When Computers Were Amateur

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Attempting to illuminate the utility of amateurism for the history of computing, this article examines the records of the Amateur Computer Society (1966–1976), a hobbyist organization whose newsletters chronicle an important corner in the field. The author looks at both the discussion of schematics as a contested representation of amateur expertise and the crucial links between amateur practice and domesticity.

"It is a little difficult for me to see a computer sitting around doing nothing."[1] This is how one man begins a short article about the possibilities for repurposing PDP-8/S "minicomputers" in 1968. The article, published in the newsletter of a small hobbyist organization called the Amateur Computer Society (ACS), bears witness to an amateur itch. The author sees new uses for these machines everywhere: for high school students, for small business inventory systems, for a whole network of consultants to provide support to the booming software industry. As excited as he is, this man also knows how hard it can be to redesign an entire computer. Dealing with delicate hardware could quickly get overwhelmingly complicated: "[I]f the back-panel weren't pre-wired, how long would it take a man to go crazy trying to wire it all himself?"[2]

Perhaps not long, if going crazy is the point. Another member of the organization replied in a later issue of the newsletter: "As to the feasibility of a PDP-8 kit, you laughed off the possibility of having to do the back-panel wiring yourself as being an invitation to insanity. It seems to me that this is what amateur computer building is all about: the wiring and the insanity."[3]

What is meant by this "insanity" is a deep, disquieting obsession with machinery. The amateurs of the ACS were attempting to bring the computer into the home when it was still thought of as a hulking thing in the basement of a corporation or university. You can sense the thrill of the amateur tackling the impossible in this label of "insanity." Calling it "crazy" was a way to deflect some of the reactions from people who would not yet understand the computer as "personal." And calling it crazy among peers who are plodding along in similar pursuits gives the obsessive tinkering a twinge of pride and exclusivity. Such is a partial skein of the imperatives that informed what it meant to be a computer amateur in the 1960s and 1970s.

If it is true, as Michael Mahoney said, that what makes the history of computing hard is that "it is not primarily about computers," we must render computers in their social and cultural orbits. "Creating software for work in the world," Mahoney said, "has meant translating into computational models the knowledge and practices of the people who have been doing that work without computers."[4] Computer building, like history, is about ordering the mess. For the historian, evidence about more than just technological objects must be made into a narrative that deepens our understanding of them. This article seeks to contribute to a multifarious history of computing by thinking about an elusive and complicated figure: the amateur.

Perhaps it's not surprising that amateurism has an unsettled position in the history of technology. Necessarily outside of the lab or office where documentation is often an integral process, the amateur works in the shadows of well-marked historical arenas, at the limits of what the archive can acquire. The garage, in other words, is harder to observe than the cubicle. But is the amateur always so cloistered? One conceptual difficulty here is that drawing boundaries around amateur practice reveals blurry and tenuous distinctions between office and home, work and play, personal and professional. Another difficulty is that tinkering, the meandering and often playful *modus operandi* of amateur technologists, can often happen alone, in fits

 Published by the IEEE Computer Society 1058-6180/14/$31.00

and starts, or in circuitous ways that addle linearly conceived progress. The hobbyist's mess is an appropriate foil to the workplace's order. Yet if we're to find a historiography that mirrors the complexity of computing science itself, it's essential that we find ways to turn problems of historical research into new areas of inquiry. Paying close attention to the role of the amateur is not less important for its wiliness, but more so.

This article looks at what we might glean from one group of computer amateurs. Before the flood of computer kits, user groups, and system-specific conferences of the late 1970s, personal computing was not a truly personal pursuit. "Microcomputing" was largely pursued by engineers in labs and firms where it was a segmented and specialized labor practice. Yet there was a dedicated group of amateurs who were tinkering with integrated circuits (ICs) and soldering irons long before a desktop computer was thought to be an attainable goal. Who were these people? What compelled them to tinker with computers? What do they say about amateur practice that can deepen our understanding of the history of the personal computer? Taking amateurism seriously enables us to home in on a puzzle—of evidence, of drive, of sociality—that might throw into relief larger puzzles in the history of computing around invention, progress, and creativity.

There are two related aspects of this article's goal to render the amateur as a meaningful analytic for the history of computing. The first is to offer a portrait of the computer-building hobbyist in the late 1960s and early 1970s through readings of the ACS newsletters. My account of these amateurs focuses on the crucial role of schematics as a contested abstraction of amateur expertise and the inextricable relationship between amateurism and domesticity in the mid-century home. The second aspect of this project is to show how this account can be modeled as a programmatic intervention for the history of computing, an attempt to illuminate the utility of amateurism for the field. In other words, I hope to use a particular descriptive account of one group of users as a way to elucidate the conceptual benefit of the larger user category.

Between Work and Play

It is not controversial to point out that most of our histories of computing take place in a corporation, university, or military lab. A glance at the scope of this journal, the field's oldest and finest collection of knowledge on computer history, makes this quite plain. And it is equally uncontroversial to note that within these histories, it is technology that has taken center stage in keeping with what David Alan Grier has called the "great machine theory of history."[5] This tendency might be an effect of the hugely influential role of corporations in shaping the computer. Thomas Haigh has argued that office machinery was an important antecedent to the American computer industry in the early 20th century.[6] Nathan Ensmenger has explained the "persistent personnel problem" that beleaguered the computer's rise to a mainstream business technology, describing the bevy of employees needed to configure, program, and maintain even a single machine.[7] And of course the well-documented relationships between the military and universities—for example, as in the case of the US Army contracting with the University of Pennsylvania to build the ENIAC in the 1940s and 1950s—help to further explain why most of our histories have an institutional backdrop.

Concealed by the emphasis on already established domains are fissures in the boundaries of these spaces. We know that the people who have contributed to the development of the computer (not truly a single entity itself) were not divided between static social groups that were born out of whole cloth. Amateurs emerge in the cracks between extant categories, and even the label "amateur" has a historically mutable character. This category emerges, in part, from the social epiphenomena of the Industrial Revolution. Stephen Barley and Julian Orr explained how the exponential rise of technical jobs in the United States since 1950 is inseparable from the specialization of labor ushered in just decades before: "The Industrial Revolution brought workers together in larger shops and factories, where propinquity allowed owners to divide tasks into constituent activities and assign those activities to individuals who performed them repeatedly."[8] The need to escape this "propinquity," along with the shortened workweek ushered in by Progressive labor reform, created a new experience that allowed individuals control over non-work-related projects at home.

In its intellectual history, the term "amateur" has been a liminal concept that can help to explain "the system of professions," to borrow the title of Andrew Abbott's important 1988 essay.[9] Robert Stebbins's *Amateurs: On the*

Margin Between Work and Leisure is one attempt to schematize amateurism through case studies in theatre, archaeology, and baseball.[10] In more recent work, Stebbins theorized amateurism in terms of "serious leisure" as a way to capture the nuances of avocational verve.[11] Harry Collins and Robert Evans's *Rethinking Expertise* offers an exhaustive vocabulary and a detailed "periodic table" to the variants of expertise that are not always linked to professional characteristics.[12]

In all these accounts, amateurism is not entirely at work and not entirely at play. This is a doubleness inherent in the etymology of the word itself. Its first definition in the *Oxford English Dictionary* is about love: "One who loves or is fond of." But the second definition is about superficiality: "sometimes used disparagingly, as = dabbler, or superficial student or worker."[13] And so the amateur is defined alternatively in terms of passion and puerility, dash and dilettantism.

There is another liminality in amateurism: the relationship between people and objects. David Alan Grier's *When Computers Were Human* helped set the stage for a study of the computer hobbyist by offering a portrait of the days when the computer was literally a human. In doing so, he "invert[s] the history of scientific computing by narrating the stories of those who actually did the calculations."[14] In a similar tack, Jennifer Light's article "When Computers Were Women"[15] reminds us that these human computers, at least in the case of the ENIAC, were women, a corrective to the notion that women have been perpetually uninterested in the field. The amateur of the 1960s and 1970s, then, was the crucial link between Grier or Light's human computer and the already recognized computer-as-technology. In the interim, a different kind of amateur, the radio ham, became the computer hobbyist's literal and figurative forefather, the history of which has been extensively chronicled by Susan Douglas and Kristen Haring.[16] As radio hams gave way to a new amateur, computers were no longer people, but not yet imagined to sit atop a desk inside the house.

During this period, the computer was amateur. Inheriting the central tenets from the paradigm of the social construction of technology (SCOT), we can think of amateurs as what Trevor Pinch and Wiebe Bijker would call a "relevant social group," one of many that sculpt a technology's cultural value.[17] To say that the computer was amateur is to implicate a milieu of amateur influences, the ones this article seeks to render writ small and then model as a historiographical intervention. To understand the computer-as-amateur, we must render its amateurs. In this way, we begin to develop a sociotechnical system defined by the interface between a certain kind of user described in the pages that follow and the larger, nimble meanings of the technological artifacts themselves, all of which are moving targets we can theorize as "amateur."

The Amateur Computer Society

The ACS was a group of men who formed around a newsletter that was published every few months from 1966 until 1976. The society was started by Stephen Barrat Gray, who sent out a list of goals for the group on 1 July 1966: "The main reason for the existence of the ACS," Gray writes, "is to enable amateur computer builders to help each other, saving time and money by trading ideas."[18] The notion of a club for amateurs was obvious to Gray, who later wrote in a retrospective:

> After several years of trying to build a digital computer in my spare time, I began to realize how difficult it must be for other computer hobbyists. The idea of a newsletter soon presented itself, in 1965, as much for soliciting information of help to me, as for sharing what little I'd been able to learn on my own.[19]

Gray soon became the amateur serving the amateurs. He sent out letters to the editors of various technical journals advertising the ACS as a forum for hobbyists to share tips and support. Gray was "doing all the work, including typing, collating, folding, stuffing, and stamping."[20]

The "computer" the amateurs were after seems primitive to our contemporary sensibilities. As Gray wrote in the advertisement he sent to five trade magazines to call for new members, "the ACS is open only to those who are building or operating a homemade computer that can at least perform automatic multiplication and division."[21] The newsletters became the lifeblood of the ACS as its members tried in various ways to complete a machine with these specifications.

At the time the ACS was born, computers were entering their "third generation" in the major computing corporations referred to by the mid-1960s coinage "IBM and the Seven Dwarfs."[22] The semiconductor IC was being firmly entrenched in the field of electronics, which allowed for increasing miniaturization

of new computers.[23] And the software industry was rising to booming interest.[24] Yet the term "personal computer" was still years away when the ACS first formed.[25] While much was unfolding in the industrial worlds for computing during this time, amateurs were toiling away at bringing computing home. They detailed much of their travails in the ACS newsletters, which arrived in each member's mailbox about every three months.

The newsletters were designed as a multiply authored communication system. That is, their structure reflected a decentralized editorial process. Each newsletter came with a no-frills heading, followed by five or six pages of letters or articles from the community (there were no ads). At one point, Gray issued a call for content, worrying that there wouldn't be enough to print; this is evidence that Gray thought of the newsletter not as a publication with a heavy editorial hand but as a reflection of collective authorship. These texts are important historical documents because they show how amateurs were representing themselves to each other, in sometimes contested ways that illustrate boundary work around the category of "amateur."

We can begin to understand these amateurs through data collected by the ACS itself. In the seventh issue of the newsletter (November 1967), Gray printed a page-long member survey to be filled out and mailed back. The following issue, in January 1968, printed the results. Much of the survey asked about technical specifications of the computers members were building, including things like type of memory being used, clock speed, and I/O hardware. Gray also collected some personal information. "Most of those responding have at least one technical degree," Gray writes, "including BSEE, MEE, BA in Math, PhD EE, 'BA and BS and working on MS,' and several students."[26] The earliest year that a member began work on a computer was 1951, another began when he was 13, and another said he had been interested for 17 years.[27] A windfall of a community organized around the postal system is that anyone who requested help in the newsletter gave his contact information. Members wrote in from Texas, Nebraska, Arizona, Maryland, several from New Jersey and New York, and about as many from California as from the East Coast. In 1971, Gray speculated that "probably no more than 200 [amateurs] in the United States are actively trying [to build a digital computer]."[28]

These data are important to help label the work the amateurs were doing with their computers. In the late 1960s, professional computer specialists would have been divided among engineering, architecture, and programming. Although an expert in one area, such a specialist may have been a complete amateur in others when he needed to combine parts and skills that were kept separate in firms and labs. Only rarely were ACS members actually programming their machines, in large part because this comes after a machine's hardware has been configured. They spent most of their time instead working on designs, gathering parts, and assembling hardware. What the ACS members were doing, then, could generally be called "computer building," although it is important to note that building was necessarily connected to designing.

It's also important to note that the ACS is not an exalted version of amateur computing. For that, we could turn to the Homebrew Computer Club or the People's Computer Company or Stewart Brand's Whole Earth Network that came later.[29] It's important that "amateur" does not become equated with "early adopter" or "pioneer" if we're to find a way around what David Nye has called the "innovation-centric" model of history that lionizes a certain kind of advancement at the expense of more pedestrian knowledge. The ACS testifies to the amateur nature of amateurism itself—not perfectly developed nor easily located—and amateurs are not to be glorified as stewards in a teleological history. Indeed, investigating amateurism in the history of technology is crucial precisely because of this.

Amateur Expertise

Speaking about the formal education of the ACS members, Gray writes,

> Because the great majority of those sending in the survey have technical degrees, and because those who sent it in are among those who have advanced the most with their computers, it seems that a lack of a technical education is holding back many ACS members from pushing ahead with their machines, or perhaps just from getting started.[30]

This quickly becomes a chicken-or-egg riddle for amateur practice: Even if it happens outside of professional and educational arenas, how does one get off the ground enough to become an amateur? And if one is a

professional by training or education, is one truly an amateur?

This calls into question the very notion of amateur knowledge, which is at once expert and lay. Reflecting on prerequisite amateur training, Gray writes the following:

> The main problem in building a computer is that many technologies are involved. Computer companies have specialists in logic, input/output, core memory, mass memory, peripherals and other areas. To build one's own computer requires learning a great deal about each one of these fields. If the computer hobbyist is an electronics engineer working for a computer manufacturer, he can drop in on a friend down the hall and ask, 'Say George, just what kind of drivers do I need for a core memory with these specs?' Most hobbyists, of course, do not have these resources, and must spend many hours in study, not only in the electronic fields mentioned, but also in mechanical areas such as packaging, backplane wiring, metal-working, plastics, and many others.[31]

This illustrates perhaps the cardinal characteristic of amateurism: complete control over the process and product being built, but at the risk of often unwieldy horizontal sprawl across all aspects of production. Amateurs must be an expert in all parts of the production and yet must necessarily spread themselves thin, like an acrobatic dilettante.

This juggling of general and specialized knowledge was a central mark of amateur computing, and the newsletters show that it was often navigated around questions of intellectual property. One of the most consistently published topics in the ACS newsletters was a zealous reporting on various pursuits of schematics. Where an amateur with specialized knowledge about only one part of a computer might flounder, the schematic offered hope. The problem with obtaining schematics, however, was that they were almost always the exclusive proprietary information of the company or university that produced them, and it was difficult to find an "overall schematic" that gave a larger sense of a complete system. When a schematic could be found, from technical notes available freely from the National Bureau of Standards, texts from Navy training courses, or in patent publications,[32] the components being used might be so large or expensive that it would be almost impossible for amateurs to use these designs reliably for their own machines.

The schematic was an important part of the ACS members' pursuits, and as an abstracted representation of technical knowledge, it also captures something more urgent and essential about what amateurism means to how the members thought of their practice. As Gray writes in his introduction to an issue that was solely devoted to schematics, "Although many ACS members say they find their designing the circuits for their computers is the most interesting part of their hobby, there are just as many members who cannot design their own, and who need help."[33] That schematics were contested in this way suggests that amateur practice was thought of (by some) to be centrally defined by its hardships.

We see this in one member's thoughts about repeated analogies made in the newsletters between radio hams and computer hobbyists:

> It should be emphasized that the popular analogy between the amateur computer builder and a radio ham is simply not valid. The complexity of even a small computer outweighs by at least an order of magnitude [ten times] the design effort necessary to construct an amateur transmitter. This is doubly compounded by the fact that: the nature of basic building blocks changing at a rapid rate; many commercial designs are proprietary; there does not exist 40 years of computer design history to draw upon.[33]

Here the lack of schematics illustrates the infancy and proud excitement of amateur computing. The differing views on using schematics were not trivial; this tension snowballed into the debates surrounding a "standardized amateur computer kit" (SACK) that began to appear in 1967 and can be seen in the letters sent in to the newsletter for years afterward.

Gray first introduced the idea of an amateur computer kit with the same even-handed tone with which he had dealt with the similar problem of the schematic:

> Although the mere idea of a standard computer makes the true-blue home-brew types shudder, the fact is that amateur radio would not be where it is today without the kits and the off-the-shelf equipment available.[34]

He then tried to anticipate some of the negative reactions:

> The ACS can advance the state of the amateur computer art by designing a standard amateur

> computer, or at least setting up the specs for one […] For those who don't believe in conformity, the computer kit can be a jumping-off place, a basic machine on which to build their own variations and special add-ons.[34]

Two kinds of responses emerged. Bill Pfeiffer's letter in a later newsletter lionizes the kit:

> The idea of the standard amateur computer is excellent. I don't see where it is incompatible with the home-brew idea […] With the right kind of a beginning, all kinds of possibilities could develop for adding new features.[35]

For Pfeiffer, the kit does not obliterate amateur tinkering, but enables it.

For Dave Vednor, however, the kit was anathema:

> I must say that I am against the idea of SACK. By placing a kit of this type on the market, amateur computer builders would not have any major problems, and very few new ideas would result. Amateur radio is a good case in point. Today most of the gear in use is not home-brew, but manufactured to commercial standards. This is great for the hams who don't know how to build, but what is the purpose of amateur radio? The FCC thinks that the U.S. hams should increase radio technology. This is being done, but not to the extent that it could be. If amateur radio gear was not produced commercially, we would not have as many hams, but those hams would make more contributions than all of the hams make today.[35]

To Vednor, struggle is the essential hallmark for amateur innovation. Tinkering, he implies, should be entirely inventive, painstaking, and idiosyncratic.

The kit, like the schematic, defines amateur practice by calling into question amateur practice itself. The saga of the SACK is perhaps understood as the saga of the craft of hacking. And "craft" is an appropriate way to think of amateur computer building because what we see is captured by what Richard Sennett explained as the imperatives of "quality-driven work"[36] or what Pamela Smith would call the "artisanal epistemology"[37] involved in craftsmanship. What is at stake in these ACS debates is a definition of what makes computer building hard and also what makes it productive or generative. The two amateur ideals typified by Pfeiffer and Vednor differ in terms of a relationship between amateurs and their community of non- or quasi-professionals. On the one hand, mimicking the data-processing industry by circulating schematics is essential, and thus the lack of schematics is a lamentable setback for amateurs. But to others, the escape from this mimicry defines amateurism as a more creative, thrilling pursuit. The debates around SACK, then, offer a story about standardization "from below," a contrast to the better-known histories of standardization in elite institutional arenas as with, for example, the International Organization for Standardization's oversight of the Open Systems Interconnection, which had profound implications for the structure of the Internet.[38]

The contested role of the kit and schematics also illustrates what Ronald Kline and Trevor Pinch meant, in their eponymous article, by "Users as Agents of Technological Change." More than simply finding new applications for technologies, user agents "have helped to shape the artifact or system itself."[39] In deciding on two different notions of amateur practice, Pfeiffer and Vednor give us examples of the computer's "interpretive flexibility." The amateur computer could be either a symbol of a community's mētis or it could be the symbol of one individual's perseverance. The ACS members, then, widened the social meanings of the computer while contributing to stabilized cultural value as they enacted rough consensus around certain aspects of the computer's use (for example, in its capacity to dramatically change the daily lives of its users).

I would like to suggest that the schematic and the kit offer representations of amateur expertise that lie at the heart of what the ACS members imagined as their hobby. The abstraction of amateur expertise in the schematic and kit is simultaneously a representation of the knowledge required to build a computer and the process by which one can actually do it, tantamount to the imagination of amateur computing. As a central feature of the ACS newsletters, they captured what the amateurs defined as "amateur" even in contesting others' notions. This, we can start to see, is what gives the computer-as-amateur much of its personal, social, and cultural heft.

At Home

In a letter to the newsletter in 1971, one ACS member sends an update about his machine: "I've taken over the master bedroom for the installation and I find it helps a lot. There is a lock on the door to keep out little fingers and all of my test equipment is in two 6-foot racks

on wheels at the end of the workbench."[40] When we picture this scene—a sprawling kludge near a bed with a child clamoring to examine the various parts—we're reminded that amateur computing was not just about expertise or equipment, but also importantly about space. What is at stake in this consideration of amateur computing at this particular time is a transportation of a technology out of the workplace and into the home. In the following reading of the ACS newsletters, I show that using computers in the home helped define amateurs' goals and objectives in repurposing technology for personal pursuits.

One of the most successful members of ACS was Jim Sutherland, who chronicled the development of his machine that now sits at the Computer History Museum in Mountain View, California. The machine is known as ECHO-IV, which stands for Electronic Computing Home Operator.[41] When it was first introduced in the ACS newsletter, it was given two quick sentences. The latter of these laconically read: "Jim's computer, 7 feet long, 2 feet deep and six feet high, took a year to build and will take ten years to program."[42] Indeed, Sutherland tinkered with the machine for about 10 years before it was retired.

Before Sutherland had a working machine in the house, though, he had ideas about how it could be integrated into daily home life. What Sutherland described in the ACS newsletters demonstrates the way his desire to bring computing into the home was bootstrapped, borrowing the analogy from Douglas Engelbart's imploration to create circuits of technical exploration where feedback is sent in again as input to create better results. In a May 1968 issue of the newsletter, the computer is described in terms of utility for family bookkeeping: "keeping track of monthly budgets and expenditures, so that when tax time comes, deductions can be identified and grouped to simplify filling out the tax forms."[43] In addition, the computer could keep a schedule, catalog recipes, take inventory, control TV viewing times, and control the house temperature. When it was up and running, Sutherland had I/O connections in rooms all over the house that ran down to the machine in the basement.

Sutherland was not the only ACS member to find inspiration from the home. Another member reported in 1972 that he had built a machine with the following software: "wife's adding machine, desk calculator for me, random flash-card exercises for children with messages typed to user, line by line text edit."[44] For some, having a computer at home was about extending their capacity to be professional engineers, lessening the gulf between home and work. Discussing the sales of a training computer called the Kenbak-1, an engineer explained, "I have an IBM computer at work with half a million words of storage, but I didn't have a computer at home."[45] Another member reports having "an entire garage full of stuff that needs cleaning out," suggesting what was a likely common scenario among hobbyists who unwittingly hoarded extraneous parts as they built their machines. We should note that in many of these examples, the work being automated was traditionally done by the women in the family. This should remind us that while amateurs' accounts of their hobbies come to us in terms of technical specifications, they nonetheless index the politicized space of the mid-century home.

One example that integrates a computer with daily personal tasks is particularly demonstrative here. An early issue of the newsletter included this story from a man describing the retrograde amnesia that accompanied his cerebral meningitis, which he had contracted some years before:

> The first solution [after losing my memory] was to keep a journal of my activities and copies of everything I wrote (letters, orders, etc.). This worked for a while (10 years), but now I'm being driven out of the house by the mountains of accumulated paperwork […]
>
> So the second solution is to put it all on mag tape a let a computer keep track of it […]
>
> My real problem, of course, is the computer's enormous complexity, with many different things going on simultaneously. A poor memory is obviously a great handicap here. While I concentrate on what's going on in one area, the activity elsewhere escapes from me […]
>
> However, it seems possible that the type of limited-scope, single-purpose computer I have in mind might be encompassed in only a few drawings that I could eventually comprehend.[46]

Here is perhaps the best illustration of how amateurism was located in the home. This pursuit could not have been anything but amateur because it involved such an intimately personal objective. It also could not have taken place anywhere but in the home because it involved the material accumulated in daily activities stored in the house.

Amateurism and domesticity are thus intimately implicated in each other in this man's hobbyist project. It demonstrates an innovation from below, not less important for its provenance in the home, but more so.

Not everyone found amateur practice reducible to inspiration found at home. One member wrote that he has "been too busy designing computers at work to feel much like doing it also at home," leaving his projects in "various stages of non-completion."[46] Another member criticized Jim Sutherland for wasting his time on programming the ECHO-IV to control house climates when, as he saw it, writing solid software was becoming the far more important area of concern.[47] We can't say, then, that amateurs worked solely in the home, where they found and then recursively incorporated their creativity for computing. However, to ignore the importance of place would be to miss a critical depth about amateur computing at this time.

Kristen Haring has argued that radio hams created a "social and spatial distance" in the home through their technical hobbies in the 1940s and 1950s. Phrases like "A man's ham shack is his castle!" were common in ham publications, illustrating a cocktail of heightened masculine technical identification and contentious family roles ordered by the escape into a private space for tinkering. "'Freer men' emerged when amateur radio interrupted domestic relationships, just as the accumulation of alien equipment in the corner of a room set off a shack," Haring wrote.[48] This contributes to what Haring called the "technical identity" of radio hams, invoking the double meaning of identity being produced both for the user and for the technology itself. She wrote,

> I use the term to indicate that some people choose, because of their technical inclinations or skills, to identify with a technology. 'Technical identity' also intentionally reminds us that technologies possess identities. The double meaning suggests an important connection between the two senses of technical identity, namely that the technical identities of machines and people are coproduced.[49]

We have trouble corroborating direct similarities between radio hams and computer hobbyists, not only because of the different sociopolitical climates of the two time periods, but also because the ACS newsletters simply do not lay out this picture of home life the way ham radio magazines did. Yet, we can't automatically assume that because the amateur computer was not networked for interconnectivity in the way amateur radios were that they had any less involvement in domestic politics. What is not said, or said obliquely, might help us here. In her article on the transformation of laundry (a domestic task done by women) into an industrial process (done by men), Arwen Palmer Mohun noted that "laundrywork" was made more masculine by male workers' insistence on a virility immanent to the complexity of the system devised to complete the tasks.

> Confronted with the persistent notion that laundrywork was women's work, [laundrymen] presented their own complex arguments suggesting that while individual parts of the process might better be carried out by women, laundries as technological systems were essentially masculine; that they required masculine ways of thinking about and organizing technology in order to function properly.[50]

We can understand the ACS members' excitement about reporting on the triumphs over mundane domestic tasks in a similar light: amateurs elevated a seemingly menial duty (bookkeeping) into a gambit in an otherwise masculine hobby.

In addition to the politics of domesticity, the newsletters' discourse around the home illustrates an important movement in the spatial circumscription of technology. It illustrates the development of what Thomas Hughes would call "technological momentum." As another facet of the cultural relativism of technology, Hughes proposes the notion of momentum that is sensitive to temporality in determining the factors that shape the technology-society relationship. Momentum, Hughes said, "infers that social development shapes and is shaped by technology."[51] If we take one assumption of Hughes's proposal as true, that technologies are more interpretively malleable when they are new, then the ACS newsletters give us an interesting glance into the start of the momentum of the personal computer.

The momentum, in this case, was away from the office and toward the home (and then later, away from the home and toward the office as things such as VisiCalc and the IBM PC made their way into workplaces). Therefore, locating amateur computing in the home also compels us to think about scale. The massive corporate and university

computers of the mid-1960s simply would not do for hobbyists at home. They had to use a clever combination of recycled and found parts to create their kludges. At the end of one newsletter, in a section devoted to "problems and (some) answers," a member asks where to buy computer components. One of the short answers suggests the "Salvage Depts of Autonetics and Hughes Aircraft, in California, Saturday mornings." This implies that these companies made selling used parts to amateurs a regular business practice, one conveniently carried out on the weekend when amateurs would be at work on their projects. The newsletters also suggest that what the amateurs were looking for most was ICs; there was a considerable amount of page space devoted to ICs throughout the newsletter publication, a frenzy that lags behind the larger computer industry's obsession with ICs, as chronicled by David Brock and David Laws.[52] This sophistication in ferreting out parts that could be combined into a working machine demonstrates for us the intricate attention to detail and often frustrating juggling act amateurs had to perform. It also shows an interesting inversion at work: Amateurs were attempting to anticipate the dawning personal computer market, but they were doing so by relying on outdated parts.

I have tried to show how amateur practice was intricately entwined with domestic space in the ACS newsletters. This offers another vantage point in describing what amateur practice was like in the late 1960s and early 1970s. In the final section, I recount the end of the ACS and then transition from a descriptive project around amateur practice into a programmatic one that can be modeled as a meaningful intervention into the history of computing.

Farewell

The end of the ACS newsletter came with few warning signs to a contemporary reader, although members probably expected it. In February 1977, Gray sent a letter to all remaining ACS members along with a check for their unused subscription money.

> After two years of Volume IV, the Newsletter of the Amateur Computer Society is ceasing publication. Published regularly since August 1966, the Newsletter was the first hobby-computer publication in the world.
>
> Times have changed and now that kits are so prevalent, there are other publications that serve the readers' interests better than the ACS Newsletter. Also, the ACS Newsletter always depended heavily upon reader input, and this input has dwindled.[53]

The "other publications" that Gray mentions took many forms. They included newly mainstream publications that had amateur appeal, such as *Byte* and *Creative Computing*. They also included newsletters specific to new machines starting to be sold to home users. These newly manufactured machines in fact included the commercial versions of the kits the ACS members envisioned. Indeed, one member correctly predicted that there would be a commercial kit available within a few years. These kits, as well as preassembled microcomputers, solved many of the amateurs' headaches because they came with an already designed and engineered system, the one that amateurs had labored over making bespoke in their homes. What drew ACS members together across many different machines was now obsolete by the early standardization of the personal computer.

It might seem like kits killed the amateur, but we know this is not true. The Homebrew Computer Club, perhaps the most famous amateur computer organization, which included members like Apple visionaries Steve Jobs and Steve Wozniak, was just getting started in Silicon Valley in 1975 as the ACS was winding down. It is not that amateur computing waned when the market of kits and operating systems proliferated; it was that this group of amateurs fell apart. And because the ACS was a space for the hobbyist computer community to debate the merits of kits before they were popular, it makes some sense that it was overshadowed when the kits actually became readily available.

It is important to note here that the ACS was not known and cannot be remember for its success in terms of influence or innovation. This is also not why we should be interested in it to begin with. We should be interested in it for its more pedestrian and therefore more easily ignored testimony about how computing came home.

What do we gain by tracing the dead-ends of a small group of amateur tinkerers? We gain an appreciation for what makes the personal computer "personal." We gain insight into the way that users take up technologies and adapt them for use. We gain an understanding of how technologies acquire their social meanings. We gain a history from below that serves as an essential foil to the

histories of computing that start and end with institutions and focus heavily on objects rather than their cultural milieus. I have tried to model here a number of ways of reading the ACS newsletters, as much to give a small history of the computer amateur as to suggest that the amateur may be similarly researched in other domains. We can "follow the amateur" as a productive strategy for the histories of computing we haven't yet written.

Can we imagine a sociotechnical system and its many moving parts as a system that is itself amateur, as I suggested earlier that we might? Amateurs are a group of users as emergent and flexible as the historiography we might use to understand how technical innovation happens in sometimes startling, unpredictable ways. They help us elucidate the histories of our computers while showing us why these histories are rarely as linear or smooth as we sometimes imagine. Amateurism should not be a denigrated category that conveys a lack, but instead a lens through which we understand technology itself as amateur and therefore emergent and capacious.

When a young Alan Turing imagined a machine that could operate according to a finite set of rules, he was inspired not only by a cosmic mathematical problem but also by an intriguing similarity between humans and machines. Could a machine learn to love? Could it learn to feel and think and express itself? Turing was known for these kinds of idiosyncratic thought experiments about determinism and animism. Although the field of artificial intelligence is still at work on the conundrums Turing posed, we might begin to understand some of Turing's obsession and joy when we think about amateur computers. When we look at our computers, it is not simply a machine we see, but also some of ourselves. This intimacy is not a foregone conclusion for the science and engineering that brought it about. It is also, as I have tried to show, a possibility made by amateurs. Amateurs give the history of computing its "wetware," its wiliness, and its spirit. They compel us to reckon with the interface between human enthusiasm and mechanical possibility. They remind us that the materiality of computing is deeply entwined with the social and cultural skeins of the people who build and use it.

Acknowledgments

Research for this article was made possible by the Arthur L. Norberg Travel Fund from the Charles Babbage Institute for the History of Information Technology at the University of Minnesota. This article benefitted in crucial ways from the loving pedagogy of Ruth Schwartz Cowan, the excellent feedback from the anonymous reviewers, and the helpful suggestions of Sharrona Pearl.

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