CHAPTER

Man not a machine: Models, minds, and mental labor, c.1980☆

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Abstract

This essay is concerned with the fate of the so-called "computer metaphor" of the mind in the age of mass computing. As such, it is concerned with the ways the mighty metaphor of the rational, rule-based, and serial "information processor," which dominated neurological and psychological theorizing in the early post-WW2 era, came apart during the 1970s and 1980s; and how it was, step by step, replaced by a set of model entities more closely in tune with the significance that was now discerned in certain kinds of "everyday practical action" as the ultimate manifestation of the human mind. By taking a closer look at the ailments and promises of the so-called postindustrial age and more specifically, at the "hazards" associated with the introduction of computers into the workplace, it is shown how models and visions of the mind responded to this new state of affairs. It was in this context—the transformations of mental labor, c.1980—my argument goes, that the minds of men and women revealed themselves to be not so much *like* computing machines, as the "classic" computer metaphor of the mind, which had birthed the "cognitive revolution" of the 1950s and 1960s, once had it; they were positively *unlike* them. Instead of "rules" or "symbol manipulation," the minds of computer-equipped brainworkers thus evoked a different set of metaphors: at stake in postindustrial cognition, as this essay argues, was something "parallel," "tacit," and "embodied and embedded."

Keywords

History of science, Embodied cognition, Connectionism, Computer metaphor, Mental labor

The new machines are so clean and light.
Haraway (1985).

☆I took the liberty to borrow (parts of) my title from Eugene Rignano, *Man not a machine; a study of the finalistic aspects of life*, London (1926).

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1 INTRODUCTION

As the 1970s turned into the 1980s, a series of carefully planted bombs—strategically targeting computer facilities in Southern France—disturbed the immature postindustrial idyll. The first, in April 1980, struck computer centers operated by CII-Honeywell-Bull and Philips Data-Systems in Toulouse; International Computers Limited, also based in Toulouse, was hit in May, followed by the offices of a local computer society in August, an electronics store in September, and an insurance provider in December. The last computerized installation to incur the wrath of CLODO was, reportedly, a Sperry Univac branch office in October 1983: "Reagan attacks Grenada, SPERRY multinational is an accomplice," read a graffiti discovered in the remains (Holz, 1984, p. 35). CLODO, or *Le Comité Liquidante ou Detournant les Ordinateurs*, consisted, as readers of *Computerworld* learnt at the time, of "workers in the field of DP [data processing] and telematics" (much like them); and it considered computers to be "the favorite tool of the dominant" (BloomBecker, 1981, p. 22).

Making gestures toward the "machine breakers of the 19th century," *Processed World*, a magazine operating out of the Bay Area, had more details: "The dominant ideology," as CLODO related in an interview published in the aftermath of the Sperry Univac attack, "has clearly understood that, as a simple tool, the computer didn't serve its interests very well. So the computer became a parahuman entity (cf. the discussion on artificial intelligence) […] By our actions we have wanted to underline the material nature of the computer-tools on the one hand, and on the other, the destiny of domination which has been conferred on it" (Holz, 1984, p. 36). Meanwhile, and in safe distance from Southern France, the 1980 Pulitzer prize winner (nonfiction) Douglas Hofstadter launched his own assault on such parahuman entities, lamenting in his column for the *Scientific American* that there was "in AI today a tendency toward flashy, splashy domains." These domains, Hofstadter pronounced, prominently included "programs that can do such things as medical diagnosis, geological consultation, […] designing VLSI circuits, and on and on. Yet there is no program that has common sense. […] Like chess programs, they may serve a useful intellectual or even practical purpose, but despite much fanfare, they are not shedding much light on human intelligence" (Hofstadter, [1982] 1985, p. 636). What did shed light on "genuine cognition," according to Hofstadter, was something very different from playing chess or solving mathematical puzzles—different from, that was, the type of exemplary thought-activity held up by students of the mind for much of the preceding decades. It was, rather, a phenomenon which Hofstadter termed "subcognition"; and it notably was evinced in the pursuit of fairly unassuming, "everyday practical actions" (ibid, p. 639): riding a bicycle, for example; or steering around an obstacle; or using a personal computer—a new and peculiar kind of activity whose impact on "models" of the mind, c.1980, will be the subject of this essay.

While it cannot, of course, be said that Hofstadter's antichess diatribe—titled *Waking up from the Boolean dream*—had a great deal in common with the doings of French technoanarchists in either inspiration or aspiration, this essay is going to suggest that nevertheless the timing—sabotaging computers here, discarding the cognitive psychology of chess programs there—was not entirely fortuitous. Obviously enough, what "computers"—as the parahuman model-thing par excellence—meant and were, the way they looked and the things they did, transformed quite dramatically in the final few decades of the 20th century. The vast "electronic brains" that had inspired the first generation of cognitive scientists, cyberneticists, and kindred spirits to concoct (so-called) models of the mind (e.g., Boden, 2006; Edwards, 1997; Kay, 2001) faded into distant memory as computers turned "mini," "micro," and then "personal." Simultaneously, computing machinery encroached upon the lives of people in ways undreamt of by this generation of pioneers—in a process that evidently was not appreciated by everyone.

Any history of the making and use of models in the mind sciences post-WW2 will have to factor in these broader, social, and political currents: they shaped the intellectual and ideological imports that computers had. And in this respect, as we shall see, the actions of CLODO were indeed only one, if particularly drastic indicator that by the late 20th century something was amiss in the popular equation of men and machines. CLODO considered themselves, quite rightly, to be just the "visible tip of the iceberg" as regards early 1980s anticomputer resentments (Holz, 1984, p. 36).

"Computer phobia," "technostress," "Neo-Luddism," and kindred symptoms were, did one believe the sociologists, rampant at the time (e.g., Taylor, 1982; Weinberg and Fuerst, 1984); combined with the still more widespread fears caused by the specters of office automation, they conspired into an intellectual climate within which the image of would be intelligent machines—an image of rules, logic, and inhumane, abstract operations—increasingly ran counter to novel and heretic notions of "genuine" cognition as situated, tacit, and embodied. Seen in this light, as I shall argue, Hofstadter's contemporaneous embrace of "everyday practical actions" as the true key to the mind simply points to another facet of these newly common man/machine relations: where significant portions of the populace came to redefine their image of the mind in opposition to the diffusion of the computerized workplace, scientists of the mind, not unlike Hofstadter above, drew inspiration from the very phenomena exposed by such arrangements. After all there was underway, as one cognitive scientist put it at the time, a great experiment in "naturally occurring human–computer interaction" (Kraut et al., 1984, p. 120).

Put differently, then, what this essay will be concerned with is the fate of the so-called "computer metaphor" of the mind in the age of mass computing. It will be concerned with the ways the mighty metaphor of the rational, rule-based, and serial "information processor," which dominated neurological and psychological theorizing in the early post-WW2 era (Borck, 2012; Crowther-Heyck, 1999), came apart during the 1970s and 1980s; and how it was, step by step, replaced by a set of model entities more closely in tune with the significance that was now discerned in certain kinds of "everyday practical action" as the ultimate manifestation of the human mind. Much like historians of science have traced the career of the "rational mind" (qua chess program) to the ideological landscapes of the early cold-war period

(Cohen-Cole, 2014; Ensmenger, 2011; Erickson et al., 2013), the following suggests that in order to make sense of its incremental demise, we take a closer look at the ailments and promises of the subsequent, so-called "postindustrial age." It was in this context, my argument goes, that the minds of men and women revealed themselves to be not so much *like* computing machines, as the "classic" computer metaphor of the mind, which had birthed the "cognitive revolution" of the 1950s and 1960s, once had it (e.g., Gardner, 1985; Greenwood, 1999; Miller, 2003); they were positively *unlike* them.

Consequently, the following will be less concerned with the making and use of this or that specific model of the mind (or brain), but with a fuzzier set of intellectual reconstellations: with some of the more nebulous cultural factors that, as one might say, make a given type of model or metaphor plausible in the first place. As we shall see, regarding the parahuman qualities of computers, c.1980, the single most important development in this connection was the rapidly expanding and transforming domains of mental *labor*: what irked the members of CLODO (who won't concern us much further), irked, of course, a great many people. In fact, to the fast-growing population of computer users at the time computers, rather than having "model" qualities, were merely beige and dull machines that primarily served to numb their senses, stifle their creativity, and threaten their mental and physical well-being. Rather than being somehow congenial, in this view computers only forced upon people their sterile and inflexible routines. Conversely, the scientific communities enrolled in the efforts to understand (or at least mend) the psychophysiological make-up exhibited by such "casual" users, soon gravitated toward their own versions of such post-Boolean models of the mind (to pick up Hofstadter's phraseology). Both tendencies, I will argue, undergirded, and converged onto the type of biomorphic, postchess vision of the mind advocated by Hofstadter above—and which more generally was in ascendency in the latter third of the 20th century.

To be sure, (digital) computers, the electronic brains of yesteryear, had caused concern among the literati practically from their humble beginnings in the 1940s and 1950s, when they first emerged, not only as the essential signifier for the human mind (and brain), but also as a more ambiguous portent of an age of automatic factories, endless leisure, and machines turning against their creators (e.g., Kline, 2015). No one other than Norbert Wiener, famed author of *Cybernetics, or Control and Communication in the Animal and the Machine*, had warned ominously and repeatedly that "the tendency of these new machines [was] to replace human judgment on all levels but a fairly high one" (Wiener, 1949, p. 1). As part I of this essay recapitulates, by and large such fairly hypothetical scenarios did not, however, affect those who busied themselves with modeling the mind; it was "the fairly high" level of thinking that arguably intrigued students of cognition—chess, logic, language, trigonometry, and so on—not the sorts of "everyday practical action" which, as parts II and III will demonstrate, progressively moved into the limelight as computers began to morph from experimental, giant piece of equipment into a "tool" decorating anyone's desk. Part II will sketch out an account of the emergence of a peculiar type of psychophysiology which, beginning in the mid-1970s, coalesced around these new tools and their sedentary users. The impacts this and related developments had on views of cognition will be subject of part III.

2 ROLE MODELS OF THE MIND

A more graphic (and schematic) way of looking at the mutation of metaphors at issue—the mind as a computer—is in terms of what we might call role-model thinkers: exemplary types of people, embodying a particular, historically specific vision of the "genuine" intellect. Fig. 1 depicts a version of the peculiar type of cognitive agent who arguably personified what thinking was all about during the hey-days of cognitive psychology in the 1950s and 1960s: it's a true period piece, featuring white, male, and spectacled people decked out in black jackets and the proverbial gray flannel suits—physicists or mathematicians, possibly engineers. Depicted are, at any rate, agents of a visibly scientific mindset who engage in an activity that contemporaries liked to call "problem-solving." The blackboard in the back, a sure sign of such problem-solving activity, is covered with formulae and graphs, underscoring the air of cool rationality. On the desk we see pens and notepads (and an ashtray); no other machines are in sight. The caption read: "Research and Development Staff members discuss heat flux during reentry of a hypersonic vehicle".

The photograph—a 1958 job advertisement for *Lockheed* Missile Systems—is, needless to say, not depicting genuine thinking, nor can we be sure that these

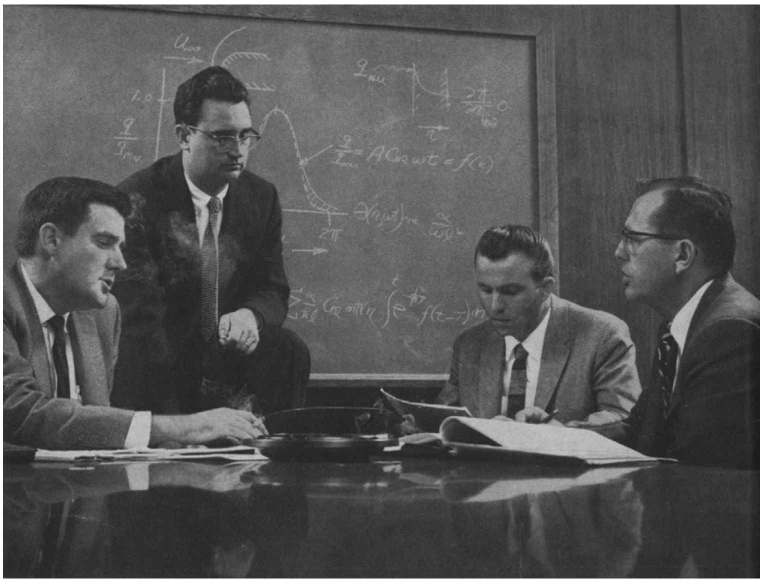

FIG. 1

1958: Problem-solvers "discuss[ing] heat flux during reentry of a hypersonic vehicle."

scientific Organization Men were actually discussing difficult problems of heat flux when the picture was taken. Unremarkable as the job advertisement (and corresponding genre) is, it nevertheless is a fairly accurate, flesh-and-bone rendition of the idealized, rational agent who diffusely underpinned the new science of psychological model making in this period.

Most famously perhaps, it were the pioneers of mind modeling, Herbert Simon (of the Carnegie Institute of Technology) and Alan Newell (at the RAND Corporation), who by the late 1950s had advanced a series of computer programs whose competences suspiciously resembled those of the scientific suit-and-tie guy courted by *Lockheed* above. Such models of the mind will consist, as they explained it in a 1961 article on *Computer Simulations of Human Thinking and Problem Solving*, of a "system of methods" or, for that matter, rules "believed to be those commonly possessed by intelligent college students" (Newell and Simon, 1961, p. 36). Both species, computers and college students, excelled at "symbol manipulation," from which it followed that certain computer programs "could be regarded as theories, in a completely literal sense, of the corresponding human processes." These human processes notably included such processes as: solving logical theorems or mathematical "puzzles," "abstracting and planning," and "chess" (of course). Simultaneously, the two pioneers of AI distanced themselves from models of a different sort, also popular in the 1950s, which included "nerve nets" and other electronic devices geared toward "imitating" the nervous system all too truthfully: a "fundamental theory" of "complex thinking tasks," Newell and Simon insinuated, looked different (ibid).

As Newell and Simon's potshot at the mere "imitators" of the nervous systems betrays, there was no universal agreement in those days regarding the ideal form that models of the mind should take. Nor were the implications of their own, appropriately "abstract" take on the computer metaphor—dubbed the *General Problem Solver*, or GPS in short—entirely unequivocal. Indeed, there exists an immense literature today on the cultural histories of cybernetics, cognitive psychology, and kindred ventures, which shows just how protean and fragile said metaphor, much like the computers it was based on, truly was. The very first "electronic brains," for one, naturally were not simply radiating some special air of rationality. As "evocative objects" (Turkle, 2007), the vocabulary these huge machines provoked was, if anything, organicist in tendency: machines were equipped with "memory," special "organs," and "neuron"-like elements (John von Neumann's famous *First Draft of a Report on the EDVAC* (1945) is a nice example); they were also prone, as Joseph Dumit has argued, to displaying "neurotic" behavior, epileptic fits, and other psychotic conditions (Dumit, 2016). To others, including the theorist of "personal knowledge," Michael Polanyi, the computing machinery of the 1950s meant a red flag more so than an inspirational device (Schaffer, 1999): things programmed to do only what they were told to do, after all, and automata reminiscent of the communist mindset rather than the intelligent college student. And there were those, among them the majority of electrophysiologists, who simply did not seem to appreciate the metaphor at all, as the British cybernetician John Z. Young lamented not infrequently: "seldom, or never" did the scientists obsessing with the biophysical details of axons and neurons "use words such as 'code' or 'symbol'" (Young, 1977, p. 9).

The vagaries of computational metaphors notwithstanding, there arguably was a special affinity, however, between these novel technologies, and, on the level of theorizing the human psyche, a general predilection for logic, linguistics, information theory, codes, diagrams, flowcharts, and so on. Or more cautiously: that was, not entirely without justification, a notion on the ascendancy in the 1980s, when the cognitive psychologies of the postwar period acquired the qualifier "classic" (more on which in due course). Historians of science, too, have come to refer to this constellation of epistemic values as "Cold War Rationality," as a short hand for the widespread infatuation with all things quantitative, formal, and rational at the time—which prominently included the psychological and social sciences (Cohen-Cole, 2014; Erickson et al., 2013; Solovey and Cravens, 2012). As the historian Jamie Cohen-Cole has argued, as exemplary representatives of such rational thinkers, the first generation of cognitive scientists in particular—Herbert Simon, George Miller, Jerome Bruner, and others—furnished accounts of the mind suspiciously resembling their own image as (rational) scientists, conflating normative and descriptive levels of analysis in the process (Cohen-Cole, 2005). Much like the scientist—the epitome of the problem solver—the mind of cold-war Everyman was suspected to rely on theories, methods, or certain heuristics (rather than brute stimulus–response patterns); the process of thinking was pronounced to consist in the conception of abstract "models" (in the head); perception was not unlike taxonomic classification (of sensory data); and so on—the "scientist," Cohen-Cole suggests, emerged in those years "as [a] model of human nature" (ibid).

And such rational, role-model scientists would not have looked much different, of course, than our *Lockheed* staff above: they clearly lived up to the cliché. Consider how unalike such role-model thinkers came across some 30 years later—that is, by the time Hofstadter above began lashing out at Newell, Simon, and other veteran modelers-of-the-mind (Fig. 2).

Gone were the suits, formulae, and blackboard; instead, a video display terminal (VDT) and (detachable) keyboard is placed prominently in front of this "user," who evidently is engaged, to paraphrase Hofstadter, in some sort of everyday practical action.

The source of the photograph is yet another commercial advertisement, reproduced from a 1982 brochure called *Olivetti and Ergonomics*. Issued by the cherished Italian manufacturer of office equipment, it served as proof that Olivetti cared about people and thus, about human-friendly machines. Because, not only had Olivetti a track record in machines that looked good (for example, their famous red *Valentine* typewriters, designed by Ettore Sottsass in the late 1960s; Brennan, 2015); by the time, Olivetti was busy cultivating a reputation as a pioneer of "user-friendliness." The foreword, written by the VDT-expert Etienne Grandjean of ETH Zurich, consequently was full of praise, emphasizing how the incipient computerization of office work made mandatory such special attention toward the proper, namely "ergonomic"

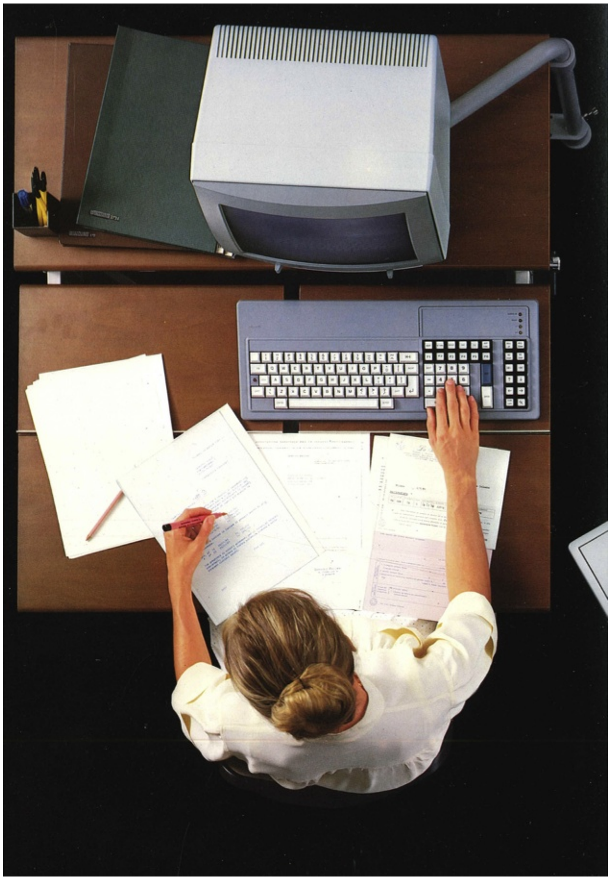

FIG. 2

Mental labor, 1982.

design of VDT workplaces. The reason was simple, as Grandjean submitted (Scagliola, 1982, p. 11): "as long as only engineers and other highly motivated experts operated the data-terminals, nobody complained about adverse health conditions"—or about badly designed machines, for that matter.

The situation, of course, was very different now. Special attention toward people-oriented design therefore included, as the brochure detailed, not only such classic items of ergonomic interest as chairs or lighting; it also included such novelty items as display characteristics (refresh rates, color contrast, etc.), input devices (keyboards, trackpads), as well as a few pointers to what scientists at the time began to refer to as "cognitive ergonomics": information display, dialog menus, the placement of special function keys, etc. Unlike the problem solvers of the 1960s, then, here was a type of role-model thinker who was not as conspicuously engaged in abstract "high level" thinking or similar kinds of rational conduct. On the contrary, this type of everyday activity was, quite palpably so, a deeply physical, sensory, and bodily affair. It typically involved less rarified pursuits than discussing problems of heat flux or solutions to trigonometric "puzzles." And the use of tools was not optional, it was essential: "The VDT operator is tied to a man–machine system," as Grandjean noted elsewhere, "[a]ttention is concentrated on the screen, the hands are linked to the keyboard; constrained postures are inevitable" (Grandjean, 1987, p. 5).

It was, at the very least, a very different type of cognition that quite suddenly and dramatically appeared on the scene. There were an "estimated five to seven million workers in America [who] now use VDTs and by 1985 there will be more than 10 million VDTs in use," as *Science for the People* reported at the beginning of the decade (Hanauer, 1981, p. 19); and it was, as I shall argue in the remainders of this paper, partly in consequence of such escalating figures that this latter, postindustrial type of cognitive agent—embodied, situated, and tool using—was set to replace the abstract-minded problem solver as the true model of "genuine" cognition.

3 MEN VS MACHINES: THE SOMATIZATION OF MENTAL LABOR

Needless to say, the demise of the ethereal, cold-war era problem solver, and its displacement by a cognitive model persona both "embodied and embedded," had many reasons *besides* the miniaturization—and democratization—of computing since the late 1970s. Clearly, such ideal-types resonated in complex ways with shifts in sociocultural norms, generally (e.g., Kaiser and McCray, 2016; Turner, 2006). Neither, of course, was it the case that computers had not been used before. The very term "user," for one, as essentially a synonym for "operator" (of computers), had begun circulating in the 1950s at the latest; and so did implicated terms such as "ergonomics" (the term was coined in the UK in 1949, to be precise).

The rapid diffusion of computerized workplaces, c.1980, was one of the more crucial factors in the rise to prominence of this other, less-than-rational actor, however. And, more to the point here, not until they were turning into mass products, had computers-as-*tools*—rather than computers-as-*metaphors*—impacted much on the ways human nature was "modeled." And to the extent they had, they had done so at the fringes of the mainstream discourses in the human sciences; without impinging much, that is, on the substance of contemporary doctrine or on broader cultural currents. (The relative marginality of "cyborg" talk prior to the 1980s is a case in point; see Kline, 2009). As the present section argues, in order to grasp how the above rationalist vision of the mind gradually was displaced by constructions of cognition as something "embodied," it is instructive to take into account the concomitant transformations of mental labor. This was a type of labor which would not only be vastly more common in the future, as prophets of the Post-Industrial Society had been arguing since the 1950s (Brick, 1992); as computers and associated periphernalia actually turned into everyday items, and "brainworkers" into mere VDT operators, such "higher" forms of labor lost much of their former mystique. Far from revolving around abstract operations "in the head," they also turned out to be a very physical affair.

Of course, even such modern man–machine systems were not exactly without precedent. Most fondly remembered, perhaps, it was the psychologist-turned-enabler-of-computing J.C.R. Licklider (of DARPA fame) who, as early as 1960, envisioned a true "symbiosis" of man and computer (Bardini, 2000; Licklider, 1960). By this he meant, first, a much "tighter coupling" between these two elements than what current systems offered—very little, as Licklider complained, had been achieved in the direction. And second, Licklider envisioned a "coupling" in contradistinction to the many, already existing symbioses of men and machines—these (merely) "mechanically extended" men did not, to Licklider's mind, have much to do with the sort of *intellectual* symbiosis he was expounding. Tellingly, there was no overt trace of the "computer metaphor" in Licklider's famous tract. Instead, the SAGE-veteran painted a "picture of dissimilarity" (as it would have been quite typical among human factors engineers): computers were "single-minded," Licklider said, while men were "noisy" and had "many parallel and simultaneously active channels." Computers did not respond in "real-time"; men did; and computers lacked, as Licklider lamented, "input and output equipment" of the kind "used by men in technical discussion"—such as "the pencil and doodle pad or the chalk and blackboard" (ibid, p. 9).

Prophetic as it was, on closer inspection, then, Licklider's premature vision of symbiosis in many ways was vintage 1950s—a problem solver's "Boolean dream" come true. Clearly, it was not "chess" that had impressed Licklider, but the intimacy of interfaces (or the lack thereof). Yet its vanishing point still belonged to a different kind of machine–age: "scientific thinking," "decisions," "insights," and "hypotheses," which future computers might help to "prepare," remained at its core (ibid, p. 4). In emphasizing the latter, my aim, of course, is not to be little such earlier, pioneering efforts in ergonomics, human factors engineering, and so on (they were, quite evidently, significant in their own right, and they could be read differently). The simple point I wish to make is that for the most these were fairly esoteric problems, removed from the kind of "everyday" activities which would trouble later generations of machine minders—and thus ultimately from mainstream psychological theorizing. Suggestively enough, the apotheosis of such man/computer dissimilarity, c.1960, consisted in the dissimilarity between human and machine *languages*—some symbiotic progress had been made, as Licklider allowed, with the recent development of FORTRAN and ALGOL. And unsurprisingly so, of course: by and large, the users of such unfriendly and unwieldy digital machines still made up an élite; indeed, they belonged to the vanguard of the type of expert "technocrats" that sociologists imagined would rule the postindustrial future (Bell, 1974; Touraine, 1971).

Similarly unsurprising, some 15, 20 years later, the outlook for such users looked already drastically different: "[*W*]e have a problem," as the Infotech *State of the Art Report: Man/Computer Communication* alarmed in 1979 (Schilling, 1979, p. 291). This referred to the many, many "casual" users who had just appeared on the horizon.

And the problem was, that with prices plummeting, with machines growing ever smaller and smaller, and with Western "traditional" industries stumbling from crisis to crisis, conceivably *anyone* would soon have to use a computer to toil along with—if he or she did not already. No longer, that was, could manufacturers or employers or, indeed, anyone rely on the notion that a "user" was someone highly motivated and technically literate.

The year 1978 presented something of a watershed in this regard, when microprocessors suddenly became very difficult to ignore, and the "new technologies" escaped the boffins' backrooms seemingly definitely and irreversibly. That year, the BBC-Horizon program *Now the chips are down* reportedly caught the island unprepared, resulting in a flurry of postindustrial damage control (among other things, the British government launched a "Microelectronics Awareness Programme" (MAP) still in the fall of 1978) (Gazzard, 2016). The German media reported excitedly of "jobkillers," "Third Industrial Revolution[*s*]," and the prospective social costs of microelectronics (e.g., Der Spiegel, 1978). Meanwhile, American clerical workers geared into action—the first "VDT coalitions" were formed in 1979 (Brenner et al., 2015) (with analogous, computer-unfriendly labor organizations springing up elsewhere); and in France, the so-called *Nora-Minc Report* (1978) dominated the headlines, sending shock waves through the Grand Nation and beyond: the *Computerization of Society*, as the American translation was called, authoritatively submitted that the future belonged to "Telematics," that knowledge was "power," and that technologies hitherto "reserved for the elites" were, for better or worse, already turning into "mass activity" [sic] (Nora and Minc, [1978] 1981, p. 17). All the while, of course, eyes were trained onto the United States, the undisputed leader in all things digital. There, things soon were moving at a frightening pace: "It is estimated that VDT's are being installed at the rate of one every 13 min" (Video Views, 1983, p. 1).

While notorious enough, these were developments that are not typically given much room in cultural histories of recent computing, which tend to be more attuned to "hackers" and the more agreeable Silicon Valley Sagas in the making—Apple, Atari, Microsoft, and so on (see Levy, 1984; Roszak, 1986; Turner, 2006). But in terms of the minds of the casual users, they arguably made all the difference: even before computers turned truly "personal," VDUs had already arrived "with a vengeance" (Maloney, 1981, p. 43). And so it came about, as another such newly minted VDU scientist noted at the time (in a little book published by Ericsson Information Systems), that the symbiosis of people and computers, which had not particularly troubled most psychologists, physiologists, or human factors engineers so far, turned deeply problematic. In the past, both users and computers had been small in number, after all; and more significantly (echoing his colleague Grandjean above): such people "hardly ever complained about visibility or health issues due to improper display design" (Knave, 1983, p. 15). But they now did—and the operations that common people performed with and around VDUs could not be ignored for much longer. They became, if you will, an "epistemic object" (Rheinberger, 1997).

As Brian Shackel, the veteran British ergonomist, would address what amounted to the first international conference on "human–computer interaction," *Interact '84* in London: the "importance of the subject" had become widely recognized in recent years, for manifest reasons: "the speed of growth [of microelectronic technology] has surprised everyone" (Shackel, 1985, p. 9). Indeed, even the slower-moving captains of industry had now come around to the view, that, as Lewis Branscombe, then Vice President and Chief Scientist at IBM, had announced just the year before, "our industry" had to pay "increasing attention to the field of applied psychology called human factors, or ergonomics" (quoted in Shackel, 1985, p. 11).

It is not the place here to try and recount the emergence of what began to be floated now, on both sides of the Atlantic, and partly as a consequence of such commercial insights, as "computer ergonomics," "user psychology," or "MCI" (man–computer interaction)—a field of expertise which by the mid-1980s had morphed from an exclusive pursuit, largely confined to select populations of specialist users, into a recognizable, technoscientific specialty that targeted, at least in principle, everyone (see e.g., Norman, 1984; Shackel, 1985; Shneiderman, 1980). With the promise of actually existing man/computer symbiosis unfolding, men, women, clerks, engineers, lowly data personnel and the more "creative" types (designers, journalists, etc.) were all to be included in this new category of the "casual" user. Even managers and other "nonsecretaries" were not spared, who frequently and similarly found computers to be "terrifying"—because, or so the business magazine *Fortune* conjectured in a piece on the *Office of the Future*, the "keyboards look[*ed*] so complicated" (Utta, 1982, p. 184). But to make the point I wish to make—pertaining to the progressive "somatization" of mental work rather than to the discipline of computer ergonomics per se—a few pointers will suffice.

Shackel's career in fact already conveys something of the outwards spiral which brought more and more casual users under the purview of the ergonomic gaze. He had worked his way up from the earliest, postwar problems of machine minding (knobs and dials), to heading one of the first commercial "Ergonomics" laboratories in the 1950s (at E.M.I. Electronics Ltd.), to the time-sharing systems and their "specialist-trained users" of the late 1960, to launching the more civilian *Human Sciences and Advanced Technology Research Institute* (HUSAT) in the 1970s (Anderson and Beevis, 1970; Shackel and Shipley, 1970). *Terminals are for People* was the (befitting) title of one of the very first research reports that was issued from Shackel's eventual scientific home base, HUSAT, located near Nottingham, in 1973. It was a slogan which would dominate the nascent sciences of the computerized workplace over the next 10 years or so: like no other computational thing had terminals—the "VDU"—emerged as a "symbol" for the transformation of labor, as Ahmet Çakir of the Technical University Berlin, a frequent collaborator with HUSAT scientists, noted a decade later (Çakir, 1983, p. 3).

And importantly for my purposes here, as both such a symbol and a thing did VDUs bring home now the point that mental labor was a very physical thing indeed. So physical, in fact, were the problems that haunted the initial wave of "casual" users, that the sort of psychological considerations which would later become dominant—"people oriented" information design, menu structures, dialog systems, and so on—still hardly registered at all. The most prototypical problems involved—headaches, blurry vision, vertigo, and so forth—were not even veering toward something ostensibly "subcognitive," but layers yet deeper and bodily. The cumulative effect, however, was that the common user began to take definite shape as an object, as the historian of science Mara Mills might say, of "ergonomopolitics" (Mills, 2011).

Even before the Great Microprocessor Scare of 1978, the Great VDU Scare thus was already smoldering fast. Just about 3 years before, a series of alarming reports, surfacing in relatively quick succession from across Europe, provided something of a first portent that something was not quite right with the future of work: In 1975, the *Swedish National Board of Occupational Safety and Health* published a report which announced that "CRTs pose health problems for operators" (Östberg, 1975). Meanwhile in Austria, a white collar union was causing some considerable stir with a report on *Workload, Eyestrain, and VDUs*, which had been prepared by two Viennese ophtalmologists and carried a similar message—VDU workers suffered from certain afflictions with alarming frequency, including "considerable degradation of visual performance," headaches, eyesore, and "flickering before the eyes" (Haider and Slezak, 1975). And also in 1975, the German Ministry of Labor (GDR), busy already with an extensive program on the *Humanisation of Worklife*, commissioned an investigation into the nature of the "VDU workplace" from the Technical University in Berlin; its interim report, authored by the above-mentioned Çakir, would appear 3 years later: *Untersuchungen zur Anpassung von Bildschirmarbeitsplätzen an die physische und psychische Funktionsweise des Menschen* (Çakir and Reuter, 1978). The mid-1970s thus saw the rapid accumulation of evidence that, apparently, the VDUs were not the frontend to a clean and sterile, postindustrial wonderland, after all.

As yet, there was little in this flurry of reports, hasty surveys, and questionnaires which would have troubled those who believed that the mind worked like a digital computer. As far as the science was concerned, the findings at stake boiled down to "questions of great complexity," as it was typically put, which encompassed the "humane" design of display equipment, its physical characteristics (luminance, character stability, and so on), as well as the physiological, sensory, and psychological effects it had on the people who used it (Çakir and Reuter, 1978; Pearce, 1980). Indeed the sheer number of manufacturers, VDU models, and different types of make was perplexing and difficult to see through. But from here on, the bad news quickly got out of hand, generating an enormous trail of data, special investigations, and counter investigations in the process.

In 1976, the VDU "hazards" scandal-in-the-making duly spilled over into the wider public discourse, when two copy editors with the *New York Times* developed cataracts, shortly after the newspaper's editorial offices had gotten computerized. As the media reported it, several experts went on record claiming that the "radiation emitted from the CRTs [was] to blame" (French and Hebert, 1977, p. 1). Among them was the opthalmologist Milton Zaret, medical adviser to the Newspaper Guild of New York, who believed that nonionizing radiation—"microwaves"—had cause the young editors' eye conditions (Zaret, 1978). Predictably, in the course of the follow-up investigations (and law suit) it was determined, by the *American National Institute for Occupational Health and Safety* (NIOSH) and other parties who got enrolled (yet more opthalmologists, the UK's Radiological Protection Board, various manufacturers of VDUs), that even though VDUs emitted all sorts of radiation, none of them were emitted at levels that could have caused the cataracts (Yanchinski, 1978).

While this particular diagnosis was thus quickly rendered implausible, or at least discredited, equally predictable, those (increasingly numerous) actors who were negatively predisposed toward computers encroaching upon their everyday working lives were not so easily silenced. Flanked on both sides by scientists (un)sympathetic to the cause to varying degrees, the ensuing controversy surrounding the putative VDU hazards raged on well into the 1980s—refueled at regular intervals by novel VDU-related incidences; by popular interventions in the style of *The Zapping of America: Microwaves, Their Deadly Risk and Cover-Up* (which was published in 1977 by the erstwhile *New Yorker* staff writer Paul Brodeur); by innumerable VDU-hazard manuals, guides, brochures, and other (typically) trade union literature; as well as, of course, by the progressively rapid diffusion of VDUs into an ever more varied range of occupations (see e.g., Hayes, 1985; Rosenthal and Grundy, 1979; Weale, 1981).

Impressive was the list of *psychosomatic* ailments which potentially afflicted these early VDU users, who began to resemble their abstract-minded progenitors only faintly at best. They included: migraines, eyesore, blurred vision, double vision, visual flicker, dizziness, diminished intellectual functioning, irritability, skin rashes, and a host of other conditions. Manufacturers—counted in the dozens in those days—naturally had none of this, retorting that the charges brought forward against their products were "emotional" and without objectivity (Humane Produktion, 1980; Science for the People, 1985). Naturally, too, this did not deter them from beginning to ship VDUs with higher refresh rates, featuring green or amber numeric displays (colors which had the reputation of being more friendly to the eyes), as well as an assortment of safety accessories which included special "micromesh" filters and protective lenses. "VDU's—a nightmare to the operator?" went the typical computer-magazine headline, trivializing the hazards narrative while cautiously admitting that "[y]ou can't find anybody with terminals in [his] office who doesn't have operators complaining about eye fatigue and visual problems" (Thornton, 1980, p. 57).

The more level-headed observers, meanwhile, judged that the VDU-hysteria was, evidently, just that: a mere "smoke-screen for essential socioeconomic issues" (Weale, 1981, p. 105). Or as one ergonomist opined (in a Siemens magazine): "to describe the situation it suffices to say that is has been likened to the weavers' riots [of the 18th and 19th centuries]" (Siemens, 1980, p. 4). No friend of the "VDU-fanatics," Robert Weale of the Institute of Ophthalmology in London was one of those who firmly came down on the side of these "essential socioeconomic issues," which, according to the then dominant reading, included the "deskilling" of workers, a computer-induced revival of Taylorist ideology, and the degradation of even the more demanding "intellectual" jobs to simplistic, fragmented, and thus automatable routines (Braverman, 1974; Cooley, 1977a; Noble, 1984). VDU hazards, in this view, at best were a symptom of precisely the sort of aberrations that the AI-pioneer Joseph Weizenbaum had indicted, in his tremendously successful *Computer Power and Human Reason: From Judgment to Calculation* (1976), as the pathologies of "instrumental reason."

And this too was a reading of the coming of the casual user, which, as we shall see shortly, did not sit very well with the idea that people using computers were much *like* computers. "Gradually," these more sinister predictions went, even the more scientific brainworkers "will be subordinated to the machines (computers) and processes which they themselves have devised, and like manual workers before them will experience severe mental, physical and ocular stress as they attempt to keep pace with the machines" (Cooley, 1977b, p. 26). The casualties would prominently include—or this was a take on the nature of cognition now gaining traction—the true, and therefore, largely "tacit" (or "implicit") skills that people had: a nonpropositional, embodied type of knowledge that, of course, was fundamentally at odds with the notion that knowledge and cognition could be viewed as essentially some kind of "symbol manipulation"; or, for that matter, that it could be viewed as some kind of chess-program executed in the heads of people.

On the contrary, in the face of the new microelectronic machines, these unspeakable, everyday skills—most conspicuously possessed by those threatened now with CAD-, word processing-, expert-, typesetting—and other such systems—constituted, as afflicted parties discovered, the last resort and most "important barrier to total automation" (Athanasiou, 1985, p. 52). And it was, as Weale above conceded, only too understandable therefore "why VDUs, more than cars and gardening tools, have created an insatiable demand for information on the relevant ergonomics" (Weale, 1979, p. 631).

4 YOUR FRIEND, THE COMPUTER

By the early 1980s, a plethora of pertinent regulations, legislations, and recommendations for employers, employees, or equipment makers was thus underway. While typically infuriating the more libertarian types of industry representative ("Who dictates your display terminal design?," asked one incensed *Hewlett Packard* researcher, Smith, 1984), it put those manufactures at an advantage who could claim to comply with this or that ergonomic requirement or theory: particular viewing angles and distances, eye-friendly colors, VDU-stations sporting detachable keyboards, and so on. Olivetti, as noted, counted itself in the latter camp, with Olivetti officers now floating the notion that for too long had specialists in IT been proffering "simplified conceptual models of reality and of the people in it," neglecting the needs and limitations of real people almost entirely (de Benedetti, 1980, p. 32). Or as Renzo Zorzi, the learned director of Olivetti's industrial design division, put it: in the 1980s, "the machine" could "no longer be considered a separate entity, but [...] an ensemble of things. [...] It includes chairs, desks, keyboards, displays, printed matter, and all the things which come into direct contact with our bodies" (quoted in Scagliola, 1982, p. 8).

Companies with names such as *Humanetics Group*, *Office Humanation Company*, or *Ergonomic IT* thus were quite suddenly flourishing—so much so that specialists in the field began worrying about their righteous cause being "clouded by the marketers" (Tate, 1984, pp. 198–199). In West Germany, where the local bureau of standardization (DIN) had gotten involved early on in the process of devising ergonomic standards geared toward "VDU workplaces," researchers drawn from academic and industrial laboratories (notably Siemens) went ahead regardless, issuing the first, influential such set of "norms." At the time, these pertained to such largely subcutaneous items as "visibility" of characters, their "geometric design," or the "grouping" of information on the screen (Koch, 1983; Lynch, 1984).

The troublesome revelations regarding VDUs, then, meant a tremendous boost not least for the fledgling communities of "computer ergonomists" and allied specialists, propelling (particularly European) government agencies into action, while swaying reluctant manufacturers to embrace, or at least pay lip service, to this newly *en vogue* science of the humane machine. Even in the United States, where, as one commentator opined, "we have perhaps embraced this new technology without first studying all of the implications" ("as is the wont of American culture"), the psychopolitics of VDUs could no longer be ignored (Maloney, 1981, p. 43). The American National Standards Institute (ANSI) pondered the subject by 1982, the same year the Association for Computing Machinery (ACM) spawned SIG-CHI, the *Special Interest Group on Computer–Human Interaction*; meanwhile, a committee set up by the National Academy of Sciences had concluded (on behalf of NIOSH) that VDUs were not hazardous things "per se," but they frequently had been "introduced into workplaces with little attention to principles of human factors, illuminating engineering, and industrial and organizational psychology" (Panel on Impact of Video Viewing on Vision of Workers, 1983, p. 2). Evidently, the putative hazards that haunted the early, casual user still barely touched upon the (cognitive) questions of graphic user interfaces, interaction design, or "software ergonomics," which would soon dominate the field.

By the same token, however, these quite evidently were hazards whose subjects bore, as we have already seen, only little resemblance with the erstwhile ideal of the rational problem solver. If anything these subjects—"intellectual workers," no less—related to computers in an emphatically *antithetical* fashion: mental labor, qua use of microelectronic tools, was an activity that was suspiciously embodied and embedded; or, indeed, an activity that was somatic through and through. The ingredients of friendly computers—absence of "flicker," improved contrast ratios, character stability, etc.—unobtrusively testified to that; as did, the more intangible effects of computerization, which could be seen (and typically were seen) in a similarly sinister light. It was in more optimistic times that "the term 'man–computer symbiosis' [had been] coined to reflect the harmony between man and machine", as two British psychologists noted apropos the burdens of "Visual Display Unit Operation" (Mackay and Cox, 1981, p. 92).

The recurrent theme in man–computer relations, c.1980, was rather that of disharmony. Computers, or so computer-critics (a flourishing genre) insisted, were not the neutral wonder tools that industry had promised; and despite assurances to the contrary, they did not unleash unprecedented levels of productivity and creativity. Quite the opposite: their diffusion only fostered monotonous, rigid, and machine-paced work procedures; their growing presence in offices and factories caused stress, boredom, and anxiety among the workforce; and they generally rendered people deskilled and alienated, while reifying "unnatural," because logic-based ways of thought (e.g., Jenkins, 1979; Shaiken, 1985).

Part real and part imagined, it were these very effects of massified microcomputing that now helped to throw into relief a rather different kind of cognitive ideal type. The hyperrational, logic-driven problem solver clearly did not cut a very good figure in the sensuous, tangible worlds of postindustrial labor. As we already know (and shall see in more detail below), it was a different type of mental agent whose time had come now: its salient features were not so much new and unheard of, as they were newly urgent and capable of mustering widespread appeal; and it distinguished herself not so much by possessing a "system of methods" or similarly abstract powers, but by forms of knowledge that were sensory, implicit, situated, bodily, and even slightly irrational. "Often human logic is not logical," as the British trade union activist Mike Cooley put it bluntly (with an approving nod to the ergonomist Brian Shackel) (Cooley, 1980, p. 25).

Cooley—a computer-savvy engineer and avid reader of Polanyi's—knew the "dehumanizing" outcomes of rationalization first hand. A specialist in computer-aided design (CAD), Cooley was acutely aware of the ways in which computers could frustrate the informal knowledge of workers especially. Or as he put it in his widely circulating call-to-arms *Architect or Bee? The Human/Technology Relationship* (1980), the skill-destroying effects of computerization revealed just how misguided the underlying, "mechanized concept of human beings" really was: "A microphone is not an ear, a camera is not an eye and a computer is not a brain" (Cooley, 1980, p. 77). Ergonomists, to be sure, frequently were accused of cultivating precisely that—a reductionist, machinic vision of people. Their appeals to "humanization," this line of criticism went, merely were a cover-up for promoting the interests of capital: efficiency and profit. Future-minded technocrats, in turn, were quick to accuse the profession of playing into the hands of those eager to "seize upon the issues and adopt a luddite stand" (Pearce, 1980, p. 13). For better or worse, human factors specialists were caught in the middle, equally committed to people's "well-being" and "performance and productivity," as Grandjean noted in 1979: with all the "publicity" of late, the "risk of misuse of ergonomic arguments [was], of course, increasing greatly" (Grandjean, 1979, n.p.).

The knowledge produced by ergonomics, then, was hardly pointing in just one direction; but neither was this machinic vision of people static. If, in the face of this latest technological revolution, the casualties of progress were discovering the everyday import of "implicit" skills or even of "savage thought" (Cooley, 1980; WILAB, 1983, p. 66), VDT scientists, for their part, now gradually began to look beyond the most immediate, physical shortcomings of protopersonal computers; and gravitated instead toward an "ergonomics of information processing" (as one researcher put it), which would tackle the subtler details of such externalized mind tools as keyboards, text editors, or even pocket calculators (e.g., Çakir, 1982). And along with this came, unsurprisingly, an emphasis on visual perception, eye/hand coordination, attention, short-term memory, and kindred processes and phenomena, which, more palpably so than proving theorems in logic were of an organic, "parallel" rather than "serial" nature (e.g., Carroll and Campbell, 1986); and which touched, if not exactly on savage thought, upon matters of bodily skill rather than the more rarified kinds of knowledge. It was a set of scientific sensibilities emergent almost anywhere where the more casual type of user came under purview.

HUSAT above, which had developed out of an earlier *Department for Ergonomics and Cybernetics*, was one the several places where this *other* take on the man/machine—a complex and delicate assemblage, if you will, of technological, environmental, bodily, *and* psychic ingredients—got bolstered at the time. In 1978, a one-day meeting there on "Eyestrain and Visual Display Units"—the first of many, jointly organized by HUSAT, the British Ergonomics Society, and the Applied Vision Association—turned out to be an "almost embarrassing success," with more than 300 people in attendance and discussions ranging through the wide range of everyday "factors" which still sabotaged truly symbiotic relationships with computers (Fig. 3): "grime" on VDU surfaces, "poorly spaced and shaped characters," "poorly designed workplace[*s*]," "excessive illumination," unsuitably positioned document holders, the "epileptogenic attributes" of VDUs, and so on (Stewart, 1978, pp. iii, passim).

FIG. 3

"Impossible VDU workplace."

Two people making a prominence appearance on that day were the ergonomist Tom Stewart (a researcher at HUSAT) and the aforementioned Ahmet Çakir, who would shortly release their *VDT Manual* (1979)—the most systematic and exhaustive exposition of VDU ergonomics available to date (close on the heels followed *Ergonomic Aspects of Visual Display Terminals* (1980) by Grandjean above). "What ophthalmologists fail to realize is that there is something behind the eyes," as one of the *VDT Manual*'s authors, Stewart, set forth the shifting terms of the debate, now that the first shockwave of VDU hazards began to be reigned in by improved design and regulations (quoted in Yanchinski, 1978, p. 413). VDU work, in this view, was a "complex dynamic type of visual task," involving questions going beyond just computer hardware. People, at any rate, were not just the "servant[*s*] of some anonymous machine" (Stewart, 1978, pp. 6, 26).

Not everyone liked the *Manual*—though "commendable" in detail, VDUs were a negligible hazard compared with the "100,000 annual smoking casualties," as one such ophthalmologist riposted (Weale, 1979, p. 631). But it was no accident that the *Manual*, while insisting on the "very real practical problems with existing equipment" that remained, emphasized the ultimately "social" (and "complicated") nature of these "new technologies" (Çakir et al., 1979; Stewart, 1978, p. 53): the comprehensive *Manual* was the outcome principally of studies commissioned by IFRA, the INCA FIEJ Research Association, a joint enterprise of the *International Newspaper Color Association* and the *International Federation of Newspaper Editors*.

Indeed, the types of casual user featuring most prominently and vocally in the early controversies surrounding the introduction of VDUs into the workplace—printers, typesetters, newspaper editors, engineers, and clerical staff—typically were occupations not neatly mapping onto either category: "manual" or "mental" labor; and it were occupations whose knowledges thus qualified as particularly skilled, tacit and creative—rather than as rational or scientific. The "unthinkable," as a 1978 booklet on the social implications of "Computer-Aided Design" ominously warned, had already become true, however: "the subordination of mental labor—and that includes the labor of engineers—to the computer" (Cooley, 1978, p. 5).

As ergonomists at HUSAT and elsewhere came round to the view that computers were "complex sociotechnical systems," and that the prevailing obsession with VDUs was diverting attention away "from the less quantifiable but no less important issues such as the software interface" (Pearce, 1980, p. 3), the critics of unabashed computerization began rallying around the view that users of machines were quite in principle unquantifiable. The "intelligence" of designers, technicians, printers, or draughtsmen arguably and most obviously was based on "tacit knowledge and experience"—and it thus was more of an art rather than a science (Cooley, 1980, p. 99). Likewise, the monotony, boredom, and psychosomatic suffering inflicted by unresponsive, confusing, or inflexible dialog systems, and by endless columns of meaningless symbols, ciphers, and numbers, revealed that office people were not so easily wedged into a man/machine symbiosis. It was in this point, the argument went, that the computerizers went wrong. And so did the prevailing "rationalist," "traditionalist," and "Western" conception of knowledge that went along with it (ibid, pp. 74–75).

And it was in this point, of course, where our two stories begin to converge. For if genuine knowledge was really tacit, sensory, and bodily, the incipient "automation of mental labor" qua computers not only meant an "epochal assault on living labor" (Nake, 1984, p. 109), the very assumption that computers and minds were somehow congenial itself must have been misguided. Indeed, it was this very type of everyday activity—*using* computers, rather than thinking *like* a computer—that Hofstadter referred to when alerting the readers of *Scientific American* to the irrelevance of chess programs in 1982—and to the importance of "subcognitive" and "parallel" processes (Hofstadter, [1982] 1985, p. 639).

Hofstadter, of course, then was not taking issue with the impending Taylorization of the brain workers, but intervening into a more academic kind of debate that was about to take shape at the time. The well known, contemporaneous diffusion of (mostly pejorative) labels such as "mentalism," "cognitivism," or "GOFAI" (good old fashioned AI), or of prefixes such as "classic," "symbolic," and "traditional"—used to qualify particular strands of cognitive research—were other, visible symptoms of this state of affairs: it owed as much to the intellectual rehabilitation of "connectionism" as it did to the vicissitudes of large-scale research programs such as, notably, the so-called *Fifth Generation Computing Project* (1982–1992) (see e.g., Agre, 1988; Boden, 2006; Clark, 1987; Edwards, 1986; Haugeland, 1985; Winograd and Flores, 1986). For present purposes, however, the point to emphasize is how this unfolding and seemingly aloof "dispute over cognitivism" (Woolgar, 1987, p. 317) in fact did intersect with, and mirror closely, the troubles that were being caused by (un)friendly computers at ground level. Contemporary observers, for one, had little difficulty to decode the "business" which AI had infamously become by the early 1980s as merely a case of "cleverly disguised politics": a proxy debate, and one with potentially devastating effects on the knowledge workers (Athanasiou, 1985b; also see Winston and Prendergast, 1984; Woolgar, 1986). And as we've already had occasion to see, at any rate there were plenty of reasons now to stylize "genuine cognition" as something tacit, everyday, and situated.

Seen in this light, Hofstadter's arcane bidding was, above all, symptomatic. Not only had the "flashy, splashy domains" lampooned by Hofstadter—"expert systems"—already become a *cause célèbre* among both, the friends and enemies of rationalization; the prospects for a "radically new approach to cognition" along the lines envisaged by Hofstadter above had quite intimately become embroiled with late modern labors, too. Just how intimately, of course, is a question which would deserve a much closer look than is possible here at the resurgence of "neural network" type models in the 1980s, and at the ensuing debates, which pitted the new "connectionists" against the defenders of symbolic AI in a "holy war" of models, as the philosopher Andy Clark put it when intervening in this particular contest in 1987: when it came to the essential questions of just "being there"—"embodied and embedded intelligent behaviors"—his point was, "implementation matter[*ed*]" (Clark, 1987, p. 243). While this is beyond the scope of this essay, let me give you some pointers in closing.

As for the former, the so-called "expert systems," it is perhaps not too difficult to see why or how such systems—the latest and most spectacular step in the evolution of "classic" AI—came to be construed as the ultimate specter of postindustrial rationalization. For these intelligent, rule-based systems could and would replace brainworkers of *any* kind: physicians, chemists, geologists, business analysts, generals, and anyone (e.g., Alexander, 1982a,b). "The reasoning animal has finally made the reasoning machine," as Edward Feigenbaum, the entrepreneurial Stanford scientist whose name had become almost synonymous with the technology, announced in a book on said fifth generation—the *Fifth Generation. Japan's Computer Challenge to the World* (Feigenbaum and McCorduck, 1983, p. 7; Swaine, 1984, p. 99).

It was a book that would catapult "AI" right in the midst of the postindustrial discomfort zone. A British working party on *New Technology: Society, Employment and Skill*, for instance—it included as one of its members the aforementioned champion of "implicit knowledge," Mike Cooley—then concluded that such expert systems, far from constituting the "engine[s] for the new wealth of nations" (Feigenbaum), merely threatened to extend the "process of deskilling" which had begun "at the lower levels […] to higher levels" (Council for Science and Society, 1981, p. 7). Unsurprisingly, the working party invoked a very different image of the genuine, human mind in response: "we should prefer to stress 'knowledgeable practice'"—human intelligence did "not come into being through abstract contemplation divorced from action" (ibid, 23, pp. 40–41).

Unlike VDUs—tangible, flickering, and unwieldy—the specter of expert systems was, to be sure, a fairly virtual threat (certainly in retrospect); but it was hardly less scandalous as a result. Feigenbaum and allied "computer Taylorists" heralded nothing less than the "end of mental labor," as one German industrial psychologist opined, appalled by the very idea of an "expert system." Real people were not "automata of cognition" but living beings with "a body *and* a mind" (Volpert, 1984, 1985, p. 18). As much as postindustrialists celebrated the coming of such futuristic reasoning machines—"[m]any large, savvy companies—Digital Equipment, Texas Instruments, Xerox, Schlumberger, Hewlett Packard, General Motors—[were already] engaged in substantial research" into expert systems, as *Fortune* excitedly reported in 1982 (Alexander, 1982a, p. 82)—intellectually and ideologically speaking, the rationalist take on cognition clearly began to face an uphill struggle. And more to the point here, prominent dissenters from the (by now) "classic" view thus conspicuously orbited around that less traditional project in machine psychology: not computer metaphors, but friendly computers.

Lucy Suchman, for example, an anthropologist who in the late 1970s had joined Xerox PARC as part of their "Office Research Group," condemned in no uncertain terms "the image of the European navigator" that was so "deeply entrenched in the Western human sciences as *the* correct model of the purposeful actor." The alternative image, proffered by Suchman in her 1985 dissertation on the "situatedness" of cognition, was that of a *Micronesian* navigator—someone who did not follow some abstract "plan" in the head, precalculating the optimal course for his or her voyage. The Micronesian canoeist—exemplar of "situated" cognition—instead went with the flow, utilizing the "information provided by the wind, the waves, the tide and current, the fauna, the stars, the clouds, the sound of the water on the side of the boat" (Suchman, 1985, p. 1). AI wunderkind Terry Winograd, author of "SHRDLU" (1968) and the first national president of *Computer Professionals for Social Responsibility*, too gradually drifted in those years from a version of classic AI to cognition conceived of as a "biological phenomenon," which entailed fundamental questions of *using* machines (not of *being* one). As he would expound in his book *Understanding Computers and Cognition: A New Foundation for Design*: "the image of 'computer as brain' can lead us away from the important questions" (Winograd and Flores, 1986, p. 4).

The important questions, as the title gave away, had to do with *design*—of interactive machines. Suggestively enough, in 1982 Hofstadter's main piece of anti-Boolean evidence thus came from a San Diego-based group of investigators known as the "PDP Research Group." PDP stood for "Parallel Distributed Processing," and the group typically is remembered today as one of the main driving forces behind the rebirth of "connectionism" since the mid-1980s (Rumelhart et al., 1986). As Hofstadter recommended them: these were psychologists who were "not afraid to let their vision of how the mind works be inspired by research and speculation about how the brain works" (Hofstadter, [1982] 1985, p. 639). What particularly impressed Hofstadter, however, was the special interest certain members of the PDP Research Group took in "studying genuine cognition in detail": the "errors" that people committed in the pursuit of everyday practical action (such as "typing errors"), the difficulties in understanding particular types of machines (pocket calculators, for example), and the associated problems of perception, both "visual" and "auditory." There was "more to intelligence than meets the AI," as Hofstadter quipped (ibid).

Which still rings true: the reference was, first and foremost, to Don Norman, head of the Cognitive Science Department at UC San Diego, consultant to Xerox, and future author of the tremendously influential *The Psychology of Everyday Things* (1988). A core member of the PDP Research Group, Norman's vision of intelligence, much like his reputation, quite evidently was not built upon chess, logic, or formal languages. Speculations about the brain aside, it were the everyday problems of ordinary users that revealed to him the importance of the "subcognitive." And in this, Norman's about-face of course was not unlike that of his psychologist colleagues in Europe or elsewhere. Reporting in 1981 on studies of text editing and typewriting, he, too, had already lost faith in the rational, tidy, and rule-based mind: "From our attempt to construct a processing model of these aspects of human behavior we have been forced to deviate from the more traditional processing structures. Instead, we find that a viable structure seems to require multiple, parallel units, all interacting with one another" (Norman, 1981, p. 1100).

5 CONCLUSION

Given the prominent role of computers in this late-modern demotion of the "computer metaphor" of the mind, it is perhaps ironic, that those very computers—VDUs and other such paraphernalia, to be exact—should have had such a significant role in helping to bring about and sustain this different, more organic and visceral model of the mind. The case for the "subcognitive," "embodied," and "situated" mind was a proposition that still implicated *some* kind of computer, to be sure; but if so, this new type of brain computer was a decidedly more biomorphic thing than the "classic" von Neumann computers of the past.

Needless to say, this transmogrification could hardly be reduced to the troubles miniature computers brought to the common brainworkers; nor to the role, for that matter, that was assumed in these disputes by the sciences of the friendly computer. At this point, after all, even the more traditionally oriented Boolean dreamers distanced themselves routinely from overly literal interpretations of computational metaphorics. As John McCarthy, Head of the Stanford Artificial Intelligence Department, conceded in a 1983 interview with the New-Agey tech-magazine *Omni* (treating on the subject of "wealth, leisure, and [...] gibbon like automatons"): "what is simple for a computer is difficult for human beings: chess, mathematics, and expert knowledge. And what is difficult for computers is simple for human beings: common sense thinking" (Hilts, 1983, p. 102). Needless to say, too, as viewed from the laboratories of AI, these were highly technical debates, responding to an internally generated sense of exhaustion as much as they surfed on a wave of technological optimism (as regards parallel computing, for example).

And yet, as this essay has attempted to convey, these were debates surrounded by a much broader contestation—and revaluation—regarding the nature of mind. Historiographically speaking, its core themes—the present and future of mental labor—has subsequently been overshadowed again by the renewal of cold-war logics, which brought with them their own *agents provocateurs*—in the form of outgrowths, most notoriously, of "Star Wars" (or Strategic Defense Initiative). "[T]he rule-based, formal-mechanical mode of understanding [that] AI promotes," as Paul Edward noted in 1986, in a still more defiant prequel to the *Closed World*, "is profoundly suited to military social structures using rigorous discipline and narrowly constricted methods and domains of action to combine humans and machines in large-scale cybernetic systems" (Edwards, 1986, p. 46; 1997). It was "C^3I"—command, control, communications, and intelligence—rather than "Taylor," which began to dominate this particular discourse, and the ways in which such formal-mechanical understandings of the mind then came under intense, and typically unsympathetic, scrutiny.

But cyborg-dreams and cold-war nightmares were not all there was to it; in many ways, this unsympathetic scrutiny only continued where the postindustrial skirmishes of CLODO, the VDU scientists, or the likes of Mike Cooley left off: the cumulate effect was that the prototypical activities that counted as "genuine" cognition now gradually morphed from the recognizably rational, "high-level" activities—of the chess program type—to activities more closely resembling such seemingly banal, everyday practical actions as typewriting, or staring at a computer screen.

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