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Vaunting the independent amateur: *Scientific American* and the representation of lay scientists

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SUMMARY

This paper traces how media representations encouraged enthusiasts, youth and skilled volunteers to participate actively in science and technology during the twentieth century. It assesses how distinctive discourses about scientific amateurs positioned them with respect to professionals in shifting political and cultural environments. In particular, the account assesses the seminal role of a periodical, *Scientific American* magazine, in shaping and championing an enduring vision of autonomous scientific enthusiasms. Between the 1920s and 1970s, editors Albert G. Ingalls and Clair L. Stong shepherded generations of adult 'amateur scientists'. Their columns and books popularized a vision of independent non-professional research that celebrated the frugal ingenuity and skills of inveterate tinkerers. Some of these attributes have found more recent expression in present-day 'maker culture'. The topic consequently is relevant to the historiography of scientific practice, science popularization and science education. Its focus on independent non-professionals highlights political dimensions of agency and autonomy that have often been implicit for such historical (and contemporary) actors.

The paper argues that the *Scientific American* template of adult scientific amateurism contrasted with other representations: those promoted by earlier periodicals and by a science education organization, Science Service, and by the national demands for recruiting scientific labour during and after the Second World War. The evidence indicates that advocates of the alternative models had distinctive goals and adapted their narrative tactics to reach their intended audiences, which typically were conceived as young persons requiring instruction or mentoring. By contrast, the monthly *Scientific American* columns established a long-lived and stable image of the independent lay scientist.

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1. Introduction

Through the twentieth century, scientific amateurs multiplied in response to evolving leisure, commercial, educational and political contexts. This paper examines the role of media representations in shaping American public discourse about non-professionals, and in encouraging enthusiasts, youth and skilled volunteers to participate actively in science and technology. Influenced significantly by their portrayals in print, lay scientific activities played significant roles in shaping public understandings, spawning waves of career workers, supporting economies and achieving national goals.

My focus is a seminal periodical, *Scientific American* magazine, and its role over five decades in championing a popular template of the scientific amateur. I argue that the *Scientific American* vision of lay science was shaped during a fertile period for American publishing, and contrasted with earlier media portrayals and significant contemporary alternatives promoted by the activities of an influential media organization, Science Service, and by rising national demands for generating scientific labour during and after the Second World War. While other media sources actively adapted their narrative tactics to influence youthful practitioners, the monthly *Scientific American* columns established a long-lived and stable image of the adult lay scientist.

I show that that the rhetoric and reality of scientific enthusiasms have not always matched. Publishers, engineering and supply companies, educators and government were active agents in deliberately promoting and guiding subsets of amateur scientific activities. In distinct contexts, sponsors and mentors have portrayed amateur passion for science variously as an innate juvenile interest to be nurtured; as an enabling trigger to launch adolescents towards nationally valuable careers; or as an inspirational adult avocation that can be harnessed to promote wider public understandings of science. These conceptions periodically have been supported by, or conflicted with, commercial marketing, professional scientific practice and government policy. Such unnuanced portrayals under-represent the richly varied social contexts in which scientific amateurs and enthusiasts have practised, as well as the disparate goals and networks that have motivated them. The central claim of the paper is that media portrayals of amateur science have evolved episodically as a product of context and agency.

The range of portrayals, and the contexts and motivations that influenced them, provide a valuable empirical resource for understanding not only the historical contexts and trajectory of amateur science, but also the present-day expression and future potential of such activities in wider culture.[1] The topic consequently is relevant to the historiography of scientific practice, science popularization and the educative dimensions of scientific enquiry. I also explore the changing political and cultural contexts in the United States to highlight more general political dimensions of agency and autonomy for the historical actors.

2. Problematizing the lay scientist and technical enthusiast

The historiography of lay science has been shaped by contributors ranging from established scientists and scholars in varied disciplines to amateurs themselves and, as foregrounded here, by portrayals in popular media. Consequently, the appropriate definition, place and role for scientific amateurs have evoked recurrent debate.

In popular understandings through the twentieth century, the term *amateur* often has been employed as a label that crudely demarcates, and often subtly disparages, certain scientific activities

[1]For example, amateur enthusiasms during the early twenty-first century have been expressed through so-called 'maker culture' and 'maker spaces', which encourage and facilitate the sharing of expertise between peers in special cultural environments.

and competences. Drawing on the better known context of sport, common usage defines it merely as unpaid and non-career-oriented work, suggesting an activity that is both unvalued and unranked. Amateurs may engage in their activities without financial recompense, hinting at an individualistic or self-interested dimension; they may be bereft of recognized qualifications in a scientific discipline, and so have low status in the hierarchy of expertise. In professional and scholarly usage, too, such negative characterisations of amateurs were increasingly contrasted with those of career workers as science became professionalized in the late nineteenth century.[2] Thus scientific amateurism may be relegated to a byway in the historiography of professionalization. On the other hand, closer to the themes developed by *Scientific American* magazine, lay practitioners may be conceived as free of client, funder or even peer relationships, allowing unconstrained exercise of their creativity. In short, the qualities and status of the amateur are variously configured, hinting at a practitioner who may be a free spirit driven by intellectual curiosity, or alternatively a dilettante pursuing a pastime on the periphery of science.

An equally important historiographical thread is the presumed link between applied science and invention, and the role of amateur participants in these activities. The rise of scientific amateurism, particularly in the American context, has been framed in popular and scholarly discourse in terms closely allied with technical enthusiasms during the twentieth century. Both built on, but had a distinct orientation from, earlier hobbies. The zeal to collect, for example, has long had documented scientific expressions (as in cabinets of curiosities and Victorian botany).[3] Alternatively, traditional hobbies centring on manual skills such as model-making could be extended to inform experimental studies. Thus both aspects of hobbies – collecting and making – could combine a leisure activity with scientific explorations.

New pastimes incorporated these traditional attractions, but fitted a rapidly changing scientific and technological environment. Photography melded chemistry and physics; electrical technologies for lighting, communication and mechanical power began to invade public spaces, institutions and some middle-class homes; petrol engines flourished in farm equipment and urban automobiles. Such technologies transformed life and aspirations, providing attractions for both passive and active participation. Historians of technology have highlighted the cultural contexts of invention in industrialized countries, and the inspiration provided by new science.[4] On the one hand, the principles were mysterious and inspired reflection: how did a car engine work, for example, and what exactly was electricity? On the other, the new technologies fostered a growing culture of active tinkerers, offering empowerment for those who mastered them. The roles of innovator and knowledge-seeker carried wider groups of imitators in their wake. The work of Ronald Kline has explored the interpretation of engineering innovation as applied science, which, as discussed below, was to distinguish American publishing initiatives after the First World War.[5]

Among professionals across disciplines, scientific amateurism has been understood and valued in distinctive terms. The link between scientific enthusiasms, education and youth has been a perennial theme for science educators and scholars, as discussed below, and is well depicted in the historical

[2]The seminal work on the topic is Nathan Reingold, 'Definitions and Speculations: The Professionalization of Science in America in the Nineteenth Century', in *The Pursuit of Knowledge in the Early American Republic*, ed. by J. Oleson and A. Voss (Baltimore: Johns Hopkins University Press, 1976), pp. 33–69. On related case studies, see also John D. Holmfield, 'From Amateurs to Professionals in American Science: The Controversy over the Proceedings of an 1853 Scientific Meeting', *Proceedings of the American Philosophical Society*, 114 (1970), 22–36; Allan Chapman, *The Victorian Amateur Astronomer* (London: Wiley, 1999); Jack Meadows, *The Victorian Scientist: The Growth of a Profession* (London: British Library, 2004).

[3]Oliver R. Impey and Arthur MacGregor, *The Origins of Museums: The Cabinet of Curiosities in Sixteenth and Seventeenth-Century Europe* (Oxford: Clarendon Press, 1985); Robert E. Kohler, 'Finders, keepers: collecting sciences and collecting practice', *History of Science*, 45 (2007), 428–54. On Victorian life-science amateurs see, for example, Elizabeth B. Keeney, *The Botanizers: Amateur Scientists in Nineteenth-Century America* (Chapel Hill & London: University of North Carolina Press, 1992).

[4]See, for example, Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870-1970* (Chicago: University of Chicago Press, 1989); John L. Wright, ed., *Possible Dreams: Enthusiasm for Technology in America* (Dearborn: Henry Ford Museum & Greenfield Village, 1992).

[5]Ronald Kline, 'Construing "technology" as "applied science": public rhetoric of scientists and engineers in the United States, 1880-1945', *Isis*, 86 (1995), 194–221.

research of Sevan Terzian, Rebecca Onion and others.[6] The historical implications for children's activities and for education policy have also been examined, for example, by Ronald Tobey and Patrick McCray, and by contemporary policy-makers.[7] This categorization by age mirrors the equally obvious hierarchy of authority between adult professional and non-professional science practitioners. The power relations between amateurs and professionals – particularly during the period of greatest change, between the mid-nineteenth and early twentieth centuries – consequently have attracted studies oriented toward political philosophy.[8] It is important to note that such preceding accounts identify contentions about the notion of the 'amateur' in American science, while sometimes adopting working definitions aligned to prevailing models.

Prior studies are further distinguished by social and disciplinary context. The work of Robert Stebbins, for example, has explored sociological dimensions of scientific amateurism as a leisure activity.[9] Broader social history investigations of the relationship between hobbies, work and leisure pastimes have argued for their dependence on specific political and economic contexts. In particular, the rise of hobbies during the late nineteenth century, especially among the working class, was both a reflection of, and a limited resistance to, industrialization and the free market.[10] The histories of two of the popular fields discussed here – the domains of amateur astronomy, which straddled the nineteenth and twentieth centuries, and amateur radio – have also attracted enduring interest of enthusiasts themselves, and more recently the analytical work of Gary Cameron and Kristen Haring, respectively.[11] The studies of Marcel LaFollette and John Burnham draw attention to the role of magazines and other media in shaping popular understandings of professional science. They conclude that stereotypes and misrepresentations dominated popular accounts.[12]

The present research extends prior studies in three key respects. First, it focuses on amateurs as *active* practitioners of science: experimenting, innovating and generating physical and intellectual

[6]Sevan G. Terzian, 'The 1939-1940 New York World's Fair and the Transformation of the American Science Extracurriculum', *Science Education*, 93 (2009), 892–914; Sevan G. Terzian, *Science Education and Citizenship: Fairs, Clubs, and Talent Searches for American Youth, 1918-1958* (New York: Palgrave Macmillan, 2013); Rebecca Stiles Onion, *Innocent Experiments: Childhood and the Culture of Popular Science in the United States* (Chapel Hill: University of North Carolina Press, 2016). On historical studies of education, see, for example, Michael D. Stephens, 'The role of the amateur in nineteenth century American and English scientific education', *The Vocational Aspect of Education*, 34 (1982), 1–5; E. W. Jenkins, 'School science, citizenship and the public understanding of science', *International Journal of Science Education*, 21 (1999), 703–10; Michael G. Gibbs and Margaret Berendsen, 'Effectiveness of amateur astronomers as informal science educators', *Astronomy Education Review*, 5 (2006), 114–26.

[7]E.g. Ronald Tobey, *The American Ideology of National Science* (Pittsburgh, PA: University of Pittsburgh Press., 1971); W. Patrick McCray, *Keep Watching the Skies! The Story of Operation Moonwatch and the Dawn of the Space Age* (Princeton, NJ: Princeton University Press, 2008). On historically-informed present-day policy-making, see P. J. Fensham, 'The link between policy and practice in science education: the role of research', *Science Education*, 93 (2009), 1076–95.

[8]This is a theme of the sources cited in footnote 2, but more explicit in Morris Berman, '"Hegemony" and the amateur tradition in British science', *Journal of Social History*, 8 (1975), 30–50, and Marc Rothenberg, 'Organization and control: professionals and amateurs in American astronomy, 1899–1918', *Social Studies of Science*, 11 (1981), 305–25. Linking historical and contemporary contexts, see; Richard Edwards, 'The "citizens" in citizen science projects: educational and conceptual issues', *International Journal of Science Education, Part B*, 4 (2014), 376–91; Sean F. Johnston, Benjamin Franks and Sandy Whitelaw, 'Crowd-sourced science: societal engagement, scientific authority and ethical practice', *Journal of Information Ethics*, 26 (2017), 49–65.

[9]E.g. R. A. Stebbins, 'The amateur: two sociological dimensions', *Pacific Sociological Review*, 20 (1977), 582–606; R. A. Stebbins, 'Avocational science: the amateur routine in archaeology and astronomy', *International Journal of Comparative Sociology*, 21 (1980), 34–48; R. A. Stebbins, 'Science amateurs? Rewards and costs in amateur astronomy and archaeology', *Journal of Leisure Research*, 13 (1981), 289–304.

[10]See, for example, Ross McKibbin, 'Work and hobbies in Britain, 1880-1950', in *The Working Class in Modern British History: Essays in Honour of Henry Pelling*, ed. by J. Lerner (Cambridge: Cambridge University Press, 1983), pp. 143–45; Steven M. Gelber, *Hobbies: Leisure and the Culture of Work in America* (New York: Columbia University Press, 1999); Rachel P. Maines, *Hedonizing Technologies: Paths to Pleasure in Hobbies and Leisure* (Baltimore: Johns Hopkins University Press, 2009).

[11]Gary L. Cameron, *Public Skies: Telescopes and the Popularization of Astronomy in the Twentieth Century*, thesis, Iowa State University (2010), esp. Chapter 4; Kristen Haring, *Ham Radio's Technical Culture* (Cambridge, MA: MIT Press, 2007). The American Astronomical Society has also favoured historical studies of its membership, e.g. Brant L. Sponberg, 'Amateurs in the Early A.A.S.', Washington, DC, 1999.

[12]Marcel C. LaFollette, *Making Science Our Own: Public Images of Science 1910-1955* (Chicago: University of Chicago Press, 1990); Marcel C. LaFollette, *Science on the Air: Popularizers and Personalities on Radio and Early Television* (Chicago: University of Chicago Press, 2008); Marcel C. Lafollette, *Science on American Television: A History* (Chicago: University of Chicago Press, 2013); John C. Burnham, *How Superstition Won and Science Lost: Popularizing Science and Health in the United States* (New Brunswick, NJ: Rutgers University Press, 1987).

scientific products. Second, it compares and contrasts how productive scientific enthusiasms were channelled by key media sources – particularly *Scientific American* magazine – to represent and shape distinctive audiences and practices of lay science. And third, the paper explores how practising amateurs responded to these portrayals and, in highly constrained contexts, represented themselves.

3. Portraying the scientific amateur

Scientific pastimes had become an increasingly visible activity from the early nineteenth century, communicated to growing audiences through publications. Popular science periodicals proselytized the values, achievements and (most ardently and consistently) the practical products of modern science.[13]

In the American context, science was vaunted with specifically utilitarian and economic dimensions. *Scientific American* was born in 1845 to capture this public enthusiasm, chronicling new invention week by week, and later on a monthly schedule. Over the following seventy years, it was joined by a growing number of popular periodicals that conflated scientific discovery with invention.[14]

Popular writing constructed a specifically American identity for the scientific enthusiast. As depicted by adolescent fiction in the first two decades of the century, American science was active, innovative and profitable. The *Tom Swift* series of books (1910–1941) devised by American writer and publisher Edward Stratemeyer (1862–1930) focused on a young inventor and his adventures with exhilarating electrical and transport technologies. The Stratemeyer Syndicate churned out mysteries that mixed invention, clear thinking, adventure, wondrous capabilities and industrial secrecy, usually with boys as protagonists.[15] Mirrored by other publishers, several thousand titles provided role models for three generations of American children and young adults.[16]

Some of those same audiences were inspired further by magazines dedicated to hands-on experimentation and innovation. Another seminal American publisher was responsible for a large fraction of these ventures. Hugo Gernsback (1884–1967), an entrepreneur in the early American radio industry, chronicled invention through his periodicals aimed at technical amateurs and emerging science fiction enthusiasts. He followed his first magazine, *Modern Electrics* (1908), with dozens more seeking to capture a growing public appetite for popular science and invention.[17] During the early twentieth century, then, 'science' was broadly construed for American readers of popular literature as what today might be labelled 'optimistic technoscience': a progressive and culturally transformative activity linked with personal improvement, economic benefits and expanding knowledge. In the periodicals, scientific curiosity was blended with technological enthusiasms and individual expertise to generate new pastimes and potential career skills.

[13]Susan Sheets-Pyenson, 'Popular science periodicals in Paris and London: The emergence of a low scientific culture, 1820–1875', *Annals of Science*, 42 (1985), 549–72. For complementary coverage see also Peter Broks, *Media Science Before the Great War* (London: Palgrave Macmillan, 1996) and Peter Bowler, *Science for All: The Popularization of Science in Early Twentieth-Century Britain* (Chicago: University of Chicago Press, 2009). Ina Heumann, *Gegenstücke: Populäres Wissen im transatlantischen Vergleich (1948–1984)* (Wien: Böhlau Verlag, 2014), esp. pp. 298–311, explores some of the primary sources and historical actors discussed in the present paper, comparing the popular communication of scientific knowledge after the Second World War in the USA and Germany via *Scientific American* and *Bild der Wissenschaft*.

[14]Among the more prominent of the genre were *Popular Science* (1872-), *Electrician and Mechanic* (1890–1914), *Popular Mechanics* (1902--) and *Technical World Magazine* (1904–1923).

[15]John Dizer, *Tom Swift & Company: "Boys' Books" by Stratemeyer and Others* (Jefferson, NC: McFarland, 1982); Deirdre Johnson, *Edward Stratemeyer and the Stratemeyer Syndicate* (New York: Twayne, 1993); Francis J. Molson, 'The boy inventor in American series fiction: 1900-1930', *Journal of Popular Culture*, 28 (1994), 31–48.

[16]The successful format fitted the American cultural and political landscape between about 1910 and 1970. Everett Bleiler argues for the capitalist underpinnings of such juvenile fiction into the twentieth century, noting that the *Tom Swift* stories communicated 'economic parables' about intelligence and hard graft as much as scientific adventure [Everett F. Bleiler, 'From the Newark Steam Man to Tom Swift', *Extrapolation*, 30.2 (1989), 101–16 (112)]. A late example of such fiction is a series of adventures (1954-71) featuring the updated inventions of the original protagonist's son, Tom Swift Jr, to capture the enthusiasm of readers of the baby-boom generation.

[17]Keith Massie and Stephen D. Perry, 'Hugo Gernsbach and radio magazines: an influential intersection in broadcast history', *Journal of Radio Studies*, 9 (2002), 264–81; Mike Ashley, *The Gernsback Days* (Holicong, PA: Wildside Press, 2004).

The content and themes of such publications altered markedly after the First World War to offer overt encouragement to amateurs. In the postwar environment, new publishing initiatives, including a renewed *Scientific American,* were oriented towards articles displaying more explicit scientific content and aiming to promote active engagement by enthusiasts. Gernsback's *Everyday Mechanics* (1915–1916), for instance, included articles and colourful cover art that depicted scientific experiments, and *The Experimenter*, subtitled '*Electricity – Radio – Chemistry*', specialized in articles providing hands-on projects to build and use scientific apparatus.[18] Through the twenties, popular titles mutated to reflect science-oriented content more explicitly. Thus Gernsbach's *Practical Electrics* (launched 1921) became *The Experimenter* from 1924; *Electrical Experimenter* (launched 1913) became *Science and Invention* from 1920; *Everyday Mechanics* (1915–1916) was reintroduced as *Everyday Science and Mechanics* (1931).[19]

In distinctive ways, a smaller cohort of organizations was to champion *active* amateur engagement in science by hands-on experimentation and invention. The increasingly public face of science after the First World War was sensed by an American journalist, Edward W. Scripps (1854–1926). His initial notions of science promotion focused on popularizing exemplary American scientists; his planned approach was hierarchical and paternalistic, seeking to influence a receptive but largely passive and unskilled audience. In 1919, he proposed an American Society for the Dissemination of Science that would employ syndicated press stories to instruct the public 'quickly and well' on the 'painstaking research carried on by a few hundred, or at most a few thousand, well-trained men equipped with great mental capacity'. Scripps's aim – sharpened by his conviction that the past war could have been avoided by rational international dialogue – was to provide unbiased scientific information that would allow an educated public to 'think like a scientist', and foster reasoned decision-making.[20] This initial notion was nonetheless an arms-length greeting: members of the public were meant to appreciate the exceptional powers and authority of elite scientists, rather than to actively emulate them. As explained in a discussion paper by its co-founder, zoologist William Ritter, the organization's early aim was 'to beget in the public generally more of the scientific attitude than now exists … by presenting such facts which seem mysterious and arouse feelings of astonishment and wonder and awe'.[21]

On the other hand, the organization sought ultimately to expunge mysticism and anti-science feeling. Its first Director, chemist Edwin Slosson (1865–1929), warned the trustees that 'the chemist has become conspicuous as maker of poison gas and regarded as a malignant power as in the Middle Ages', and noted the 'wave of superstition and reaction … now sweeping the world', with both science and medicine popularly regarded as modern forms of magic. Slosson argued that the way forward was 'an aggressive campaign for the popularization of science' to enrol a larger public in scientific enthusiasms: not just the 'minority consisting chiefly of men and largely mechanics who read the scientific and technical periodicals with great eagerness', but also the 'large majority that never touch scientific books or papers, even the lightest of the popular scientific periodicals'.[22]

[18]E.g. 'How two boys cultivated plants with electricity', *Everyday Mechanics*, 1 (3) ; 'How to make an electric water-finder', *The Experimenter*, 1 (Nov 1924), 24–28.

[19]In Britain, a similarly prolific and influential publisher was Frederick J. Camm (1895-1959), promoting active engagement in scientifically-informed hobbies. His first book was on model aircraft, and he founded *Practical Wireless* (1932-), *Practical Mechanics* (1933–63), and *Practical Television* (1934–2008), authoring over a hundred books to become the doyen of amateur British radio in the interwar and postwar periods [Gordon G. Cullingham, *F. J. Camm, The Practical Man* (Windsor, UK: Thamesweb publishing, 1996)].

[20]E. W. Scripps, 'The American Society for the Dissemination of Science', in Smithsonian Institution Archives, Washington DC (henceforth SI) RU7091 Box 1 Folder 1 (1919).

[21]W. E. Ritter, 'Possible aims of "The American Society for the Dissemination of Science"', Oct 1919, SI RU7091 Box 1 Folder 1.

[22]Edwin E. Slosson, 'Notes of a talk to trustees of Science Service at the meeting of 17 June 1921: Hostility toward science', typescript, 17 Jun 1921, SI RU7091 Box 1 Folder 2. See also David J. Rhees, *A New Voice for Science: Science Service Under Edwin E. Slosson, 1921-1929*, MA dissertation thesis, History, University of North Carolina at Chapel Hill (1979). Chemists re-presented their science in positive terms; see David J. Rhees, *The Chemists' Crusade: The Rise of an Industrial Science in Modern America, 1907-1922*, PhD thesis, University of Pennsylvania (1987), especially Chapter 5.

Founded under the unassuming title 'Science Service' in 1921, the not-for-profit organization consequently provided a news syndication service focusing on the accurate reporting of science.[23] American periodicals began to pick up the news feeds encouragingly, but the impact of the items on readers proved difficult to gauge for local newspaper editors as much as for Science Service itself. The young organization was agile in adapting its goals and methods, and consequently launched a new initiative: promotion of scientific hobbies. The aim was to encourage enthusiastic hobbyists to gain first-hand experience with scientific culture, in order to transmit their passions to friends, families and acquaintances.

The first such campaign was Science Service's popularization of experimental amateur radio. Radio amateurism had spun-off from professional activities during the First World War, when many operators and technicians had been trained in the use of communications equipment. With the availability of war-surplus components and the explosion of voice transmission experiments from the early 1920s, amateurs kept pace with commercial development and expanding government regulation. Their activities led to scientific and technological advances: experimental transmissions between radio amateurs, for example, discovered the utility of frequency bands that had not been considered viable by the nascent industry.[24] Non-professionals, this seemed to suggest, could genuinely extend scientific knowledge just as Stratemeyer's adventure fiction portrayed them as doing.

Amateur enthusiasts also gained the interest of government as the social locus of grassroots science. In 1922, Herbert Hoover, then Secretary of Commerce and responsible for allocating radio broadcasting frequencies, identified 'the genius of the American boy' as the best means 'to make the possession of receiving sets almost universal in American homes', a message echoed by Science Service.[25] The Bureau of Standards drafted informational pamphlets; the Department of Agriculture fostered Boys and Girls Radio Clubs for adolescents who would master radio and serve as information conduits between government departments and farmers; and Science Service disseminated the information through feeds to major newspapers and popular periodicals such as *Good Housekeeping*, *Harper's Magazine* and *Popular Science Monthly*.[26] As more practical magazines were gaining would-be inventors as readers, Science Service sought to align with government views to convert the 'boy geniuses' into science popularizers.[27] By the end of the decade, its second Director, physicist Watson Davis (1896–1967), argued that his organization's instructional articles had inspired a new generation of active young experimenters by linking abstract scientific advances to hands-on experience:

> Science Service in its early days pioneered in giving newspaper readers accurate and understandable instructions for building radio sets. When Lindbergh flew it told how to build model airplanes. When radiovision became experimental the organization described the construction of a radiovisor.[28]

While these campaigns of Science Service, government departments and industry were increasingly targeted at young people, it is notable that there was no acknowledged involvement of schools or teachers. Despite targeting a variety of audiences and cultural niches, media sources in the first three decades of the century portrayed a broadly consistent vision of scientific amateurism. Across

[23]Edwin E. Slosson, 'A new agency for the popularization of science', *Science*, 53 (1371), 8 Apr 1921, 321–23.

[24]An amateur radio club station in Connecticut, 1BCG, transmitted Morse signals around the world in December 1921, and enthusiasts experimented with two-way communication during 1923-24.

[25]Herbert Hoover, 'Statement of the Secretary of Commerce at the opening of the Radio Conference on February 27, 1922', press release, 27 Feb 1922, SI RU7091 Box 11 Folder 2. Science Service identified this as citizen empowerment: 'There is one block of the ether that the conference granted to "that precious thing – the American small boy, to whom so much of this rapid expansion of interest is due"'. [Watson Davis, 'A new addition to our national life: results of the Radio Conference', typescript, n.d., c Mar 1922, SI RU7091 Box 11 Folder 3]

[26]Bureau of Standards, 'Construction and operation of a very simple radio receiving equipment', Letter Circular LC 43, 16 Mar 1922, SI RU7091 Box 11 Folder 2; U.S. Dept. of Agriculture and State Agricultural Colleges, 'Cooperative extension work in agriculture and home economics - boys and girls radio clubs', n.d., c 1922, SI RU7091 Box 11 Folder 3.

[27]Articles linking youth, innate abilities and scientific enthusiasms were common, e.g. Gaston P. Fontaine, 'Fourteen year old genius makes own successful television receiver', *Television: America's First Television Journal*, 1 (3) (1929), 76.

[28]Watson Davis, 'Make your own telescope', promotion letter to newspaper editors, n.d., 1930, SI RU7091 Box 120 Folder 9.

popular fiction, practical magazines and newspaper 'feeds', science experimenters were conceived as young latent scientists and eager individualists who required not mentoring, but merely a kick-start.

4. Albert Ingalls and the *Scientific American* model of the adult amateur

In this science-conscious cultural milieu of post-First World War publishing, a more self-directed scientific amateurism was promoted by *Scientific American* magazine. Relaunched in 1921 under new editorial management, the periodical was reoriented towards more educated and aspirational audiences. One of its contributors, Albert Graham ('Unk') Ingalls (1888–1958) – who had done 'fifteen courses on geology at Cornell 1910–1914, tho forgotten most of it', and worked for a time as a telegraph operator – joined the magazine as an associate editor in 1923.[29] Over the next decade, as Science Service was extending its activities, Ingalls at *Scientific American* magazine carefully defined and nurtured a cohort of enthusiasts, beginning with a regular column on amateur telescope-making.

Ingalls's vision of the amateur evolved over a decade. 'Sheer accident' is how he described the growth of amateur telescope making in the USA, although it appears to have been more a case of tactical publishing. Browsing the public library, Ingalls had come across an article, 'The Poor Man's Telescope' in a 1921 *Popular Astronomy* magazine. Its author, Russell W. Porter (1871–1949) – a sometime artist, Arctic expeditioneer, university teacher of architecture, research engineer and amateur astronomer – described a group of Vermont telescope enthusiasts whom he had mentored following a course on practical astronomy.[30] Ingalls was intrigued enough to build his own telescope but discovered only a single book on the topic by an Irish cleric and director of the Armagh Observatory, William F. A. Ellison (1864–1936). Ellison's publishing path and readership – the book being a collection of some 100 pages of articles that he had published in *The English Mechanic and World of Science* during 1918 – appears to have informed Ingalls's own writing.[31] Ingalls published an article in *Scientific American* about the Springfield amateur group in 1925.[32] The result was unexpectedly direct evidence of the enthusiasm that Science Service had been seeking: over 300 readers responded with requests for further information. So, beginning with Porter's assistance the following year, Ingalls launched a monthly column, 'The Back Yard Astronomer', in *Scientific American* and published a slim book, *Amateur Telescope Making*, which included extensive extracts from Ellison's work.[33]

Expanded editions quickly followed, supplemented by the accounts of avid readers, and two more advanced volumes were published in 1937 and 1953, respectively.[34] While noting that the topic 'was imported from Great Britain', Ingalls credited his magazine column and later volumes of the book with stimulating communities of 'scientifically minded persons' showing 'keen enthusiasm, sometimes almost fanatical' for the growing hobby 'wherever the *Scientific American* circulated'.[35] Explaining this unexpected response from 'eager workers, young and old, skilled and less skilled, men and women (several of these)', Ingalls summarized the qualities of the scientific amateur:

> It exacts intelligence; requires patience and sometimes dogged persistence in order to whip the knotty but fascinating problems which arise; demands hard work – is not dead easy; and compels the exercise of a fair amount

[29] Albert G. Ingalls to Bernard Williams Powell, 10 Apr 1953, Archives Center of the National Museum of American History, Washington DC (henceforth ACNMAH) 0175 Box 8, folder 2 1953.

[30] Russell W. Porter, 'The poor man's telescope', *Popular Astronomy*, 29 (1921), 527–36; see also Horace A Smith, 'Popular Astronomy Magazine and the Development of Variable Star Observing in the United States', *The Journal of the American Association of Variable Star Observers*, 9 (1980), 40–42. On Porter, whose father and uncle had been inventors, see Berton C. Willard, *Russell W. Porter - Arctic Explorer Artist Telescope Maker* (Freeport, ME: Bond Wheelwright Company, 1976); Jordan D. Marché II, 'Porter, Russell W.', in *Biographical Encyclopedia of Astronomers* (Springer, 2007), pp. 926–27.

[31] W. F. A. Ellison, *The Amateur's Telescope* (Belfast: Carswell & Son, 1920).

[32] Albert G. Ingalls, 'The heavens declare the glory of God: how a group of enthusiasts learned to make telescopes and became amateur astronomers', *Scientific American*, 133 (November 1925), 293–95.

[33] Ingalls visited Ellison in Ireland in 1928 [Ingalls to O. Gingerich, letter, 2 Dec 1948, ACNMAH 0175 Ingalls papers, Box 3 file 6].

[34] On Ingalls's influence on the amateur telescope movement, see Thomas R. Williams, 'Albert Ingalls and the ATM Movement', *Sky & Telescope*, 81 (February 1991), 140–42.

[35] Albert G. Ingalls, *Amateur Telescope Making* (New York: Scientific American, 1933 (3rd edition)), cited on pp. vii–viii, x.

> of handiness – enough to exclude the born bungler but no more than is possessed by the average man who can 'tinker' his car or the household plumbing, or dissect and wreck a watch.[36]

This model of the scientific enthusiast was not Ingalls's alone, but rather that distilled from Porter's community of Springfield Telescope Makers. Ingalls attended their conventions at Springfield, Vermont, each summer from their origin in 1926 (Figure 1). The cohort exhibited the diversity, handiness and curiosity that Ingalls later praised in his columns. Contemporary articles identified them as engineers, poets, inventors, cooks and writers; among their ranks was a stereograph photographer, a bank cashier, a foundry-man, an artist, a pattern-maker, a high-school teacher, a lathe operator and a bookkeeper. Several were mechanics at the company for which Russell Porter worked as an engineer.[37] Porter described their activities as relating to 'laymen … not to the dilettante, but to the seriously-inclined amateur as compared to the professionals themselves'.[38]

Ingalls portrayed Porter's cohort as independent and autonomous adult amateurs, not followers of published instructions as in Science Service news feeds and practical magazines. His synthesis also owed much to Ellison's decade-old British columns. Like Ellison's writing, Ingalls's columns vaunted individual innovation. Providing recognition for contributors as role models, it enabled a new mode of communication between enthusiasts as peers operating independently of professional scientists. By uniting isolated individuals across the continent, Ingalls's columns picked out and knitted together a *virtual* community of enthusiasts as equals who were unlikely ever to meet, some seventy years before this style of interaction was popularized by internet news groups. The publications of Ellison, Porter and Ingalls provided an appealing template for such scientific hobbyists and promoted a kind of avocation.

They also literally gave the amateur a face. Porter's original article on the Springfield group included photographs of individuals with their telescopes, and Ingalls's subsequent articles and books depicted everyday people making, using and displaying their apparatus.[39] These exemplars – soon multiplied by the self-portraits sent in by Ingalls's readers – were not mere snapshots. They were carefully staged by their creators: well-dressed men (not boys, and only rarely women) displaying innovation with scarce resources. The photos displayed a recognizable shared identity, mirroring the Springfield amateurs. This was not depersonalized objective science. Nor was it applied science of the kind that contemporary engineering periodicals and do-it-yourself magazines were touting. The images and captions (frequently prefaced 'A Home Made Telescope') underlined the attributes of the *Scientific American* amateur: not the rare qualities of genius emphasized in the popular press, but rather the more democratic and attainable qualities of clear thinking, innovation and dedication. Typical of their frugal ingenuity and emulation was 'C. C. Chapman with his small telescope, driven by an alarm clock movement, assisted by a phonograph spring' (Figure 2).[40] The focus of Ingalls's amateurs was on character and process, not product.

The complementarity between lay technical enthusiasts, on the one hand, and dedicated career scientists, on the other, was seldom addressed. The *Scientific American* columns and books stressed the satisfaction of independent tinkering, while only occasionally did a professional voice intrude to suggest the fulfilment of playing a subordinate role in knowledge acquisition. Professional astronomer Harlow Shapley, for example, suggested in the Foreword to Ingalls's book that amateurs model themselves on professionals. Linking their hobby to Christiaan Huygens and his seventeenth century

[36]Ingalls, *Amateur Telescope Making* (note 35), quotation p. viii.
[37]Oscar S. Marshall, 'Russell W. Porter -- some glimpses of the Vermonter who will assist in designing and building the World's Greatest Telescope', *The Vermonter*, 33 (1928), 118–22; Webb Waldron, 'On a mountaintop in Vermont I found one really happy man', *American Magazine*, 112 (Nov 1931), 50–53; Anonymous, 'Hobby of a Theta Chi brings happiness to many and scientific recognition and gain to himself', *The Rattle of Theta Chi*, 20 (1932), 18–22.
[38]'From Russell W. Porter', *Engineering and Science Monthly*, 11 (1948), 32.
[39]Russell W. Porter, 'The telescope makers of Springfield, Vermont: one way of absorbing astronomy', *Popular Astronomy*, 31 (1923), 153–63.
[40]Albert G. Ingalls, *Amateur Telescope Making Advanced: A Sequel to Amateur Telescope Making* (New York: Munn, 1937), p. 306. Among them, as an adolescent in 1948, was the later historian of astronomy, Owen Gingerich [ACNMAH 0175, Box 3 file 6 (correspondence, 1946–1948)].

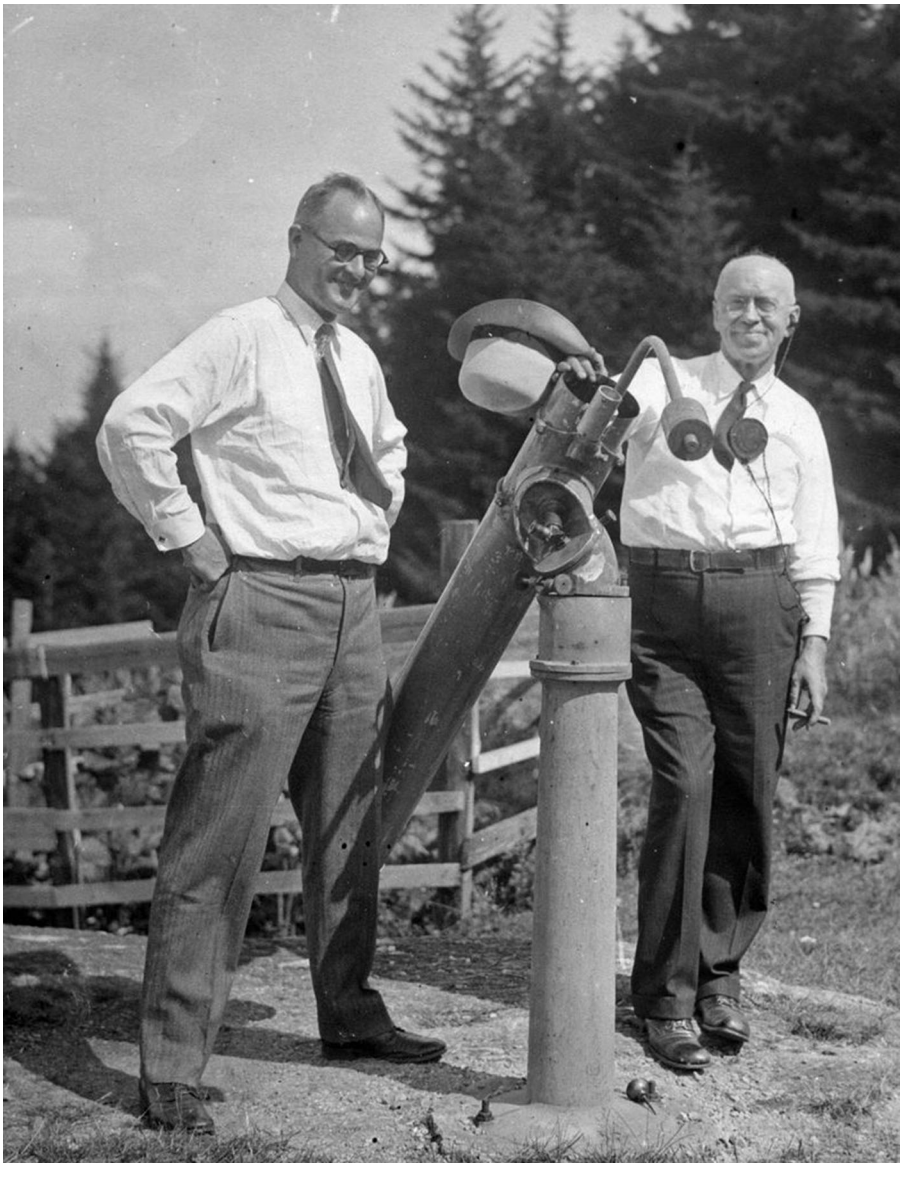

Figure 1. Albert Ingalls and Russell Porter at the Stellafane Convention, late 1920s [courtesy of Springfield Telescope Makers Inc].

telescopic investigations, Shapley hinted at their position as potential acolytes or junior partners. 'If you have "fashioned some glasses" into a telescope', he noted, 'you can do some valuable work on variable stars. The American Association of Variable Star Observers would welcome you to its international membership, give you instructions, charts and encouragement'. He offered them a niche as subordinate contributors: 'your observations will be directed and studied by professionals … If you communicate your earnest astronomical aspirations to any of the observatories, you will be freely counselled'.[41]

Ingalls's correspondents nevertheless resisted such direction and counselling. Instead, they offered to their peer readers insights embodied in an uncommon mixture of competences. As the

[41]Harlow Shapley, 'Foreword', in Ingalls, *Amateur Telescope Making* (note 35), p. xi.

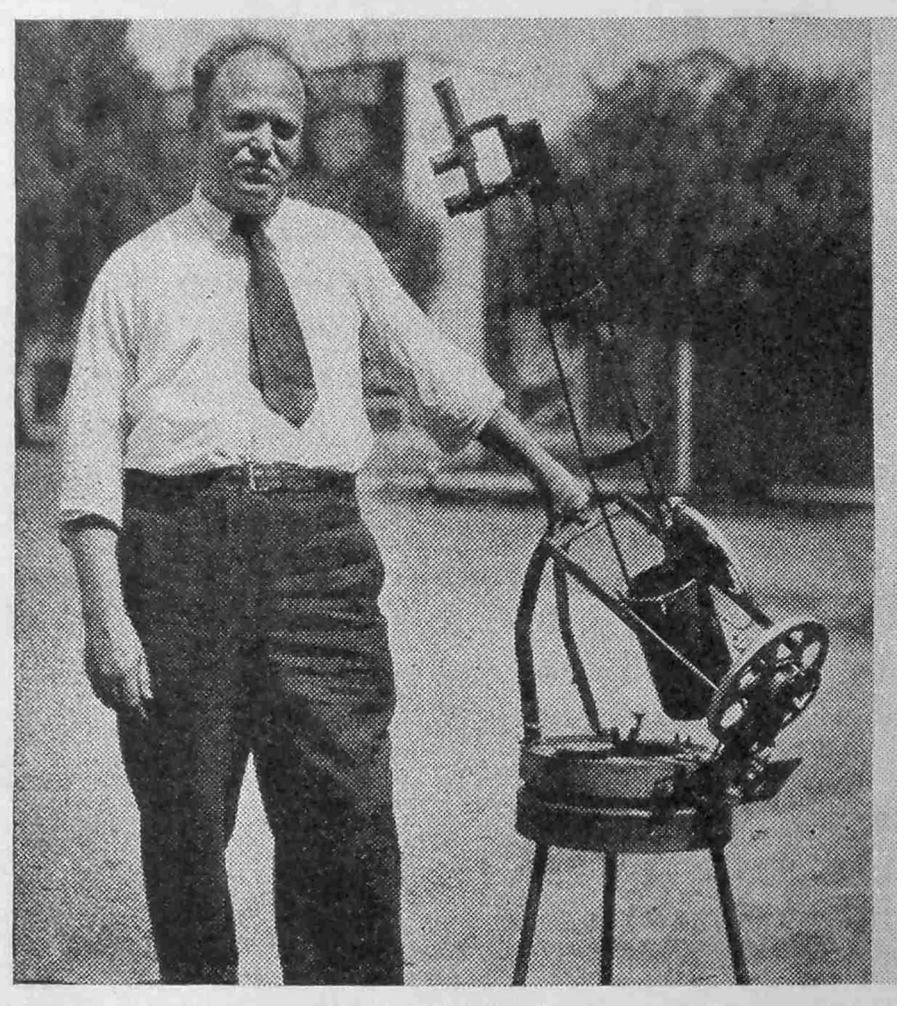

Figure 2. C. C. Chapman in *Amateur Telescope Making*, p. 306.

editor reported, they nurtured the artisanal skills of mirror grinding and telescope building alongside scientific proficiencies such as optical testing, celestial mechanics and patiently systematic astronomical observation. The material product of such a devoted worker, promised Ingalls, would be 'a valuable scientific instrument which places him on the threshold of astronomy and astrophysics, perhaps the most romantic branch of modern science'.[42]

The publications communicated a sense of enduring values for lay scientists, too. As depicted by Ingalls, amateur telescope-making and astronomy were virtuous activities. The frontispiece for his first book, drawn by Porter, was entitled '3 AM And Still At It'. Unlike illustrations in a professional scientific periodical, it depicted the human investment required of practical science: an enthusiast standing at a basement work-bench, 'utterly absorbed in the most exacting and demanding part of the work – parabolizing the mirror'.[43] Scientific romance could even be recast as a transcendent pursuit having affinities to religious devotion. The opening chapter of Ingalls's second book, *Amateur Telescope Making Advanced*, was introduced by a contributor's poem about the seemingly

[42]Ingalls, *Amateur Telescope Making* (note 35), p. xi.
[43]Ingalls, *Amateur Telescope Making* (note 35), p. iii.

utilitarian drudgery of mirror grinding, revealing how 'that simple disk' revealed 'suns and stars, yea universes, … for man to ponder – and adore'.[44] As suggested by the section title 'backwoods philosophy', Ingalls and Porter sought to evoke essential qualities of the scientific amateur akin to characteristics that Henry David Thoreau had written about in *Walden* eighty years earlier: virtues of simple living, experimentation, self-reliance, reflection, and spiritual discovery.[45]

5. Contrasting audiences for *Scientific American* and Science Service

The distinctive *Scientific American* and Science Service visions of the lay scientist were first measured against each other when the two publishing organizations embarked on a collaborative project in 1930. As it had with amateur radio, Science Service sought to promote amateur telescope-making as a scientific hobby to wider audiences. Its newsletter editor, James Stokley (1900–1989), lobbied Russell Porter, but eventually convinced Albert Ingalls, to write a series of articles on the subject to be syndicated in newspapers nationally.[46]

Stokley was at the time writing a column in his organization's *Science News* periodical about night sky observations, and was well acquainted with existing astronomical societies and their mainly non-professional members. He and Ingalls had traded texts, figure illustrations, sources and anecdotes for a couple of years. Conforming to the Science Service vision, Stokley sought broad audiences, urging Ingalls to 'write articles very simply and to conceive them as a way of tempting amateurs into their hobby.[47] For his part, Ingalls regularly jibed that *Scientific American* readers were of a higher standard, and confided to Porter: 'Remember the newspaper readers of Stokley's Scripps-Howard papers are mostly morons … Can't assume even a knowledge of geometry. Everything [sic] got to be purely empirical and concrete. Abstractions are beyond such readers; they think wholly in concrete terms, having heads of concrete'. 'Fact is', he concluded, 'telescope making is not suited to such folks but that's Stokley's worry – they wanted the articles'.[48]

Aptitude was one line of demarcation between their readers, but so, too, was age. For Stokley, amateur telescope-making mapped neatly onto his organization's earlier promotion of amateur radio, which had been taken up most actively by adolescents. Ingalls, by contrast, complained that youths would not make competent scientific amateurs, and might even drag down popular engagement by their failures at such a difficult endeavour: 'this is pre-eminently not work for boys or boy scouts', he cautioned; 'they lack the schooling, the judgment and particularly the patience. We have almost no record of lads making telescopes'.[49]

Via both editors, however, science hobbies and amateur experimentation reached mass audiences. The building and using of telescopes, estimated by Ingalls as a hobby involving about three thousand enthusiasts during the early 1930s, had been taken up by some fifty thousand individuals by the end of the decade. Similarly, Science Service's original promotion of amateur ('ham') radio grew steadily as a technical pastime, enrolling an estimated 100,000 American enthusiasts by 1945.[50]

A changing political context further divided the publishers' vision of scientific amateurs and sharpened their contrasting depictions. The context of the Second World War, and its aftermath, shaped how the age profile of scientific amateurism was portrayed in the USA. On America's entry into the war in 1941, Science Service expanded its campaigns to focus consistently on youthful enthusiasts. It launched clubs and competitions, and promoted scientific engagement through its syndicated

[44]C. A. Olson, 'A Piece of Glass', in *Amateur Telescope Making Advanced*, ed. by A. G. Ingalls (New York: Scientific American, 1937), p. 3.
[45]Henry David Thoreau, *Walden; or, Life in the Woods* (Boston: Ticknor and Fields, 1854).
[46]James Stokley to A. G. Ingalls, 28 Mar 1930, SI RU7091 Box 120 Folder 8.
[47]James Stokley to A. G. Ingalls, 21 Mar 1930, SI RU7091 Box 120 Folder 8.
[48]Albert G. Ingalls to R. W. Porter, n.d. c1930, ACNMAH 0175 Box 22, folder 7.
[49]Albert G. Ingalls to J. Stokley, letter, 8 Apr 1930, SI RU7091 Box 120 Folder 8.
[50]Usage of the terms 'amateur radio' and 'amateur telescope making' trebled in print by 1939 and 1945, respectively. The terms 'telescope making' and 'telescope makers' appeared most frequently in publications between 1930 and the early 1950s, peaking in the late forties, falling by a factor of four by the mid-1950s. See http://books.google.com/ngrams.com (retrieved 7 June 2017).

articles and radio programs. That year, the organization championed an offshoot, Science Clubs of America, as a means of nurturing adolescent science enthusiasts for the war effort and national benefit.[51] As Watson Davis explained, the initiative stressed enthusiasm and active group participation over competence: 'Almost anyone can organize a science club … the members of the clubs should be interested in doing something or studying a particular thing'. He also stressed enthusiasm and freedom from authority: 'You can make your own rules and hold meetings when and where you wish.[52] On his regular CBS radio series, *Adventures in Science*, Davis preached the advantages of cooperation, recasting the solitary hobby of telescope-making as a collective effort in the national interest and having career potential: 'Many telescope makers are organized into telescope making clubs and have special workshops … Telescope makers today are in great demand by optical firms around the country, since the experience gained in making a telescope is just the kind one needs to help make optical equipment for the army and navy'.[53]

Albert Ingalls, in his turn, organized a group of 'prismaniacs' from readers of his *Scientific American* column to hand-produce instrument prisms for the Navy. His column, now retitled 'Telescoptics', hinted at the practical value of amateur astronomy, and continued to be aimed at skilled mature hobbyists.[54] Science Service went further during the first year of the war, linking science hobbies to formal education in schools. The organization founded Science Talent Search, a scholarship competition for students in their final year of secondary school, to encourage university studies in science and engineering. With sponsorship from Westinghouse Electric and Manufacturing Company, local clubs and prize events spread quickly.[55] Davis proselytized to his 'scientists of tomorrow' that 'what grass roots are to agriculture, science clubs are to science education'. The informal science clubs, 'squeezed in after school with the help of a teacher-sponsor, or the equivalent gang that makes models, or builds a radio set, or does chemical experiments, or collects insects', would be just as valuable to the contributors as their school work.[56] By 1945, Davis could claim that 'our best amateurs have started from the interest … developed in clubs in the national high schools', with an impressive '200,000 boys and girls in more than 8,000 clubs'.[57]

In some respects, the end of the Second World War reproduced an environment conducive to scientific pastimes for all ages. As had been the case immediately after the First World War, public enthusiasm for science was amplified. The postwar popular appeal of science was extended further by the new availability of television.[58] *Watch Mr Wizard*, a popular weekly program between 1951 and 1965, portrayed a science enthusiast demonstrating his latest home experiments to visiting children. Within three years of its first airing, the after-school show was being telecast on some 90 stations. Fostered by the program, a growing network of 'Mr Wizard science clubs' spread to primary-school students through the USA and Canada.[59]

[51]Watson Davis, 'Science teaching and science clubs now and postwar', *School Science and Mathematics*, 45 (1945), 257–64. On the national and corporate dimensions, see Terzian, *Science Education and Citizenship* (note 6); Sevam G. Terzian and Leigh Shapiro, 'Corporate Science Education: Westinghouse and the Value of Science in Mid-Twentieth Century America', *Public Understanding of Science* 24.2 (2015), 147–66.

[52]Watson Davis, 'Science for Everybody', *Science News Letter*, 25 Oct 1941.

[53]Watson Davis, '*Adventures in Science*: Charles A. Federer, amateur astronomy (radio script broadcast 2 Jul 1941)', CBS radio script, 2 July 1941, SI RU7091 Box 388, folder 42. On this radio series, see Sevan G. Terzian, '"Adventures in science": casting scientifically talented youth as national resources on American radio, 1942–1958', *Paedagogica Historica*, 44 (2008), 309–25.

[54]Albert G. Ingalls to G. Chartier, 11 July 1949, ACNMAH 0175 Box 3, folder 4.

[55]See Rhees, *A New Voice for Science* (note 22). Eventually the organization oversaw some 800 science clubs across the USA and its possessions, and later still in Canada, Portugal and the British West Indies.

[56]Watson Davis, 'Science Clubs and the Future', in SI RU7091 Box 444 Folder 1 (1948).

[57]Watson Davis, '*Adventures in Science*: Fourth Annual Science Talent Search (radio script, broadcast 17 Feb 1945)', SI RU7091 Box 391, folder 1, 1945.

[58]Lafollette, *Science on American Television* (note 12).

[59]See also Don Herbert, *Mr Wizard's Science Secrets* (USA: Popular Mechanics Co., 1952). Rather like a junior version of 'The Amateur Scientist', the book and programme sought to encourage curiosity and practical skills 'while learning science, … the part of science that's fun to investigate for yourself right at home. Milk bottles are your flasks, glasses are your beakers and the whole house is your laboratory' [p. 5].

Who were the postwar adult counterparts of these young enthusiasts? At war's end, adults were able to return in much-increased numbers to the independent pursuit of scientific hobbies that had been the hallmark of the interwar period, many of them with practical training in mechanics, electronics and optics. In the early postwar years, fed by low-cost components and increasing leisure time, new technical hobbies – electronics, ham radio, model aircraft, hot-rodding – exploded in popularity.[60] Amateur radio boomed from 1946, when wartime government restrictions on short-wave radio broadcasting were lifted.[61] A Science Service broadcast suggested that many hobbyists were ex-servicemen who, as during the previous war, had been trained as technicians or operators. And a considerable fraction of the amateurs tempted into science hobbies before the war returned to it, raising the average age of licensed radio amateurs from 22 to 30 years old. They came from all walks of life: 'students, financiers, newsboys, princes, miners, motion picture stars, airplane pilots, farm hands, concert pianists, famous doctors and newspaper men'. One in 35 of them were women although, as relative outsiders, they still had to contend with the Morse-code moniker YL (for 'young lady') or XYL ('ex-young lady', meaning married). Building 95% of their own transmitting equipment, the qualities of such hobbyists again emphasized hands-on expertise and national benefit: 'The amateur is an experimenter … Not hesitating to tackle problems that he has not heard were insoluble, he frequently turns up with the answer'.[62]

Amateur astronomers similarly characterized themselves as thinkers and innovators who could improvise from available resources. A rare newsletter article provided a tongue-in-cheek survey of its readership: 'the A.T.N. [Average Telescope Nut] … realizing that science does not require intricate apparatus and experiments for all research shows respect for its greatest tool, the human mind'. It concluded, 'we find the ATN to be intelligent, well cultured, and interested in science and the scientific method'.[63]

Such activities illustrated another nuance to *Scientific American*'s dissenting vision of the amateur: that of the lone adept versus a club member. Albert Ingalls disclosed to Porter his amusement at 'the goings of these clubs', which were 'so deadly serious … with cliques, sub-cliques, fights', that he consequently preferred channelling the work of individuals.[64]

6. Citizens as Scientific Americans: C. L. Stong and 'The Amateur Scientist'

Scientific American did adapt to the growing cohorts of postwar amateurs, but retained a more exclusive vision. In 1948, the struggling magazine, last revitalized after the First World War, was reimagined under new ownership and pitched at a yet more refined audience. Graphically striking, it adopted a novel approach to authorship for its articles: instead of journalistic interpretations, scientists would write about their own field, aided by a staff editor and illustrator. As guidance to these expert contributors, the magazine advised focusing on non-expert enthusiasts, presenting the 'progress of science to an audience of educated laymen'. Thus, 'An author who is a physicist, for example, should address his article to a botanist, a teacher of science, a chemical engineer, a lawyer interested in science, and so on'.[65]

The ethos behind the new house style was, in effect, a generalization of Albert Ingalls's interwar column in which scientific amateurs had shared their own experiences, carried over to career scientists – a then-uncommon example of non-professionals influencing the professional sphere of

[60]H. F. Moorhouse, 'The work ethic and leisure activity: the hot rod in post-war America', in*The Historical Meaning of Work*, ed. by P. Joyce (New York, 1987), pp. 257–81.
[61]Kristen Haring, *Ham Radio's Technical Culture* (Cambridge, MA: MIT Press, 2007).
[62]Watson Davis, 'Adventures in Science: George W. Bailey, President of the American Radio Relay League', in SI RU 7091 Box 388, folder 36 (1945).
[63]AAFI -ATM, 'Personality analysis results', *TN News*, 1.3 (1948), Oct 2, cited p. 5.
[64]Albert G. Ingalls to R. W. Porter, 3 Dec 1954, ACNMAH 0175 Box 8, folder 3.
[65]*Scientific American* magazine, 'An Author's Guide to *Scientific American*', New York, 1949. On the evolving adult readerships for popular science, see Bruce V. Lewenstein, 'Magazine Publishing and Popular Science After World War II', *American Journalism*, 6 (1989), 218–34.

practice. And as the magazine was reoriented to professional scientists as writers, the column itself was recast in broader and clearer terms. Combined with the wider cultural enthusiasm for science and *Scientific American*'s reorientation, Albert Ingalls's telescope and astronomy column was retitled 'The Amateur Scientist' in 1952 and, until his retirement in 1955, largely ghost-written by one of the founding editors of the new magazine, Clair L. ('Red') Stong (1902–1975).[66]

The new editor was to broaden and stabilize Ingalls's vision of the amateur. He epitomized both the professional that the new magazine sought as reader, and also the type of mature enthusiast that Ingalls had envisaged. Having pursued electrical engineering at the University of Minnesota, and then graduate courses at the University of Michigan, C. L. Stong was employed at the Western Electric Company from 1926 until his retirement in 1962, latterly in the newly defined post of information manager. Stong's interests had ranged from barnstorming aviation in the 1920s to shortwave and ham radio in the 1940s.[67] For a would-be contributor to the column, Stong described himself as 'an engineer of sorts' and 'a classical old Newtonian duffer'. His contributions to *Scientific American* were equally avocational, constituting 'what is known locally as the "night shift", plus being the Saturday, Sunday and Holiday shift. Scientific American makes quite a nice hobby, really'.[68]

Stong recounted that he had socialized with 'Gerry Piel, scion of a local beer maker; Dennis Flanagan, former science editor of LIFE; Leon Svirsky, former science editor of TIME', and his breezily-drafted account revealed postwar attitudes about popular science circulating through American publishing:

> Science seemed to make more sense to us than God. (Proof, doubtless, that we are much in need of the analyst's couch.) Seemed to us that the Common Man could come more effectively to grips with his social problems if he knew a bit more about the cultural force which (in our opinion) above all others currently shapes them – science.

The group had raised $1.25 million and 'took over the decrepit *Scientific American* and proceeded happily about the business of transforming it into a magazine'.[69]

The result was a tripling of circulation within three years, but the 'Amateur Scientist' column was nevertheless a shot in the dark. Stong recognized the popular connotations of 'amateur' and privately admitted 'we sometimes feel that "non-professional scientists" would be a more accurately descriptive title for the group we have in mind'. He speculated that scientific hobbyists ('gifted laymen who have turned to science as an avocation') might welcome recognition alongside professionals, and serve as a model for wider publics interested in active involvement. 'Not only would publication aid the amateur in gaining professional recognition', he suggested, but more importantly 'it would encourage a broader public understanding and participation in science'. Yet he was unsure initially whether amateurs would be competent contributors and likely readers. He asked, '[do] amateurs of accomplishment exist in sufficient numbers to maintain a flow of adequate editorial material? By adequate, we mean reports of work meriting the attention of professional scientists in all fields'.[70]

Making matters worse, Albert Ingalls found adult readers' interest in amateur astronomy declining markedly after the column changed its name to 'The Amateur Scientist'. To one friend he complained, 'Just now they are asking me to ease up on telescope descriptions and write on things all, and not merely a fraction, of the readers understand or find interesting … ', and a year later he was 'completely demoralized' by the 'very little material left that will make up real articles'.[71] Capturing audiences for amateur science seemed to require active and continuing promotion.

[66]The changing vision of the imagined readership – as well as their varying commitment to science over engineering – is indicated by successive titles of Ingalls's column: 'The Back Yard Astronomer' (1928–1929), 'The Amateur Astronomer' (1929–1935); 'The Amateur Telescope Maker' (1935–1937); 'Telescoptics' (1937–1948) and, again, 'The Amateur Astronomer' (1948–1952).

[67]John Morton Stong (son), 'J. Morton Stong', http://www.qsl.net/w0zs/aboutme.html, last updated 2004; [accessed 3 April 2017]; Marjorie Adickes (daughter) to author, email, 14 Apr 2015. On Stong's manual arts of science, see James E Hammesfahr and Clair L. Stong, *Creative Glass Blowing* (New York: W. H. Allen, 1968).

[68]C. L. Stong to H. Morgenroth, 2 Feb 1955, ACNMAH 0012 Box 4, folder 1.

[69]C. L. Stong to H. Morgenroth, 2 Feb 1955, ACNMAH 0012 Box 4, folder 1.

[70]C. L. Stong to H. H. Larkin, 11 Sep 1951, ACNMAH 0012 Box 1, folder 1.

[71]Albert G. Ingalls to B. W. Powell, 17 Mar 1953, ACNMAH 0175 Box 8, folder 2; Albert G. Ingalls to R. Hayward, 26 Oct 1954, ACNMAH 0175 Box 13, folder 1.

Desperately seeking contributors, 'trying to find enough stuff to fill the void after Unk's retirement' and now writing the column under his own name, Stong's model of the amateur sharpened. He 'rounded up *middle-aged* amateurs who do really first grade work'.[72] From a New Zealand correspondent, he chased up leads on 'any amateurs who are doing interesting things in *avocational science*', ranging from 'butterfly collecting to the home-brewing of "H" bombs, (almost!)'.[73] Offering $100 per article during the first year that the column carried his name, the avuncular Stong eventually found himself channelling readers who had contacted the magazine eager to describe their own leisure-time scientific achievements. While he never included their photographs as his predecessor had done, Stong faithfully reported first-person accounts, giving the contributors a collective sense of identity and control, and readers a template to emulate. Ingalls had typically identified their towns, but Stong offered to publish home addresses, allowing readers to directly contact the enthusiasts described in the column. To one contributor, Stong emphasized the column's role in linking enthusiasts: 'The Amateur Scientist Department is conducted primarily as a forum through which those who turn to the sciences for recreation may exchange data'.[74] Just as under Ingalls's editorship, their correspondence nevertheless indicates how closely contributors conformed to Stong's published model, capturing not the full spectrum of amateur enthusiasts, but merely those who self-selected themselves as fitting the *Scientific American* template.

Stong also quickly discovered for himself the difference between the Science Service and *Scientific American* notions of amateurs. Soliciting the first year's articles from recent crops of Science Talent Search contestants recommended by his contacts proved disappointing. With few exceptions, Stong argued, 'brilliant youngsters' in mentored clubs did not meet his criteria of a dedicated amateur scientist:

> Primarily, we are seeking the advanced amateur, the fellow whose interest in science keeps him on the job year after year. In contrast, the Westinghouse youngsters usually tackle a project suggested by their science teacher, complete it with the teacher's help and then either drop it for some other field of inquiry or abandon science altogether … None make an avocation of science.[75]

Just as Ingalls's photographs of proud telescope makers had done, Stong sought to inspire his readership by carefully selecting exemplary topics. He aimed to 'bridge the gap between professional journals and so-called popular magazines', explaining to another early contributor that his intended readers were not 'amateur craftsmen' but 'the amateur scientist [who] deserves the encouragement that comes with publication'.[76] Initially, he sought accounts involving 'tools or special gear' that the magazine's artist could illustrate in the appealing 'how-to-build-it' sketches similar to Porter's illustrations from the earlier 'Back Yard Astronomer' column.[77]

Once having published examples of amateurs in action, 'The Amateur Scientist' column became self-sustaining. A surplus of potential contributors corresponded with Stong over the next twenty-two years, and his columns described an inspiring range of investigations and apparatus ranging from studies of reptile vision to amateur seismology to a home-made atom-smasher. Stong made no attempt to classify them into conventional disciplines, but subject areas traditionally claimed

[72] C. L. Stong to R. Hayward, 3 Apr 1955, ACNMAH 0012 Box 4, folder 8 (emphasis added).
[73] C. L. Stong to A. J. Southgate, 1 Jul 1955, ACNMAH 0012 Box 4, folder 1 (emphasis added).
[74] C.L. Stong to S. M. Heumann, 30 Jun 1966, ACNMAH 0012 Box 23, folder 7.
[75] C. L. Stong to I. C. Cornog, 4 Mar 1952, ACNMAH 0012 Box 1, folder 4. Only one column was to feature a Westinghouse winner: Carol De Decker on geological analysis [A. G. Ingalls, 'The Amateur Scientist: Mountain geology and an amateur contribution to a new ruling engine', *Scientific American*, June 1952; see ACNMAH 0012 Box 1 folder 3]. Adolescents were occasional contributors, as they had been in Ingalls's columns. Examples include columns on mouse genetics (Dec 1952), an observatory (Jun 1955), archaeology (Dec 1967) and a spectrometer (Jan 1975).
[76] C. L. Stong to C. L. De Decker, 10 Feb 1951, ACNMAH 0012 Box 4, folder 8.
[77] C. L. Stong to F. H. H. Roberts Jr, letter, 25 Mar 1952, ACNMAH 0012 Box 1, folder 4. Most columns were illustrated by artist/engineer Roger Hayward, who also illustrated the books of mid-century chemist Linus Pauling and experimental physicist John Strong, aimed at the same readership.

by physicists, engineers and astronomers dominated (about two-thirds of the total), while topics identifiable as biology, chemistry and natural/earth sciences shared the remainder.[78]

None of Stong's columns linked amateur science explicitly to education, careers or national benefit. But, like Science Service, 'The Amateur Scientist' Department was attuned to its times. The launch of the Sputnik satellite in October 1957, for example, led to an article just three months later on how to view and time it, and coverage of even more challenging home-made lasers and holograms followed in short order (Figure 3).[79]

Unsurprisingly, given Stong's ongoing employment at Western Electric, the 'Amateur Scientist' column also became more visibly attuned to business. The new magazine format had been conceived to attract new sponsors. While impressive corporate advertisements trumpeted the postwar advances of American industry interspersed among the professionally-penned articles in the magazine, the 'Amateur Scientist' column was surrounded by ads from smaller firms offering component parts, tools and measuring instruments. Its active scientific enthusiasms were fuelled by a glut of cheap war-surplus components and equipment ranging from optics to exotic electronics. The Edmund Salvage Company, for example, founded in1942 to resell government contract 'seconds' to amateurs seeking inexpensive optical components, had been a frequent advertiser alongside Ingalls's postwar 'Amateur Astronomer' columns, and was renamed the Edmund Scientific Corporation in 1951 to capitalize on the association. His successor typically identified suppliers of useful war surplus components in the 'Amateur Scientist', and the co-evolution of the column, amateur scientists and burgeoning supply companies is evident.[80]

7. Reconceiving and educating the Cold War scientific citizen

The relatively cosy postwar portrait of the science hobbyist painted by 'The Amateur Scientist' and its advertisers – that of an inventive individual personally motivated and fuelled both by make-do solutions and a burgeoning supply of inexpensive components – was subsumed within wider political and economic transformations. The successes of government-funded wartime scientific research and development, combined with postwar concerns about Cold War supremacy and competition in international markets, encouraged the American government to promote science education at the national level.[81] In August 1949, detection of the first Soviet atomic weapon test received blanket coverage in American newspapers and popular magazines. The resulting rhetoric, escalating through the decade, strengthened the link between amateur enthusiasms and national needs.[82]

Caught up in the rising cultural tide favouring popular science and technology and hastened by anxieties about Soviet competition, the vogue for science clubs and science fair competitions intensified through the 1950s. Science Service urged closer convergence of firms, educators and

[78]Analysis by the author of some 400 'Amateur Scientist' topics, Apr 1953--Jan 1976. Some months' columns included two or three subjects, and numerous topics had an instrumentation slant, such as recording voiceprints of birdsongs (Feb 1975), apparatus to measure wind speed (Oct 1971) and bio-medical telemetry (Mar 1968). Stong's 1960 book collection of 56 articles had a similar distribution, with discipline-labelled chapters and contents weighted towards the physical sciences: Astronomy (6), Nuclear Physics (7), Aerodynamics (7), Optics/Light/Heat (7), Mathematical Machines (7) and Earth Sciences (8, featuring instruments to measure seismology, satellite tracking, earth rotation and charge). The other three chapters, located nearer the beginning of the book, were Archaeology (2), Biology (5) and Natural Sciences (5), and dealt principally with experimental procedures such as growing algae, experimenting with animals and performing chemical analysis by electrophoresis.

[79]C. L. Stong, 'The Amateur Scientist: Mostly about how to study artificial satellites without complex equipment', *Scientific American* 201 (1948), 98–109; C. L. Stong, 'The Amateur Scientist: How a persevering amateur can build a gas laser in the home', *Scientific American* 211 (1964), 127–34; C. L. Stong, 'The Amateur Scientist: How to make holograms and experiment with them or with ready-made holograms', *Scientific American* 216 (1967), 122–28.

[80]Other postwar suppliers of optics parts advertising in *Scientific American* included the Associated Surplus Company, United Trading Company, F. W. Ballantyne, Columbo Trading Company, A. Cottone, A. Jaegers and Harry Ross, each based in either California or New York.

[81]Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill: University of North Carolina Press, 1999). See also Wendy Swanberg, 'The Forgotten Censorship of Scientific American in 1950', Association for Education in Journalism and Mass Communication Annual Conference. Chicago, IL, 2008.

[82]John L. Rudolphs, *Scientists in the Classroom: The Cold War Reconstruction of American Science Education* (New York: Palgrave, 2002).

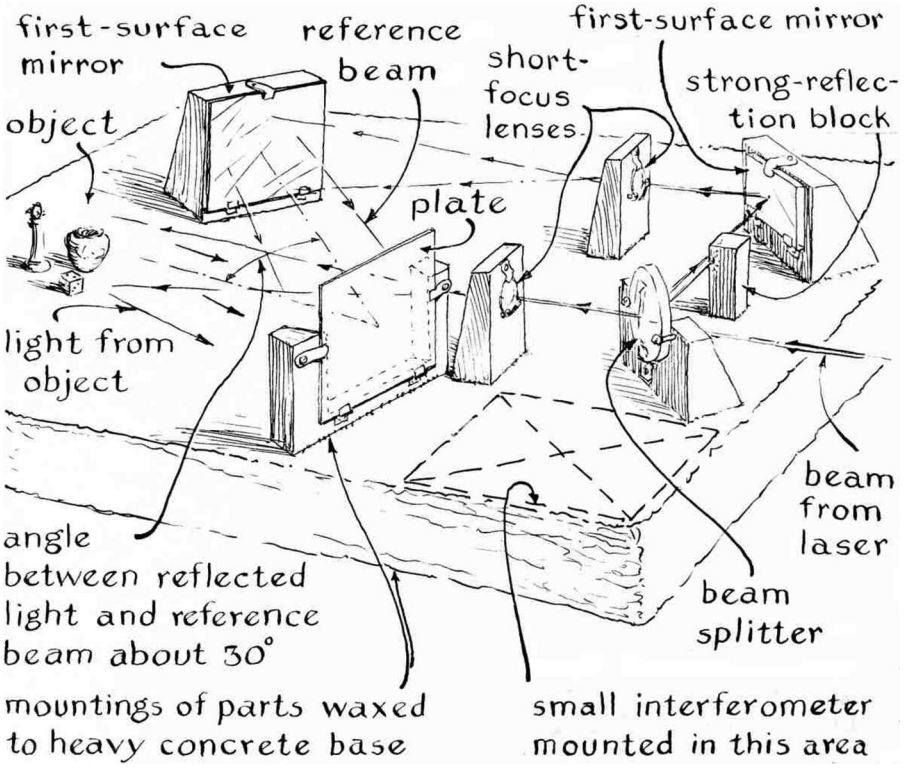

Figure 3. Making holograms in 'The Amateur Scientist', February 1967 [original illustration by Roger Hayward, 1966, ACNMAH 0012 Box 23, folder 7 (by permission of Miriam and Jim Kramer, Roger Hayward estate)].

government funding to train young enthusiasts as 'cures for threats': 'If high schools would take as much pride in outfitting chemistry and physics labs as they do in outfitting their football teams', claimed a 1956 press release, 'the United States would be well on its way to solving the serious threat to its survival posed by the alarming shortage of engineering and scientific man-power and the growing threat of Soviet technological superiority'.[83] The three Sputnik launches over the following two years galvanized government support. Science clubs were drafted into efforts to urgently produce a generation of technically-competent scientists, technicians and managers.

After-school science clubs became a bridge to more formal teaching initiatives. The National Science Foundation (NSF), founded in 1950 'to promote the progress of science, to advance national health, prosperity and welfare and to secure national defense', found itself suddenly emphasizing education.[84] 'Bookish' studies of scientific knowledge in primary and secondary schools were rapidly replaced by opportunities to practise hands-on science. At the Massachusetts Institute of Technology, a group of physics teachers, the Physical Science Study Committee (PSSC), designed a curriculum based on assembling simple experimental equipment to stimulate students' interest and intellectual independence. Supporting these educational reforms were a series of rapid institutional innovations to support research and development in the national interest, including the creation of the National Aeronautics and Space Administration (NASA) and the Advanced Research Projects Agency (ARPA) in 1958. Westinghouse scholarships were

[83]The Science Talent Institute, 'Teen-age scientists offer cures for threats to U.S. technological survival', press release, 5 Mar 1956, SI RU7091 Box 330 Folder 5.

[84]The American Congress allocated $40 million to the NSF in 1958, eleven times more than in 1952, and its subsequent budgets spiralled upwards to reach one billion dollars in 1983.

soon supplemented by awards and achievement medals from scientific societies and the American military.

In this political context, the rhetoric of amateurism was reconfigured. Gone were the interwar notions of lone geniuses and dedicated experimenters; in their place were visions of active all-rounders. Science Service radio broadcasts and brochures promoted a new trope for the model American science student. Science Talent Search winners, for example, were now epitomized by:

> a mathematician-chemist from Pennsylvania who stars in his high school's varsity tennis team … A soft-spoken brown-eyed girl scientist who is a self-taught biologist and an accomplished pianist … A Colorado boy entomologist who excels in his chosen field, has a consuming interest in Shakespeare, and plays a hot guitar.[85]

Exemplars of scientific amateurism were not only shifted downward in age but also scaled up by schools' initiatives and new technical hobbies that required group involvement and hierarchical direction. The case of model rocketry traces the new template. As a professional pursuit, rocketry had blossomed between the wars, when work in several countries combined hobbyist enthusiasm with state funding. Technologist Willy Ley (1906–1969) noted after Sputnik I that 'for a year or so, virtually every youngster wanted to make rockets'. Countering claims about the dangers of hobbyist rocketry, he argued that amateur experimentation was essential for gaining experience. His examples foregrounded the links between amateurism and science, and included 'a high-school teacher called Strache; a man who had studied mainly zoology and who had thought he would become a geologist, myself', comprising a 'group of rank amateurs [who] built the first German liquid fuel rockets'.[86]

Such amateur activities, argued the popular literature, demanded supervision. Science fairs were supplemented by teacher-sponsored after-school clubs and activities, and now further encouraged by official support from American military experts.[87] Rocketry was a hierarchical and collective activity rather than an individual hobby or typical science-fair project. Teamwork, not individual expertise, marked out this new breed of scientific amateurs. As the captain appointed director of the First Army Amateur Rocket Liaison Program observed, 'Successful groups have generally been made up of members whose particular interests are quite different, but whose general interest in the advancement of scientific knowledge about the universe is mutually shared by all other members of the group'. He also emphasized that mentoring was essential:

> If I were asked to define the *average* or *typical* amateur rocket group in America that is successful in its work and has an intelligently planned program of study and developmental projects under way, I would say that it consists of *seven* bright young men between the ages of 13 and 17, *one* sympathetic and understanding parent or high-school teacher who acts as the adult adviser of the group, and *one* engineer or chemist who acts as a technical adviser.

The Army's interest in these amateur enthusiasts, he implied, extended Science Service's post-Sputnik activities, 'to support and maintain the rocket programs of the United States [, which] will require the best thinking of thousands of young scientists and technicians'.[88]

Business rhetoric, too, adapted to the new political environment to represent amateurs in ways that promoted both scientific pastimes and profits. Supported by national goals for technical education and manpower in the context of the Cold War, scientific amateurs were being portrayed and actively courted by companies seeking no longer to exploit war surplus stocks, but to create expanding markets. Unlike the previous organisational initiatives, this was more genuinely a grassroots affair. A handful of enthusiasts promoted early commercial ventures via new hobbyist groups. Applying a marketing model familiar since the 1920s, model rocket companies, for example, fostered neophyte experimenters and mentored their development via a graded range of tempting projects.

[85]Science Service, '1955 Science Talent Search winners', press release, 28 Feb 1955, SI RU7091 Box 330 Folder 5.
[86]Willy Ley, 'Foreword', in *Rocket Manual for Amateurs*, ed. by Bertrand R. Brinley (New York: Ballantyne, 1960), p. vi.
[87]Charles M. Parkin Jr, *The Rocket Handbook for Amateurs* (New York: John Day, 1959).
[88]Brinley, *Rocket Manual for Amateurs* (note 85), p. 16 (original emphases).

Thus some amateurs were translated into business people directly channelling the enthusiasms of their peers.[89]

The company literature written by these amateurs-turned-businessmen appropriated the role that *Scientific American* and Science Service had pioneered between the wars, and provided an updated model of the scientific enthusiast.[90] The promotional literature of such firms emphasized the scientific dimensions of the hobby to align themselves explicitly with government rhetoric, educational initiatives and popular media. Thus the Estes Company supported its products – and characterized its customers – through its *Model Rocket News* and a series of technical reports detailing advanced topics. Their publications described the principles and practice of stable rocket design, wind tunnel testing and multi-staging. The link between the exhilarating technology, deeper science and scientific enthusiasms was a recurring refrain that echoed the style adopted by the successful Edmund catalogues:

> Today's youth are finding model rocketry an ideal means for aiding their studies in aerodynamics, math, physics, optics, biology, space medicine, astronautics, electronics, photography and psychology … These young people who are pursuing, on their own, a study of the sciences with model rocketry are a vital part of this new generation of scientists. These are the young people who will explore the planets and beyond.[91]

The transition from *Scientific American*'s model of autonomous enthusiasts to the postwar emphasis on mentored teams was consolidated by growing recognition of another form of amateur activity: volunteer scientific assistants for national and international programs. The amateur astronomy promoted by *Scientific American* could be allied with contemporary enthusiasms for space flight. W. Patrick McCray has discussed the role of amateurs in satellite tracking made briefly popular during the activities of the International Geophysical Year (IGY) in 1957–1958. Initiated by the Smithsonian Astrophysical Observatory, Project Moonwatch had aims similar to those of Science Service between the wars: to foster interest and direct involvement in scientific practice and to discover latent aptitudes that could generate a new generation of professional scientists. Initially enrolling amateur astronomers and radio buffs, it soon extended to wider publics.[92]

8. Celebrating dependent versus independent lay scientists

By 1960, when Clair Stong published a selection of his 'Amateur Scientist' articles in book form, the *Scientific American* model of the amateur was thriving and yet increasingly out of step with evolving rhetoric. The values of amateurism espoused in his columns traced a direct lineage from William Ellison's British articles, Albert Ingalls's columns and Russell Porter's Springfield telescope amateurs,

[89]E.g. Orville Carlisle (1917–1988), a pyrotechnics enthusiast, developed the 'Rock-A-Chute' in 1954, a development of traditional fireworks technology. With G. Harry Stine (1928–1997) – a physicist and writer of popular science who had worked at White Sands Proving Grounds, the Naval Ordnance Missile Test Facility and Martin during the 1950s – he founded the National Association of Rocketry in 1957. Fireworks manufacturer Vernon Estes (b. 1930), supplying 'kits, engines, information and supplies for future space scientists', sold a growing variety of model rockets in the form of nearly-ready-to-fly packages, complete kits of rocket parts, tools and 'scientists' specials' – grab bags of varied components – for the self-constructor [G. Harry Stine, 'The roots of model rocketry', *Sport Rocketry* (Jan-Feb 1998), 6–9; G. Harry Stine, *The Handbook of Model Rocketry* (Chicago: Follet Publishing, 1965)].

[90]Estes sold associated items to broaden scientific expertise further. An 'Altiscope', provided with trigonometric tables, allowed maximum altitude to be measured; a '2-D Computer' consisting of graph paper and rulers could plot the trajectory of a flight, and slide rules could help compute rocket performance and stability. Both accessories fitted neatly into high school mathematics curricula. With them, the hobbyist could adopt the roles of designer, flight technician and applied scientist.

[91]Estes Industries Inc, *Model Rocket Supplies Catalog No. 651* (Penrose, CO: Estes Industries Inc, 1966). From the early 1950s, Edmund had pioneered the educational market by packaging low-cost collections of components and demonstration supplies for schools, and during the late 1960s the firm expanded into home meteorology apparatus, chemistry kits and science gadgets to satisfy the rising interest in amateur science and technology. Other firms of the period aimed at other markets, notably Atomic Laboratories Inc (Berkeley, CA) specializing in kits marketed directly to schools, and Science Associates (Princeton, NJ) focusing on equipment for industrial prototype and training departments [American Institute of Physics Niels Bohr Library and Archives (College Park, MD), 'Education and Manpower Division' box 4, 'American apparatus firms correspondence', 1958].

[92]W. Patrick McCray, 'Amateur scientists, the International Geophysical Year, and the ambitions of Fred Whipple', *Isis*, 97 (2006), 634–58; W. Patrick McCray, *Keep Watching the Skies! The Story of Operation Moonwatch and the Dawn of the Space Age* (Princeton, NJ: Princeton University Press, 2008).

but had been subtly shaped, and increasingly eroded, by competing templates. The syndicated newsfeeds, radio programs, science clubs and competitions promoted by Science Service stressed youth, careers and national relevance; Cold War initiatives had seen government, educators, and business become active voices in portraying and capturing scientific enthusiasms.

The *Scientific American* model of the amateur nevertheless remained stable and popular. Where Ingalls had vaunted intelligence, patience, persistence, handiness and even a transcendental spirit, Stong addressed his readers even more overtly as curiosity-driven individualists, who 'take boundless delight in finding out what makes things tick, whether the object of your interest has been fashioned by nature or man':

> You are an inveterate tinkerer. You love to take organized structures apart and put them together again in new and interesting ways – be they rocks, protozoa, alarm clocks or ideas … you are an amateur scientist.[93]

The growing disjuncture between this life-long, aptitude-driven model and contemporary trends is hinted at, however, in the Introduction to the collection. In it, Vannevar Bush (1890–1974) – electrical engineer, university administrator and famed wartime overseer of the Manhattan Project – emphasized the link between amateur enthusiasms, science and the progress of modern society. 'There are', he said, 'lots of amateur scientists, probably a million of them in this country':

> The Weather Bureau depends on some 3,000 well-organized amateur meteorologists. Other groups observe bird and insect migrations and populations, the behavior of variable stars, the onset of solar flares, the fiery end of satellites, earth tremors, soil erosion, meteor counts, and so on … there are amateurs who are truly masters of their subjects, who need take a back seat at no professional gathering in their field. It was an amateur who discovered Pluto, and an amateur who was primarily responsible for the development of vitamin B1.[94]

Bush's commendation carried a hint of faint praise, and also stressed social and political dimensions that the *Scientific American* columns did not address. Scientific enthusiasts, he suggested, should be recognized by others, and should understand themselves, as a resource for professionals. And while individually amateurs could achieve remarkable scientific success, collectively they could serve national interests.

As portrayed by Stong, Science Service and Bush, the traits of the amateur enthusiast were different but equally intense. While the pages of *Scientific American* magazine proselytized a vision of independent amateurs co-existing with professional scientists without hierarchy or condescension, anecdotal accounts suggest that the distinctive models exemplified by Science Service's amateur radio campaigns and postwar rocketry clubs all were represented in its readers. Teamwork, mentored projects and independent experimentation characterized particular historical periods and contexts, but could also be combined in individual motivations, too.[95]

Scientific American's distinctive format dedicated to the independent amateur was retained until Stong's death in 1975.[96] Its half-century run had proven perennially appealing, but arguably was a partial portrayal of the scientific enthusiast. Enthusiasms shifted: as hands-on tinkering declined in popular culture in favour of computer programming and consumption of packaged technologies, the active amateur found new ways of channelling curiosity and creativity.

9. Conclusions: advocates, media models and curated enthusiasms

I have traced the evolution of a publishers' construct: the notion of the modern amateur scientist and technical enthusiast and have argued that the portrayals of scientific amateurism by the *Scientific*

[93]C. L. Stong, 'Preface', *The Scientific American Book of Projects for the Amateur Scientist* (New York: Simon & Schuster, 1960), p. xxi.
[94]V. Bush, 'Introduction', in *The Scientific American Book of Projects for the Amateur Scientist*, ed. by C. L. Stong, (New York: Simon & Schuster, 1960), pp. xviii–xix.
[95]For one such biographical account, see Homer Hickam Jr, *Rocket Boys* (New York: Delacorte, 1998) and footnote 98.
[96]The magazine published Stong's pending columns monthly until Jan 1976, and subsequently reoriented the column towards simple home scientific experiments under physicist Jearl Walker until 1988. It appeared intermittently thereafter without a regular editor until 1995. Monthly columns resumed under Shawn Carlson until 2001.

American columnists were uniquely empowering representations that served as a rallying-call for a tranche of readers through the five middle decades of the twentieth century. Its advocacy of lay scientists as independent adult researchers differed from the shorter-lived and episodic templates provided by earlier popular magazines, later commercial brochures, and its principal American cultural cousins, Science Service's syndication initiatives and the rhetoric of Cold War government, educators and businesses.

These imagined lay identities, actively shaped by their promoters, nevertheless carried generations of enthusiasts along in their wake. The fifty-year backbone of *Scientific American* columns provided a stable vision that suited a large subset of adult amateurs and the commercial firms that evolved to supply them. The magazine depicted the scientific amateur as a dogged individualist pursuing a scientific avocation. The readership promoted by Ingalls and Stong was buttressed by the rhetoric and products of supply companies, and arguably faltered as war-surplus supplies became scarcer, and pre-packaged science kits and inexpensive electronics short-circuited home experimentation.[97]

By contrast, the Science Service notion of amateurism identified adolescents, innate aptitudes and mentors as key components of technical enthusiasms. Their model challenged that of *Scientific American* when national circumstances demanded an increase in the scientific workforce. The urgent contexts of the Second World War and early Cold War encouraged government, scientific institutions, educators and commercial suppliers to expand the interwar initiatives of Science Service in new directions.

While revealing much about shared cultural notions of the scientific amateur, the present focus on their portrayals by publishers and institutions veils the lay practitioners themselves. While it is clear that adolescent adventure novels, *Scientific American*, Science Service and post-Sputnik initiatives attracted large numbers of scientific enthusiasts, relatively little is revealed about participants' inherent aptitudes, personal motivations, and 'fit' to the proffered templates of amateurism. The sources investigated suggest that the social contexts of amateur activities were largely invisible to the publishers who promoted them. Typically, there was little information to be found regarding the prosopography of the participants, and the subsequent progression of their amateur (or professional) lives. A handful of contributors revealed lives of varied education and chronic curiosity.[98] This is a dimension requiring further study, and ongoing historical investigation is focusing on the network of peer interactions, knowledge sharing, and relationships with professionals at the grassroots level of practising amateurs.

Nevertheless, this historical examination of publishers' constructs of amateur identity, and their adaptation in changing cultural environments, illustrates three characteristics. First, the history of lay science enthusiasms during the twentieth century demonstrates perennial engagement in an evolving variety of forms. The cultural visibility of amateur scientists and their jostling portrayals were particularly high in mid-century. Such distinctive expressions of scientific amateurism were neither progressive nor inevitable, but rather were firmly shaped in changing cultural and political contexts.[99]

[97]The model of independent innovators and experimenters re-emerged in the home computing movement and, more recently, 'Maker culture'. The Ingalls/Stong identity for amateurs contrasts with the end-of-century stereotype of the 'geek', but links a recognizable culture of autonomous enthusiasts that mutated over the second half of the century from radio hams to electronics hobbyists to software hackers. See, for example, Roli Varma, 'Women in computing: the role of geek culture', *Science as Culture*, 16 (2007), 359–76 and Douglas Thomas, *Hacker Culture* (Minneapolis: University of Minnesota Press, 2003).

[98]Perhaps because of the no-nonsense correspondence from Ingalls and Stong, their correspondents typically focused on the technical details, and strayed into social dimensions only rarely. Ingalls found a confidante in Bernard Powell, for example, who saw 'Science as a way of life', having studied creative writing, philosophy and geology at college, experimented with fossil collecting, radioactivity and micrometeorite detectors [Bernard Williams Powell to A. G. Ingalls, 28 Mar 1953, ACNMAH 0175 Box 8, folder 2]. Stong found his equivalent sounding-board in another traceable amateur, Sylvain (later Sylvan) Heumann (1925–2013), a New Jersey furniture-maker with lifelong interests in ham radio, astronomy, aviation, home computing and new technologies, who contributed not only two articles on home-built lasers to the 'Amateur Scientist' column during the 1960s, but also pieces for *Sky & Telescope* and *Experimental Aircraft* magazines, and who remained an active amateur into his later years (Wendy Heumann to author, email, 21 Jan 2015; Makerbot llc, 'We love the Makerbot operators: Sylvan Heumann', www.makerbot.com/blog/2011/09/09/we-2/ (9 September 2011 [Accessed 16 February 2015])).

[99]Particular cases have been explored in studies of amateur meteorology by inter-comparing historical and contemporary practices of non-professional science, e.g. in V. Jankovic, *Reading the Skies. A Cultural History of the English Weather, 1650-1820* (Manchester:

Second, these evolving amateur activities were strongly influenced by the agency of publishers and other advocates. We may imagine amateur science to be a free-wheeling expression of individualistic and social aptitudes and interests, but the contexts examined here suggest, instead, a paternalistic (and sometimes patronizing) hierarchical shaping by sponsors. The growth of hands-on scientific amateurism was a mediated process in which publishers through the twentieth century identified latent readership, advertising and labour markets among technological enthusiasts, and promoted their distinct visions of the typical or desirable amateur scientist.

Third, these successful initiatives to promote amateur science each sampled a point on the spectrum of individual autonomy. The dependence, and independence, of scientific amateurs was variously portrayed. Where *Scientific American* courted the mature amateur as a self-sufficient practitioner unneedful of professional direction and validation, Science Service and its associated Science Clubs of America, Westinghouse Scholarships and young scientist programs on radio and television saw their audience as youthful would-be scientists to be mentored by more knowledgeable superiors. The current term 'citizen science' captures the essence of Vannevar Bush's vision in which volunteers act as assistants or adjuncts under the direction of a professional scientist, often as junior members of cooperating teams. Bush's vision downplays age as a relevant dimension, but highlights the subordinate and dependent status of citizen scientists.[100]

Over the past century, the longstanding advocacy of *Scientific American* and the distinctive, but typically shorter-lived initiatives of other publishers, firms, institutions and educators generated waves of scientific enthusiasts who identified with their portrayals. The historiography of publishers' representations of the amateur scientist reveals the contrasting views about autonomy that are at the heart of their practices. The *Scientific American* model of the independent lay scientist represents a long-lived model that continues to challenge prevailing notions of the relevance of age, competence and dependence on professionals.

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Manchester University Press, 2001), Carol Morris and Georgina Endfield, 'Exploring contemporary amateur meteorology through an historical lens', *Weather*, 67 (2012), 4–8, and in the practice of amateur experimental biology, identifying a continuity between Victorian garden practices and the empowerment of present-day non-institutional science (Helen Anne Curry, 'From garden biotech to garage biotech: amateur experimental biology in historical perspective', *British Journal for the History of Science*, 47 (2014), 539–66).

[100]Such citizen science projects have been particularly promoted for astronomy, distributed computing and ecology. See, for example, Eric Paulos, Sunyoung Kim and Stacey Kuznetsov, 'The rise of the expert amateur: citizen science and microvolunteerism', in *From Social Butterfly to Engaged Citizen: Urban Informatics, Social Media, Ubiquitous Computing and Mobile Technology to Support Citizen Engagement*, ed. by M. Foth, L. Forlano, C. Satchell and M. Gibbs (Cambridge, MA: MIT Press, 2011), pp. 167–91; Janis Dickinson and Rick Bonney, eds., *Citizen Science: Public Participation in Environmental Research* (Ithaca, 2015).