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Computers Made of Paper, Genders Made of Cards

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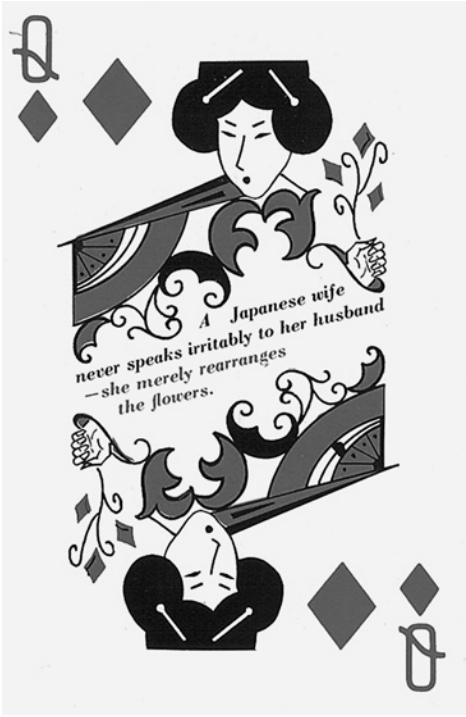
In 1969, Marshall McLuhan published a deck of cards, meant to be used for problem solving. His Distant Early Warning Line Card Deck (DEW deck) referenced the chain of sixty-three Cold War Arctic radar stations built by the Canadian and US governments across Inuit land between 1952 and 1957.[1] This electronic boundary would give joint combat operations a two-hour warning of impending Soviet missiles. McLuhan's cards are illustrated with cartoons, aphorisms, and jokes characteristic of his work. The cards functioned like a Magic 8 Ball: a user facing a decision could pull a card from the deck and read its aphorism as a through-line to pondering their problem. For McLuhan scholar Peter Zhang, "The cards stretch the mind. They put the user in a state of mind conducive to the solving of problems. They do not so much shed light on the situation directly as arouse and lubricate the user's mental apparatus."[2] Like the actual Distant Early Warning Line, this deck staged a prophylactic media problem: how might technologies ward off harm and manifest the future?[3] Though this was the deck's intent, many of the actual aphorisms on the cards ("The stripper puts the audience on

by taking them off," "Thanks for the mammories," or "A Japanese wife never speaks irritably to her husband—she merely rearranges the flowers") read more like jokes about gender, race, and sex work uttered behind a Boys Club's closed doors by those with enough power to approach decision making as a card game (figures 8.1–8.3). Women appear but only as objects holding up a theory and function.[4]

Index cards like these are key objects in electronic media's extensions and translations of experience into information systems, but they also have a story to tell about gender that is much richer than the bad jokes on McLuhan's DEW deck.[5] Index cards were often marketed as accessible, tactile entries to information management via turns to their use in domestic contexts. Framed in gendered terms, manual information handling became a soft entry to computing in the 1960s and '70s.

That McLuhan created and published this card deck suggests more than a passing interest in paper cards as a way of designing an information system. For McLuhan, cards formalized a mediated relationship to information—according to McLuhan's son Eric McLuhan, who codesigned the cards, they "provoke lateral thinking."[6] Cards here are vested with immense formal significance as technologies that alter experience. Index cards—a broader category of cards that reference other information—are significant objects in the transition to electronic information management characterizing the mid-twentieth-century period of McLuhan's analysis in *Understanding Media.* Index cards organized recipes in boxes, helped maintain card catalogs, and input information into computers. As Shannon Mattern argues, through their use, display, and storage, index cards helped usher in a twentieth-century computational sensibility that informed how North Americans thought about information, management, and systems.[7] As they were encoded, shuffled, and categorized by hand, index cards provided users with tactile experiences of information as an object to be systematized and managed.

This chapter analyzes how a selection of instructional articles and manuals on indexing with paper cards from this period explained new computing processes to readers. These texts drew on cultural understandings of women's craft and aptitude for domestic organization in order to frame computers as tactile, approachable tools, ready for use by amateurs. I focus on a prefabricated device called the Knitting Needle Computer, which repurposed computer punch cards for manual, hobbyist indexing, and was designed to sort cards with knitting needles. Through devices like this one, gendered labor and gendered experiences with paper cards underwrote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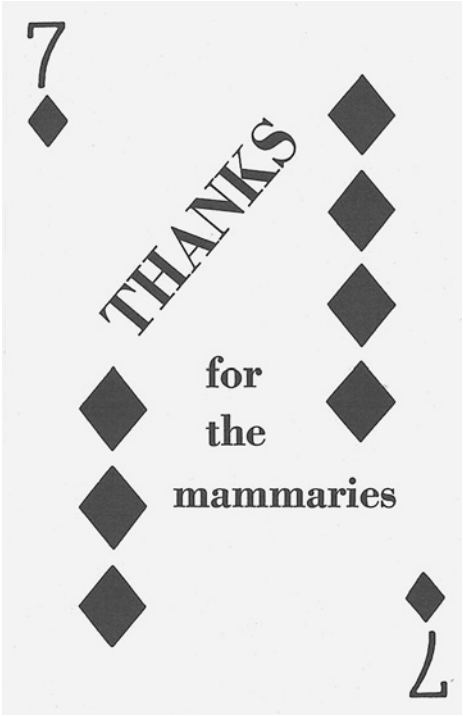


8.1–8.3 Three cards from McLuhan's Distant Early Warning Line Card Deck, 1969. Jeff Trexler, CC BY-NC 2.0.

midcentury efforts to ease information-saturated publics into the ideas and practices of computing.

Here, tools are extensions of man, where paper cards usher information sensibilities part of the way to computing. *Information sensibilities* describes how people understand, manage, and make data actionable using specific techniques and devices, both existing and on the horizon. Information sensibilities are constructed in practice, as the formal dimensions of media meet users and their socially situated techniques, which are always gendered and gendering. As feminist media history recenters craft methods and domestic metaphors like cleaning and sorting as rightly technological labor, the "Strippers," "Japanese wives," and lactating women scorned as objects depicted on McLuhan's cards become active participants in the transition to a computational information sensibility. A feminist analysis of paper cards as precomputational devices shows how gender is entangled with the ways new information sensibilities develop.

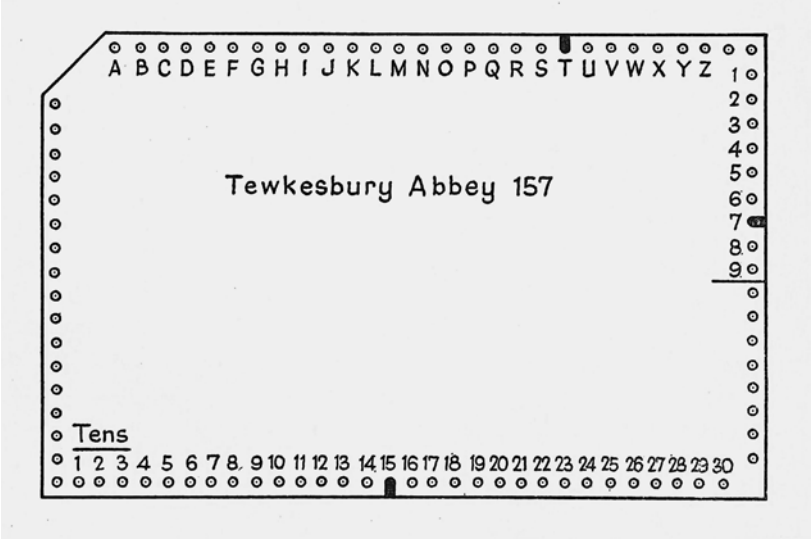
The Knitting Needle Computer

The Knitting Needle Computer reimagined computer punch cards as the raw material for manual information storage and data-matching functions. All one needed to build one of these computers was a hole punch, a deck of cards, a shoebox, and a sorting needle appropriated from the knitting basket. In the instruction manual *Indexes and Indexing* (1959), Robert Collison lays out how to build one of these computers. Aimed primarily at amateur indexers, Collison's manual provided practical instructions on how to manage information using simple tools, like paper index cards. First, he describes the twentieth century in terms that evoke McLuhan's obsessive emphasis on the electronic information age: the 1960s would usher in a "great age of indexing," in which "heroic efforts" would be needed "to provide a key to the growing mass of information which is accumulating so rapidly that no-one can grasp its immensity."[8] Collison's chapter on mechanized indexing features a hypotheti cal discussion of how "business machines"—early punch-card-operated computers—might be "adapted" "for indexing purposes."[9] Similarly, amateur indexers could adapt computer punch cards for small-scale, manual indexing using knitting needles.

Knitting Needle Computers made small data-matching projects easier by semiautomating how information could be encoded and then retrieved. Take, for example, Collison's illustration, which depicts how to make an index to a book about English churches using this method (figure 8.4). Each church in the book is represented by a card, its name handwritten on the front of that card. Each card is prefabricated with a uniform set of punched-out holes along its edges, giving the Knitting Needle Computer its technical name: an edge-notched card system. Sets of holes are assigned to diff erent information categories chosen by the user or designer of the computer. To encode a card, the user converts a single hole into a notch in the card edge, using a punch. Collison's sample card represents where Tewkesbury Abbey is mentioned in the book: The top edge of the card encodes letters, and "T" for "Tewkesbury" is punched. The bottom edge and the right edge of the card indicate the page number where Tewkesbury Abbey appears in the book: 15 and 7 are punched to indicate page 157. The same method can be used to create other kinds of small databases by changing the information categories the holes represent. For example, a softball fan could create a database of all the players in a league. Holes along the top edge of the card might correspond to "first letter of player's last name," while holes along the right edge of the card can describe "position played" or "batting average."

According to Collison, a batch of matching cards could then be retrieved from the larger stack, by sliding "a knitting needle of slightly smaller diameter than the holes in the cards" through the appropriate hole.[10] Using their knitting needle and a batch of "not more than two hundred" cards ready to be sorted, "the indexer thrusts the knitting needles through the hole denoting the letter [T] and shakes the cards." All of the cards that have had their T hole punched into a notch will not be picked up by the needle and will fall to the table below. The user is left with a pile of cards that share a common notch and data point.

As Collison optimistically explains, "this process is repeated batch by batch and letter by letter until, at the end all the cards will be found to have been sorted *automatically* into the order of the letters of the alphabet."[11] Despite his word choice, little about this process is automatic except for the future computing processes it aspired toward. Edge-notched cards looked like punch cards used to input information into a mainframe computer during this era, but they were designed to work within a cumbersome hand-sorting system.



8.4 Illustration of punch card and knitting needle mechanized indexing system (Collison, *Indexes and Indexing*, 144). This example shows that Tewkesbury Abbey, an English church, is mentioned on p. 157 of a given book, and was used to create a subject index for the back of that book.

Like most midcentury indexing manuals written in the shadow of emergent database computing, Collison was teaching readers how to manage information using analog tools, but with an eye to the digital revolution that would soon offer new forms of what he called "mechanized indexing." An ambitious reader of Collison's instructions would not learn how to input data and run-type commands into a computer, but they could design a semiautomated, paper classification system that was conceptually similar to electronic database tools. In other words, edge-notched card users were experiencing something approaching computing, using knitting needles and paper cards.

Edge-notched systems were based on the large-scale, mechanized punch card databases that had been used as early as the 1890s for applications such as national census keeping and Social Security administration.[12] Edge-notched systems were sold to hobbyists as small kits that could be handled and manipulated without expertise, or the help of tabulators and sorting machines. The Knitting Needle Computer provides an example of how emergent computing figured in the imaginations of amateur information managers when actual computers were not available to them. Collison explains that the inaccessibility of computers "need not deter the average indexer from at least considering what measure of mechanization lies within his grasp, and what more—with the coming of mass-produced equipment—may shortly be at his disposal."[13]

Of course, the Knitting Needle Computer was not really a computer at all: it could not manage large volumes of data like an actual computer could; it was not made of metal, semiconductors, or wire; it did not need to be plugged in. The Knitting Needle Computer's distant proximity to actual computing was its point—by being not quite a computer but close enough to one, the machine helped explain computing processes to amateurs in highly tactile, unintimidating terms that they already understood. The device used gendered experiences and understandings of information to do this translation work, bridging paper cards and computers in an information sensibility animated by knitting needles.

Naming this paper card system a computer draws on gendered labor as a form of what Lisa Nakamura has called "flexible capital" for explaining, marketing, and building trust in computers.[14] The Knitting Needle Computer gently ushered potential computer users working in information fields (librarians, indexers, cataloguers, and hobbyists)—into the principles of automated information retrieval, and exemplified how computing could change the way information was imagined, managed, and mediated.

Edge-notched cards were effective at specific, small tasks known as "personal indexing," exemplified by the alphabetizing bibliographic project Collison illustrates above.[15] These tasks are much smaller in scale than the computational possibilities that the Knitting Needle Computer moniker promised. Collison admits that "not more than 200 cards" could be sorted at a time.[16] While indexing manuals tend to dwell on the positive aspects of edge-notched systems, it is easy to imagine the frustration and mess involved in shaking out matching sets of cards from a stack of hundreds. Here, shaking out a haphazard pile of cards on the table or floor is supposed to be productive instead of a total nightmare. The chaos of falling cards and worry that the wrong information might slip through the needle's grasp undetected undermined the system's promise to order and efficiently manage data. The Knitting Needle Computer was bad at robust data management, but succeeded in other pedagogical ways; namely, by providing an exemplary metaphor through which new, potentially intimidating database imaginaries and "bureaucratic machines" could be explained using practical materials that made computing seem accessible and tactile.

This accessibility was produced, in part, by articulating mechanized information management to the gendered practice of knitting. Articulation across disciplines is a common rhetorical tactic for building comfort with new technologies. Geoffrey Bowker calls this process "legitimacy exchange," where experts in one field justify their work through reference to the authority of experts in another field, building a closed system of expertise.[17] The Knitting Needle Computer exemplifies gendered legitimacy exchange, where typically undervalued domestic work is capitalized upon for its craft authenticity in order to build trust in new database computing. In this scenario, "women's work" is understood as properly technological to the extent that it maps onto the tools and processes at play in emergent computing technologies.

Collison's choice of a knitting needle is notable for the tool's status as a familiar household item used in domestic work. There are precedents for adapting these kinds of tools in information management. The first sixteenth-century designs for indexing devices were based on looms used to weave textiles.[18] Paper slips inscribed with information to be ordered were fed through two vertical strings, mounted to a board. The strings represented the vertical warp on a loom while the slips became the horizontal weft, temporarily woven through the strings in lieu of glue that would

make reordering difficult.[19] While these card looms borrowed physical design from handicraft, more recent feminist media histories have shown how midcentury women textile makers and their equipment were used to build amateur belief in the accessibility of computerized information management.

In the 1960s—the heyday of edge-notched card systems—women's textile labor was used to shore up the reliability of new computer hardware that the public did not readily understand and trust. Daniela Rosner has explored how NASA built memory for Apollo 11's guidance computer—via its subcontractor Raytheon—by hiring a factory staff of women textile workers near Boston to weave binary programs into "rope-core memory" using copper wire.[20] Engineers at NASA touted this "LOL" (Little Old Ladies) computer as fail-safe because it was made using a form of traditionally female labor. Nakamura has shown how the Fairchild Corporation employed Navajo women weavers toward similar ends, drawing on racialized and gendered capital to depict their "handiwork" assembling semiconductors as a reliable foundation for complex computing applications. In publicity materials, Fairchild promoted Navajo women's "natural" characteristics of docility, manual dexterity, and creative cultural handicraft to construct the circuits they built as high quality and reliable, because they were like weavings.[21]

Here, gendered and racialized ideas about care, craft, and skill become public relations strategies for making computers and spaceships seem as comfortable as a quilt made by Grandma. These weavers knew how to weave a program or semiconductor, but this weaving is not recognized as knowledge-based technological work.[22] The weavers' gendered capital is flexible enough to bridge the traditional world of textiles with new forms of computing.

Today, applications of textile work to computing are evident within maker cultures that promote the accessibility of coding through turns to knitting. Code Academy, a suite of online tutorials that teaches amateurs how to program, explains that "knitters and other 'yarncrafters' understand what it means to build something one stitch (bit) at a time, and yarncrafting pattern designers (coders) know what it means to code, use an API, design, test, debug, and maintain the source code—even if they don't realize it yet."[23] There are material, technical similarities between making textiles and using computers, but highlighting these similarities always serves a pedagogical purpose more than an experiential or technical one; in this case: you will not fail at coding because it's just like knitting, and anyone

can learn to knit. Weaving and knitting are tactile processes that require a great deal of technical skill, but they are crafts performed with accessible tools.[24] This is part of their gendered quality, and part of how they are used to construct a developing information sensibility in which computers are teachable, usable, and handle-able.

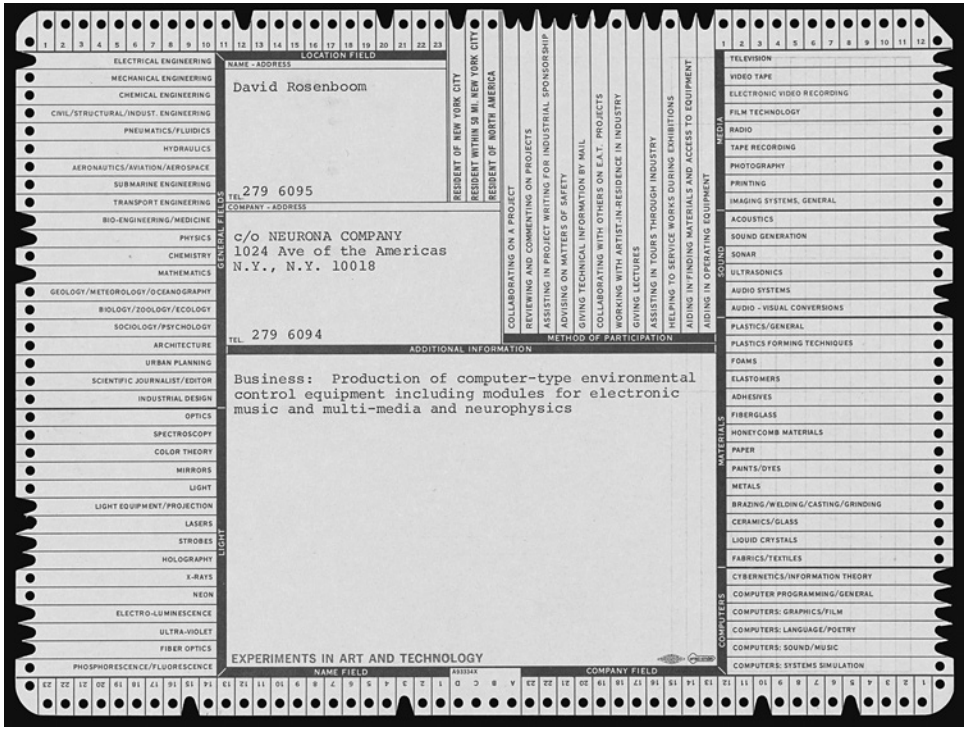
Beyond computing, the approachability of indexing with cards by nonprofessionals during the midcentury was often explained through domestic metaphors that extended into other kinds of household tasks. Indexing manuals describe the commonplace, household "systems designs" of women as prototypical "indexing" in order to cast mediated information management as second nature, and to lend indexing the authenticity and necessity of craft. Writes Collison, "Indexing is largely a matter of setting one's house in order. Nearly everyone does it in private life in some way or other, merely so that they can find things again when they need them. When a housewife makes a separate place for everything in the kitchen she is in fact creating a living index, for not only she, but all her household, will gradually get used to the system she has created and be able to discover things for themselves."[25] Here women workers are conceived as a general type, ideal for the practice of indexing because of experience designing small-scale functional systems—pantries, recipe boxes, domestic schedules. This housewife's kitchen ordering is a mediated systems-design practice that transforms the experience of "all her household." Within these terms we might recast the "Japanese wife" who merely rearranged the flowers confined to McLuhan's DEW deck as an information worker in her own right, whose work on home systems translates and circulates in wider information management cultures.

Indexing's organizing concepts and common materials are articulated to the realm of women's work in order to communicate ease and accessibility. Domestic materials stand in as a basic unit of information, unremarkable, familiar, and therefore easily managed in everyday life. Using the domestic sphere to illustrate how indexing is easy also has the effect of diminishing indexing work: if a woman can index, anyone can.[26] Using an anthropological gaze, the would-be indexer reading this manual is told to notice and observe housewives' information management practices (the reader is by necessity not one of these housewives), and recognize this activity as a naive, secondary class of "craft indexing" that is not apparent to itself as technical work. Makers of ordered pantries and seamless domestic schedules lend expertise to the indexing discipline without status as legitimate participants or potential collaborators in that field.

Recipe boxes and pantry systems are forms of personal indexing, a term that describes small-scale projects best suited to management through edge-notched card kits. Because of their small scale and hobbyist application, there are limited records documenting actual use of edge-notched card systems. A 1967 *Guide to Personal Indexes Using Edge-Notched, Uniterm and Peek-a-boo Cards* opens with the general suggestion that these systems are useful "to keep a note of periodical articles, pamphlets and reports . . . found interesting."[27] More specific amateur uses include prefabricated children's fingerprinting kits, character cards for Dungeons and Dragons games, amateur naturalist identification of birds and trees, and dissertation writing or personal research file management.[28] Well-documented edge-notched card databases are limited to high-level projects where indexing work eventually led to publication or public display. Edge-notched cards presented a logical fit for 1960s technotopian countercultural aesthetics in conceptual art and back-to-the-land movements; edge-notched card systems' use in these projects reflected the broader computational ethos of this work as it emphasized access to tools as a means of mastery and resource management.[29]

Experiments in Art and Technology (E.A.T.), a collective founded in 1967 by Bell Telephone engineers Billy Klüver and Fred Waldhauer, and artists Robert Rauschenberg and Robert Whitman, paired engineers and artists in technology-related collaborations. The E.A.T. collective relied on an edge-notched card system to match participants' technical skills, type of desired collaboration, media format, location, and equipment, among other categories (figure 8.5). Pairings were organized by matching information categories instead of subjective, intuition-based decisions about who ought to work together. The insertion of tiny sorting needles in holes marked with data categories like "lasers," "fiberglass," and "giving lectures" ensured that both parties were equally interested in the same materials and activities. While managing collaboration is most often considered a form of gendered, affective labor, the technologies at play in E.A.T.'s system privileged detached efficiency, rationalizing the alchemy of matchmaking through database logics.

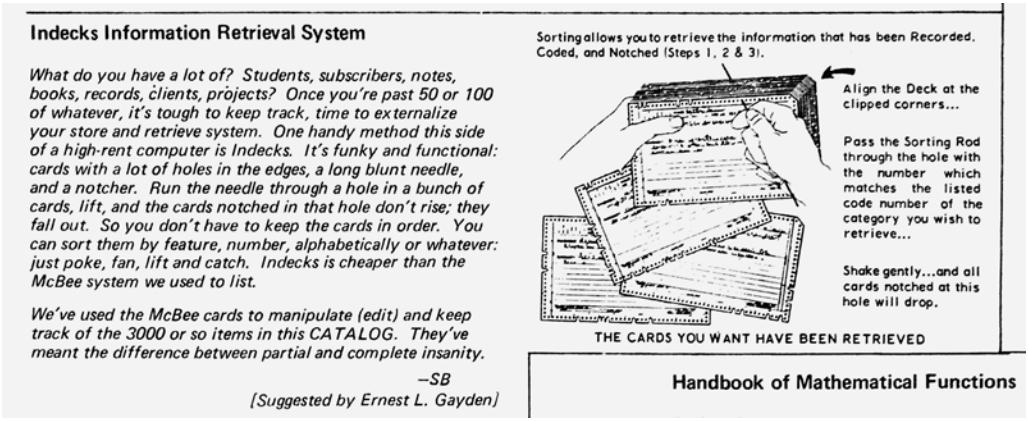
The *Whole Earth Catalog* is perhaps the most notable use of an edge-notched card system during the long 1960s. This counterculture-defining document drew on aesthetics similar to E.A.T.'s in order to provide readers with access to tools such as books, recreational equipment, and mechanical



8.5 Job-printed, edge-notched card used in Experiments in Art and Technology, 1968. 20 × 26 cm. Getty Research Institute, Los Angeles (940003).

devices.[30] In this catalog, new computing technologies became just another resource-management device, like gardening equipment or bicycle repair tools. Catalog editor Stewart Brand used an out-of-the-box edge-notched card system manufactured by Indecks to manage entries for the *Whole Earth Catalog*, and also sold the deck within the catalog's pages.

Whole Earth's audience provides a window onto the kinds of users who might have found value in, and access to, edge-notched card systems for personal indexing. Media historian Fred Turner identifies the catalog's readership as home-brew computing enthusiasts, back-to-the-landers, artists, libertarians, and tech-industry hippies, a list in which E.A.T. engineers and artists would easily fit.[31] The Indecks listing in the 1971 catalog explains: "What do you have a lot of? Students, subscribers, notes, books, records, clients, projects? Once you're past 50 or 100 or whatever, it's tough to keep track, time to externalize your store and retrieve system. One handy method *this side of a high-rent computer* is Indecks. . . . [It's] meant the



8.6 Indecks kit advertised in the *Last Whole Earth Catalog*, 1971.

difference between partial and complete insanity" (figure 8.6).[32] Crucially in this catalog listing, Indecks is not a computer, but does the same thing as one (just more handily) by releasing information retrieval from the confines of human memory through mediated externalization.

Instead of drawing upon comparisons to women's work, E.A.T. and *Whole Earth* both turned to other kinds of gendered metaphors to communicate tactility, simplicity, and usability by artists, engineers, and catalog readers. Like McLuhan's DEW cards, E.A.T. and *Whole Earth* imagined and celebrated forms of white, settler masculinity grounded in using the right tools to master resources, including information. They drew upon accessible craft techniques inherent in edge-notched cards' textures as media, but extended these techniques toward the masculine-coded realms of engineering, conceptual art, and tool cultures. Here, cards pushed information sensibilities t oward the horizon of computing, where craft techniques shed their associations with knitting and took on masculine edges—tinkering, coding, shuffling as nearly computational extensions of man toward new information sensibilities.

A third case of edge-notched cards used for a traditionally domestic task challenges divisions between information management and women's work. Librarian Barbara Wheaton used edge-notched cards to create her Cook's Oracle recipe database, beginning in 1962 (the project is ongoing). Wheaton attempted to index every recipe ever published in American and European cookbooks. She adopted an edge-notched system in the 1970s, but l ater transitioned to a Microsoft Access Computer database when her

Knitting Needle Computer failed to keep up with the project: "my categories kept expanding, and the cards did not."[33] Wheaton's work turns the "indexing is easy because it's like a recipe box" premise on its head, showing that domestic information is just as unwieldy as any other data set, and that managing this information is indeed technological and even computational labor. By using edge-notched cards within the domestic realm normally invoked only for rhetorical purposes, Wheaton's work challenges the gendered division between information indexer and craft indexer. In a twist of irony, Wheaton's is the only project to engage explicitly in the edge-notched card system's failure; the growing deck of cards could not keep up with domestic information purported to be far less complex than engineering, conceptual art, or countercultural infrastructure. In response, Wheaton's recipe box became an Access file, moving on to an actual computer.

Nearly Electronic

The Knitting Needle Computer was nothing like a computer in relation to that era's room-sized, mainframe business machines; it was small, portable, easy for amateurs to operate, had physically limited storage capacities, could not output data by printing or writing to tape, and was resolutely analog. Calling what is essentially a deck of cards a computer nonetheless produces proximities to computing cultures. To some extent, naming these decks computers has the effect of making them into computers by expanding that category and articulating it to existing gendered information sensibilities; computing is demystified as "The Computer" becomes merely a device for externalizing and abstracting memory as information to be managed with technology. Proximities to computing—what I call the Knitting Needle Computer's nearly electronic status—provide one way that publics eased into widespread database cultures. Wheaton's transition from edge-notched cards to an Access database is a case in point. The Knitting Needle Computer figured users as physically capable of, and engaged with, the creation and manipulation of information using nearly electronic machines, and serves as a unique example of what "The Computer" meant within the 1960s public imagination. People did not necessarily understand how these machines worked, but associated them with social and technological progress.[34]

Edge-notched card systems were popular during a transitional stage in how institutions managed large quantities of information. The postwar introduction of mainframe computing allowed information storage and

retrieval to become more technologically complex than manual systems such as card catalogs allowed.[35] Using computer databases, information could be stored and sorted quickly, and across multiple categories. By the early 1970s, information technology corporations such as Santa Monica's RAND offered computerized indexing software for institutional use, and by the early 1990s, consumer-grade software such as the Microsoft Access program used by Wheaton became available.[36] During the 1960s, however, computing was the jurisdiction of technologically sophisticated institutions like universities, large corporations, or government agencies. The transition to widespread computing for amateur information management required technological change through the personal computer, but also pedagogical processes: ways of explaining to would-be users what computers could do.

The mass production of edge-notched systems by the mid-twentieth century responded to demand for mechanized systems that could make information retrieval instantaneous. Printed information proliferated in workplaces, libraries, institutions, and other contexts, ushering in an era of bureaucratic, scientific management, systems thinking, and emerging computational understandings of how information might be organized and used.[37] An indexing sensibility is part of this developing "scriptural economy" that media historian Lisa Gitelman attributes to changes in printing methods, the availability of cheap paper, and scholarly subspecialization.[38] Indexes and bibliographies represent a distinct genre of midcentury document, constituting "materials that inventory, describe, catalog, or otherwise facilitate control over other materials."[39]

As a transition period marking both technological change and an emerging information sensibility, this nearly electronic era positioned edge-notched card systems as a stepping-stone for those who could not otherwise access computer databases. Beyond hobbyist use, these systems were recommended for small organizations that needed to manage records collections. Leslie Axelrod makes this recommendation to engineers in his 1962 article "An Information Retrieval System for a Small Research Department." Axelrod writes, "after considering several alternatives, I finally decided on edge-notched cards because they are relatively inexpensive and convenient to manipulate and store."[40] Celebrating cards' simplicity and manipulability, Axelrod justifies his choice against the inaccessibility of computing for some: "the biggest lesson to be learned is that not every IR [Information Retrieval] System requires a digital computer and a full time staff. With only a modest investment in material and time, even a small research organization can have a workable information retrieval system."[41] Edge-notched systems

became a manual practice of resistance to digital computing in technical workplaces, promising good-enough information retrieval solutions that were, above all, affordable and usable by existing workers who need not be replaced or reskilled. Here, edge-notched card systems represent resistance to the new working conditions engendered by computing, in which subspecialization and systems administration inserted more layers of bureaucracy and distance between workers, their tools, and their colleagues. The warm, domestic sphere and joyful hobby cultures represented by edge-notched card kits did not match the sterile "digital computer and full time staff" to manage it that these engineers wanted to avoid.

Though hobbyists worked with information from home, they did so within the same scriptural economy as these engineers, drawing on the same techniques, whether as birders or recipe collectors. The small-scale systems described by Axelrod were developed and sold as kits for home users beginning in the early 1950s. A handful of companies mass-produced prefabricated edge-notched systems that amateurs could order by mail and adapt to their own needs (see figure 8.7). The Indecks kit advertised in the *Whole Earth Catalog*, along with the McBee system, are the most widely cited within instructional literature from the period.[42] These companies sold cards, sorting needles, and edge-notching punches, along with starter kits that contained all of these elements in a portable, plastic case that materialized the ready-to-hand tool status of the device. Starter kits also came with illustrated instruction booklets for using the deck, which reflected the product's amateur audience.[43] Needles sold with these sets came in bundles of five and were made specifically for the task of sorting cards. They were thinner and more like the precision-cut needles used in factory-based knitting machines than the thicker, coated metal, wood, or plastic knitting needles used in handicraft.[44] Collison's instructions for creating a DIY edge-notched system suggest that users appropriate actual knitting needles for the task and punch holes to match their size.

The Knitting Needle Computer was resolutely tactile because it placed computing in the hands and actions of its users; computing and needling are made equivalent. Edge-notched systems are further described in computational terms when information is "encoded" on them.[45] Punch encoding is more complex than simpler inscriptive techniques like shorthand because it requires machine sensibilities to be read: the needle instrument deciphers a predetermined punch code to cross-reference multiple cards, potentially across several categories, drawing associations that human memory can't make on its own. An adept edge-notched card user could brandish two

8.7 Indecks information retrieval system, Computer History Museum, Mountain View, California.

needles at once in order to extract cards with two data points in common, for example all the players in a softball league database whose names start with "M" (name category of holes) and play third base (position category of holes).

Knitting Needle Computer users did not just create information; they repaired it, using mending sensibilities also apparent in craft cultures. John Bryan's edge-notched system instructions include advice on performing repair.[46] As Bryan explains, "miscoding" was a common problem caused by "punching out the wrong hole or holes" on cards.[47] "Fortunately, the remedy is simple. Cut a strip of suitable size from another card and glue it in place."[48] Indecks sold prefabricated "Hole Repair Belts" to complement their kits.[49] Just as code could be written with a hole punch, and read with a knitting needle, it could be repaired with a little bit of glue and paper. Mispunching a card becomes an opportunity to demonstrate the easy manipulability of edge-notched cards; code could be rewritten with the simple application of a tiny, needle-blocking piece of paper, cut to size.

Information encoded on cards is parsed using conspicuously simple, gendered imagery. Not only were sorting needles described as "knitting needles," the phrase "peek-a-boo cards" (a game used to amuse babies) was sometimes attributed to these systems to illustrate how cards appeared out of a larger stack when sorted by needle.[50] While the Knitting Needle Computer could not parse large quantities of information, the machine still put into practice several rudimentary database functions including coding, mechanized storage and retrieval, and cross-referencing capabilities. Most importantly, the device made these functions visible and controllable, like reaching for the sugar on the pantry's top shelf. In other words, for computing to seem appealing and within reach to hobbyist information managers, men needed to be guided through these processes gently, not by their actual mothers and wives, but by their proxies: knitting needles and ordered pantries, or the women on McLuhan's cards.[51] These gendered techniques and imaginaries about media are critical to a feminist understanding of how information sensibilities emerge.

Conclusion

The amateur information manager figured by prepackaged card kits and edge-notched indexing instruction manuals enjoys leisure time devoted to bird watching or Dungeons and Dragons, hobbies that suggest lives free from the rigors of domestic work or child care. Knitting needles are tools this hobbyist does not own, but might borrow and repurpose, both literally from their wives, and figuratively through the gendered capital they offer. The Knitting Needle Computer promised this hobbyist accessibility, tactility, and mastery over information, all key components of an emerging information sensibility that included computing, during a period when women were the most common users of actual computers in workplaces. As Mar Hicks has shown, despite the prevalence of women as computer programmers during the midcentury, programming was feminized and cast as merely clerical, a practice of carrying out instructions issued by others using new business machines.[52] Knitting Needle Computer users, on the other hand, were creatives who used small-scale information systems to manage information of their own making.

For our media histories, when a new technology sits close to computing, we might need to look a bit sideways or askance to understand what that technology is doing with this proximity to actual computers; if the Knitting Needle Computer could only store and manage a small

quantity of information, often awkwardly, then it served other purposes within the computational imaginary. This tool drew on gendered capital to explain electronic information management in approachable terms, and to encourage amateurs to practice some of the database functions that would become commonplace by the 1980s and 1990s. New technologies and the transformations they bring require explanation. This was McLuhan's focus as a public intellectual in the 1960s. Though his analysis left women on cards and in the margins, the emergent understandings of media he described were bound up with gendered techniques such as knitting. Looking in these margins at minor objects like paper cards, it becomes clear that emergent information sensibilities drew on ideas about gender just as much as they did electricity, computers, and other tools.

Notes

1. Hird, "The DEW Line and Canada's Arctic Waste."

2. McLuhan and Zhang, "The DEW Line Card Deck as a Metagame," 242.

3. Mulvin, "Media Prophylaxis."

4. This point about the function of the figures on McLuhan's cards builds on Armond Towns's analysis of the Black body simultaneously present and excised by the "Western Man" concept undergirding McLuhan's media theories: Towns, "Toward a Black Media Philosophy."

5. , McLuhan, *Understanding Media*, 2001, 63–67.

6. McLuhan and Zhang, "The DEW Line Card Deck as a Metagame."

7. Mattern, "The Spectacle of Data."

8. Collison, *Indexes and Indexing*, 19.

9. Collison, *Indexes and Indexing*, 143.

10. Collison, *Indexes and Indexing*, 144.

11. Collison, *Indexes and Indexing*, 145, emphasis added.

12. For a history of these large-scale systems, see Heide, *Punch-Card Systems and the Early Information Explosion*.

13. Collison, *Indexes and Indexing*, 143.

14. Nakamura, "Indigenous Circuits," 933.

15. See Foskett, *A Guide to Personal Indexes*.

16. Using a different form of measurement, John Bryan suggests selecting a stack of no more than one and a half inches thick. Bryan, "A Multi-purpose Information Retrieval System," 404.

17. Bowker, "How to Be Universal," 116; see also Fred Turner's discussion of legitimacy exchange and closed loops of expertise in *From Counterculture to Cyberculture*, 25.

18. See Krajewski, *Paper Machines*, 13–14.

19. Krajewski, *Paper Machines*, emphasizes the relationship between sorting cards and weaving fibers to provide a media archaeological explanation for how new technologies emerge through the remediation of established practices.

20. Rosner, *Critical Fabulations*. See also Wolfinger, *Moonshot*; Fildes, "Weaving the Way to the Moon."

21. Nakamura, "Indigenous Circuits," 921, 926–27.

22. The talking-head-style documentary cited above (Wolfinger, *Moonshot*) features several male Apollo engineers telling the LOL weavers story according to this narrative strategy.

23. Carroll, "How Knitters Are Human Computers."

24. On craftsmanship, tactility, and skill, see Sennett, *The Craftsman.*

25. Collison, *Indexes and Indexing*, 12.

26. Classification work's construction as easy because women can do it has a longer history in library and information management cultures. See Garrison, "The Tender Technicians," 132. While these examples turn women indexers into abstractions, women made important contributions to the development of indexing systems: some of the earliest indexers were women, including Mary Petherbridge, whose book *The Technique of Indexing* (1904) was a popular early instructional manual. See Archibald, "Indexes, in Praise of."

27. Foskett, *A Guide to Personal Indexes*, 9.

28. Kevin Kelly's blog post on edge-notched card systems as "dead" media includes a lengthy comment section in which readers of the post relate their own uses of edge-notched cards, past and present. See Kelly, "One Dead Media."

29. On this counterculture technological aesthetic, see Turner, *From Counterculture to Cyberculture*.

30. Turner, *From Counterculture to Cyberculture*, 71.

31. Turner, *From Counterculture to Cyberculture*, 71–73.

32. *The Last Whole Earth Catalog*, 320, emphasis added. Kelly's blog post alerted me to this use of Indecks in the catalog.

33. Barbara Wheaton, quoted in Wilson, "The Archive of Eating." In this article, Wheaton says she transitioned to a Microsoft Access database in the 1980s; however, Access was not introduced until 1992.

34. See Peters, *How Not to Network a Nation*, especially chapters 1 and 2.

35. See Bourne and Hahn, *A History of Online Information Services*.

36. See RAND, *Specifications for the RAND Abstract and Index System*; Ware, *RAND and the Information Revolution*.

37. Robertson, "Learning to File."

38. Gitelman, *Paper Knowledge*, 54.

39. Gitelman, *Paper Knowledge*, 58.

40. Axelrod, "An Information Retrieval System," 92.

41. Axelrod, "An Information Retrieval System," 93.

42. Other suppliers included Information Retrieval Systems Inc. of Princeton, NJ. It was also possible, though quite labor intensive, to design one's own cards, as Collison suggests in *Indexes and Indexing*.

43. Indecks Research Deck Needle Sort Punched Card Kit, 1966, Catalog Item #102647065, Computer History Museum, Mountain View, California, http://www.computerhistory.org/collections/catalog/102647065.

44. Bryan, "A Multi-purpose Information Retrieval System," 407.

45. Bryan, "A Multi-purpose Information Retrieval System," 402.

46. Bryan, "A Multi-purpose Information Retrieval System," 406.

47. Bryan, "A Multi-purpose Information Retrieval System," 406.

48. Bryan, "A Multi-purpose Information Retrieval System," 406.

49. *The Last Whole Earth Catalog*, 320.

50. *The Last Whole Earth Catalog*, 402.

51. Mulvin, *Proxies.*

52. Hicks, *Programmed Inequality*.