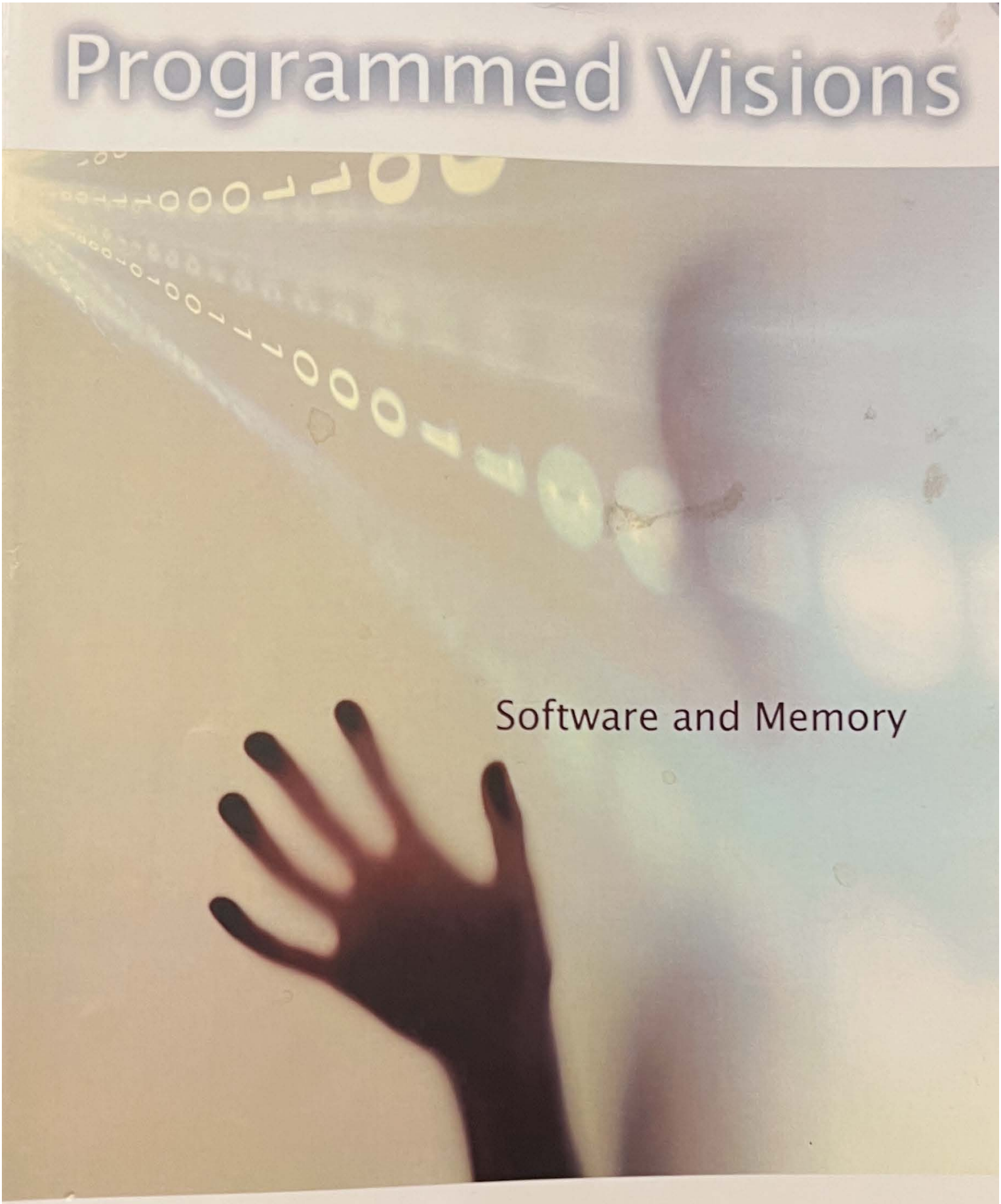
Programmed Visions



Software and Memory

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1 On Sourcery and Source Codes

The spirit speaks! I see how it must read,
And boldly write: "In the beginning was the Deed!"
—Johann Wolfgang Goethe[1]

Software emerged as a thing—as an iterable textual program—through a process of commercialization and commodification that has made code *logos*: code as source, code as true representation of action, indeed, code as conflated with, and substituting for, action.[2] Now, in the beginning, is the word, the instruction. Software as logos turns *program* into a noun—it turns process in time into process in (text) space. In other words, Manfred Broy's software "pioneers," by making software easier to visualize, not only sought to make the implicit explicit, they also created a system in which the intangible and implicit drives the explicit. They thus obfuscated the machine and the process of execution, making software the end all and be all of computation and putting in place a powerful logic of sourcery that makes source code—which tellingly was first called pseudocode—a fetish.[3]

This chapter investigates the implications of code as logos and the ways in which this simultaneous conflation and separation of instruction from execution, itself a software effect, is constantly constructed and undone, historically and theoretically. This separation is crucial to understanding the power and thrill of programming, in particular the nostalgic fantasy of an all-powerful programmer, a sovereign neoliberal subject who magically transforms words into things. It is also key to addressing the nagging doubts and frustrations experienced by programmers: the sense that we are slaves, rather than masters, clerks rather than managers—that, because "code is law," the code, rather than the programmer, rules. These anxieties have paradoxically led to the romanticization and recuperation of early female operators of the 1946 Electronic Numerical Integrator and Computer (ENIAC) as the first programmers, for they, unlike us, had intimate contact with and knowledge of the machine. They did not even need code: they engaged in what is now called "direct programming," wiring connections

and setting values. Back then, however, the "master programmer" was part of the machine (it controlled the sequence of calculation); computers, in contrast, were human. Rather than making programmers and users either masters or slaves, code as logos establishes a perpetual oscillation between the two positions: every move to empower also estranges.

This chapter, however, does not call for a return to direct programming or hardware algorithms, which, as I argue in chapter 4, also embody logos. It also does not endorse such a call because the desire for a "return" to a simpler map of power drives source code as logos. The point is not to break free from this sourcery, but rather to play with the ways in which logos also invokes "spellbinding powers of enchantment, mesmerizing fascination, and alchemical transformation."[4] The point is to make our computers more productively spectral by exploiting the unexpected possibilities of source code as fetish. As a fetish, source code produces surprisingly "deviant" pleasures that do not end where they should. Framed as a re-source, it can help us think through the machinic and human rituals that help us imagine our technologies and their executions. The point is also to understand how the surprising emergence of code as logos shifts early and still-lingering debates in new media studies over electronic writing's relation to poststructuralism, debates that the move to software studies has to some extent sought to foreclose.[5] Rather than seeing technology as simply fulfilling or killing theory, this chapter outlines how the alleged "convergence" between theory and technology challenges what we thought we knew about logos. Relatedly, engaging source code as fetish does not mean condemning software as immaterial; rather, it means realizing the extent to which software, as an "immaterial" relation become thing, is linked to changes in the nature of subject-object relations more generally. Software as thing can help us link together minute machinations and larger flows of power, but only if we respect its ability to surprise and to move.

Source Code as Logos

To exaggerate slightly, software has recently been posited as the essence of new media and knowing software a form of enlightenment. Lev Manovich, in his groundbreaking *The Language of New Media*, for instance, asserts: "New media may look like media, but this is only the surface. . . . To understand the logic of new media, we need to turn to computer science. It is there that we may expect to find the new terms, categories, and operations that characterize media that become programmable. *From media studies, we move to something that can be called 'software studies'—from media theory to software theory.*"[6] This turn to software—to the logic of what lies beneath—has offered a solid ground to new media studies, allowing it, as Manovich argues, to engage presently existing technologies and to banish so-called "vapor theory"—theory that fails to distinguish between demo and product, fiction and reality—to the margins.[7]

This call to banish vapor theory, made by Geert Lovink and Alexander Galloway among others, has been crucial to the rigorous study of new media, but this rush away from what is vapory—undefined, set in motion—is also troubling because vaporiness is not accidental but rather essential to new media and, more broadly, to software. Indeed, one of this book's central arguments is that a rigorous engagement with software makes new media studies more, rather than less, vapory. Software, after all, is ephemeral, information ghostly, and new media projects that have never, or barely, materialized are among the most valorized and cited.[8] (Also, if you take the technical definition of information seriously, information increases with vapor, with entropy). This turn to computer science also threatens to reify knowing software as truth, an experience that is arguably impossible: we all know some software, some programming languages, but does anyone really "know" software? What could this knowing even mean? Regardless, from myths of all-powerful hackers who "speak the language of computers as one does a mother tongue"[9] or who produce abstractions that release the virtual[10] to perhaps more mundane claims made about the radicality of open source, knowing (or using the right) software has been made analogous to man's release from his self-incurred tutelage.[11] As advocates of free and open source software make clear, this critique aims at political, as well as epistemological, emancipation. As a form of enlightenment, it is a stance of how not to be governed like that, an assertion of an essential freedom that can only be curtailed at great cost.[12]

Knowing software, however, does not simply enable us to fight domination or rescue software from "evil-doers" such as Microsoft. Software, free or not, is embedded and participates in structures of knowledge-power. For instance, using free software does not mean escaping from power, but rather engaging it differently, for free and open source software profoundly privatizes the public domain: GNU copyleft—which allows one to use, modify, and redistribute source code and derived programs, but only if the original distribution terms are maintained—seeks to fight copyright by spreading licences everywhere.[13] More subtly, the free software movement, by linking freedom and freely accessible source code, amplifies the power of source code both politically and technically. It erases the vicissitudes of execution and the institutional and technical structures needed to ensure the coincidence of source code and its execution. This amplification of the power of source code also dominates critical analyses of code, and the valorization of software as a "driving layer" conceptually constructs software as neatly layered.

Programmers, computer scientists, and critical theorists have reduced software to a recipe, a set of instructions, substituting space/text for time/process. The current common-sense definition of *software* as a "set of instructions that direct a computer to do a specific task" and the OED definition of software as "the programs and procedures required to enable a computer to perform a specific task, as opposed to the physical components of the system" both posit software as cause, as what drives

computation. Similarly, Alexander Galloway argues, "code draws a line between what is material and what is active, in essence saying that writing (hardware) cannot *do* anything, but must be transformed into code (software) to be effective. . . . Code is a language, but a very special kind of language. *Code is the only language that is executable* . . . code is the first language that actually does what it says."[14] This view of software as "actually doing what it *says*" (emphasis added) both separates instruction from, and makes software substitute for, execution. It assumes no difference between source code and execution, between instruction and result. That is, Galloway takes the principles of executable layers (application on top of operating system, etc.) and grafts it onto the system of compilation or translation, in which higher-level languages are transformed into executable codes that are then executed line by line. By doing what it "says," code is surprisingly logos. Like the King's speech in Plato's *Phaedrus*, it does not pronounce knowledge or demonstrate it—it transparently pronounces itself.[15] The hidden signified—meaning—shines through and transforms itself into action. Like Faust's translation of logos as "deed," code is action, so that "in the beginning was the Word, and the Word was with God, and the Word was God."[16]

Not surprisingly, many scholars critically studying code have theorized code as performative. Drawing in part from Galloway, N. Katherine Hayles in *My Mother Was a Computer: Digital Subjects and Literary Texts* distinguishes between the linguistic performative and the machinic performative, arguing:

> Code that runs on a machine is performative in a much stronger sense than that attributed to language. When language is said to be performative, the kinds of actions it "performs" happen in the minds of humans, as when someone says "I declare this legislative session open" or "I pronounce you husband and wife." Granted, these changes in minds can and do reach in behavioral effects, but the performative force of language is nonetheless tied to the external changes through complex chains of mediation. By contrast, code running in a digital computer causes changes in machine behavior and, through networked ports and other interfaces, may initiate other changes, all implemented through transmission and execution of code.[17]

The independence of machine action—this autonomy, or automatic executability of code—is, according to Galloway, its material essence: "The material substrate of code, which must always exist as an amalgam of electrical signals and logical operations in silicon, however large or small, demonstrates that code exists first and foremost as commands issued to a machine. Code essentially has no other reason for being than instructing some machine in how to act. One cannot say the same for the natural languages."[18] Galloway thus concludes in "Language Wants to Be Overlooked: On Software and Ideology," "to see code as subjectively performative or enunciative is to anthropomorphize it, to project it onto the rubric of psychology, rather than to understand it through its own logic of 'calculation' or 'command.'"[19]

To what extent, however, can source code be understood outside of anthropomorphization? Does understanding voltages stored in memory as commands/code not

already anthropomorphize the machine? The title of Galloway's article, "Language *Wants* to Be Overlooked" (emphasis mine), inadvertently reveals the inevitability of this anthropomorphization. How can code/language want—or most revealingly *say*—anything? How exactly does code "cause" changes in machine behavior? What mediations are necessary for this insightful yet limiting notion of code as inherently executable, as conflating meaning and action?

Crafty Sources

To make the argument that code is automatically executable, the process of execution itself not only must be erased, but source code must also be conflated with its executable version. This is possible, Galloway argues, because the two "layers" of code can be reduced to each other: "uncompiled source code is *logically* equivalent to that same code compiled into assembly language and/or linked into machine code. For example, it is absurd to claim that a certain value expressed as a hexadecimal (base 16) number is more or less fundamental than that same value expressed as binary (base 2) number. They are simply two expressions of the same value."[20] He later elaborates on this point by drawing an analogy between quadratic equations and software layers:

> One should never understand this "higher" symbolic machine as anything empirically different from the "lower" symbolic interactions of voltages through logic gates. They are complex aggregates yes, but it is foolish to think that writing an "if/then" control structure in eight lines of assembly code is any more or less machinic than doing it in one line of C, just as the same quadratic equation may swell with any number of multipliers and still remain balanced. The relationship between the two is *technical*.[21]

According to Galloway's quadratic equation analogy, the difference between a compact line of higher-level programming code and eight lines written in assembler equals the difference between two equations, in which one contains coefficients that are multiples of the other. The solution to both equations is the same: one equation is the same as the other.

This reduction, however, does not capture the difference between the various instantiations of code, let alone the empirical difference between the higher symbolic machine and the lower interactions of voltages (the question here is: where does one make the empirical observation?). To state the obvious, one cannot run source code: it must be compiled or interpreted. This compilation or interpretation—this making executable of code—is not a trivial action; the compilation of code is not the same as translating a decimal number into a binary one. Rather, it involves instruction explosion and the translation of symbolic into real addresses. Consider, for example, the instructions needed for adding two numbers in PowerPC assembly language, which is one level higher than machine language:

```
li      r3,1          *load the number 1 into register 3
li      r4,2          *load the number 2 into register 4
add     r5,r4,r3      *add r3 to r4 and store the result in r5
stw     r5,sum(rtoc)  *store the contents of r5 (i.e., 3) into the memory location
                      *called "sum" (where sum is defined elsewhere)
blr                   *end of this snippet of code[22]
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This explosion is not equivalent to multiplying both sides of a quadratic equation by the same coefficient or to the difference between E and 15. It is, instead, a breakdown of the steps needed to perform a simple arithmetic calculation; it focuses on the movement of data within the machine. The relationship between executable and higher-level code is not that of mathematical identity but rather logical equivalence, which can involve a leap of faith. This is clearest in the use of numerical methods to turn integration—a function performed fluidly in analog computers—into a series of simpler, repetitive arithmetical steps.

This translation from source code to executable is arguably as involved as the execution of any command, and it depends on the action (human or otherwise) of compiling/interpreting and executing. Also, some programs may be executable, but not all compiled code within that program is executed; rather, lines are read in as necessary. Software is "layered" in other words, not only because source is different from object, but also because object code is embedded within an operating system.

So, to spin Galloway's argument differently, a technical relation is far more complex than a numerical one. Rhetoric was considered a *technê* in antiquity. Drawing on this Paul Ricoeur explains, "*technê* is something more refined than a routine or an empirical practice and in spite of its focus on production, it contains a speculative element."[23] A technical relation engages art or craft. A technical person is one "skilled in or practically conversant with some particular art or subject."[24] Code does not always or automatically do what it says, but it does so in a crafty, speculative manner in which meaning and action are both created. It carries with it the possibility of deviousness: our belief that compilers simply expand higher-level commands—rather than alter or insert other behaviors—is simply that, a belief, one of the many that sustain computing as such. This belief glosses over the fact that *source code only becomes a source after the fact*. Execution, and a whole series of executions, belatedly makes some piece of code a source, which is again why source code, among other things, was initially called pseudocode.

Source code is more accurately a *re-source*, rather than a source. Source code becomes the source of an action only after it—or more precisely its executable substitute—expands to include software libraries, after its executable version merges with code burned into silicon chips; and after all these signals are carefully monitored, timed,

and rectified. Source code becomes a source only through its destruction, through its simultaneous nonpresence and presence.[25] (Thus, to return to the historical difficulties of analyzing software outlined by Mahoney, every software run is to some extent a reconstruction.) Source code as *technê*, as a generalized writing, is spectral. It is neither dead repetition nor living speech; nor is it a machine that erases the difference between the two. It, rather, puts in place a "relation between life and death, between present and representation, between two apparatuses."[26] As I elaborate throughout this book, information—through its capture in memory—is undead.

Source Code, after the Fact

Early on, the difficulties of code as source were obvious. Herman H. Goldstine and John von Neumann emphasized the dynamic nature of code in their "Planning and Coding of Problems for an Electronic Computing Instrument." In it, they argued that coding, despite the name, is not simply the static translation of "a meaningful text (the instructions that govern solving the problem under consideration) from one language (the language of mathematics, in which the planner will have conceived the problem, or rather the numerical procedure by which he has decided to solve the problem) into another language (that of our code)."[27] Because code does not unfold linearly, because its value depends on intermediate results, and because code can be modified as it is run (self-modifying code), "it will not be possible in general to foresee in advance and completely the actual course of C [the sequence of codes]." Therefore, "coding is . . . the technique of providing a dynamic background to control the automatic evolution of a meaning."[28] Code as "dead repetition," in other words, has always been regenerative and interactive; every iteration alters its meaning. Even given the limits to iterability that Hayles has presciently outlined in *My Mother Was a Computer*—limits due to software as axiomatic—coding still means producing a mark, a writing, open to alteration/iteration rather than an airtight anchor.[29]

Much disciplinary effort has been required to make source code readable as the source. Structured programming, which I examine in more detail later, sought to rein in "goto crazy" programmers and self-modifying code. A response to the much-discussed "software crisis" of the late 1960s, its goal was to move programming from a craft to a standardized industrial practice by creating disciplined programmers who dealt with abstractions rather than numerical processes.[30]

Making code the source also entails reducing hardware to memory and thus erasing the existence and possibility of hardware algorithms. Code is also not always the source because hardware does not need software to "do something." One can build algorithms using hardware. Figure 1.1, for instance, is the logical statement: if notB and notA, do CMD1 (state P); if notB and notA and notZ OR B and A (state Q) then command 2.

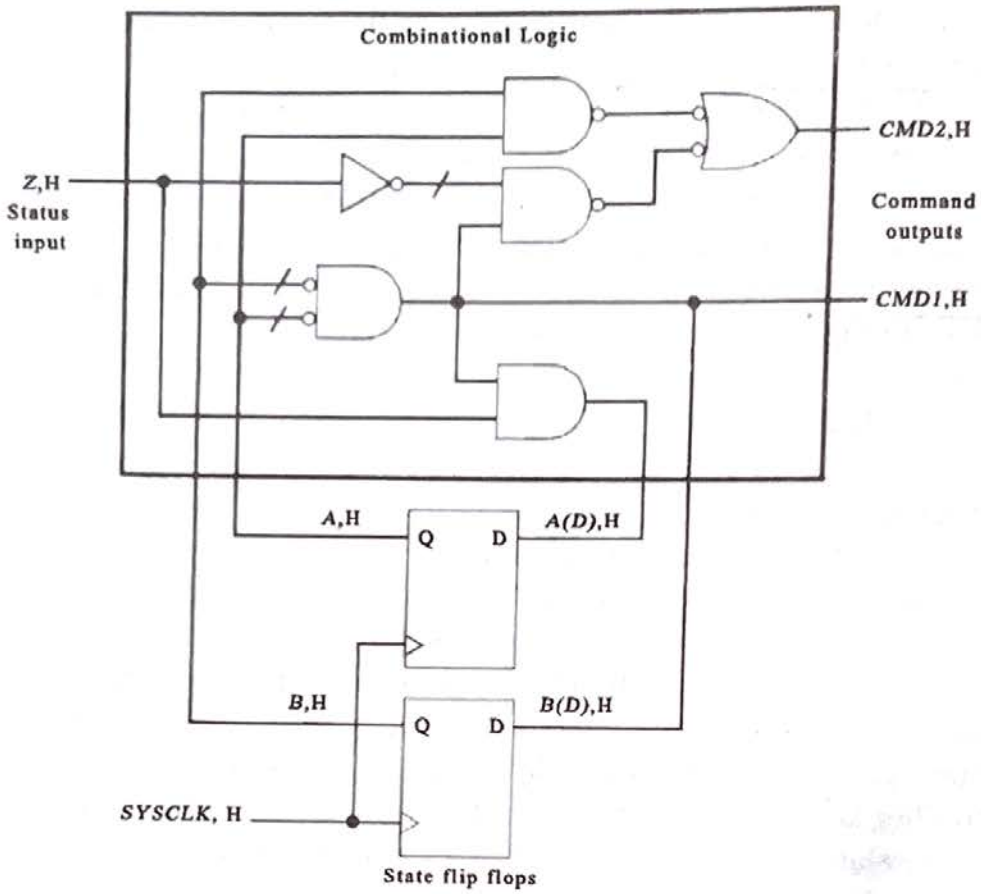

Figure 1.1
Logic diagram for a hardware algorithm

To be clear, I am not valorizing hardware over software, as though hardware naturally escapes this drive to make space signify time. Crucially, this schematic is itself an abstraction. Logic gates can only operate "logically"—as logos—if they are carefully timed. As Philip Agre has emphasized, the digital abstraction erases the fact that gates have "directionality in both space (listening to its inputs, driving its outputs) and in time (always moving toward a logically consistent relation between these inputs and outputs)."[31] When a value suddenly changes, there is a brief period in which a gate will give a false value. In addition, because signals propagate in time over space, they produce a magnetic field that can corrupt other nearby signals (known as *crosstalk*). This schematic erases all these various time- and distance-based effects by rendering space blank, empty, and banal. Thus hardware schematics, rather than escaping from the logic of sourcery, are also embedded within this structure. Indeed, as chapter 4 elaborates, John von Neumann, the generally acknowledged architect of the stored-memory digital computer, drew from Warren McCulloch and Walter Pitts's conflation of neuronal activity with its inscription in order to conceptualize modern computers. It is perhaps appropriate then that von Neumann, who died from a cancer stemming

from his work at Los Alamos, spent the last days of his life reciting from memory *Faust Part 1*.[32] At the source of stored program computing lies the Faustian erasure of word for action.

The notion of source code as source coincides with the introduction of alphanumeric languages. With them, human-written, nonexecutable code becomes source code and the compiled code, the object code. Source code thus is arguably symptomatic of human language's tendency to attribute a sovereign source to an action, a subject to a verb.[33] By converting action into language, source code emerges. Thus, Galloway's statement, "To see code as subjectively performative or enunciative is to anthropomorphize it, to project it onto the rubric of psychology, rather than to understand it through its own logic of 'calculation' or 'command,'" overlooks the fact that to use higher-level alphanumeric languages is already to anthropomorphize the machine. It is to embed computers in "logic" and to reduce all machinic actions to the commands that supposedly drive them. In other words, the fact that "code is law"—something legal scholar Lawrence Lessig emphasizes—is hardly profound.[34] After all, code is, according to the OED, "a systematic collection or digest of the laws of a country, or of those relating to a particular subject." What is surprising is the fact that software is code; that code is—has been made to be—executable, and this executability makes code not law, but rather every lawyer's dream of what law should be: automatically enabling and disabling certain actions, functioning at the level of everyday practice.[35]

Code is executable because it embodies the power of the executive, the power of enforcement that has traditionally—even within classic neoliberal logic—been the provenance of government.[36] Whereas neoliberal economist and theorist Milton Friedman must concede the necessity of government because of the difference between "the day-to-day activities of people [and] the general customary and legal framework within which these take place," code as self-enforcing law "privatizes" this function, further reducing the need for government to enforce the rules by which we play.[37] In other words, if as Foucault argues neoliberalism expands judicial interventions by reducing laws to "the rules for a game in which each remains master regarding himself and his part," then "code is law" reins in this expansion by moving enforcement from police and judicial functions to software functions.[38] "Code is law," in other words, automatically brings together disciplinary and sovereign power through the production of self-enforcing rules that, as von Neumann argues, "govern" a situation.

"Code is law" makes clear the desire for sovereign power driving both source code and performative utterances more generally. David Golumbia—looking more generally at widespread beliefs about computers—has insightfully claimed: "The computer encourages a Hobbesian conception of this political relation: one is either the person who makes and gives orders (the sovereign), or one follows orders."[39]

This conception, which crucially is also constantly undone by modern computation's twinning of empowerment with ignorance, depends, I argue, on this conflation of code with the performative. As Judith Butler has argued in *Excitable Speech*, Austinian understandings of performative utterances as simply doing what they say posit the speaker as "the judge or some other representative of the law."[40] It resuscitates fantasies of sovereign—that is *executive* (hence executable)—structures of power: it is "a wish to return to a simpler and more reassuring map of power, one in which the assumption of sovereignty remains secure."[41] This wish for a simpler map of power—indeed power as mappable—drives not only code as automatically executable, but also, as the next chapter contends, interfaces more generally. This wish is central to computers as machines that enable users/programmers to navigate neoliberal complexity.

Against this nostalgia, Butler, following Jacques Derrida, argues that iterability lies behind the effectiveness of performative utterances. For Butler, iterability is the process by which "*the subject who 'cites' the performative is temporarily produced as the belated and fictive origin of the performative itself.*"[42] The programmer/user, in other words, is produced through the act of programming. Moreover, the effectiveness of performative utterances, Butler also emphasizes, is intimately tied to the community one joins and to the rituals involved—to the history of that utterance. Code as law—as a judicial process—is, in other words, far more complex than code as logos. Similarly, as Weizenbaum has argued, code understood as a judicial process undermines the control of the programmer:

> A large program is, to use an analogy of which Minsky is also fond, an intricately connected network of courts of law, that is, of subroutines, to which evidence is transmitted by other subroutines. These courts weigh (evaluate) the data given to them and then transmit their judgments to still other courts. The verdicts rendered by these courts may, indeed, often do, involve decisions about what court has "jurisdiction" over the intermediate results then being manipulated. The programmer thus cannot even know the path of decision-making within his own program, let alone what intermediate or final results it will produce. Program formulation is thus rather more like the creation of a bureaucracy than like the construction of a machine of the kind Lord Kelvin may have understood.[43]

Code as a judicial process is code as *thing*: the Latin term for thing, *res*, survives in legal discourse (and, as I explain later, literary theory). The term *res*, as Heidegger notes, designates a "gathering," any thing or relation that concerns man.[44] The relations that Weizenbaum discusses, these bureaucracies within the machine, as the rest of this chapter argues, mirror the bureaucracies and hierarchies that historically made computing possible. Importantly, this description of computers as following a set of rules that programmers must follow—Weizenbaum's insistence on the programmer's ignorance—does not undermine the resonances between neoliberalism and computation; if anything, it makes these resonances more clear. It also clarifies the desire

driving code as logos as a solution to neoliberal chaos. Foucault, emphasizing the rhetoric of the economy as a "game" in neoliberal writings, has argued, "both for the state and for individuals, the economy must be a game: a set of regulated activities . . . in which the rules are not decisions which someone takes for others. It is a set of rules which determine the way in which each must play a game whose outcome is not known by anyone."[45] Although small-s sovereigns proliferate through neoliberalism's empowered yet endangered subjects, it still fundamentally denies the position of the Sovereign who knows—a position that we nonetheless nostalgically desire . . . for ourselves.

Yes, Sir!

This conflation of instruction with result stems in part from software's and computing's gendered, military history: in the military there is supposed to be no difference between a command given and a command completed—especially to a computer that is a "girl." For computers, during World War II, were in fact young women with some background in mathematics. Not only were women available for work during that era, they also were considered to be better, more conscientious computers, presumably because they were better at repetitious, clerical tasks. They were also undifferentiated: they were all unnamed "computers," regardless of their mathematical training.[46] These computers produced ballistics tables for new weapons, tables designed to control servicemen's battlefield actions. Rather than aiming and shooting, servicemen were to set their guns to the proper values (not surprisingly, these tables and gun governors were often ignored or ditched by servicemen).[47]

The women who became the "ENIAC girls" (later the more politically correct "women of the ENIAC")—Kathleen/Kay McNulty (Mauchly Antonelli), Jean Jennings (Bartik), Frances Snyder (Holberton), Marlyn Wescoff (Meltzer), Frances Bilas (Spence), and Ruth Lichterman (Teitelbaum) (married names in parentheses)—were computers who volunteered to work on a secret project (when they learned they would be operating a machine, they had to be reassured that they had not been demoted). Programmers were former computers because they were best suited to prepare their successors: they thought and acted like computers. One could say that programming became programming and software became software when the command structure shifted from commanding a "girl" to commanding a machine. Kay Mauchly Antonelli described the "evolution" of computing as moving from female computers using Marchant machines to fill in fourteen-column sheets (which took forty hours to complete the job), to using differential analyzers (fifteen minutes to do the job), to using the ENIAC (seconds).[48]

Software languages draw from a series of imperatives that stem from World War II command and control structures. The automation of command and control, which

Paul Edwards has identified as a perversion of military traditions of "personal leadership, decentralized battlefield command, and experience-based authority,"[49] arguably started with World War II mechanical computation. Consider, for instance, the relationship between the volunteer members of the Women's Royal Naval Service (called Wrens), and their commanding officers at Bletchley Park. The Wrens also (perhaps ironically) called *slaves* by the mathematician and "founding" computer scientist Alan Turing (a term now embedded within computer systems), were clerks responsible for the mechanical operation of the cryptanalysis machines (the Bombe and then the Colossus), although at least one of the clerks, Joan Clarke (Turing's former fiancé), became an analyst. Revealingly, I. J. Good, a male analyst, describes the Colossus as enabling a man–machine synergy duplicated by modern machines only in the late 1970s: "the analyst would sit at the typewriter output and call out instructions to a Wren to make changes in the programs. Some of the other uses were eventually reduced to decision trees and were handed over to the machine operators (Wrens)."[50] This man–machine synergy, or interactive real-time (rather than batch) processing, treated Wrens and machines indistinguishably, while simultaneously relying on the Wrens' ability to respond to the mathematician's orders. This "interactive" system also seems evident in the ENIAC's operation: in figure 1.2, a male analyst issues commands to a female operator.

The story of the initial meeting between Grace Murray Hopper (one of the first and most important programmer-mathematicians) and Howard Aiken would also seem to buttress this narrative. Hopper, with a PhD in mathematics from Yale, and a former mathematics professor at Vassar, was assigned by the U.S. Navy to program the Mark 1, an electromechanical digital computer that made a sound like a roomful of knitting needles. According to Hopper, Aiken showed her "a large object with three stripes . . . waved his hand and said: 'That's a computing machine.' I said, 'Yes, Sir.' What else could I say? He said he would like to have me compute the coefficients of the arc tangent series, for Thursday. Again, what could I say? 'Yes, Sir.' I didn't know what on earth was happening, but that was my meeting with Howard Hathaway Aiken."[51] Computation depends on "Yes, Sir" in response to short declarative sentences and imperatives that are in essence commands. Contrary to Neal Stephenson, in the beginning—marking the possibility of a beginning—was the command rather than the command line.[52] The command line is a mere operating system (OS) simulation. Commands have enabled the slippage between programming and action that makes software such a compelling yet logically "trivial" communications system.[53] Commands lie at the core of the cybernetic conflation of human with machine.[54] I. J. Good's and Hopper's recollections also reveal the routinization at the core of programming: the analyst's position at Bletchley Park was soon replaced by decision trees acted on by the Wrens. Hopper, self-identified as a mathematician (not programmer), became an advocate of automatic programming. Thus routinization or automation lies at the

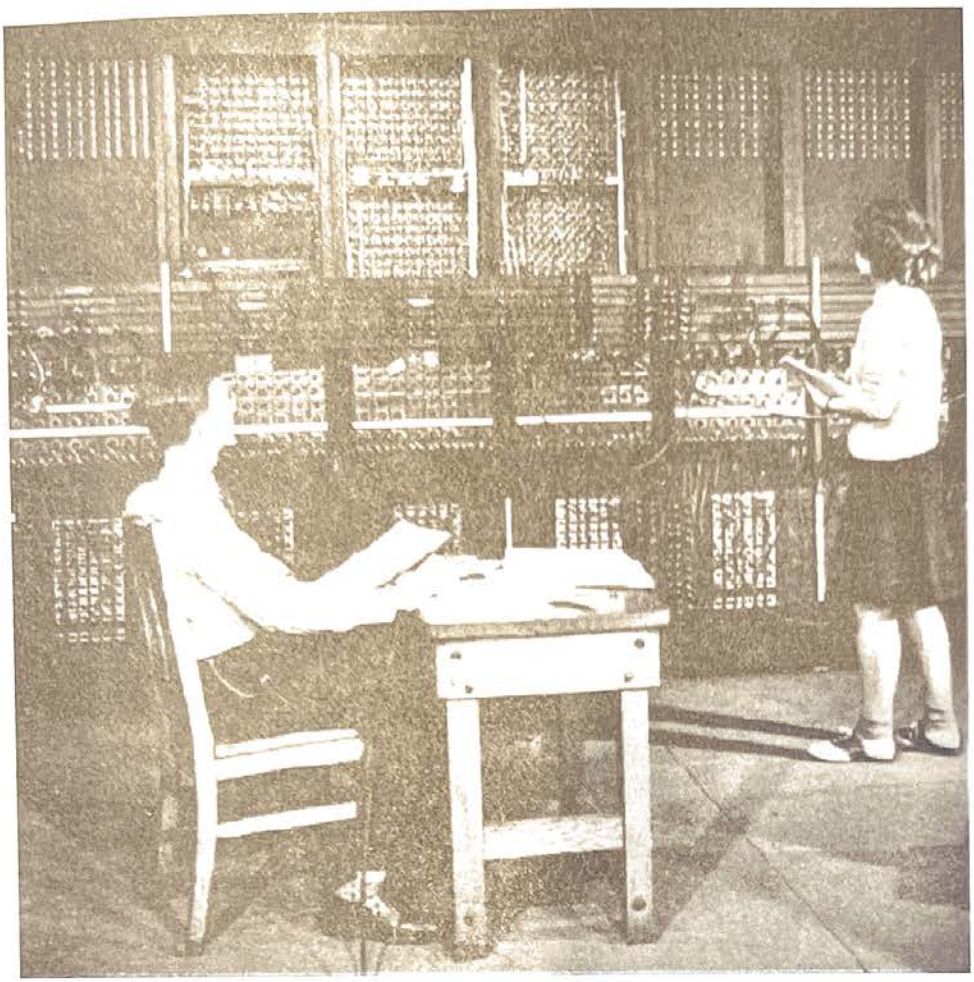

Figure 1.2
ENIAC programmers, late 1940s. U.S. military photo, Redstone Arsenal Archives, Huntsville, Alabama.

core of a profession that likes to believe it has successfully automated every profession but its own.[55]

This narrative of the interchangeability of women and software, however, is not entirely true: the perspective of the master, as Hegel famously noted, is skewed. (Tellingly, Mephistopheles offers to be Faust's servant.)[56] The master depends on the slave entirely, and it is the slave's actions that make possible another existence. Execution is never simple. Hopper's "Yes, Sir" actually did follow in the military command tradition. It was an acceptance of responsibility; she was not told how to calculate the trajectory. Also, the "women of the ENIAC," although an afterthought, played an important role in converting the ENIAC into a stored-program computer and in determining the trade-off between storing values and instructions: they did not simply operate the machine, they helped shape it and make it functional.[57] Users of the ENIAC usually were divided into pairs: one who knew the problem and one who knew the

machine "so the limitations of the machine could be fitted to the problem and the problem could be changed to fit the limitations."[58] Programming the ENIAC—that is, wiring the components together in order to solve a problem—was difficult, especially since there were no manuals or exact precedents.[59] To solve a problem, such as how to determine ballistics trajectories for new weapons, ENIAC "programmers" had first to break down the problem logically into a series of small yes/no decisions; "the amount of work that had to be done before you could ever get to a machine that was really doing any thinking," Bartik relates, was staggering and annoying.[60] The unreliability of the hardware and the fact that engineers and custodians would unexpectedly change the switches and program cables compounded the difficulty.[61]

These women, Holberton in particular, developed an intimate relation with the "master programmer," the ENIAC's control device. Although Antonelli first figured out how to repeat sections of the program, using the master programmer, Holberton, who described herself as a logician, specialized in controlling its operation.[62] As Bartik explains:

> We found it very easy to learn that you do this step, step one, then you do step two, step three, but I think the thing that was the hardest for us to learn was transfer of control which the ENIAC did have through the master programmer, so that you would be able to repeat pieces of program. So, the techniques for dividing your program into subroutines that could be repeated and things of this kind was the hardest for us to understand. I certainly know it was for me.[63]

Because logic diagrams did not then exist, Holberton developed a four-color pencil system to visualize the workings of the master programmer.[64] This drive to visualize also extended to the machine as a whole. To track the calculation, holes were drilled in the panels over the accumulators so that "when you were doing calculations these lights were flashing as the numbers built up and as you transferred numbers and things of this kind. So you had the feeling of excitement."[65] These lights not only were useful in tracking the machine, they also were invaluable for the demonstration. Even though the calculation for the demonstration was itself buggy, the flashing lights, the cards being read and written, gave the press a (to them) incomprehensible visual display of the enormity and speed of the calculation being done. In what would become a classic programming scenario, the problem was "debugged" the day after the demonstration. According to Holberton:

> I think the next morning, I woke up and in the middle of the night thinking what that error was. I came in, made a special trip on the early train that morning to look at a certain wire, and you know, it's the same kind of programming error that people make today. It's the, the decision on the terminal end of a do loop, speaking Fortran language, had the wrong value. Forgetting that zero was also one setting and the setting of the switch was one off. And I'll never forget that because there it was my first do loop error. But it went on that way and I remember telling Marlyn, I said, "If anybody asks why it's printing out that way, say it's supposed to be that way." [Laughter][66]

Programming enables a certain duplicity, as well as the possibility of endless actions that animate the machine. Holberton, described by Hopper as the best programmer she had known, would also go on to develop an influential SORT algorithm for the UNIVAC 1 (the Universal Automatic Computer 1, a commercial offshoot of the ENIAC).[67] Indeed, many of these women were hired by the Eckert–Mauchly company to become the first programmers of the UNIVAC, and were transferred to Aberdeen to train more ENIAC programmers.

Drawing from the historical importance of women and the theoretical resonances between the feminine and computing (parallels between programming and what Freud called the quintessentially feminine invention of weaving, between female sexuality as mimicry and Turing's vision of computers as universal machines/mimics) Sadie Plant has argued that computing is essentially feminine. Both software and feminine sexuality reveal the power that something that cannot be seen can have.[68] Women, Plant argues, "have not merely had a minor part to play in the emergence of digital machines. . . . Theirs is not a subsidiary role which needs to be rescued for posterity, a small supplement whose inclusion would set the existing records straight. . . . Hardware, software, wetware—before their beginnings and beyond their ends, women have been the simulators, assemblers, and programmers of the digital machines."[69] Because of this and women's early (forced) adaptation to "flexible" work conditions, Plant argues, women are best prepared to face our digital, networked future: "sperm count," she writes, "falls as the replicants stir and the meat learns how to learn for itself. Cybernetics is feminisation."[70] Responding to Plant's statement, Alexander Galloway has argued, "the universality of [computer] protocol can give feminism something that it never had at its disposal, the obliteration of the masculine from beginning to end."[71] Protocol, Galloway asserts, is inherently antipatriarchy. What, however, is the relationship between feminization and feminism, between so-called feminine modes of control and feminism? What happens if you take seriously Grace Murray Hopper's claims that the term *software* stemmed from her description of compilers as "layettes" for computers and the claim of J. Chuan Chu, one of the hardware engineers for the ENIAC, that software is the "daughter" of Frankenstein (hardware being the son)?[72]

To address these questions, we need to move beyond recognizing these women as programmers and the resonances between computers and the feminine. Such recognition alone establishes a powerful sourcery, in which programming is celebrated at the exact moment that programmers become incapable of "understanding"—of seeing through—the machine. The move to reclaim the ENIAC women as the first programmers in the mid- to late-1990s occurred when their work as operators—and the visual, intimate knowledge of machine operations this entailed—had become entirely incorporated into the machine and when women "coders" were almost definitively pushed out of the workplace. It is love at last (and first) sight, not just for these women but also for these interfaces, which really were transparent holes, in which inside and

Source Code as Fetish

Source code as source means that software functions as an axiom, as "a self-evident proposition requiring no formal demonstration to prove its truth, but received and assented to as soon as it is mentioned."[147] In other words, whether or not source code is only a source after the fact or whether or not software can be physically separated from hardware,[148] software is always posited as already existing, as the self-evident ground or source of our interfaces. Software is axiomatic. As a first principle, it fastens in place a certain neoliberal logic of cause and effect, based on the erasure of execution and the privileging of programming that bleeds elsewhere and stems from elsewhere as well.[149] As an axiomatic, it, as Gilles Deleuze and Félix Guattari argue, artificially limits decodings.[150] It temporarily limits what can be decoded, put into motion, by setting up an artificial limit—the artificial limit of programmability—that seeks to separate information from entropy, by designating some entropy information and other "non-intentional" entropy noise. Programmability, discrete computation, depends on the disciplining of hardware and programmers, and the desire for a programmable axiomatic code. Code, however, is a medium in the full sense of the word. As a

medium, it channels the ghost that we imagine runs the machine—that we see as we don't see—when we gaze at our screen's ghostly images.

Understood this way, source code is a fetish. According to the OED, a fetish was originally an ornament or charm worshipped by "primitive peoples . . . on account of its supposed inherent magical powers."[151] The term *fetisso* stemmed from the trade of small wares and magic charms between the Portuguese merchants and West Africans; Charles de Brosses coined the term *fetishism* to describe "primitive religions" in 1757. According to William Pietz, Enlightenment thinkers viewed fetishism as a "false causal reasoning about physical nature" that became "the definitive mistake of the pre-enlightened mind: it superstitiously attributed intentional purpose and desire to material entities of the natural world, while allowing social action to be determined by the . . . wills of contingently personified things, which were, in truth, merely the externalized material sites fixing people's own capricious libidinal imaginings."[152] That is, fetishism, as "primitive causal thinking," derived causality from "things"—in all the richness of this concept—rather than from reason:

> Failing to distinguish the intentionless natural world known to scientific reason and motivated by practical material concerns, the savage (so it was argued) superstitiously assumed the existence of a unified causal field for personal actions and physical events, thereby positing reality as subject to animate powers whose purposes could be divined and influenced. Specifically, humanity's belief in gods and supernatural powers (that is, humanity's unenlightenment) was theorized in terms of prescientific peoples' substitution of imaginary personifications for the unknown physical causes of future events over which people had no control and which they regarded with fear and anxiety.[153]

A fetish allows one to visualize what is unknown—to substitute images for causes. Fetishes allow the human mind both too much and not enough control by establishing a "unified causal field" that encompasses both personal actions and physical events. Fetishes enable a semblance of control over future events—a possibility of influence, if not an airtight programmability—that itself relies on distorting real social relations into material givens.

This notion of fetish as false causality has been most important to Karl Marx's diagnosis of capital as fetish. Marx famously argued:

> the commodity-form . . . is nothing but the determined social relation between men themselves which assumes here, for them, the phantasmagoric form of a relation between things. In order, therefore, to find an analogy we must take a flight into the misty realm of religion. There the products of the human head appear as autonomous figures endowed with a life of their own, which enter into relations both with each other and with the human race. So it is in the world of commodities with the products of men's hands. I call this the . . . fetishism.[154]

The capitalist thus confuses social relations and the labor activities of real individuals with capital and its seemingly magical ability to reproduce. For, "it is in interest-

bearing capital . . . that capital finds its most objectified form, its pure fetish form. . . . Capital—as an entity—appears here as an independent source of value; a something that creates value in the same way as land [produces] rent, and labor wages."[155] Both these definitions of fetish also highlight the relation between things and men: men and things are not separate, but rather speak with and to one another. That is, things are not simply objects that exist outside the human mind, but are rather tied to events, to the timing of events.

Things as tied to events & timing

The parallel to source code seems obvious: we "primitive folk" worship source code as a magical entity—as a source of causality—when in truth the power lies elsewhere, most importantly, in social and machinic relations. If code is performative, its effectiveness relies on human and machinic rituals. Intriguingly though, in this parallel, Enlightenment thinking—a belief that knowing leads to control, to a release from tutelage—is not the "solution" to the fetish, but, rather, what grounds it, for source code historically has been portrayed as the solution to wizards and other myths of programming: machine code provokes mystery and submission; source code enables understanding and thus institutes rational thought and freedom. Knowledge, according to Weizenbaum, sustains the hacker's aimless actions. To offer a more current example of this logic than the FORTRAN one cited earlier, Richard Stallman, in his critique of nonfree software, has argued that an executable program "is a mysterious bunch of numbers. What it does is secret."[156] Against this magical execution, source code supposedly enables an understanding and a freedom—the ability to map and know the workings of the machine, but, again, only through a magical erasure of the gap between source and execution, an erasure of execution itself. If we consider source code as fetish, the fact that source code has hardly deprived programmers of their priestlike/wizard status makes complete sense. If anything, such a notion of programmers as superhuman has been disseminated ever more and the history of computing—from direct manipulation to hypertext—has been littered by various "liberations."

But clearly, source code can do and be things: it can be interpreted or compiled; it can be rendered into machine-readable commands that are then executed. Source code is also read by humans and is written by humans for humans and is thus the source of some understanding. Although Ellen Ullman and many others have argued, "a computer program has only one meaning: what it does. It isn't a text for an academic to read. Its entire meaning is its function," source code must be able to function, even if it does not function—that is, even if it is never executed.[157] Source code's readability is not simply due to comments that are embedded in the source code, but also due to English-based commands and programming styles designed for comprehensibility. This readability is not just for "other programmers." When programming, one must be able to read one's own program—to follow its logic and to predict its outcome, whether or not this outcome coincides with one's prediction.

This notion of source code as readable—as creating some outcome regardless of its machinic execution—underlies "codework" and other creative projects. The Internet artist Mez, for instance, has created a language called mezangelle that incorporates formal code and informal speech. Mez's poetry deliberately plays with programming syntax, producing language that cannot be executed, but nonetheless draws on the conventions of programming language to signify.[158] Codework, however, can also work entirely within an existing programming language. Graham Harwood's perl poem, for example, translates William Blake's nineteenth-century poem "London" into London.pl, a script that contains within it an algorithm to "find and calculate the gross lung-capacity of the children screaming from 1792 to the present."[159] Regardless of whether or not it can execute, code can be—must be—worked into something meaningful. Source code, in other words, may be the source of things other than the machine execution it is "supposed" to engender.

Source code as fetish, understood psychoanalytically, embraces this nonteleological potential of source code, for the fetish is a deviation that does not "end" where it should. It is a genital substitute that gives the fetishist nonreproductive pleasure. It allows the child to combat castration—his inscription within the world of paternal law and order—for both himself and his mother, while at the same time accommodating to his world's larger oedipal structure. It both represses and acknowledges paternal symbolic authority. According to Freud, the fetish, formed the moment the little boy discovers his mother's "lack," is "a substitute for the woman's (mother's) phallus which the little boy once believed in and does not wish to forego."[160] As such, it both fixes a singular event—turning time into space—and enables a logic of repetition that constantly enables this safeguarding. As Pietz argues, "the fetish is always a meaningful fixation of a singular event; it is above all a 'historical' object, the enduring material form and force of an unrepeatable event. This object is 'territorialized' in material space (an earthly matrix), whether in the form of a geographical locality, a marked site on the surface of the human body, or a medium of inscription or configuration defined by some portable or wearable thing."[161] Even though it fixes a singular event, the fetish works only because it can be repeated, but again, what is repeated is both denial and acknowledgment, since the fetish can be "the vehicle both of denying and asseverating the fact of castration."[162] Slavoj Žižek draws on this insight to explain the persistence of the Marxist fetish:

> When individuals use money, they know very well that there is nothing magical about it—that money, in its materiality, is simply an expression of social relations . . . on an everyday level, the individuals know very well that there are relations between people behind the relations between things. The problem is that in their social activity itself, in what they are *doing*, they are *acting* as if money, in its material reality is the immediate embodiment of wealth as such. They are fetishists in practice, not in theory. What they "do not know,"

> what they misrecognize, is the fact that in their social reality itself—in the act of commodity exchange—they are guided by the fetishistic illusion.[163]

Fetishists, importantly, know what they are doing—knowledge, again, is not an answer to fetishism, but rather what sustains it. The knowledge that source code offers is no cure for source code fetishism: if anything, this knowledge sustains it. As the next chapter elaborates, the key question thus is not "what do we know?" but rather "what do we do?"

To make explicit the parallels, source code, like the fetish, is a conversion of event into location—time into space—that does affect things, although not necessarily in the manner prescribed. Its effects can be both productive and nonexecutable. Also, in terms of denial and acknowledgment, we know very well that source code in that state and without the intercession of other "layers" is not executable, yet we persist in treating it as so. And it is this glossing over that makes possible the ideological belief in programmability.

Code as fetish means that computer execution deviates from the so-called source, as source program does from programmer. Turing, in response to the objection that computers cannot think because they merely follow human instructions, contends:

> Machines take me by surprise with great frequency. . . . The view that machines cannot give rise to surprises is due, I believe, to a fallacy to which philosophers and mathematicians are particularly subject. This is the assumption that as soon as a fact is presented to a mind all consequences of that fact spring into the mind simultaneously with it. It is a very useful assumption under many circumstances, but one too easily forgets that it is false. A natural consequence of doing so is that one then assumes that there is no virtue in the mere working out of consequences from data and general principles.[164]

This erasure of the vicissitudes of execution coincides with the conflation of data with information, of information with knowledge—the assumption that what is most difficult is the capture, rather than the analysis, of data. This erasure of execution through source code as source creates an intentional authorial subject: the computer, the program, or the user, and this source is treated as the source of meaning. The fact that there is an algorithm, a meaning intended by code (and thus in some way knowable), sometimes structures our experience with programs. When we play a game, we arguably try to reverse engineer its algorithm or at the very least link its actions to its programming, which is why all design books warn against coincidence or random mapping, since it can induce paranoia in its users. That is, because an interface is programmed, most users treat coincidence as meaningful. To the user, as with the paranoid schizophrenic, there is always meaning: whether or not the user knows the meaning, s/he knows that it regards him or her. To know the code is to have a form of "X-ray vision" that makes the inside and outside coincide, and the act of revealing sources or connections becomes a critical act in and of itself.[165] Code

as source leads to that bizarre linking of computers to visual culture, to transparency, which constitutes the subject of chapter 2.

Code as fetish thus underscores code as thing: code as a "dirty window pane," rather than as a window that leads us to the "source." Code as fetish emphasizes code as a set of relations, rather than as an enclosed object, and it highlights both the ambiguity and the specificity of code. Code points to, it indicates, something both specific and nebulous, both defined and undefinable. Code, again, is an abstraction that is haunted, a source that is a re-source, a source that renders the machinic—with its annoying specificities or "bugs"—ghostly. As Thomas Keenan argues, "haunting can only be thought as the difficult (simultaneous and impossible) movement of remembering and forgetting, inscribing and erasing, the singular and the different."[166] Embracing software as thing, in theory and in practice, opens us to the ways in which the fact that we cannot know software can be an enabling condition: a way for us to engage the surprises generated by a programmability that, try as it might, cannot entirely prepare us for the future.