The Craftsman

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There are wrinkles in this gloomy picture. The sociologist Christopher Jencks has shown that economic "returns to skill" are robust at the upper reaches of the skills ladder but weaker lower down; crack systems designers are handsomely rewarded today, but low-level programmers often do no better and sometimes worse than people with manual service skills like plumbers and plasterers. Again, Alan Blinder argues, although many higher-skilled technical jobs in the West are being sent offshore to places in Asia and the Middle East, there are unexportable jobs that require face-to-face contact. If you live in New York, you can work with an accountant in Bombay, but you cannot usefully deal with a divorce lawyer there.[23]

Still, the trials of the craftsmen of the new economy are a caution against triumphalism. The growth of the new economy has driven many of these workers in America and Britain inside themselves. Those firms that show little loyalty to their employees elicit little commitment in return—Internet companies that ran into trouble in the early 2000s learned a bitter lesson, their employees jumping ship rather than making efforts to help the imperiled companies survive. Skeptical of institutions, new economy workers have lower rates of voting and political participation than technical workers two generations ago; although many are joiners of voluntary organizations, few are active participants. The political scientist Robert Putnam has explained this diminished "social capital," in his celebrated book *Bowling Alone*, as the result of television culture and the consumerist ethic; in our study, we found that withdrawal from institutions was tied more directly to people's experiences at work.[24]

If the work people do in new economy jobs is skilled and high pressure, requiring long hours, still it is dissociated labor: we found few among the technicians who believed that they would be rewarded for doing a good job for its own sake. The modern craftsman may hew inside him- or herself to this ideal, but given the structuring of rewards, that effort will be invisible.

From the social point of view, in sum, demoralization has many sides. It can occur when a collective goal for good work becomes hollow and empty; equally, sheer competition can disable good work and depress workers. Neither corporatism nor capitalism as crude labels get at the institutional issue. The forms of collective communication in Japanese auto plants and the practices of cooperation in firms like Nokia and Motorola have made them profitable. In other realms of the new economy, however, competition has disabled and disheartened workers, and the craftsman's ethos of doing good work for its own sake is unrewarded or invisible.

Fractured Skills

Hand and Head Divided

The modern era is often described as a skills economy, but what exactly is a skill? The generic answer is that skill is a trained practice. In this, skill contrasts to the *coup de foudre*, the sudden inspiration. The lure of inspiration lies in part in the conviction that raw talent can take the place of training. Musical prodigies are often cited to support this conviction—and wrongly so. An infant musical prodigy like Wolfgang Amadeus Mozart did indeed harbor the capacity to remember large swatches of notes, but from ages five to seven Mozart learned how to train his great innate musical memory when he improvised at the keyboard. He evolved methods for seeming to produce music spontaneously. The music he later wrote down again seems spontaneous because he wrote directly on the page with relatively few corrections, but Mozart's letters show that he went over his scores again and again in his mind before setting them in ink.

We should be suspicious of claims for innate, untrained talent. "I could write a good novel if only I had the time" or "if only I could pull myself together" is usually a narcissist's fantasy. Going over an action again and again, by contrast, enables self-criticism. Modern education fears repetitive learning as mind-numbing. Afraid of boring children, avid to present ever-different stimulation, the enlightened teacher may avoid routine—but thus deprives children of the experience of studying their own ingrained practice and modulating it from within.

Skill development depends on how repetition is organized. This is why in music, as in sports, the length of a practice session must be carefully judged: the number of times one repeats a piece can be no more than the individual's attention span at a given stage. As skill expands, the capacity to sustain repetition increases. In music this is the so-called Isaac Stern rule, the great violinist declaring that the better your technique, the longer you can rehearse without becoming bored. There are "Eureka!" moments that turn the lock in a practice that has jammed, but they are embedded in routine.

As a person develops skill, the contents of what he or she repeats change. This seems obvious: in sports, repeating a tennis serve again and again, the player learns to aim the ball different ways; in music, the child Mozart, aged six and seven, was fascinated by the Neapolitan-sixth chord progression, in fundamental position (the movement, say, from a C-major chord to an A-flat major chord). A few years after working with it, he became adept in inverting the shift to other positions. But the matter is also not obvious. When practice is organized as a means to a fixed end, then the problems of the closed system reappear; the person in training will meet a fixed target but won't progress further. The open relation between problem solving and problem finding, as in Linux work, builds and expands skills, but this can't be a one-off event. Skill opens up in this way only because the rhythm of solving and opening up occurs again and again.

These precepts about building skill through practice encounter a great obstacle in modern society. By this I refer to a way in which machines can be misused. The "mechanical" equates in ordinary language with repetition of a static sort. Thanks to the revolution in micro-

computing, however, modern machinery is not static; through feedback loops machines can learn from their experience. Yet machinery is misused when it deprives people themselves from learning through repetition. The smart machine can separate human mental understanding from repetitive, instructive, hands-on learning. When this occurs, conceptual human powers suffer.

Since the Industrial Revolution of the eighteenth century, the machine has seemed to threaten the work of artisan-craftsmen. The threat appeared physical; industrial machines never tired, they did the same work hour after hour without complaining. The modern machine's threat to developing skill has a different character.

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An example of this misuse occurs in CAD (computer-assisted design), the software program that allows engineers to design physical objects and architects to generate images of buildings on-screen. The technology traces back to the work of Ivan Sutherland, an engineer at the Massachusetts Institute of Technology who in 1963 figured out how a user could interact graphically with a computer. The modern material world could not exist without the marvels of CAD. It enables instant modeling of products from screws to automobiles, specifies precisely their engineering, and commands their actual production.[25] In architectural work, however, this necessary technology also poses dangers of misuse.

In architectural work, the designer establishes on screen a series of points; the algorithms of the program connect the points as a line, in two or three dimensions. Computer-assisted design has become nearly universal in architectural offices because it is swift and precise. Among its virtues is the ability to rotate images so that the designer can see the house or office building from many points of view. Unlike a physical model, the screen model can be quickly lengthened, shrunk, or broken into parts. Sophisticated applications of CAD model the effects on a structure of the changing play of light, wind, or seasonal temperature change. Traditionally, architects have analyzed solid buildings in two ways, through plan and section. Computer-assisted design permits many other forms of analysis, such as taking a mental journey, on-screen, through the building's airflows.

How could such a useful tool possibly be abused? When CAD first entered architectural teaching, replacing drawing by hand, a young architect at MIT observed that "when you draw a site, when you put in the counter lines and the trees, it becomes ingrained in your mind. You come to know the site in a way that is not possible with the computer. . . . You get to know a terrain by tracing and retracing it, not by letting the computer 'regenerate' it for you."[26] This is not nostalgia: her observation addresses what gets lost mentally when screen work replaces physical drawing. As in other visual practices, architectural sketches are often pictures of possibility; in the process of crystallizing and refining them by hand, the designer proceeds just as a tennis player or musician does, gets deeply involved in it, matures thinking about it. The site, as this architect observes, "becomes ingrained in the mind."

The architect Renzo Piano explains his own working procedure thus: "You start by sketching, then you do a drawing, then you make a model, and then you go to reality—you go to the site—and then you go back to drawing. You build up a kind of circularity between drawing and making and then back again."[27] About repetition and practice Piano observes, "This is very typical of the craftsman's approach. You think and you do at the same time. You draw and you make. Drawing . . . is revisited. You do it, you redo it, and you redo it again."[28] This attaching, circular metamorphosis can be aborted by CAD. Once points are plotted on-screen, the algorithms do the drawing; misuse occurs if the process is a closed system, a static means-end—the "circularity" of which Piano speaks disappears. The physicist Victor Weisskopf once said to his MIT students who worked exclusively with computerized

experiments, "When you show me that result, the computer understands the answer, but I don't think you understand the answer."[29]

Computer-assisted design poses particular dangers for thinking about buildings. Because of the machine's capacities for instant erasure and refiguring, the architect Elliot Felix observes, "each action is less consequent than it would be [on] paper . . . each will be less carefully considered."[30] Returning to physical drawing can overcome this danger; harder to counter is an issue about the materials of which the building is made. Flat computer screens cannot render well the textures of different materials or assist in choosing their colors, though the CAD programs can calculate to a marvel the precise amount of brick or steel a building might require. Drawing in bricks by hand, tedious though the process is, prompts the designer to think about their materiality, to engage with their solidity as against the blank, unmarked space on paper of a window. Computer-assisted design also impedes the designer in thinking about scale, as opposed to sheer size. Scale involves judgments of proportion; the sense of proportion on-screen appears to the designer as the relation of clusters of pixels. The object on-screen can indeed be manipulated so that it is presented, for instance, from the vantage point of someone on the ground, but in this regard CAD is frequently misused: what appears on-screen is impossibly coherent, framed in a unified way that physical sight never is.

Troubles with materiality have a long pedigree in architecture. Few large-scale building projects before the industrial era had detailed working drawings of the precise sort CAD can produce today; Pope Sixtus V remade the Piazza del Popolo in Rome at the end of the sixteenth century by describing in conversation the buildings and public space he envisioned, a verbal instruction that left much room for the mason, glazier, and engineer to work freely and adaptively on the ground. Blueprints—inked designs in which erasure is possible but messy—acquired legal force by the late nineteenth century, making these images on paper equivalent to a lawyer's contract. The blueprint signaled, moreover, one decisive disconnection between head and hand in design: the idea of a thing made complete in conception before it is constructed.

A striking example of the problems that can ensue from mentalized design appear in Georgia's Peachtree Center, perched on the edge of Atlanta. Here is to be found a small forest of concrete office towers, parking garages, shops, and hotels, edged by highways. As of 2004, the complex covered about 5.8 million square feet, which makes this one of the largest "megaprojects" in the region. The Peachtree Center could not have been made by a group of architects working by hand—it is simply too vast and complex. The planning analyst Bent Flyvbjerg explains a further economic reason why CAD is necessary for projects of this scope: small errors have large knock-on effects.[31]

Some aspects of the design are excellent. The buildings are laid out in a grid plan of streets forming fourteen blocks rather than as a mall; the complex pays allegiance to the street and is meant to be pedestrian friendly. The architecture of the three large hotels is by John Portman, a flamboyant designer who favors such dramatic touches as glass elevators running up and down forty stories of interior atriums. Elsewhere, the three trade marts and office towers are more conventional concrete-and-steel boxes, some faced outside with the Renaissance or Baroque detailing that has become the stamp of postmodern design. The project as a whole reaches for character rather than anonymity. Still, pregnant failures of this computer-driven project are evident on the ground—three failures that menace computer-assisted design more largely as a disembodied design practice.

The first is the disconnect between simulation and reality. In plan, the Peachtree Center populates the streets with well-designed sidewalk cafés. Yet the plan has not actually engaged with the intense Georgia heat: the outdoor seats of the cafés are in fact empty from late morning to late afternoon much of the year. Simulation is an imperfect

substitute for accounting the *sensation* of light, wind, and heat on site. The designers would perhaps have done better to sit unprotected in the midday Georgia sun for an hour before going to work each day; physical discomfort would have made them see better. The large issue here is that simulation can be a poor substitute for tactile experience.

Hands-off design also disables a certain kind of relational understanding. Portman's hotel, for instance, emphasizes the idea of coherence, with its inner drama of all-glass elevators running up a forty-story atrium; the hotel's rooms look outward over parking lots. On-screen, the parking-lot issue can be put out of mind by rotating the image so that the sea of cars disappears; on foot, it cannot be disposed of in this way. To be sure, this is not the computer's inherent fault. Portman's designers could perfectly well have put in an image of all the cars and then viewed the sea, on-screen, from the hotel rooms, but then they'd have had a fundamental problem with the design. Whereas Linux is set up to discover problems, CAD is often used to hide them. The difference accounts for some of CAD's commercial popularity; it can be used to repress difficulty.

Finally, CAD's precisions bring out a problem long inherent in blueprint design, that of overdetermination. The various planners involved in the Peachtree Center rightly point with pride to its mixed-use buildings, but these mixtures have been calculated down to the square foot; the calculations draw a false inference about how well the finished object will function. Overdetermined design rules out the crinkled fabric of buildings that allow little start-up businesses, and so communities, to grow and vibrate. This texture results from underdetermined structures that permit uses to abort, swerve, and evolve. There is thus missing the informal and so easy, sociable street life of Atlanta's older neighborhoods. A positive embrace of the incomplete is necessarily absent in the blueprint; forms are resolved in advance of their use. If CAD does not cause this problem, the program sharpens it: the algorithms draw nearly instantly a totalized picture.

The tactile, the relational, and the incomplete are physical experiences that occur in the act of drawing. Drawing stands for a larger range of experiences, such as the way of writing that embraces editing and rewriting, or of playing music to explore again and again the puzzling qualities of a particular chord. The difficult and the incomplete should be positive events in our understanding; they should stimulate us as simulation and facile manipulation of complete objects cannot. The issue—I want to stress—is more complicated than hand *versus* machine. Modern computer programs can indeed learn from their experience in an expanding fashion, because algorithms are rewritten through data feedback. The problem, as Victor Weisskopf says, is that people may let the machines do this learning, the person serving as a passive witness to and consumer of expanding competence, not participating in it. This is why Renzo Piano, the designer of very complicated objects, returns in a circular fashion to drawing them roughly by hand. Abuses of CAD illustrate how, when the head and the hand are separate, it is the head that suffers.

Computer-assisted design might serve as an emblem of a large challenge faced by modern society: how to think like craftsmen in making good use of technology. "Embodied knowledge" is a currently fashionable phrase in the social sciences, but "thinking like a craftsman" is more than a state of mind; it has a sharp social edge.

Immured in the Peachtree Center for a weekend of discussions on "Community Values and National Goals," I was particularly interested in its parking garages. A standardized bumper had been installed at the end of each car stall. It looked sleek, but the lower edge of each bumper was sharp metal, liable to scratch cars or calves. Some bumpers, though, had been turned back, on site, for safety. The irregularity of the turning showed that the job had been done manually, the steel smoothed and rounded wherever it might be unsafe to touch; the craftsman had thought for the architect. The lighting in these aboveground car-houses turned out to be uneven in intensity, dangerous shadows suddenly appearing within the building. Painters had added odd-shaped white strip lines to guide drivers in and out of irregular pools of light, showing signs of improvising rather than following the plan. The craftsmen had done further, deeper thinking about light than the designers.

These steel grinders and painters had evidently not sat in on design sessions at the start, using their experience to indicate problematic spots in the designs plotted on-screen. Bearers of embodied knowledge but mere manual laborers, they were not accorded that privilege. This is the sharp edge in the problem of skill; the head and the hand are not simply separated intellectually but socially.

Conflicting Standards

Correct versus Practical

What do we mean by good-quality work? One answer is how something should be done, the other is getting it to work. This is a difference between correctness and functionality. Ideally, there should be no conflict; in the real world, there is. Often we subscribe to a standard of correctness that is rarely if ever reached. We might alternatively work according to the standard of what is possible, just good enough—but this can also be a recipe for frustration. The desire to do good work is seldom satisfied by just getting by.

Thus, following the absolute measure of quality, the writer will obsess about every comma until the rhythm of a sentence comes out right, and the woodworker will shave a mortise-and-tenon joint until the two pieces are completely rigid, needing no screws. Following the measure of functionality, the writer will deliver on time, no matter that every comma is in place, the point of writing being to be read. The functionally minded carpenter will curb worry about each detail, knowing that small defects can be corrected by hidden screws. Again, the point is to finish so that the piece can be used. To the absolutist in every