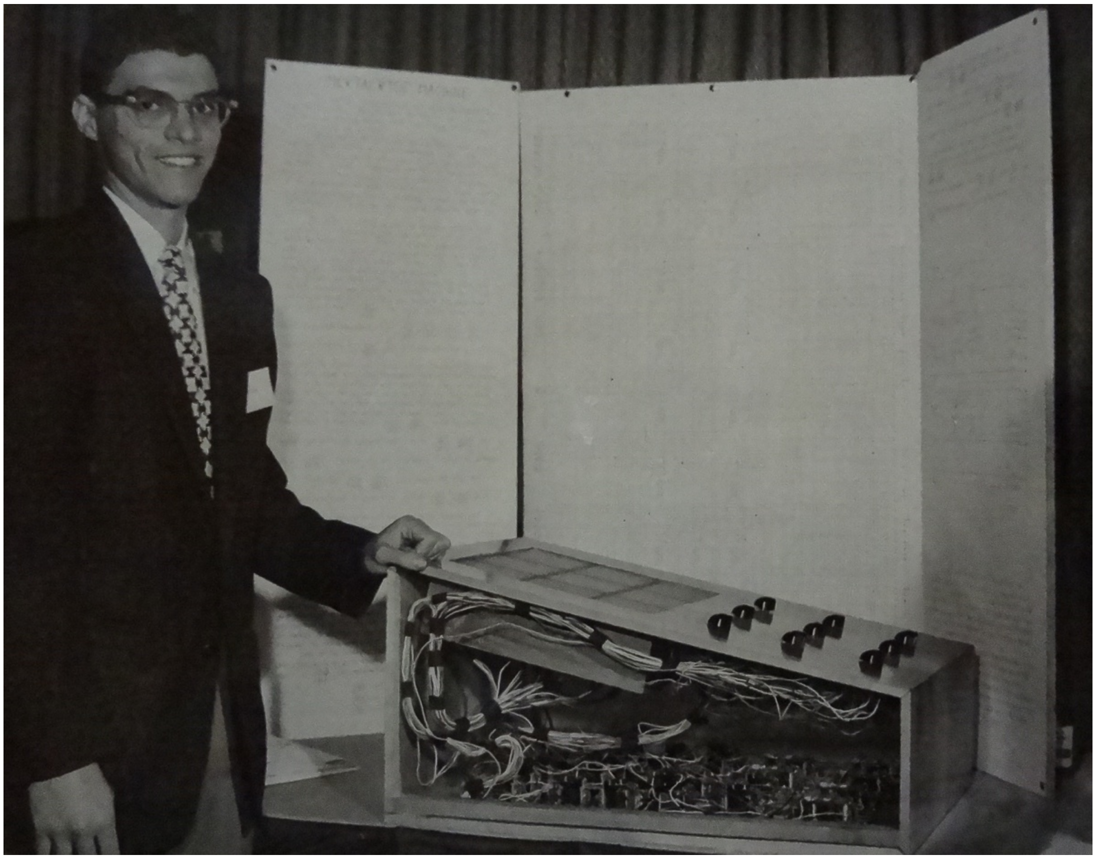

Figure 5.16 1955 National Science Fair finalist Joel Edward Johnson with his exhibit, “Tick Tack Toe Machine.” Courtesy Society for Science and the Public Photograph Collection.

Figure 5.17 1950 Science Talent Search finalist Robert Warren Detenbeck with his exhibit, “Scintillation Counter Converts Tiny Flashes of Light Produced by Radioactive Emanations on a Fluorescent Screen into Electrical Impulses.” Courtesy Society for Science and the Public Photograph Collection.

# CONCLUSION

## **Science Fairs after Sputnik, 1965-1979**

The Sputnik moment left an indelible mark not just on formal education, but it also permanently transformed extracurricular science. In its wake, it created a transformed adolescent community, one that had a less cohesive identity than in decades prior. During the 1960s, science fairs remained widespread, with the number of participants quadrupling between 1957 and 1962 to approximately one million participants.[506] As fair participation expanded, however, so too did the rules and regulations governing children's engagement. Whereas competitions fit nicely into the analytic values of the post-Sputnik world, other extracurricular activities did not fare so well. Student clubs that focused on collaboration as well toys that emphasized free play (such as chemistry outfits or Erector Sets) began to wane in popularity. Instead, students expressed greater skepticism and ethical concerns over the role of science in society.

In the era of the *Silent Spring,* the Vietnam War, and Earth Day, science began to lose its position of authority in American society.[507] Was scientific manpower still the best way to resolve issues wrought by the Cold War? How were technological

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[506] "Million Science Projects Shown in Science Fairs," *Science News-Letter* 81, no. 19 (May 12, 1962): 295.

[507] See, for instance, Zuoyue Wang, "Part III: The Politics of Technological Skepticism" in *In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America* (New Brunswick: Rutgers University Press, 2008); Thomas Hughes, "Counterculture and Momentum" in *American Genesis: A Century of Invention and Technological Enthusiasm* (New York: Penguin Books, 1989), 443-472; John Agar, "What Happened in the Sixties?" *The British Journal for the History of Science* 41, no. 4 (December 2008): 567-600; and Steve Fuller, "Being There with Thomas Kuhn: A Parable for Postmodern Times," *History and Theory* 31, no. 3 (October 1992): 241-275.

advancements affecting the environment? When science was so strongly connected to the military-industrial complex, how could adolescents disentangle their interest in science with its complicity in contributing to global conflict? Reflecting the anxieties occurring in the world of professional science, students began to challenge the assumption that science was inherently beneficial to society, opting instead to consider social and ethical implications of their work.[508]

As students and the broader public questioned the superiority of science, the Science Talent Search underwent a fundamental reorientation of its mode of evaluation. Coinciding with educational reforms that sought to mitigate socioeconomic disparities among students, members of the Science Service expressed doubts about whether aptitude testing was a true meritocratic system.[509] According to an article published in *Science News,* Dr. John L. Holland of the American College Testing program believed that extracurricular achievement was just as much a predictor of future success as intelligence tests. "Academic potential appears to be only one of several relatively independent dimensions of talent and should be used with discrimination rather than as a panacea," warned Holland.[510] In 1971, the Science Talent Search stopped administering independent aptitude tests. Instead, it placed more emphasis on student project reports, though judging standards still took into account student transcripts and standardized test

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[508] Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill: The University of North Carolina Press, 1999); Jessica Wang, "Scientists and the Problem of the Public in Cold Ear America, 1945-1960," *Osiris,* 2nd Ser., 17 (2002): 323-347; Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993); and David Kaiser, ed., *Becoming MIT: Moments of Decision* (Cambridge: MIT Press, 2012).

[509] On educational reforms, see Wayne J. Urban and Jennings L. Wagoner, Jr. "The Pursuit of Equality: 1960-1980" in *American Education: A History* 4th ed. (New York: Routledge, 2009), 355-388; Diane Ravitch, *The Troubled Crusade: American Education, 1945-1980* (New York: Basic Books, 1983); Arthur O. Jensen, "How Much Can We Boost IQ and Scholastic Achievement?" *Harvard Educational Review* 9 (Spring 1969): 1-124.

[510] Patricia McBroom, "Testing for the Spark," *Science News* 93, no. 20 (May 18, 1968): 479. See also "Intelligence: Genetic or Environmental?" *Science News* 100, No. 11 (September 11: 1971): 167.

scores. In shifting its vetting process to prioritize projects over aptitude testing, the Science Service accepted a more flexible standard for evaluating student talent.

Changes in the evaluation standards of the Science Talent Search coincided with a broader demographic shift of finalists. After the competition stopped rewarding a first place prize in 1948 to both one boy and one girl, twenty-five years passed before a girl would take first place again. In 1972, not only did a female student win first place, but five of the top ten winners were young women.[511] Students from immigrant families were still consistently represented at STS, but rather than just children of Jewish or Eastern European descent, more students claimed heritage from Asian countries, including Taiwan, India, China, and Japan.[512] In spite of these changes, some schools continued to dominate the competition. Four of the top five schools represented at the Science Talent Search were from New York City and surrounding areas. The Bronx High School of Science, where Morris Meister served as a founder and the first principal, produced the most finalists of any school in the United States.[513] Changes in evaluation expanded participation by some students, but the program remained closely affiliated with certain high schools well-known for fostering science talent.

The Science Talent Search also began to take into greater account the ethical considerations of science. In 1966, a debate surfaced in *Science News* discussing the merits of animal testing in high schools. After the New Jersey Society for the Prevention of Cruelty to Animals filed suit claiming that animal testing constituted animal cruelty,

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[511] "Five of Top 10 Science Talent Winners Females," *Science News* 101, no. 11 (March 11, 1972): 168-169.

[512] Joseph Berger, *The Young Scientists: America's Future and the Winning of the Westinghouse* (Reading, MA: Addison-Wesley Publishing Co., 1994), 19.

[513] "Top High Schools in Westinghouse Science Talent Search: 1942-1995,"ca. 1995, SSP Record Files.

the judge ultimately ruled in favor of animal experimentation.[514] Despite the approval of the courts, in 1969 the Science Talent Search prohibited experimentation on vertebrate animals. The ban followed reports that three pigeons died as a female finalist conducted experiments involving starving and blinding the animals.[515] The ban on animal testing changed the composition of student work at STS, as projects featuring animal testing that had appeared regularly since the competition's inception suddenly disappeared.

The issue of ethics also made a dramatic appearance in students' work. Dr. William D. McElroy, Director of the National Science Foundation, informed STS finalists that although they exhibited skepticism and curiosity, they needed to take into account the broader societal impact of science. McElroy warned, "We must resolve any tensions between the scientific community and the larger community that supports it."[516] Students tended to agree. According to a survey of 1970 STS participants, almost all of the forty finalists believed that scientists needed to consider the ethical consequences of their work.[517] This belief shaped students' selection of projects. Exhibits at the 1974 Science Talent Search, for instance, focused on social and ecological concerns, including "Effects of Urbanization on the Glacial Topography of the Wheaton Quadrangle," "Development and Application of Solar Energy in the Heating of Homes and Buildings," and "A Computer Model for Population Behavior."[518] In contrast to the 1940s and 50s, finalists generally engaged in science from a position of skepticism rather than optimism.

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[514] Patricia McBroom, "Question Animal Research," *Science News* 89, no. 11 (March 12, 1966): 166; Patricia McBroom, "'Animal Cruelty' Defined," *Science News* 89, no. 16 (April 16, 1966): 261, 271; "Animal Tests Justifiable," *Science News* 89, no. 24 (June 11, 1966): 464-465, 473.

[515] C. Miller-Spigel, "The Use of Animals in National Student Science Fair Projects in the United States," *ATLA. Alternatives to Laboratory Animals* 32, supplement 1 (June 2004): 495-500.

[516] Quoted in "Creative and Skeptical," *Science News* 99, no. 10 (March 6, 1971): 164.

[517] "Climax of a Search," *Science News* 97, no. 10 (March 7, 1970): 244.

[518] Science Talent Search 1974 Booklet, SSP Record Files.

Just as students and Science Service officials began to consider the broader implications of science in society, the requirements of the Science Talent Search also streamlined and standardized student reports. Whereas the reports in early Science Talent Search brochures were often presented in a narrative format, by the 1970s the style had changed to encourage step-by-step, results-oriented project descriptions.[519] According to the 1975 brochure outlining STS rules and regulations, the three sample reports were organized by including an abstract, introduction, method, results, and conclusion.[520] The new standards presented a formulaic model of student experimentation that contributed to the homogenization of science projects in the decades that followed.

Narrative-driven science fair displays also continued to wane during the 1960s and 70s. According to a 1968 *Science News* article, "Some may mourn it, but gone are the days when science fairs were replete with flashing lights, robots, and model rockets. Now the projects on display are rather dry visually. What was really on display at the Science Talent Search exhibit was creativity, curiosity, originality."[521] And indeed, during the 1950s and 60s the displays of Science Talent Search participants continued to homogenize with textual, results-oriented descriptions that placed little emphasis on aesthetics. The National Science Fair followed a similar pattern. In the 1968 International Science Fair bulletin, all but one project featured some sort of large trifold panel; by 1970, every single publicized project featured a large textual display.[522] Even as the fairs expanded topically and demographically, they also became more hierarchical in terms of presentation.

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[519] For examples of early project descriptions, see "A Book of Facts about the Sixth Annual Science Talent Search for Westinghouse Science Scholarships," ca. 1947. SSR Box 446, Folder 17.

[520] Science Talent Search 1975-6 Guidebook, SSP Records Files.

[521] "Intellectual, Not Visual," *Science News* 93, no. 11 (March 16, 1968): 264.

[522] SSP Science Fair Brochures Binder.

The decline in scientific authority among the general public threatened the future of Science Service programs. As newspapers employed specialized science syndicates and as advertising revenue declined, the Science Service began running a deficit. In 1974, R.J. Field, Manager of New York Public Relations at Westinghouse, wrote a report questioning the company's continued sponsorship of the Science Talent Search. The report considered whether STS was worth funding, and if so, whether it should continue to operate as a meritocratic competition.[523] Although Westinghouse extended its support, the Science Service battled other financial difficulties. They requested to merge with AAAS; the organization declined. A $200,000 grant from the National Science Foundation kept the Science Service afloat, but the organization faced an uphill battle in keeping its finances under control.

Although the Science Service survived, the organization suffered casualties. Programs that encouraged children's collaboration were affected the worst.[524] By the mid 1970s, the Science Clubs of America program ended in the midst of the financial overhaul.[525] The demise of the Science Clubs of America marked the end of the club network that had coincided with science fairs since their inception. Other network forums connecting enthusiasts suffered a similar fate. When C.L. Stong passed away in 1977, "The Amateur Scientist" of *Scientific American* featured columns that focused more on physical principles than do-it-yourself projects. As these platforms disappeared,

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[523] R. J. Field, "Westinghouse Science Talent Search," 1974, SSP Records Files.

[524] Philip M. Boffey, "Science Service: Publishing Pioneer in Financial Trouble," *Science* New Ser. 169, no. 3951 (September 18, 1970): 1182-1184; P.M.B., "AAAS Won't Absorb Science Service," *Science* New Ser. 170, no. 3956 (October 23, 1970): 418; R.J.B. and R.G., "Briefing," *Science* New Ser. 173, no. 3993 (July 16, 1971): 218-219.

[525] Within National Science Fair brochures, the Science Clubs of America emblem was featured for the last time in 1974. See SSP, Science Fair Brochures Binder.

adolescent hobbyists lacked the platforms of communication that brought a sense of community and commiseration.

Television also fundamentally reoriented the world of children's play, not only by offering a competing pastime, but also by presenting a more streamlined advertising venue. Toy manufacturers capitalized on using television to appeal directly to children. Television programs also served as source of inspiration for new toys, with products related to television characters taking the market by storm.[526] During the 1950s and 60s, science educational programs did make limited appearances on commercial television. Don Herbert's *Watch Mr. Wizard* proved particularly successful not just in introducing children to scientific principles, but in encouraging direct scientific engagement. Toys such as Mr. Wizard's Experiments in Chemistry Set appeared on the market (Fig. Conc.1), and over 5,000 Mr. Wizard Science Clubs sprung up across the nation by the mid 1950s. As Marcel Chotkowski LaFollette explains, however, with little support by scientific associations or the federal government, programs dedicated to science education never survived long on commercial television. *Watch Mr. Wizard* was cancelled in 1965 and again after a brief revival in the 1970s.[527] A few other educational television programs that presented science-related content to young viewers also made the primetime schedule. *Discovery,* a show sponsored by A.C. Gilbert, remained on ABC throughout the 1960s. The series *Science All Stars* featured children explaining their science projects, several of whom also participated in the competitions of the Science

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[526] Gary Cross, *Kids' Stuff: Toys and the Changing World of American Childhood* (Cambridge: Harvard University Press, 1997), 162-171.

[527] Marcel Chotkowski LaFollette, *Science on American Television: A History* (Chicago: The University of Chicago Press, 2013), 174-175.

Service.[528] However, these programs were also victim to cancellation.[529] Nonfictional science content appeared only briefly in fragments of more general children's programs such as *Captain Kangaroo, Mister Roger's Neighborhood,* or *The Wonderful World of Disney.* Instead, fictional programs with science-related themes, such as *The Jetsons, Astro Boy,* or *The Hector Heathcote Show* proved more popular on commercial television. These shows simplified, exploited, and mystified science, offering little educational value to children or faith in their abilities to comprehend underlying scientific principles.[530]

A top-down representation of science also permeated children's toys. Although science and construction outfits peaked in popularity in the 1950s, by the late 1960s they rapidly fell out of favor. Several factors contributed to their decline. Rather than the realistic recreations, child development experts began pushing for more abstract representations of the outside world that they believed would spark children's imaginations. Concerns over safety began to mount, particularly with sets that contained chemicals and other potentially hazardous materials. And changes occurred among the manufacturers themselves. Lionel purchased Chemcraft in 1961, only to be absorbed again by Gabriel Industries and CBS. In 1964 Meccano Ltd. was taken over by the Lines Brothers and *Meccano Magazine* ended circulation. Gilbert faced a similar fate, as portions of the company merged with other toy manufacturers throughout the late 1960s. As companies merged, so too did competition, leading toy manufacturers to cut costs and

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[528] "Science All Stars Features Fair Winners," *Science News-Letter* 85, no. 7 (February 15, 1964): 102; "Battle of Computers Topic of TV Show," *Science News-Letter* 85, no. 8 (February 22, 1964): 119; "New TV Show Stars Science Fair Winners," *The Science News-Letter* 84, no. 20 (November 16, 1963): 319; "Science All Stars Features Fair Winners," *The Science News-Letter* 85, no. 7 (February 15, 1964): 102.

[529] Cross, *Kids' Stuff,* 166; LaFollette, *Science on American Television,* 177.

[530] LaFollette, *Science on American Television,* 177-181.

reduce risks through streamlined production and adopting cheaper materials. Alongside these contributing factors was the changing position of science in contemporary households. Although domestic spaces for scientific and technical inquiry remained, they gradually shifted from an emphasis on “home laboratories” to less tactile domains, such as computer programming.[531]

The material and pedagogical underpinnings of children’s science and construction sets also changed rapidly during the 1960s and 70s. Most early twentieth century Erector and Meccano Sets contained few written guidelines. Instead, manuals featured dozens of pictured models that illustrated the component parts but offered no little advice in the way of construction. Gilbert and Hornby encouraged users to develop their own designs by selecting the appropriate parts, planning the correct order of assembly, and fastening together the components while envisioning the end result. Their toys provided realistic models that trained children for the age of large-scale construction and machines. Through tinkering with steel girders, gears, and motors, children not only built structures, but they also cultivated understandings of the industrial world.

When LEGO patented its interlocking system of plastic bricks in the 1950s, it took the toy industry by storm. It also marked a distinct departure from the Erector Set, both in material composition and tactile expertise. The interchangeable plastic parts quickly snapped together and required less dexterity on the part of its builders. Although early LEGO Sets sold parts that encouraged users’ creativity in creating their own designs, by the 1960s sets came with the exact number of parts to build a specific model.

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[531] See Amy F. Ogata, "Creative Playthings: Educational Toys and Postwar American Culture". *Winterthur Portfolio.* 39 (2004): 145; John Tyler, *The Chemcraft Story: The Legacy of Harold Porter* (Haworth, NJ: St. Johann Press, 2003), 50-59; Bruce Watson, *The Man Who Changed How Boys and Toys Were Made: The Life and Times of A.C. Gilbert* (New York: Penguin, 2002), 91.

Unlike the open-ended instruction books of Erector Sets, these kits came with step-by-step guidelines that provided users the exact order of assembly (Fig. Conc.2). Under new corporate management, later versions of Erector Sets began to mimic LEGO by incorporating plastic, adding detailed instructions, and marketing sets that permitted users to build a only few predetermined models. With these changes, the endless possibilities that once accompanied construction sets began to diminish (Fig. Conc.3).

Issues of safety also fundamentally changed the contents of children’s sets. Legislation of the 1960s and 70s, such as the Federal Hazardous Substances Act (1960), Toy Safety Act (1969), and Toxic Substances Control Act (1976) passed alongside the creation of the Consumer Product Commission (1972) set regulations on product labeling and limited the materials found in children’s toys.[532] Chemistry sets that once featured potentially hazardous chemicals such as potassium nitrate, lead acetate, or sodium hydroxide disappeared from the market. Subsequent chemistry sets featured extensive warning labels and fewer chemicals (or sometimes even no chemicals at all- see Figure Conc.4). Their popularity plummeted. Construction sets also faced scrutiny for posing potential threats to children. Parker Brothers’ construction set, Riviton, utilized rubber rivets to hold models together, a part that proved to be both a choking hazard and potentially dangerous projectile (Fig. Conc.5). Parker Brothers voluntarily removed the toy from the market in one of the biggest recalls of the 1970s.[533] As these sets disappeared from the market, children started playing less with physical objects and instead entered a virtual world dominated by television and arcade games.

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[532] Sarah Zielinski, “The Rise and Fall and Rise of the Chemistry Set,” *Smithsonian Magazine*, October 10, 2012, http://www.smithsonianmag.com/science-nature/the-rise-and-fall-and-rise-of-the-chemistry-set-70359831/?no-ist.

[533] Riviton 100: Basic Building Set Object Record, SMP.

In some respects, the scientific skepticism of the late 1960s and 1970s cemented the values of analytic culture. As students devoted their energies to considering the role of science in resolving social and ecological issues, they were less concerned with narrative forms of expression and more concerned with the potential outcomes of their work. Likewise, regulations for science fair project descriptions and displays became more prescriptive by providing step-by-step guidelines. As a result, students' presentation of evidence and methods of display continued to homogenize. By the end of the 1970s, the trifold panel display presenting a hypothesis, procedures and results served as the standard for science fairs in the decades to follow. Projects' underlying values such as trial and error, ingenuity, and applicability to real world problems continued to thrive even as students began to question the broader societal implications of their work.

Even as the virtues of analytic culture remained intact, the era underwent one critical shift in adolescent scientific engagement: the decline in children's autonomy. Whereas competitions remained popular, other activities that promoted collaboration, self initiative, and open dialogue fell to the wayside. The downfall of the Science Clubs of America program marked the end of a national network of science clubs devoted to supporting students working together as they created science fair projects. As network forums that treated adolescents as intellectual equals disappeared—such as Stong's column in *Scientific American*—students no longer had a platform for exchanging ideas and building a sense of community. Changes in scientific and construction toys via the increase in safety regulations and prescriptive instructions also placed limits on children's free play. As a result, a cohesive adolescent scientific culture that had thrived for over half a century lost its sense of identity. In the post-Sputnik world, science was no longer child's play.

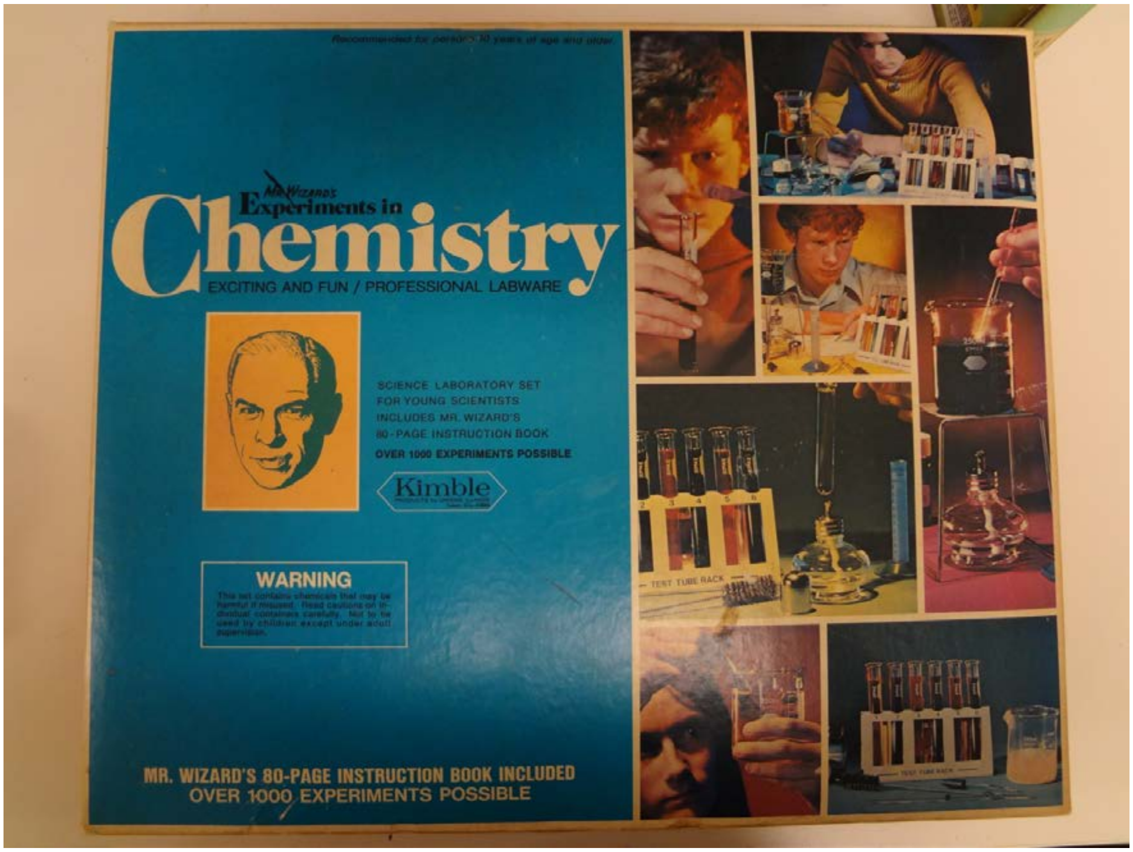

Figure C.1 Owens-Illinois MW-073 Mr. Wizard's Experiments in Chemistry Set. The kit featured an instruction along with eight chemicals, six test tubes, burner stand, beaker, and alcohol lamp. Photo by author. Courtesy Chemical Heritage Foundation Collection.

Figure C.2 1974 London Bus 760 Lego Set. The kit served as an early example of a set containing instructions and parts for a single model configuration. Photo by author. Courtesy of The Strong®, Rochester, New York.

Figure C.3 Contemporary Erector Set with plastic parts and detailed instructions. Photo by author. Courtesy of The Strong®, Rochester, New York.

Figure C.4 Harry Potter Spells & Potions Chemistry I Set No. 501. The set included a binder, cauldron, wand, hydrophobic sand, polyacrylamide crystals, pipettes, gloves, laces, and measuring scoop. Photo by author. Courtesy Chemical Heritage Foundation Collection.

Figure C.5 Riviton 100: Basic Building Set. Produced in 1977, Riviton was quickly pulled from the market due to safety concerns. Photo by author. Courtesy of The Strong®, Rochester, New York.

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