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Faustus:                   Go bear these tidings to great Lucifer:  
Say [Faustus] surrenders up to him his soul,  
So he will spare him four-and-twenty years,  
Letting him live in all voluptuousness,  
Having thee ever to attend on me.

Mephistopholes:        I will, Faustus.

Faustus:                   Had I as many souls as there be stars,  
I'd give them all for Mephistopholes.  
By him I'll be great emp'rour of the world,  
And make a bridge through the moving air,  
To pass the ocean with a band of men.  
I'll join the hills that bind the Afric shore,  
And make that land continent to Spain,  
And both contributory to my crown.

*Dr. Faustus*, Christopher Marlowe

In the misty past, before Bill Gates joined the company of the world's richest men, before the mass-marketed personal computer, long before the metaphor of an information superhighway was worn, through overuse, to a cliché, I heard Roger Schank interviewed on National Public Radio. Now, Schank, then a computer science professor at Yale, was already well-known in artificial intelligence circles. But since those circles did not include me, a new programmer at Sperry Univac, I had never heard of him. Though I have forgotten the details of the conversation, I have never forgotten Schank's insistence that most people simply do not need to own computers. Cool reason, I am sorry to report, has not prevailed. Either we own a personal computer and fret about upgrades or are scheming to own one and fret about the technical marvel yet to come that will render our purchase obsolete. Well, there are worse ways to spend our money, I suppose. For all I

know, even Schank owns a personal computer. They are fiendishly clever machines, after all, and, perhaps more to the point, have helped keep the wolf from my door for quite a long time now. It is not the personal computer itself that I object to. What reasonable person would voluntarily go back to a typewriter? The mischief is not in the computer but in the ideology surrounding it. If we hope to use computers for tasks more interesting than word processing, we must give some attention to how they are actually being used, and, beyond that, to the remarkable grip that the idol of computing continues to have.

A distressing aspect of the media attention paid to the glories of technology is the persistent misidentification of the computing sciences with microcomputer gadgetry. This manifests itself in any number of ways. Once my seat mate on a plane learns that I am a computer science professor, I am expected to be able to chat about the glories of the new DVD-ROM as opposed to the older CD-ROM drives, that home-shopping channel to the computer literate, the World Wide Web, or one of the thousand other dreary topics that fill *PC Magazine*, the daily paper, and, in general, represents computing to most Americans. On a somewhat more pernicious level, we in computer science have the phenomenon of prospective employers asking for expertise in this or that proprietary product. This has had the effect of skewing our mission in the eyes of our majors. I recently saw a student resume that listed skill with Harvard Graphics but neglected to mention course work in data communications. Another recent graduate in computer science insisted that the ability to write WordPerfect macros belonged on her resume. This is a sorry state. How we came to be there deserves some consideration.

At this point a few words of self-disclosure are in order. Coming from a computer scientist, what I have to say may strike some as deep ingratitude to an industry that continues to feed and

clothe me, that, in fact, has provided me with a life of comparative ease for nearly two decades now. You see, my career in computing, pleasant as it has been, was foisted upon me. When I discovered computers, I was working on a doctorate in English at Berkeley and contemplating a life, not of ease, but, rather, of almost certain underemployment. The computer industry found me one morning on its doorstep, wrapped me in its generous arms, and has cared for me ever since. These days, I am paid well to puzzle out the charming intricacies of computer programs with bright, attentive students, all happy in the knowledge that industry will seek them out the day after they graduate. I go to sleep each night confident that were tenure to be abolished tomorrow, the industry would welcome me back like the prodigal son I have become.

Yet I am afraid that the computer industry, for all its largesse, has never had my complete loyalty (neither, for that matter, did English studies but this probably says more about those drawn to the study of texts than about me). I remember little from those years at Berkeley beyond the glories of spring in Northern California and the snippets of poetry that continue to rattle about my brain. My time in the company of the “best that has been known and said,” are so hazy, I suppose, because the study of literature is not so much a discipline as an attitude. And the attitude that dominated all others when I was a student, that sustained my forays into the Western Americana of the Bancroft collection, is that there is no text so dreary, so impoverished, so bereft of ideas that it does not cry out to be examined, deconstructed, as a graduate student a few years my junior might have said. The text that I propose to examine, impelled as it were by early imprinting in the English department, goes beyond words on a page. From an article here, a TV program there, from a thousand conversations on commuter trains and over lunch and dinner, from the desperate scrambling of local politicians after software companies, the notion that

prosperity follows computing, like the rain that was once thought to follow the settler's plow, has become a system of beliefs, a fully-formed mythology.

In his perceptive little book, *Technopoly*, Neil Postman, argues that all disciplines ought to be taught as if they were history. That way, students "can begin to understand, as they now do not, that knowledge is not a fixed thing but a stage in human development, with a past and a future." I wish I had said it first. If all knowledge has a past, and computer technology is surely a special kind of knowledge, then all knowledge is contingent. The technical landscape is not an engineering necessity. It might be other than it is. Our prospective majors might come to us, as new mathematics or physics majors come to their professors, because of an especially inspiring high school teacher, because of a flair for symbol manipulation or even because of a--dare I use the word--curiosity about what constitutes the discipline and its objects of study, not simply because they like gadgets and there is a ton of money to be made in computing.

In fact, the misidentification of computer science with microcomputer gadgetry is a symptom of a problem that goes far beyond academe. Extraordinary assertions are being made about computers in general and microcomputers in particular. These assertions translate into claims on the American purse either directly, or indirectly through the tax system. Every dollar our school districts spend on microcomputers is a dollar not spent reducing class size, buying books for the library, reinstating art programs, hiring school counselors, and so on. In fact, every dollar that every one of us spends outfitting ourselves with the year's biggest, fastest microcomputer yet is a dollar we might have put away for retirement, saved for our children's education, spent touring the splendors of the American West, or, even, have chosen not to earn. In the spirit of Postman, then, I'd like to speculate about how the mythology of prosperity through computing has come to be, and

in the process, suggest that, like the Wizard of Oz, it may be less substantial than we imagine.

The place to begin is the spectacular spread of microcomputers themselves. By 1993, nearly a quarter of American households owned at least one. Four years later, the *Wall Street Journal* put this figure at over forty percent. For a home appliance that costs at least a thousand dollars, probably closer to two, this represents a substantial outlay. The home market, as it happens, is the smaller part of the story by far. The Census Bureau tells that in 1995, the last year for which data is available, Americans spent almost \$48 billion on small computers for their homes and businesses. This figure excludes software, peripherals, and services purchased after the new machines were installed.

The title of a 1995 article in the *Economist*--'Personal computers: The end of good times?'-- hints at the extraordinary world we are trying to understand. In it we learn that the annual growth of the home computer market slowed from 40 percent in 1994 to between 15 percent and 20 percent in 1995. By the fall of 1998, market analysts were predicting 16% growth in the industry as a whole for the current year. Those of us involved in other sectors of the economy can only look on in astonishment. When a 20%, or even 16%, growth rate--well over five times that of the economy as a whole--is 'the end of good times,' we know we're in the presence of an industry whose expectations and promises have left the earth's gravitational pull.

To put some flesh on these numbers, let's try a thought experiment. The computer on my desk is about sixteen inches by seventeen inches. The Census Bureau tells us that the microcomputer industry delivered 18 million machines in 1994, the year when, according to the *Economist*, good time ended. Of these, perhaps one third went to the home market, the balance to business. At the 40 percent growth rate in the home market cited for that year and the more modest

16% growth rate for the business market, the boys in Redmond and Silicon Valley will have covered the United States' 3,679,192 square miles with discarded microcomputers well before my daughter, who is now thirteen, begins to collect Social Security.

These figures, fabulous as they seem, come from only part of the industry. As it happens, microcomputers do not define computing, despite their spectacular entry on the scene. The standard story goes like this. There was once a lumbering blue dinosaur called IBM that dominated the computer industry by virtue of its size. In due course, smaller, more agile, and immensely more clever mammals appeared on the computing scene. The most agile and clever of these was Microsoft, who proceeded to expand its ecological niche and, in so doing, drove the feeble-minded IBM to extinction.

The business history in this story is as faulty as its paleontology. IBM may well be lumbering and blue, but in 1997 its sales were nearly \$78 billion. Compare that with Microsoft's \$9 billion. The real story is not in the sales volume of the two companies but in their profit margins. In 1997, IBM's was 7.7 percent, while Microsoft's was a spectacular 28.7 percent. This almost mythical ability to earn money is expressed best in *Forbes'* annual list of very rich Americans. We don't hear much about IBM billionaires these days, but Microsoft fortunes are well-represented in the *Forbes* list with Bill Gates at \$51 billion, Paul Allen at \$21 billion, and Steven Ballmer at \$10.7 billion. These fortunes have been accumulated in less than twenty years from manufacturing a product that requires no materials beyond the medium that it is stored on, rather like a pickle producer whose only cost, after the first jar comes off the line, is the jar itself. This is a tale of alchemical transmutation if ever there was one. Is it really a surprise that most people don't know that IBM is still a very large company (or that computer science does not begin and end with

Windows 98)?

This joyous account of fortunes waiting to be made in the microcomputer industry has a dark side, however. Just as Satan is the real hero in *Paradise Lost*, and we all love a good monster, popular fascination with computers is due as much to their dark side as to their light. Despite generally good economic news for the past few years, Americans remain gloomy about their prospects. Our brave new world, paved over with networked computers from sea to shining sea, may well be one, it is thought, in which we are mostly unemployed, or have experienced a serious decline in our living standards. Computers, if not always at the center of the problem, are popularly thought to be accomplices.

Look at the substantial decline in manufacturing as a segment of the workforce in the United States. Between 1970 and 1996 (the last year for which data is available), the number of Americans employed increased by 50 million. During this same period, the number of manufacturing jobs declined by about two hundred thousand. The culprit here is often thought to be computer technology whether through assembly line robots or through U.S.-owned (or contracted) manufacturing facilities in developing countries. Asia and Latin America, of course, would seem considerably less appealing to American corporations without the world-wide data communications networks. This account of the decline in manufacturing employment is, perhaps, more appealing than true. I will return to the relationship between computers and productivity. For now, it is enough to observe that most people believe that there is such a relationship. So, if the money to be made in the computer industry is not sufficient inducement to vote for the next school bond issue to outfit every classroom in your city with networked computers, then the poverty your children certainly face without such a network should do the trick. With the staggering Microsoft

fortunes in the background and the threat of corporate retrenchment in the fore, I am naïve to expect the strangers I chat with on planes to know that the computing sciences are more like mathematics and the physical sciences than they are like desktop publishing--or the rush to the Klondike gold fields for that matter.

The emergence of the microcomputer as a consumer item in the past decade and a half has prompted a flood of articles in the educational literature promoting what has come to be called "computer literacy." In its most basic sense, this term appears to refer to something like a passing familiarity with microcomputers and their commercial applications, rather like the ability to drive a car and to know when to get the oil changed. Sadly, the proponents of computer literacy have won the high ground by virtue of the term itself. Who would argue with literacy? It is one of the more complex human achievements. Not only is literacy a shorthand measure of a country's economic development, but, as the rhetorician Walter J. Ong has long argued, once a culture becomes generally literate its modes of conceptualization are radically altered. Literacy, like the motherhood and apple pie in the America of my youth, is unassailable.

But what about the transformative nature of literacy? I am fully aware that similar claims have been made about computers, namely, that computers, like writing, will alter our modes of conceptualization. Maybe so--but not just by running Microsoft Office. I have developed a rule of thumb about claims of this sort. If the subject matter is computers and the tense of the claim is future (and, therefore, its truth value cannot be ascertained), look at the subtext. Is the claimant a salesman in disguise? To recognize the nonsense in the claim that computers will transform the way we think, we only need to do a little honest self-examination. I would give up my word processor with great reluctance. This does not mean that my neuronal structure is somehow



fundamentally different than when I was writing essays similar to this one on my manual Smith-Corona. It does mean that the computer industry is a smidgen richer due to my contribution. It also means, as was recently pointed out to me, that it is a good bit easier to run on at great length about any topic than in the days of typewritten manuscripts.

Not surprisingly, the number of articles addressing computer literacy in the educational literature has kept pace with microcomputer developments. ERIC is a database of titles published in education journals. When I searched ERIC using the key words "computer literacy" and "computer literate," I found 97 articles for the years 1966-81, about six per year on average. The decade from 1982-91, produced 2,703 hits, or about 270 per year. At first look the production of articles since 1991 shows signs of dropping off, a welcome development to my way of thinking. But the Internet has come to the rescue of the microcomputer industry and its prognosticators. When I add the words "Internet," "world wide web," and "information superhighway" to the mix (subtracting for duplicates, of course), the total rises to an astonishing 4,680 articles from 1992 through the first half of 1998. This works out to about 720 articles per year. The bulk of the recent articles, of course, are full of blather about the so-called information superhighway and how all those school districts that do not come up with the money to give every child access will be condemning the next generation to lives of poverty and ignorance.

Since computer literacy advocates are eloquent on the benefits of computers in our schools (and equally eloquent on the grim fate that awaits those students not so-blessed), a brief look at how microcomputers are actually used in primary and secondary schools is in order. Microcomputers are now a solid presence in American education. The U.S. Census Bureau puts the number at nearly seven million in 1997, or just over seven students per machine, compared with eleven students per

machine in 1994 and sixty-three per machine a decade earlier. Picture a classroom richly endowed with computers. Several students are bent over a machine, eyes aglow with the discoveries unfolding on the screen. Perhaps there is a kindly teacher in the portrait, pointing to some complex relationship that the computer has helped the budding physicists, social scientists, or software engineers to uncover. If this is the way you imagine primary and secondary school students using computers, you are dead wrong. Several important studies conclude that primary and secondary school students spend more time mastering the intricacies of word processing than they do using computers for the kinds of tasks that we have in mind when we vote for a bond issue to outfit our schools with new machines.

In fact, programming was the one area that school computer coordinators saw decline over previous years. I would be the first to admit that programming does not define computer science. This simple fact is what makes the endless discussion of programming languages in computer science circles so tedious. Nevertheless, if computer science does not begin and end with programming, neither will it give up its secrets to those who cannot program. I greet the news that high school students do not program our millions of microcomputers with the kind of enthusiasm one might expect from an English professor upon being told that the school library is terrific but the kids don't read. Here is a puzzle worth more than a moment's thought. There is an inverse relationship between the availability of microcomputers to primary and secondary school students and the chance that those students will do something substantial with them. I am not saying that the relationship is causal. But the association is there. Draw your own conclusions.

Though the jury is still out as to the potential educational benefits of computing, we all agree that skill with computers is necessary for success in business. Even here there is a problem.

Recent studies have assembled evidence that should cause computer enthusiasts some sleepless nights. It appears that most businesses would be better off had they invested all that money they spent on computer technology in bonds at market rates. This investment, as anyone knows who has seen the piles of unopened software, the manuals still in their shrink-wrapped plastic, and the stacks of obsolete hardware accumulating in storerooms around the country. By 1995, it had totaled over \$4 trillion. This sum, it should be noted, excludes the public money involved in training (and employing) academic computer scientists and engineers.

It also excludes another hidden expenditure. The time employees spend rearranging icons on their screens, the time they spend wondering why their spread sheets will not recognize their printers, the time they spend puzzling about just why their A drives have been disabled, in fact all those minutes here and hours there spent fiddling with hardware and software is time they do not spend on the tasks they are being paid to perform. Let me tell a story. I have been a computer science professor for seven years. Before that I spent a decade working for some of the largest firms in the computer industry. I am, by any reasonable measure, computer literate. One recent Sunday afternoon, I thought I might pop into my office, copy this essay to a floppy disk and work on it at home where I was also caring for a child with chicken pox. That is, I took the microcomputer industry up on its central promise: workers will be liberated from the tyranny of place. Able to be both parents and workers simultaneously, we will prosper along with our employers.

Well, here is what really happened. I promised my wife I would be gone no more than thirty-five minutes, twenty-five for the drive to and from the university, ten to copy the file. As it happens, I am the remaining member of the professional middle class without Windows running at

home. What I have is a 286 IBM clone running DOS and Wordperfect 5.1, equipment my last employer gave me when I left seven years ago. I should point out to those who do not yet speak the lingo, that this setup, is decidedly obsolete. In fact, it was well on its way toward obsolescence when I acquired it. Were my students to learn that I write with a quill pen by the light of an oil lamp, they would hardly think me less quaint.

My reluctance to part with hard-earned money for a shiny new computer that I would use only as an abundantly well-outfitted typewriter did pose a small problem, however. I would have to get the file from my office computer, a fancy Pentium workstation (courtesy of my current employer), to run on my ever-faithful home machine. Not a problem, I thought. I can easily transform the Microsoft Word file in my office, to ASCII text, copy it to a 5¼" floppy disk, and read it into WordPerfect at home.

As we have all come to know, painfully at first, and finally with resignation, when the subject is personal computers things are not always as promised. (It has occurred to me more than once that the computer industry should have the honor of Iago and display these words boldly on every screen: "I am not what I am.") First I learned that my document was infected with the Word Macro virus. No matter how I tried, Word would not let me transform it from a template (a term known to all Word users, happily ignored by most) to a text file. So, I called a colleague who gave me what is known in the computer industry as a "work around." A "work around" is what you do when your machine is not running the way the manufacturer promised. By analogy, a work around for faulty automobile brakes might be to open the door and drag your feet. In any case, my colleague is a clever fellow and the work around, in fact, allowed me to work around the handiwork of the disgruntled Microsoft employee who infected Word with the virus. So, having transformed

my essay into a generic text file, I was ready to copy it to a floppy and return home, safe in the knowledge that I could be both productive and parental.

Unfortunately, our former systems administrator, for reasons that must have made eminent sense to him, had disabled my A drive. But as I said earlier, I am computer literate. Though annoying, this problem is not catastrophic. I need only invoke a special setup routine to let Windows 95 know that, in fact, there is a 5¼" inch floppy drive on my machine. But since this machine was a castoff from our department's lab, the systems administrator had, wisely, password-protected the setup routine. He had also, in the meantime, decamped for the vastly more remunerative pastures of the computer industry. In a word, he was unavailable and so was my machine. I arrived home nearly two hours after I had left to an unhappy wife and a sicker child--without the file. This is not an isolated story. Anyone who has dealt with a microcomputer has a store of tales just like mine.

There is another story here as well. Even if one is inclined to stick with the tried and true, the computer industry--and its minions across the land--will not permit it. By the time this book goes to press, the last computer in my department with a drive that accomodates 5 1/4" diskettes will have gone to wherever old computers go. My well-worn and well-loved 286 will then be an island cut off from the main, and I, its single inhabitant, will speak a language fast-becoming extinct.

The price of computing equipment has dropped dramatically in recent years. You can buy a microcomputer that processes millions of instructions per second and is equipped with a stunningly large memory and disk space for under two thousand dollars. At that price we can all be equipped at the office and most of us will choose to be equipped at home. As it happens, that two thousand

(plus a bit more for networking components) is the smallest part of the great pie of microcomputer costs. A recent issue of *The Economist* cites a study by the Gartner Group, a well-respected consulting firm, that puts the annual cost of a microcomputer connected to a network at \$13,200. Of this, only 21% goes to the purchase of hardware and software. Administrative costs absorb 36%. We have to pay all those people who come to our rescue, after all. This figure alone should slow down the head-first rush to outfit every desk on the planet with a microcomputer.

That administration costs more than the machine itself is not the biggest surprise. Recall my story. Just how much was my two hours worth? On average, 43% of the cost of a microcomputer is consumed in what Gartner calls "end-user operations." Just what are these end-user operations? They are all those things that one does with a computer in order to do those things that one gets paid to do. This includes rearranging icons, coaxing disk drives into action, loading and setting up software, listening to Microsoft's music as you wait helplessly on hold for advice from someone who probably knows less than you do, avoiding viruses and so on.

Though the Gartner Group has done us the service of quantifying those long hours spent mastering yet another Microsoft user interface, the effect of that time on worker productivity has been known for several years now. Many studies, including some done by the National Research Council and by the New York investment house, Morgan Stanley, fail to indicate any correlation between productivity growth and information technology expenditures. Distressingly, the opposite appears to be true. As Thomas Landauer has pointed out in his book, *The Trouble with Computers*, those industries, with the exception of communications, that invested most heavily in information technology seem to have the most sluggish productivity growth rates. Though one still might argue that schools and colleges should continue to teach courses in microcomputer literacy because

microcomputer usage has grown like a fungus after a heavy rain, it seems that our time would be more profitably spent breaking the bad news to the public who pays the bills. In the process, we might also come to understand how a machine so patently clever as the microcomputer could have done business (outside of the computer industry itself) so little good.

Given the several thousand articles on computer literacy and the emerging inverse relationship between productivity growth and computer expenditures, it seems reasonable to ask just who benefits from the computer literacy movement (and who pays for it). Students benefit is the common sense answer. Well, common sense is right but, as usual, only partially so. Students, of course, are served by learning how to use microcomputers. But the main beneficiaries are the major producers of hardware and software. The situation is really quite extraordinary. Schools and colleges across the country are offering academic credit to students who master the basics of sophisticated consumer products. Granted that it is more difficult to master Microsoft Office than it is to learn to use a VCR or a toaster oven, the difference is of degree rather than of kind.

The obvious question is why the computer industry itself does not train its customers. The answer is that it does not have to. Schools, at great public expense, provide this service to the computer industry free of charge. Actually, the situation is even worse. The educational institutions not only provide the trainers and the setting for the training, they actually purchase the products on which students are to be trained from the corporations that are the primary beneficiaries of that training. The story is an old but generally unrecognized one in the United States: the costs are socialized while the benefits are privatized.

I have described a bleak landscape. Let me summarize my observations:

- ◆ Schools and universities purchase products from the computer industry to offer training to

benefit the computer industry.

- ◆ These purchases are both publicly subsidized through tax support and come out of the pockets of students (and their parents) themselves.
- ◆ The skill imparted is, at best, trivial, certainly one not requiring faculty with advanced degrees in computer science (which, by and large, were acquired through public--not computer industry--support).
- ◆ As the number of microcomputers in our schools has grown, the chance that something interesting might be done with them has decreased.
- ◆ The stunning complexity of microcomputer hardware and software has had the disastrous effect of transforming every English professor, every secretary, every engineer, every manager into a computer systems technician.
- ◆ For all the public subsidies involved in the computer literacy movement, the evidence that microcomputers have made good on their central promise--increased productivity through computer use--is, at the very least, open to question.

If my argument is only partially correct, we should begin to rethink computing. The microcomputer industry has been with us for a decade and a half. We have poured staggering sums down its unsatisfiable maw. It is time to face an unpleasant fact: the so-called microcomputer revolution has cost much more than it has returned. One problem, it seems to me, is that microcomputers are vastly more complex than the tasks asked of them. To write a report on a machine with a Pentium II processor, sixty-four megabytes of memory, and an eight gigabyte disk drive is a little like leasing the space shuttle to fly from New York to Boston to catch a Celtics game. Though there are those among us who would not hesitate to do such a thing if they could



afford it (or get it subsidized, which is more to the point), we follow their lead at great peril. The computer industry itself is beginning to recognize the foolishness of placing such computing power on every office worker's desk. Oracle, the world's premier manufacturer of database management systems, Sun Microsystems, a maker of powerful and highly-respected engineering workstations, and IBM itself are arguing that a substantially scaled down network computer, costing under one thousand dollars would serve corporate users better than the monsters necessary to run Microsoft's products.

Please do not misunderstand. This essay is not a neo-Luddite plea to toss computers out the window. I am, after all, a computer science professor and I am certainly not ready to get off the grid (as the militias in my part of the country say). Further, the social benefits of computing from telecommunications to business transactions to medicine to science are well-known. It is a plea, however, to think reasonably about these machines, to recognize the hucksterism in the hysterical cries for computer literacy, to steel ourselves against the urge to throw yet more money at Silicon Valley and Redmond.

Putting microcomputers in their place will also have a salutary effect on my discipline. We in computer science could then begin to claim, that our field, like mathematics, like English literature, like philosophy is a marvelous human creation whose study is its own reward. To study computer science requires concentration, discipline, even some amount of deferred gratification, but neither Windows 98 nor a 400 megahertz Pentium II processor, nor a graphical Web browser. Though I am tempted, I would not go so far as to say that the introductory study of computer science requires no computing equipment at all (but Alan Turing did some pretty impressive work without a microcomputer budget). We do seem, however, to have confused the violin with the

concerto, the pencil with the theorem, and, in Yeats' words, "the dancer with the dance." I am afraid that we in computing have made a Faustian bargain. In exchange for riches, we are condemned to a lifetime of conversations about World Wide Web. An eternity in Hell with Dr. Faustus, suffering the torments of demons, is an afternoon in the park by comparison.

## References and Further Reading

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My source for productivity data. More recent statistics are slightly more optimistic than Landauer. Nevertheless, claims of productivity gains through computing have been around for three decades or more. That computers are finally--and tentatively--making good on these claims, shows that they have long been overstated.

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Provides numbers to support what I had long suspected, namely, that once you assign a cost to the time it takes to keep the computer on your desk running, the computer begins to seem like a less attractive investment.