# 1 Hands

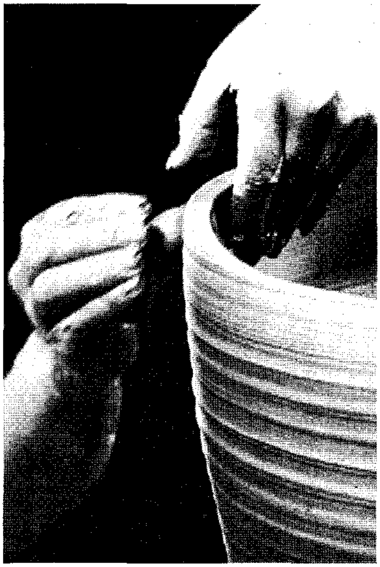
Five Prologues

## 1 Hands Are Underrated

Hands are underrated. Eyes are in charge, mind gets all the study, and heads do all the talking. Hands type letters, push mice around, and grip steering wheels, so they are not idle, just underemployed.

This is a sorry state of affairs, for hands can contribute much to working and knowing. By pointing, by pushing and pulling, by picking up tools, hands act as conduits through which we extend our will to the world. They serve also as conduits in the other direction: hands bring us knowledge of the world. Hands feel. They probe. They practice. They give us sense, as in good common sense, which otherwise seems to be missing lately.

Take a look at your hands. Right now they are holding this book. That alone makes the book more intimate than television. The two hands are working together, but sometimes one might take over the holding, by putting a thumb on the opposite leaf, while the other reaches out to adjust a lamp or raise a drink to your lips. When that hand comes back, the



**1.1 Hands enjoying direct contact with material, from the documentary *In Praise of Hands***

two may find their old positions or assume new ones: the variations seem endless. Even amid this simple activity, hands seem to have a life of their own.[1]

Hands show life most when at work. They don't just hold: they grasp, they pinch, they press, they guide. To pick up a coin, to turn a key, to lift a handle: each uses a fundamentally different grip. Work that applies force takes a different form than work that exercises precision. Moreover, all this work is fast: the hand is quicker than the eye. Hands are versatile, too: they give and take pressure, heat, and texture, and maybe other energy fields. (Try a foot massage with the hands just above the skin.) And for working hands, taking may be as important as giving: hands get shaped. They may get callused or stained. They pick up experience.

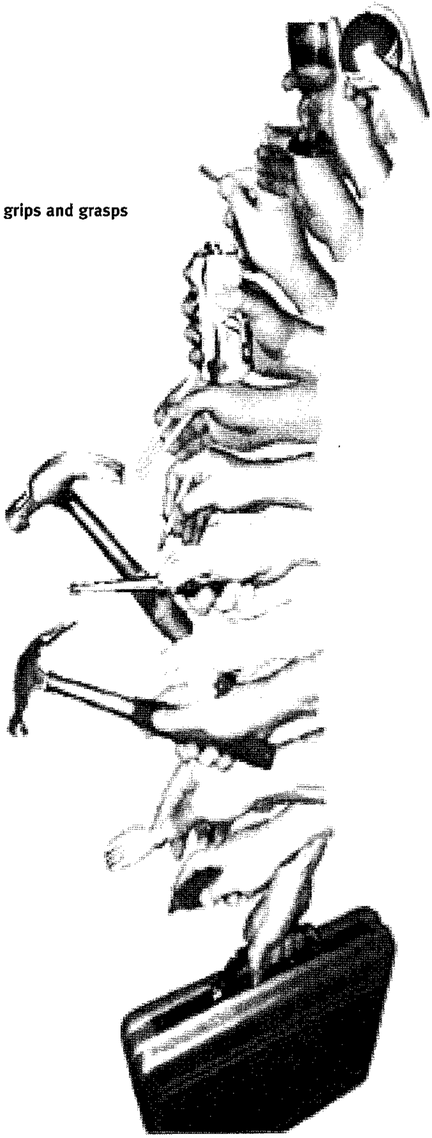
Much life of the hands is a form of knowledge: not a linguistic or symbolic knowledge such as you might use to read this book or write a computer program, but something based more on concrete action, such as sculpting plaster or clay. The knowledge is not only physical, but also experiential. The way of hands is personal, contextual, indescribable. Little can surpass the hands in showing that we know more than we can say. Psychologists and social scientists have studied this inarticulable knowledge extensively, and they have many names for it: operative, action-centered, enactive, reflection-in-action, know-how. The most common word is *skill.*

You might be skillful at anything from a plainly mechanical task to a subtle lifelong practice. For example, perhaps you can type quickly, or have mastered wood joinery. Maybe you draw quite well. You probably understand skill in terms of your own abilities, whatever their level and application, and for this reason the word has as many meanings as there are different talents. However, we might generalize: skill is the learned ability to do a useful process well.

Some forms of this ability bear detailed study; others do not. For example, among cognitive psychologists there is substantial literature on a form of hand-eye coordination known as tracking. Technically, tracking is the use of continuous compensatory feedback to keep a tool on target, as in driving a car, or catching a ball. Similarly, there has been much study of skill in executing long sequences of discrete events, as for data entry or parts assembly. By contrast, there seems to be less documentation of skills that are not so purely behavioral, for example, skills of recognition, of appraisal, of knowing the limits of material. For example, although any experienced mechanic knows the feel of a well-tightened nut and bolt—he or she can recognize the point where the elasticity of the threads has been fully taken up—there is no easy way to test this skill except by indirect means, such as statistically sampling the results of skilled work. Although productivity is perhaps a measure of such a skill, the skill is not mere productivity.

Skill also differs from talent, and from conceptual grasp, even if it may reflect them. Talent seems native, and concepts come from schooling, but skill is learned by doing. It is acquired by demonstration and sharpened by practice. Although it comes from habitual activity, it is not purely mechanical. This is evident not only in the fact that some skills are

## 1.2 The versatile hand: various grips and grasps



difficult to measure, but also in that skill can become the basis of an avocation. Commitment to skillful practice lies at the heart of traditional work, and although we cannot always explain how, we sense that the most refined practices belong to the hands.

Hands are underrated because they are poorly understood. Artists have seldom been able to simultaneously exercise and scrutinize their manual talents. Traditional artisans have seldom been inclined to articulate their expertise. Academics, despite a growing faction interested in "body criticism," generally ignore the hands in their epistemologies of the mind. There are exceptions, as in medicine. For example, kinesiologists can construct prehension for artificial hands. Psychologists can prescribe sensory-motor learning to rehabilitate wounded hands. Surgeons can use remote-control technologies that support some aspects of their delicate manual skill. Even in medicine, however, researchers seem unable to formulate much beyond the mechanical aspects of manual behavior.[2] Science has trouble explaining a caress.

Maybe the best defense of skill to appear in modern philosophical writing occurs within the philosopher/chemist Michael Polanyi's study of scientific learning, *Personal Knowledge* (1958). Polanyi aimed to show that even factual knowledge is acquired through personal commitment. His main argument concerns the subjective act of affirming objective scientific methods. Whatever it is that drives a researcher to pursue particular sorts of findings is inarticulable and personal. Polanyi's study probes tacit knowledge in a variety of nonscientific settings as well. For example, his most striking (and oft-cited) image portrays the hands playing a piano: "Musicians regard it as a glaringly obvious fact that the sounding of a note can be done in different ways, depending on the 'touch' of the pianist. To acquire the right touch is the endeavor of every learner, and the mature artist counts its possession among his chief accomplishments. The pianist's touch is prized alike by the public and by his pupils: it has a great value in money. Yet when the process of sounding a note is analyzed, it appears difficult to account for the existence of touch."[3]

Not surprisingly, many advances in touch technology that have occurred since Polanyi's time have come from digital musicians. The standard code for the musical instrument digital interface (MIDI) has effectively allowed many musicians to become instrument designers. Besides encoding sound waveforms, and supporting sequencers, MIDI controls interpretation of input actions such as keyboard strokes. Thus, for example, it can program a specific relation of touch to timbre, or it can program a pressure-sensitive device to transform an existing audio stream.[4] Yet this electro-mechanical virtuosity has not necessarily demystified traditional instruments. Nor has it carried nearly so far into other art forms, such as drawing or sculpture, let alone into everyday business.

By and large, everyday computing involves very little touch technology. Most ordinary tools and technologies, and most understandings of skillful process, exist without explicit formulations for the role of the hands. Nonmechanical aspects of touch elude practical engineering; some elude scientific description.

Often it is difficult to simultaneously apply and study a skill. Note that effectively maintained skill tends to hold a subsidiary relation to the focus of the action. Even if rules exist, we are not conscious of following them. It is emblematic, as Polanyi notes, that: "If a pianist shifts his attention from the piece he is playing to the observation of what he is doing with his fingers while playing it, he gets confused and may have to stop."[5]

Hands are not the sole locus of this kind of personal knowledge. The entire body may "know," as in dance. In such cases, knowledge is all the more likely to be physically inscribed, without an overtly intellectual component. What, for example, are the rules for swimming? Henri Bergson described this condition quite pleasingly: "Thousands and thousands of variations on the theme of walking will never yield a rule for swimming: come, enter the water, and when you know how to swim, you will understand how the mechanism of swimming is connected to that of walking. Swimming is an extension of walking, but walking would never have pushed you on to swimming."[6]

The work of hands, however, intrigues us more than most other forms of action. The hands can lend an interest to full bodily exertion, as in sport, but they can also act as guides or outlets for intellectual endeavor, as in art. Their learning can be subtle and practiced, more like piano playing and less like swimming. Hands, more than any other part of the body, become quite skilled.

If manual ability has a way of defying explanation, that is because it is based not in language but in action. Skill is participatory. This same basis makes it durable: any teacher knows that active participation is the way to retainable knowledge. In this regard skill has intrinsic, personal worth. It is an achievement. Almost any practiced person values her skill above and beyond what it is good for producing, as though there were psychological benefits to mastery itself.

For example, the circumstances of practice are often themselves a source of satisfaction. This is because skill is sentient: it involves cognitive cues and affective intent. It is also very habitual. In particular, it develops an intimate relation with certain contexts or tools, which makes it individual. No two people will be skilled alike; no machine will be skilled at all. Of course the latter is debatable if we accept simple mechanical or deductive capacity as skill—but we are maintaining that there is a sentient component too. One way our sentient activity differs from the action of machines is play. We putter about in our studios. We *enjoy* being skilled. We experiment to grow more so. Skills beget more skills.

In sum, hands are the best source of tacit personal knowledge because of all the extensions of the body, they are the most subtle, the most sensitive, the most probing, the most differentiated, and the most closely connected to the mind. They deserve to be admired.

## 2 The Phenomenon of Handicraft

"In Praise of Hands" is the name of two celebrated works of criticism worth recalling during these early days of abstract computational media. The first of these is the final chapter of Henri Focillon's classic aesthetic treatise, *The Life of Forms in Art* (1934). The second is a documentary film, *In Praise of Hands* (1974), with a narrative by poet laureate Octavio Paz.

Focillon addresses the dynamics of creativity, for which he argues that art must be tangible.[7] Object form, he asserts, is the one way to record the flux of forms that occurs in space, in matter, and especially in the mind. The apprehension and giving of form is a dynamic process, rather than a static code; giving form gives works their meaning. Of course the givers of form are the hands. Focillon writes: "When one realizes that the quality of a tone or of a value depends not only on the way in which it is made, but also on the way in which it is set down, then one understands that the god in five persons manifests himself everywhere."[8] Through the hand, authorship involves execution, and expression involves workmanship.

The quality of being set down may be understood as being what we might call "thrown," that is, executed at a particular moment, with a particular degree of skill, and with particular idiosyncrasy to the result. This suggests a focused action, at which moment the focused skill of the hands becomes critical, interrupting a more usual state during which time the hands quietly probe. The most essential point to Focillon's argument is that form giving is a two-way process. "The hand knows that an object has physical bulk, that it is smooth or rough, that it is not soldered to heaven or earth from which it appears to be inseparable. The hand's action defines the cavity of space and the fullness of the objects which occupy it. Surface, volume, density, and weight are not optical phenomena. Man first learned about them between his fingers and in the hollow of his palm."[9] Whereas the eyes stay fixed on the outer surface of things, hands have a way of getting inside, and so they contribute more to our belief in the reality of the world.

Hands also discover. They have a life of their own that leads them into explorations. For example, a sculptor's feel for a material will suggest actions to try, and places to cut. Learning through the hands shapes creativity itself. "The hand is not the mind's docile slave. It searches and experiments for its master's benefit; it has all sorts of adventures; it tries its chance."[10]

Focillon's position is all about sensate presence—it is pure phenomenology. The object is a manifestation and a gathering. This object presence is a product of a tool, and the tool used in form giving both fashions and is fashioned by the hand. The work is a daily form of communion. The practice of work maintains a necessary psychological connection to a dim archaic past. The impressions conveyed by the hands complement those expressed by speech, and both are necessary.

Focillon is ambivalent about industry, however, for he dislikes its artlessness. For example, he protests the loss of "even the most modest and uniform execution [that] betrays the artist's touch—that decisive contact between man and object."[11] In one place he accuses industry of being "a beast without hands, whose dull and monotonous products remain only at the threshold of art."[12] But he usually praises hands without any explicit critique of industrialization, and celebrates tools as a way of probing the world. "I do not know if there is a break between the manual and the mechanical orders—I am not very sure of it—but the implement at the end of his arm does not refute man's existence."[13] This is to say that tool usage, even when machine powered, can remain very much humane.

Focillon's argument survives quite well outside his own intellectual context, and it has enjoyed a recent revival for the counterpoint it offers to poststructuralist discourses. Current readers may recognize that Focillon's concern was mainly for high aesthetics, and that phenomenology was simply his form of opposition to the dematerialism of dada and schematism of the early moderns, but they may find that his lasting lesson centers on the unity of working and learning.

Another name for the same lesson might be "Use and Contemplation," which is the title of the Octavio Paz narrative accompanying the film, exhibition, and catalogue entitled *In Praise of Hands.* In this essay, Paz compares the wholeness of traditional craft with the modern separation of use and beauty: "In the work of handcraftsmen there is a constant shifting back and forth between usefulness and beauty. This continual interchange has a name: pleasure. Things are pleasing because they are useful and beautiful. This copulative conjunction defines craftwork, just as the disjunctive conjunction defines art and technology: usefulness *or* beauty."[14]

This is a remarkably clear invocation of the spirit that motivates craft. These themes of continuity, practicality, simple beauty, and play will keep coming back to us. We should take them to heart.

Paz constructs both art and industry as surrogate religions, each seeking a communion lost through this separation. Art consecrates objects that have no other function than to be. "In modern works of art meaning dissolves into the sheer emanation of being. Jackson Pollock's paintings do not mean, they are." We might say that art became separated from utility at the time of industrialization, from representation after the rise of the camera, and from symbolic interpretation in the era of television and cinema—and after two centuries at last achieved complete independence from workmanship. (Each of these was once considered a source of meaning.) In the generation that elapsed between Focillon and Paz, art became fully intertextual—that is, self-referential.

Industry, meanwhile, worships objects that have no being but their function—that are *nothing but* useful. Industry's creed is efficiency. According to Paz, "The industrial object tends to disappear as a form and to become indistinguishable from its function. Its being is its meaning and its meaning is to be useful. It is the diametrical opposite of the work of art. . . . The destination of the work of art is the air-conditioned eternity of the museum; the destiny of the industrial object is the trash barrel. The handcrafted object ordinarily escapes both of these."

The handcrafted object reflects not only an informal economy of energy (as opposed to one of process efficiency), but also pleasure. Its production involves some play, some waste, and above all a kind of communion. Its long life continues to enhance its qualities through use and contemplation—to invoke the title chosen by Paz. As an object it represents and serves its culture; its daily handling is a humble act of participation in that culture. Paz the poet evoked a metaphorical communion with archaic pasts:

> Since the thing is made by human hands, the craft object preserves the fingerprints—be they real or metaphorical—of the artisan who fashioned it. These imprints are not the signature of the artist; they are not a name. Nor are they a trademark. Rather, they are a sign: the scarcely visible, faded scar commemorating the original brotherhood of men and their separation. Being made by human hands; the

craft is made for human hands: we can not only see it but caress it with our fingers.

It has many tongues: it speaks the language of clay and minerals, or air currents flowing between canyon walls, of washerwomen as they scrub, of angry skies, of rain. A vessel of baked clay: do not put it in a glass case alongside rare precious objects. It would look quite out of place.[15]

### 3 A Short History of Craft

To wax poetic on a humble water jug is an act of which only the modern era could be capable—this kind of appreciation arises only against the threat of extinction. (Appreciation was indeed the purpose of the film *In Praise of Hands,* which was one of the earliest instances of the "trade, not aid" policies by which the developed world now tries to sustain the indigenous craftspeople it contacts.) As a way to define terms, and to generalize the idea of abstraction set forth in the introduction, consider some history of craft.[16]

The Ancients produced solely by craft—that is, without organized industry. Everything was craft, especially utilitarian production, which often involved slavery. Relatively little is known about these conditions, because the learned disdained handwork, and the artisans kept no lasting records other than their products. It is clear, however, that the decline of the ancient world was accompanied by a decline in production, and with it the loss of many expertises that ancient practices had supported. If for no other reason than this, the centuries of scarcity that followed gave craft objects greater value.

In the European early Middle Ages artisans gained rank, for as free men they took refuge in the monasteries—where it was appreciated that indeed, Jesus Christ was a craftsman's son. Later, amid expanding urbanization and trade, high Medieval guilds diversified and regulated the supply and demand for a great many crafts. The essential distinction reflected by guilds was the making of goods not for local use: towns created guilds—

and guilds made towns—in order to instigate commerce.[17] For this reason it is doubtful that this period was the apex of an innocent craftsmanship, dedicated to the glory of God, later romanticized by the Victorians. Commerce was its own reward, and work was not all whole: certainly, guild members' work contained many tedious elements, which were usually carried out by the apprentices, and even master artisans had responsibilities of toil and business outside their nominal area of endeavor.[18]

By the fifteenth century, although the prospering guilds had elevated the *Ars Mechanicae* to further respectability, the fine arts began to have a distinct identity, in which Man and Nature had emerged as muses in their own right. Meanwhile, mercantilism steadily surpassed artisanry as the basis of middle-class wealth. Economic historian Fernand Braudel has described the *Jeux d'Echange* as the economic engine of Western Europe. His classic thesis is that more than production itself, and since long before capitalized industry, elaborate structures of practice have been the main source of bourgeois prosperity. Braudel described a web of diversified production, laboring organizations, and trade patterns. Artisans and merchants alike were caught up in this net.[19]

At least in Europe, the Renaissance introduced an intellectual separation of practical craft and fine art. Art came to be held in higher esteem. The transition took a long time, but slowly the word "artisan" was coopted to distinguish the skilled manual worker from the intellectual, imaginative, or creative artist, and artists emerged as a very special category of cultural workers, producing a rare and marginal commodity: works of art.[20]

Meanwhile the artisans often organized their labors to the point where their workshops became factory-like. By the eighteenth century, this proto-industrialization made Medieval practices of craft something no longer to be taken for granted, and further degraded the stature of the artisan. The following entry from Diderot's vast *Encyclopédie* (1751–80) is still one of the best definitions available.

> CRAFT. This name is given to any profession that requires the use of the hands, and is limited to a certain number of mechanical operations to produce the same piece of work, made over and over again. I

Vol. IV, Ferblantier, Pl. I.

**1.3 Some of the hundreds of traditional craftsmen depicted in Diderot's *Encyclopédie***

> do not know why people have a low opinion of what this word implies; for we depend on the crafts for all the necessary things of life. Anyone who has taken the trouble to visit casually the workshops will see in all places utility applied with the greatest evidence of intelligence: antiquity made gods of those who invented the crafts; the following centuries threw into the mud those who perfected the same work. I leave to those who have some principal of equity to judge if it is reason or prejudice that makes us look with such a disdainful eye on such indispensable men. The poet, the philosopher, the orator, the minister, the warrior, the hero would all be nude, and lack bread without this craftsman, the object of their cruel scorn.[21]

By the nineteenth century, industrialism was in full swing. Industrial technology had consequences from the political to the aesthetic, the assessment of which remains at the foundations of many academic disciplines today. The engines of industry established new social relations, and gave force to the intellectual discipline of political economy. Amid this broad sweep, artisanry entered full decline in the face of machine-powered industry. Skills became less important, and design disciplines became distinct from handicrafts. Indeed the machine established an adverse relation between hands and mechanized production methods, one that most people still experience. This happened recently enough that many oppositional records remain. Some of the most vehement of these criticisms came from gentleman critic and historian John Ruskin, initially in *The Seven Lamps of Architecture* (1849):

> The last form of fallacy which it will be remembered we had to deprecate was the substitution of cast or machine work for that of the hand, generally expressible as Operative Deceit . . . There are two reasons, both weighty, against this practice: one, that all cast and machine work is bad, as work; the other, that it is dishonest.

Ruskin was especially attentive to the role of hands:

> For it is not the material, but the absence of the human labour, which makes the thing worthless; a piece of terra cotta, or of plaster of Paris, which has been wrought be the human hand, is worth all the stone in Carrara, cut by machinery. It is, indeed, possible, and even usual, for men to sink into machines themselves, so that even hand-work has all the characters of mechanism.[22]

Opposite Ruskin's eloquent reactionary prose, the Republican technologists of the emerging American nation saw technology as the way to realize the latent promise of a great continent. Ralph Waldo Emerson, in particular, translated this vision into a lasting national creed, as expressed in his famous aphorism that "Railroad iron is a magician's rod in its power to evoke the sleeping energies of land and water."[23] Emerson was able to reconcile unrestrained advocacies from early industrialists such as Edward Everett or Francis Cabot Lowell with emerging cautions over the ills of factory work as well as romanticisms of nature.[24] Unlike Ruskin's, this was a measured position. The image of the machine in the garden represents an unwelcome intrusion of railroad iron into the classic pastoral landscape, but also a union between liberating technology and the developing nation. This distinctly American justification of technology though democracy has endured for nearly two centuries—from woolen mill to World Wide Web.

Industrialism also bred a socialist response. If we are to judge by the sheer number of academic citations, there has yet to be a more influential scholar on the topic of work than Karl Marx, who was emblematic of the view that modern production harmed its workers. The problem as identified by Marx was twofold: serial manufacturing based on semiskilled processes denied this new form of laborers any control over quality, and specialized production still based on highly skilled processes denied artisans their previous range of other activities.[25] Avoiding such harm required conscientious resistance. Even after Marxist political economies were to have run their course, not without abuses of technological authority themselves, this oppositional stance would still inform critical theory in the electronic age.

Also of the nineteenth century we must observe more utopian forms of socialized production, such as those practiced by the Shakers in America or William Morris and his followers in Britain—great craftsmen the lot of them. The Arts and Crafts movement, whose start was signalled by Morris, became one of the more significant responses to industrialism. Its concern for the aesthetic consequences of hasty profiteering may have been socialist in its origins, but its appeal to amateur creativity and taste was ultimately quite democratic. Its emphasis on functional integrity and material economy was an important correction in the course of modern aesthetics. Its claim that art had a place outside the galleries is one we can renew today.

The fact is that by the early twentieth century, artisanry had fallen not only out of industry, but also out of art. The Arts and Crafts movement began as a valiant response to industrial aesthetic deficiencies, but a few decades after its gentlemanly start it had become burdened with the stigma of amateurism. At best, craft was the mere execution of preconceived ends; more often, it was a mere hobby.[26] Art—which was the true search—became increasingly independent of technique.[27] Early modern art expunged personal touch. A generation later, pop art, found art, minimal art, and conceptual art would deny the need for any artisanry at all. Seen against the accelerating pursuit of the latest ironic pose, particularly the appropriation of broadcast and industrial debris, any emphasis on execution would appear positively banal. Crafts, like astrology, would be left to the soft of mind.

Meanwhile, mechanized industry had become much more refined. Electrification lit the workplace and moved the heat and noise of the furnaces elsewhere. Conversely, it made it possible for small electric motors to go many places where clumsy mechanical drive belts could not—for example, away from the water mill. Electrification enabled assembly lines, switching and control signals, and hand-held power tools. It also affected materials, for example, by making aluminum and stainless steel more practical.[28]

Largely as a result of these changes, manufacturing matured to the point where its products were now art forms in themselves. This art was not of *works,* however, but of *products.* As industrialization shifted attention from piecewise execution to generative design, processes such as production planning, material optimization, and product analysis became essential. Industrial design emerged as the darling of the self-proclaimed "machine age," and a new breed of industrial craftsmen emerged as mediators between design and the machine. Herbert Read, the great advocate of industrial design as a high and abstract art, stated in 1936: "The real problem is not to adapt machine production to the aesthetics of handicraft, but to think out new aesthetic standards for new methods of production."[29] Read identified a secondary problem arising from the first: "If we decide that the product of the machine can be a work of art, then what is to become of the artist who is displaced by the machine? Has he any function in a machine-age society, or must he reconcile himself to a purely dilettante role—must he become, as most contemporary artists have become, merely a society entertainer?"[30]

Workmanship in a factory setting became less a matter of putting oneself into the job and more of getting the most out of the machines. It shifted care from individual pieces to composite processes. Certainly this was no place for the hands. In his seminal design book *Mechanization Takes Command* (1948), Sigfried Giedion wrote: "In its very way of performing movement, the hand is ill-fitted to work with mathematical precision and without pause. . . It cannot continue a movement in endless rotation. That is precisely what mechanization entails: endless rotation."[31]

At the apex of industrialism, on the eve of the digital age, the economist E. F. Schumacher observed in *Small Is Beautiful* (1973):

> The type of work which modern technology is most successful in reducing or even eliminating is skillful, productive work of human hands, in touch with real materials of one kind or another. In an advanced industrial society, such work has become exceedingly rare, and to make a living by doing such work has become virtually impossible. A great part of the modern neurosis may be due to this very fact; for the human being, defined by Thomas Aquinas as a being with brains and hands, enjoys nothing more than to be creatively, usefully, productively engaged with both his hands and his brains.[32]

Today, the electronic information machine is a new chapter in the story. As the slogans put it, the computer or communications device is inherently a tool for the *mind*—not the hands. Its essential action is to process and transmit not power but symbols. Its products are not mechanical artifacts but abstract information.

The immediate reaction to the arrival of information technology was to imagine its use in terms of furthering existing modernist agendas. By projection, trends such as managerial command and control, productive efficiency regardless of the social cost, deliberate deskilling, replacing people with machines, and so on, were now given just the leverage they needed to deliver the final blow to any humane aspects of work. The circumstances of working with the technology itself would be harmful in their own right: new class divisions, concessions to the technology providers, antisocial working arrangements, worker surveillance, endless mind-numbing technical detail, and overall sensory deprivation. For the hands, the only prospect would be painful repetitive motion disorders.

Today for an unfortunate class of data-entry workers, who perhaps outnumber any other kind of computer-based workers, these fears have proved altogether too prescient. We can easily despair. As in the time of Ruskin, we could yearn romantically—and in vain—for a more innocent way of work. Or we can strive for a future with more appealing technology more justly applied.

For example, maybe the 1990s will be remembered as the decade where technology escaped authoritarian control. It was then that the modernist masters, like Pynchonesque villains, proved unable to deliver that final blow, and an antiheroic counterforce of digital Prairies and Slothrops unwittingly seized the postmodern day by default. There in the decade of recombinant businesses, ad hoc marketplaces, digital artists, hackers and phreaks, web architects, avatars, agents, and overall online anarchy, there when nobody was looking, the modernist technological project collapsed like communism. Maybe. Other storytellers imagine more holistic and silicon-centric outcomes.

Yet surely some change will be for the better. Much as industrialists used the prosperity they so incontestably produced to remedy some of the adverse conditions their activities created, so too the disciplines of computing shall compensate for their crude and inhumane origins. Today we may deplore our personal technology for its unnatural keyboards, irradiating screens, and tedious forms of instruction, but at least we can value it for being at personal scale. We must not forget that twenty years ago personal computing did not exist at all: there were only institutionalized, air-conditioned behemoths attended by technicians in white lab coats. We cannot know what to expect twenty years from now. If computers continue to become smaller and more numerous at the same mind-boggling pace, they may conceivably pervade everything we own and operate, from office doors to garage workbenches. When it accommodates not only touch but also sound, physical context, social community, and accumulated experience, this ubiquitous technology may actually seem quite pleasant—especially to the more skillful or sensitive person.

One thing is clear. We have reached a point in the history of technology where it is especially important to take pride in human abilities. We must not only defend against further deskilling, but also direct inevitable technological change in a more human-centric direction. Just because much of the world is being spoonfed a particular form of technology (the one based on mouse, keyboard, and screen) does not mean that we know what computing is or will be just a few years from now. And if and when any chaotic fantasy and fugue comes true, and the conditions of work grow more post-whatever, there are likely to be unwitting digital artisans on the scene, making fairly good use of their hands.

## 4 What Is Craft?

Tools and technologies have both assisted and opposed the hand throughout history; the relation is not necessarily adversarial. Although we find no recourse to traditional production—no more than there was in the time of Ruskin—nevertheless we must look very closely at craft. As a part of developing more engaging technology, as well as developing a more receptive attitude toward new opportunites raised by technology, we must understand what matters in traditional notions of practical, form-giving work. This will take some study of tools, some study of human-computer interaction, and some study of practicing the digital medium. But it will not require us to identify what (if anything) is truly made by hand. Nor does our praise of hands necessarily mean condemnation of technology.

As a point of departure, consider the example of a skilled computer graphics artisan—if we may use this word. His or her hands are performing a sophisticated and unprecedented set of actions. These motions are quick, small, and repetitive, as in much traditional handwork, but somehow they differ. For one thing, they are faster—in fact, their rates matter quite a bit. They do not rely on pressure so much as position, velocity, or acceleration. The artisan's eye is not on the hand but elsewhere, on a screen. The actions have a practical component, and the skill may be practiced for a livelihood and a trade identity. If we test a description of this work against Diderot's description of craft, almost every word fits.

According to Webster, the word "craft" derives from the Middle English *craeft,* which simply meant strength or power. We must remember that because such forces were regarded with suspicion, the word retains some residual meaning of arcane intellectual skill, or even deceitful cunning (e.g., a crafty fox). In later meanings the word referred to a more specific power, namely specialized skill or dexterity in the manual arts. It also referred to a calling or occupation, or the members of a trade who share that skill.

Artisanry can be defined as the practice of a craft for a livelihood. Traditionally this implied a certain economy of means, particularly with respect to getting the most out of a limited medium. Of course very few people still practice a material craft for a livelihood. According to our current proposition, however, aspects of craft in practical computational work may lead to habitual practices that we could understand as artisanry.

Different from artisanry there is artistry, which is the role of art in other processes. There may be an element of art in craft, or an element of craft in art. Pure art has endless definitions. For example, Paul Klee said the purpose of art is to awaken reality. But relative to craft, we can say that art is the creation of artifacts for indescribable, not preconceived, and possibly impractical ends: to search, to reveal, to release.

Industry is defined in distinction to art or craft as the application of technology to practical production. (This is to ignore the word's archaic meaning of personal diligence.) Engine-powered, continuous-process mechanical reproduction works consistently without the intervention of any particular person.

Industrial design seeks to establish aesthetics for mechanized production. It seeks variation not in the individual objects, but in the kinds of standardized objects that become available. It brings artistry to the precision, detail, and material quality of work generally impossible to achieve at any cost by hand.

Technology is—literally in the Greek—the study of skill. It is order imposed on skill, and it is also the apparatus derived from applying the results of study. Technique is a method of doing something, possibly skilled, possibly using technology. Tools, machines, computers, materials, and media all will be explored in greater detail later on; but it should be safe to say that given ubiquitous technical examples such as oil painting or motion pictures, technology can become a medium, or at least the basis of a medium.

Now there is reason to explore the possibility of craft in the emerging realm of information technology—with the computer as a medium. This hardly fits the conventional usage of the word "craft," for the usual meaning opposes high-technology processes in which the hand plays a diminished role. Thus the proposal of craft in the electronic medium is something of a paradox. But can we, here in the computer age, with fully optimistic and benevolent intent, suggest that the word needs a more inclusive definition?

This seems to be happening anyway. The word has resurfaced in popular usage—but as a verb. People "craft" everything from business memos to good stout beer. In digital production, craft refers to the condition where people apply standard technological means to unanticipated or indescribable ends. Works of computer animation, geometric modeling, and spatial databases get "crafted" when experts use limited software capacities resourcefully, imaginatively, and in compensation for the inadequacies of prepackaged, hard-coded operations. As a verb, "to craft" seemingly means to participate skillfully in some small-scale process. This implies several things. First, it affirms that the results of involved work still surpass the results of detached work. To craft is to care. Second, it suggests that partnerships with technology are better than autonomous technology. For example, personal mastery of open-ended software can take computers places that deterministic software code cannot. Third, to craft implies working at a personal scale—acting locally in reaction to anonymous, globalized, industrial production—hence its appeal in describing phenomena such as microbreweries. Finally, the usage of "craft" as a verb evades the persistent stigma that has attached itself to the noun. The noun suggests class differences and amateurism. For example, craft still recalls the provincial dilution of the Arts and Crafts movement into what now consists of folk art at best, and rustic shops full of tourist trinkets at worst. Craft is seldom any longer practical trade, but it is not yet often art. It is outside of academic consideration: ever since mechanization has taken command, craft has been stranded in bourgeois territory where few self-respecting aestheticians would dare to tread. But new usage may change this situation. Based on observations of a linguistic tendency, and with a desire to explore an academically belittled area, this book is a meditation on the seeming paradox of intangible craft.

Craft remains skilled work applied toward practical ends. It is indescribable talent with describable aims. It is habitual skilled practice with particular tools, materials, or media, for the purpose of making increasingly well executed artifacts. Craft is the application of personal knowledge to the giving of form. It is the condition in which the inherent qualities and economies of the media are encouraged to shape both process and products. It is not about standardized artifacts, however. It is not industrial design. It remains about the individually prepared artifact, which is newly practical due to digital computing. Craft is certainly an application of skill, and it may yet involve the skilled hand.

Thus the defense of skill may no longer remain a losing philosophical position. If previously it was usual to assume that computation would only worsen the hand-mind splits engendered by industrialism, now we might reconsider this problem. We might observe how software usage is restoring some respect for mastery. We might also note the invention of technologies that support the subtleties of the hand. Although most people have failed to perceive in the technology's fledgling states any capacities for new kinds of active skill, perhaps it is still early in the game, and many of these views may well shift.

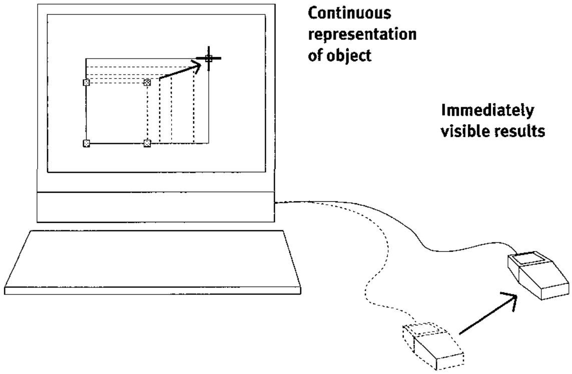
The question is largely generational: younger people, for whom computing is normal, may shape the most change. As the columnist and MIT Media Lab founder Nicholas Negroponte has noted, "All that seems to count, like learning French in France, is being a child." Within computing, "The haves and have-nots are now the young and the old."[33] Anyone on the edge of this generational change—say between the ages of thirty and forty—should be keenly aware of this distinction.

### 5 Direct Manipulation

The first glimmer of digital craft, and the main breakthrough to popular computation as we know it, was the introduction of pointing. "Direct manipulation" is a term coined in 1983 by software designer Ben Shneiderman to describe a principle that we now take for granted: pointing at our work with a mouse. More specifically, the expression referred to the combination of three fundamental activities: (1) continuous visibility of the object of interest; (2) rapid, incremental, reversible, physical actions on the object; and (3) immediately visible results.[34] The slogan "What you see is what you get" popularized the essence of this technical combination, but hand-eye coordination meant more than just visual fidelity.

The Macintosh popularized the direct manipulation strategy in the mid-1980s, and MacPaint and MacDraw became the first commercially successful direct manipulation programs. Here were the first uses of tool icons, modified cursors, and realtime pixel coloration (well, black and white at least). Here the graphical objects first developed grips and intrinsic operations, such as selecting, stretching, and replicating. Here, at last, you could draw without typing in numbers on a keyboard.

This early Macintosh was commonly referred to as the first human-computer interface good enough to criticize. By now it is a familiar and storied lineage: Xerox PARC in the late 1970s, then Apple, today Microsoft. Soon the Macintosh's direct manipulation format was imitated by most of its competitors. Some expanded it into three dimensions, as with




**1.4 Basic principle of direct manipulation**

the specialized Silicon Graphics machines of the late 1980s. And when Microsoft promoted it to the mainstream millions in the form of Windows, direct manipulation based on graphical user interfaces became the unquestioned norm.

The best measure of direct manipulation as a basis for digital craft is its capacity for continuous actions. Direct manipulation's continuity depends on having enough computing speed to calculate realtime graphical feedback, so this capacity improves almost as fast as the power of the chips themselves. It may have let us start by manipulating lines and squares in MacDraw, but there is no reason why direct manipulation cannot also be applied to gestures, three-dimensional renderings, tactile textures, complex multimodal structures, or abstracted architectures of information. In research settings, and in some specialized commercial products, it already does so.

Touch technology nonetheless remains far behind other aspects of human-computer interaction. Most interaction technology has emphasized output, not input; foreground tasks, not background contexts; and visualization, not a more fully rounded sensory balance that one might call "perceptualization." So far, the much ballyhooed "look and feel" of contemporary computing is almost all look and hardly any feel.[35] For one thing, the sense of touch is relatively difficult to engineer. This is partly because it does not rely on a particular organ like the eye or ear—unless that is the hand. Pressure feedback is relatively straightforward to engineer—some arcade games do this—but temperature, texture, and wide-area contact prove more difficult. If there is something common to much research on tactile computing, that might be an emphasis on action. Researchers often use the term *haptic,* which means the exploratory and manipulative aspects of touch, as opposed to passive sensation. Some fields such as music and medicine have been advancing pressure components of touch quite rapidly, and specialized research in haptic computing is fairly easy to find within them. For example, many remote surgical operations conduct delicate touch by means of computer technology.

Haptic skill should play an equally important role in the fields of design and fabrication; but these fields have not come as far in realizing their potential. Nor have the findings of research in better-funded fields yet found their way into much merchandised software for designers. No, the two-dimensional mouse, point-and-click form of direct manipulation has prevailed for a strangely prolonged period of time. And although there is every indication that human-computer interaction is evolving toward much more satisfactory haptic engagement (among other perceptual dimensions), there is also evidence that this just might take a while.[36]

Without touch, in the meantime, perhaps we are stretching to call direct manipulation craft. There is a natural objection: What good are computers, except perhaps for mundane documentation, if you cannot even touch your work? The fact that traditional craft endures at all is because it satisfies some deep need for direct experience—and most computers are not yet providing that experience.

However, other developments are at least partially compensating for the limited role of the hands. For example, sophisticated motion tracking can incorporate gesture, and large flat-panel displays can unite the computer's metaphorical "desktop" with a real physical desktop, so as to escape the limits of screen pointing. Multimodal activities, such as coupling actions to sounds, are beginning to emerge. These many techniques first appear on the market in computer video games, for multisensory activities awaken the intuition and heighten the sense of drama, but this suggests much capacity for talent in other applications as well. As some of these interaction developments disseminate into practice, it may seem that we do not need to wait for the arrival of haptic interfaces before we raise the possibility of craft. Rather, we can begin to develop a provisional sensibility based on what we have, and wait for eventual developments in touch technology to remove our remaining reservations.

Already plenty of skills have emerged amid the application of ordinary commercial software. This is difficult to generalize because people work in so many different contexts, but obviously a lot of computer usage involves a good deal more than coded memorization of routines. Learning involves more than operational training, for practice and outlook also contribute to expertise.

If you use a computer, you might observe several aspects of inarticulable skill in your everyday work. You might feel that this begins from manual dexterity. You have probably learned to find mouse positions and control key combinations by reflex. Your hands and eyes become closely coordinated despite being focused on different objects. You may recognize the importance of sequence: motions usually last only fractions of a second, but they occur in a constant stream, where their rate matters. With practice you become able to execute tightly synchronized combinations, as if you were playing an instrument.

Besides manual dexterity, you may feel some intellectual agility. You will learn to build mental models, and to switch frames of reference when necessary. You alertly monitor feedback from a variety of sources, and recognize and recover from errors before they compound themselves. You benefit from the habit of identifying patterns—and using them to work at a higher level. You learn to read system states in multiple ways, and this versatility lets you go about operations in whatever manner is currently most convenient. Your hands too, may work together in complementary modes, and each may move quickly between modes.

At times you may think that computer work mainly just tests your patience. It is incremental, like chiseling away at a piece of stone. It involves unexplained roadblocks and glitches. It is monotonous, fatiguing, and yet full of interruptions on a whole spectrum of time scales—some a couple of minutes, some a couple of seconds, some just subliminal fractions of a second. Unlike the soothing quality of continuous process in traditional work, this staccato pace is irritating. Fortunately you can compensate. For example, you may know how to slow down to match the pace of near realtime processes. You learn to cut down on unnecessary motions or state changes. You know when to put aside direct manipulations and resort to command languages or delegated agents. You *work around* problems: when one approach is blocked, you quickly find another that is open.

Meanwhile you experience new kinds of continuous actions. As computers become faster, and interfaces improve, more processes become operable by continuous strokes instead of discrete selections. This switch from discrete to continuous distinguishes digital craft from mere mechanical machine operation. When some continuous pointer motions become more precise than all but those required for the finest traditional tool applications, you might discover them quite satisfying.

Above all, you develop a contextual awareness. Like a good pianist you improve your ability to push what you have learned into a subconscious background, so that you don't have to keep so much in mind at any one time. Instead of thinking the actions, you feel the actions—and actions stir your memory, and give you a better sense of inhabiting your work. As an expert you sense what to try when; how far a medium can be pushed; when to check up on a process; which tool to use for what job. If you have used computers much you know this kind of judgment, or know that you want to learn.

Something very important is happening, and it has to do with the growing capacity of electronic symbol-processing technology for a range of skillful practices. There are three essential components to this sea change. First, the tools have become much more affordable. This reverses perhaps the greatest blow against the artisan two centuries ago, namely the establishment of means of production too large and complex for any individual to afford. As a result, industrial-age stereotypes about the complicity of technology with authoritarian or institutional agendas may soon be irrelevant. Second, human-computer interface technology has improved, and is now beginning to diversify. This means we are on the verge of much greater capacity for talent. As computers balance a greater breadth of input with their current emphasis on output (and so relieve us of too much burden of instruction), we should find it easier to work skillfully. Better gestures, more sensory combinations, and improved three-dimensional frameworks should open up many new niches of practice. Finally, there is a growing appreciation of new abstractions. Increasingly, computers let us treat abstract relations as visible, workable things. As a result, new kinds and levels of work become viable. This is partly due to better support for active skills, and partly due to better abstractions of background contextual awareness.

Histories of technology reveal the increasing abstraction of work. Successive levels of invention have freed us from hunting down our next meal, breaking our backs in the fields, sweating over the forge, and numbing our minds with accounting. Each level forms a layer over the old, rather than casting it aside, as in the stages of a natural growth. This means that even if new abstractions eventually become the most prominent methods, they do not replace existing activities so much as transform or complement them.

Because the move to electronic means of production is now in full swing, we must carefully consider potential losses and gains at a highly abstract order. Although computers are useful, are they good? But this question may be too broad and unanswerable, so let us inform it with a simpler question: Does further abstraction necessitate further decline of human skill, particularly of the hand? Let us direct our curiosities and practices in the high-tech realm toward one of the most humane of ends: craftsmanship.

If the beginnings of computing ultimately appear to future historians as the most significant outward expression of our time, they are not likely to do so on the basis of functional utility alone. Social and aesthetic concerns will matter too. The artifacts and practices that computing produces will demand—and reward—more refined interpretations. Note that traditionally it is in interpretation that we have used the word "craft" most broadly: the writer's craft, the actor's craft, and the conductor's craft join those of the cobbler and carpenter. What all such crafts share is not just technique, or hard work on form, but also a probing of their medium's capacity, a passion for practice, and moral value as an activity independent of what is produced. Is there any reason to expect these in the electronic realm? We must make them our goal.