THE CRAFTSMAN

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CHAPTER EIGHT

Resistance and Ambiguity

"Don't try to hit the target!" This bit of Zen advice seems so baffling that the young archer may be tempted to aim the arrow at the master. The master is not perverse: the author of *The Art of Archery* means "Don't try so hard," and he's offering practical advice: if you try too hard, are too assertive, you will aim badly and hit the target erratically.[1] The advice goes beyond counseling minimum force. The young archer is urged to work with resistance in the bow, to explore different ways of pointing the arrow, as though the procedure were ambiguous. In the end the archer will aim better.

The Zen master's advice could be applied to urbanism. Much twentieth-century urban planning proceeded on the principle: demolish all you can, grade it flat, and then build from scratch. The existing environment has been seen as standing in the way of the planner's will. This aggressive recipe has frequently proved disastrous, destroying many viable buildings as well as ways of life bedded into urban fabric. The replacements for these destroyed buildings have also, too often, proved worse; big projects suffer from overdetermined, fit-for-purpose form; when history moves on, as it always does, tightly defined buildings can soon become obsolete. So the good urban craftsman wants to take the Zen master's advice, work less aggressively, befriending ambiguity. These are attitudes—but how do they become skills?

How the Craftsman Can Work with Resistance

We want to start with resistances, those facts that stand in the way of the will. Resistances themselves come in two sorts: found and made. Just as a carpenter discovers unexpected knots in a piece of wood, a builder will find unforeseen mud beneath a housing site. These found resistances contrast to what a painter does who scrapes off a perfectly serviceable portrait, deciding to start over again; here the artist has put an obstacle in his or her own path. The two sorts of resistance would seem entirely unlike: in the first something blocks us, in the second we make our own difficulties. Yet certain techniques are shared in learning to work well with both.

The Path of Least Resistance

Boxes and Tubes

To explore what people do when they find resistance, we might consider one of the shibboleths of engineering: follow the "path of least resistance." This dictum is rooted in the human hand, based on the precept of combining minimum force with release. The history of urban engineering offers an illuminating experiment in its environmental dimensions.

Modern capitalism began, Lewis Mumford has argued, in the act of systematically colonizing the ground. Networks of mines provided the coal that fueled the steam engine; the steam engine in turn begat mass transport and mass manufacturing.[2] The technology of tunneling enabled modern sanitation systems, underground pipes diminishing the scourge of plague, and so helping to increase the population. The underground realm below cities remains today as important as in the past; tunnels now house the fiber-optic cables that exploit the resources of digital communication.

Modern mining technology derived originally from the bodily revelations of the scalpel. Andreas Vesalius, the doctor in Brussels who founded modern dissection, published *De humani corporis fabrica* in 1533. In 1540 modern technology for working belowground was codified in Vannoccio Biringuccio's *Pirotechnia,* a treatise that urged its readers to think like Vesalius, using mining techniques that lifted plates of stone or stripped back strata of earth rather than simply chopping through them.[3] Working in this way, Biringuccio argued, would follow the path of least resistance in going underground.

The end of the eighteenth century marks the time when planners felt it imperative to apply these mining principles to the realm under urban ground. The expansion of cities made it clear that transporting clean water and removing excrement required tunnels of a size that exceeded those of the ancient Roman city. More, the planners intuited that people might be moved around the city more rapidly underground than was possible on the tangle of surface streets. In London, though, the earth was an unstable mud mass; eighteenth-century techniques used to mine coal would not quite serve. Moreover, tidal pressure on the London mud mass meant that the timber supports used in hard rock or coalmines could not stabilize even relatively solid sectors of the earth. Renaissance Venice offered to eighteenth-century builders in London some insight into how pilings could float warehouses above mud—but not how to inhabit the mud itself.

Could these underground resistances be overcome? The engineer Marc Isambard Brunel had an answer. He had at age twenty-four left France for Britain in 1793 and sired the even more illustrious engineer Isambard Kingdom Brunel. The Brunels treated natural resistance as their enemy, and tried to defeat it, when in 1826 father and son sought to construct a road tunnel under the Thames River, east of the Tower of London.[4]

The elder Brunel concocted a mobile metal house that allowed workers to build a brick-lined tunnel as the metal house moved forward. The house consisted of three linked iron chambers, each roughly a yard wide and seven yards tall, each pushed forward by a large screw-turn at its base. Within each compartment, men laid the brick sides, bottoms, and tops of the tunnel as the house advanced; behind the men in the front room came a larger army of masons to thicken and reinforce the new walls. On the advancing wall of the house, small slits in the metal allowed mud to seep through, relieving forward pressure; more men carried this mud away.

Struggling against, rather than working with, mud and water, they worked poorly. In a day, the underground house could advance only about ten inches along the tunnel's four-hundred-yard path. As well as slow, the shield was fragile; it lay about five yards below the bed of the Thames, so that unusual tidal pressures could crack the first layer of walling, and indeed many workers died in the compartments when this occurred. Work stopped temporarily in 1835. The Brunels were, however, nothing if not determined. In 1836 Brunel père reconfigured the screw mechanism pushing the shield forward, and the tunnel was completed in 1841 (it opened officially in 1843). Fifteen years had been required to advance the four hundred yards underground.[5]

We owe to the younger Brunel everything from the invention of pneumatic caissons for bridges to iron-cage ships to the creation of efficient railroad carriages. The picture many people know of him is a photograph in which he poses, cigar in hand, top hat tipped back, slightly crouching as if ready to spring, against a background of massive chains hanging from the great iron-sided ship he created. It is the image of a heroic fighter, a conqueror, overcoming whatever stands in his path. But in his case, aggressive combat proved inefficient.

In the wake of the Brunels, others succeeded by working with water and mud pressure rather than fighting against it. This happened in a tunnel under the Thames built in 1869, safely and in little more than eleven months. In place of the Brunels' flat wall, Peter Barlow and James Greathead designed a snub-nosed structure, its rounded surface more easily pushing into the mud. The tunnel was also smaller, a yard wide and only two and a half yards high, the size calculated in terms of tidal pressures—a reckoning lacking in the Brunels' giant underground fortress. The new ovoid construction made use of cast-iron tubing rather than bricks for the tunnel structure. The rings of cast-iron were bolted together as excavation proceeded, the tube shape diffusing surface pressure. Practical results followed quickly; by magnifying the same ovoid tube-shape, new engineering made possible the beginnings of the Underground transport network in London.

The tubular form may seem self-evident technically, yet the Victorians didn't grasp its human implications. They labeled the new solution the "Greathead shield," generously crediting the junior partner; the moniker misleads because a shield still suggests a weapon in battle. It is certainly true, as defenders of the Brunels said in the 1870s, that without their initial example the alternative of Barlow and Greathead would never have come into being. Which is the point. Seeing that arbitrary imposition worked poorly, the engineers who came after the Brunels reimagined the task. The Brunels fought, Greathead worked with, resistance underground.

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This passage in engineering history raises first of all a problem in psychology that, like a cobweb, needs to be swept away. A classic proposition in psychology has been that resistance begets frustration and, taken a step further, that frustration begets anger. Here is the impulse to smash to bits the pieces in a do-it-yourself kit that don't fit together. In the jargon of the social sciences, this is the "frustration-aggression syndrome." Mary Shelley's Creature embodies the syndrome even more violently; her Creature is driven to kill by frustrated love. The connection ultimately linking frustration to violent behavior seems good common sense; it is common sense, but it does not make good sense.

The frustration-aggression syndrome derives from the reflections of nineteenth-century observers, notably Gustave Le Bon, on revolutionary crowds.[6] Le Bon set aside the specifics of political grievance and emphasized the fact that pent-up frustrations swell the numbers of people in crowds. Unable to discharge its anger through formal political channels, the crowd's growing frustration becomes like charging a battery; at a certain moment, the crowd releases this energy through violence.

Our engineering example makes clear why the behavior Le Bon observed in crowds is not an apt model for labor. The Brunels, Barlow, and Greathead all had a high tolerance for frustration in their work. The psychologist Leon Festinger explored such toleration of frustration, under laboratory conditions, by observing animals exposed to prolonged frustration; he found that rats and pigeons, just like engineers, often became adept at sustaining frustration rather than going berserk; the animals organized their behavior to make do, that is, at least temporarily, without gratification. Festinger's observations drew on earlier researches by Gregory Bateson on the toleration of "double-binds," frustrations from which there is no exit.[7] And a recent experiment with young people who are shown true answers to questions they have first answered falsely presents another side of tolerating frustration; they will sometimes continue to probe and poke at alternative methods or solutions even though they are now presented with the correct answer. Not surprising: they want in these instances to understand *why* they got the answer wrong.

Certainly the mental machine can grind to a halt when faced with too much resistance, or for too long, or resistance that admits of no investigation. Any of these conditions might well induce a person to give up. Are there then skills that allow people to dwell, and productively dwell, in frustration? Three skills stand out.

The first draws on the reformatting that can inaugurate a leap of imagination. Barlow records that he imagined himself swimming across the Thames (a revolting thought in that age of untreated sewage). He then imagined what inanimate shape would most resemble his body: his body was more like a tube than a box. This is an anthropomorphic assist to reformatting, and it resembles the human investment we noted in honest bricks—but with the difference that the assist here aims at problem solving. The problem is recast with, as it were, different protagonists, a swimmer instead of a channel in water. Henry Petroski makes Barlow's point much more largely: without recasting resistance, many strictly defined problems remained impossible for the engineer.[8]

This skill differs from the detective work of tracing an error back to its source. Recasting a problem with a different protagonist is a technique to be employed when that detective work reaches a dead end. At the piano we do something akin physically to what Barlow did mentally when, faced with an intractably difficult chord in one hand, we play it with the other; a change in the fingers used to make the chord, a different hand-protagonist, often provides insight into the problem; frustration is then relieved. Again, this productive address to resistance could be likened to making a literary translation; though much can be lost in moving from one language to another, meanings can also be found in translation.

The second response to resistance concerns patience. The frequently noted patience of good craftsmen signals a capacity to stay with frustrating work, and patience in the form of sustained concentration, we have seen in Chapter 5, is a learned skill that can expand in time. But Brunel was also patient, or at least determined, over many years. Here a rule can be formulated, opposite in character to the frustration-aggression syndrome: when something takes longer than you expect, stop fighting it. This rule operated in the pigeon maze Festinger contrived in his laboratory. At first the disoriented pigeons banged against the plastic walls of the maze, but as the birds proceeded further, they stopped attacking the walls even though they remained confused; they trudged more composedly forward, still not knowing where they were going. But this rule is not quite as simple as it seems.

The difficulty lies in judging time. If a difficulty lasts, one alternative to giving up is to reorient one's expectations. In most work we estimate how long it will take; resistance obliges us to revise. The error might seem that of imagining we could accomplish a task quickly, but the wrinkle is that we have to fail consistently to make this revision—or so it seemed to the author of *The Art of Archery.* The Zen master offers his counsel to stop fighting specifically to that neophyte who fails again and again to hit the target. The patience of a craftsman can thus be defined as: the temporary suspension of the desire for closure.

From which follows a third skill in working with resistance that I am somewhat embarrassed to state baldly: identify with the resistance. This might seem a vacuous principle, suggesting that to cope with a dog that wants to bite, think like a dog. But in craftwork, identification has a sharp point. Imagining himself swimming in the filthy Thames, Barlow responded more to the flow of water than to its pressure, whereas Brunel focused on the least forgiving element—water pressure—and fought against that bigger challenge. The identification a good craftsman practices is selective, that of finding the most forgiving element in a difficult situation. Often this element is smaller, and so seems less important, than the larger challenge. It is an error in technical as in artistic work to deal first with the big difficulties and then clean up the details; good work often proceeds in just the opposite fashion. Thus, at the piano, when faced with a complicated chord, the tilt of the palm is a less difficult point of entry than finger-stretch; the pianist is more likely to improve by responding positively to this detail.

To be sure, focus on small, yielding elements is a matter of attitude as much as procedure. The attitude derives, I think, from that power of sympathy described in Chapter 3—sympathy not as touchy-feely love but just the disposition to turn outward. Thus, Barlow did not approach his engineering difficulty hoping to find something like a fault in an enemy's defenses, a weak point to exploit. He dealt with the resistance by selecting an aspect of it that he could work with. Faced with a barking dog, you do better to hold your open hand in front of it than to bite back.

The skills of working well with resistance are, in sum, those of reconfiguring the problem into other terms, readjusting one's behavior if the problem lasts longer than expected, and identifying with the problem's most forgiving element.

Making Things Difficult
Skin Work

At the opposite pole of encountering resistance, we may make things difficult for ourselves. We do so because easy and lean solutions often conceal complexity. The young musician who strips off the Suzuki tapes from a string instrument makes things hard for himself or herself for just this reason. Modern urbanism offers a kindred, and richer, instance of making things difficult. This case concerns a building familiar to many readers, Frank Gehry's Guggenheim Museum in Bilbao. The work of building it contains a story not evident to the visitor's eye.

When the leaders of Bilbao commissioned an art museum in the 1980s, they hoped to stimulate investment in a tired port. Shipping had declined in Bilbao, and the city had darkened and decayed through generations of environmental abuse. Gehry, whose impulses are those of a sculptor, was chosen in part because Bilbao's leaders realized that yet another tasteful glass-and-steel box of a museum would not send a distinctive signal of change. Yet the site they had chosen made this signal difficult to send: though next to water, the location was enmeshed in a spaghetti of roads cooked up by past, poor urban planning.

Gehry has long sculpted buildings of metal, a pliant material suited to the challenge of bending over and around the tangle of streets. Here, he wanted to roll out his metal in a quilted pattern, to crinkle the light bouncing off the building and so soften its enormous mass. Lead copper was the material that would have most easily and cheaply suited Gehry's design; its fabrication in large sheets is fairly straightforward. But this metal is outlawed in Spain as a toxic material.

The path of least resistance would have been corruption. The powerful patrons of the project might have bribed government officials to permit lead copper or changed the law or obtained an exemption for the star architect. The officials and the architect accepted, however, that lead copper poses environmental hazards. So Gehry searched for another material. "It took," he has written, with a certain restraint, "a long time."[9]

At first his office experimented with stainless steel, which didn't reflect, as Gehry wanted, the play of light on the curved surfaces. In frustration he turned to titanium, which had "warmth and character" but might prove too expensive and had rarely before the 1980s been used to sheath buildings. The titanium produced for military purposes, principally airplane parts, would have cost a fortune and was never meant for architectural work on the ground.

Gehry visited a factory in Pittsburgh where such titanium was rolled out, seeking to alter the way the metal was made. Gehry says, a little misleadingly, "We asked the fabricator to continue to search for the right mix of oil, acids, rollers, and heat to arrive at the material we wanted"; the phrase "right mix" is deceptive because he and the other designers did not know exactly what they wanted at the start.

Moreover—and here was the harder technical challenge—new machinery had to be created. Gehry had at hand rollers designed to press molten steel into sheets, but these rollers were too crude and too heavy, especially when he decided he wanted a fabric imprinted with a quilt-like surface to break up reflected light. In order to roll precisely, the cushions that held the rollers had to be rethought; the new cushioning mechanism was imported and adapted from hydraulic shock absorbers in automobiles.

This domain shift only raised more difficulties. The composition of the metal now had to be explored in concert with the rolling tools, Gehry and his team at each stage judging both aesthetic and structural qualities. This took a year. Eventually the fabricators produced titanium alloy sheets, rolled out in the quilted pattern, a third of a millimeter thick. These sheets are both thinner than stainless-steel plates and less rigid, giving a bit in the wind. Light does indeed crinkle and flutter on the quilted surface; the ribbed sheets also proved immensely strong.

The spirit of craftsmanship steering this material investigation was more flexible than that of mere problem solving. The fabricators had to rethink a tool—the rollers, which were imported from another machine and reimagined as a metal-weaving loom. Investigating the composition of the titanium itself was more straightforward, proceeding by controlled variation of its elements. It's hard to know what the technicians thought and felt in staying with this demanding task, but we do know something about Gehry's mental processes. He found this experience—and I use the word advisedly—enlightening.

Once he could make and use quilted titanium, Gehry writes, he began to rethink his assumptions about stability, the most fundamental aspect of building design. He realized that "the stability given by stone is false, because stone deteriorates in the pollution of our cities whereas a third of a millimeter of titanium is a hundred-year guarantee." He concluded, "We have to rethink what represents stability." Stability can mean—counter-intuitively—thin rather than thick, or undulating rather than rigid.

Perhaps the most interesting aspect of this museum's backstory is what the architect gained by making all these difficulties for himself about the building's skin. By working on a surface he came to question a basic aspect of structure. Certainly, simplicity represents a goal in craftwork—it's part of the measure of what David Pye calls "soundness" in a practice. But to make difficulties where none need be is a way to think about the nature of soundness. "It's too easy" is a test of "there's more here than meets the eye."

This rather general observation has today a practical application. Urban planning, like other technical practices, often zeroes in on needless complexity, trying to strip away tangles in a street system or in public space. Functional simplicity carries a price; urbanites tend to react neutrally to stripped-down spaces, not caring much about where they are. The designer-planner seeking to bring these dead public spaces to life can succeed by introducing what may seem unnecessary elements, such as indirect approaches to the front entrances or bollards arbitrarily to mark out territory, or, as Mies van der Rohe did with the Seagram Building in New York, by contriving complicated side entrances to his elegantly simple tower. Complexity can serve as a design tool to counter neutrality. Additions of complexity can prompt people to engage more with their surroundings. This is the rationale for making the judgment about a public space that it's too simple, it's too easy.

In the production process, introducing complexity is a procedure that addresses the suspicion that things are not what they seem; here, making things more complex is a technique of investigation. In this regard we might note that for Gehry's industrial crew, the result of their efforts was a new understanding of the sheet roller rather than aesthetic enrichment; introducing complexity had led them back to that simple tool. Sometimes, in planning that embraces complexity, the result is also that people focus on simple elements in the built environment—a single bench, a clump of trees that have been inserted into a spatial void.

Resistances, then, can be either found or made. Both cases require toleration of frustration, and both require imagination. In found difficulties, to cope we will identify with the obstacle, seeing the problem, as it were, from the problem's point of view. Made difficulties embody the suspicion that matters might be or should be more complex than they seem; to investigate, we can make them even more difficult.

The philosopher John Dewey embraced positive learning from resistance, in part due to his embattled position at the turn of the twentieth century. His contemporaries the social Darwinists had magnified Brunel's attitude. They supposed that all living creatures aim to defeat the obstacles posed by all other contending creatures. The natural world appeared to these faulty disciples of Charles Darwin as a place of strife only; society, they argued, was ruled by self-interest, absent any altruistic cooperation. To Dewey this seemed a macho fantasy that missed the real issue: working with resistance is the key to survival.

Dewey was an heir to the Enlightenment. Like Madame d'Épinay, he believed in the necessity of learning one's limits. He was also a pragmatist, believing that to get things done you need to understand the resistances you encounter rather than aggressively conduct war against them. Dewey was a philosopher of cooperation; he declares, "Only when an organism shares in the ordered relations of its environment does it secure the stability essential to living."[10] As will appear at the end of this book, he derived from these straightforward principles an entire philosophy of action. But most of all, he was interested in resistance as an environmental problem. Dewey's use of the word *environment* is rather general and abstract; sometimes he refers to the ecology of a forest, sometimes to factories, as "the environment." He meant to convey that resistance always has a context, be that natural or social, that the experience of resistance is never an isolated event. In his spirit, but with a bit more focus, we want to specify where resistances occur.

Sites of Resistance
Walls and Membranes

All living things contain two sites of resistance. These are cell walls and cell membranes. Both resist external pressures to keep intact the internal elements of the cell, but they do so in different ways. The cell wall is more purely exclusionary; the membrane permits more fluid and solid exchange. The filter function of these two structures differs in degree, but for the sake of clarity let's exaggerate it: a membrane is a container both resistant and porous.

A homology between cell wall and cell membrane can be found in natural ecologies. An ecological boundary resembles the cell wall, an ecological border the cell membrane. A boundary can be a guarded territory, like those established by prides of lions or packs of wolves, a "no-go" zone for others. Or the boundary can be simply an edge where things end, like the tree line on a mountain that marks the boundary above which trees cannot grow. An ecological border, by contrast, is a site of exchange where organisms become more interactive. The shoreline of a lake is such a border; at the edge of water and land organisms can find and feed off many other organisms. The same is true of temperature layers within a lake: where layer meets layer constitutes a watery zone of intense biological exchange. An ecological border, like a cell membrane, resists indiscriminate mixture; it contains differences but is porous. The border is an active edge.

These natural distinctions are reflected in the built human environment. The wall Israel is building through the West Bank territories, for instance, is meant to function like a cell wall or ecological boundary; for the sake of security, not incidentally, the wall is made of metal, the least porous of materials. The plate glass window walls used in modern architecture are another version of the boundary; though these windows permit sight within, they exclude smell and sound and prohibit touch. The gated community is yet another modern variant, life sealed within its walls, policed by surveillance cameras. Most pervasive in the modern city is the inert boundary established by highway traffic, cutting off parts of the city from each other. In all these spaces, resistance to the outside is meant to become absolute, the boundary fending off human interaction.

Walls themselves are worth a little more thought, because in the history of cities, walls meant to be inert boundaries have occasionally morphed into more active borders.

Until the invention of artillery, people sheltered behind walls when attacked; in medieval cities, gates set into walls regulated commerce coming into cities; the lack of wall porosity meant that taxes could be effectively collected at these few checkpoints. Some massive medieval walls, however, such as those surviving in Avignon, modulated in time; inside Avignon's walls there grew up by the sixteenth century uncontrolled, unregulated housing; outside, informal markets selling black-market or untaxed goods nestled against the stones; foreign exiles and other misfits gravitated toward the walls, far from the controls of the center. Though they certainly don't appear to, such walls functioned more like cell membranes, both porous and resistant.

The first ghettoes in Europe also morphed into places with walls like this. Intended to contain supposedly impure or alien presences in the city, such as Jewish or Muslim traders, the walls of the early ghettoes soon, as it were, began to leak. In Venice, for instance, the islands reserved for Jews and the buildings called *fundacos* where Germans, Greeks, and Armenians lodged were defined by walls near which economic activity continually increased. The ghettoes were in form more complicated than prisons, reflecting Venice's complexity as an international city.[11]

Most urbanists now want to foster growth in a form that echoes the transformation of medieval walls. Working *with* resistance means, in urbanism, converting boundaries into borders. Economics as well as liberal values drive this strategy. A city needs constantly to absorb new elements. In healthy cities, economic energy pushes outward from the center to the periphery. The problem is that we are better at building boundaries than borders, and this for a deep reason.

From its origins, the center of the European city has been more important than its periphery; courts, political assemblies, markets, and the most important religious shrines have been located in the city center. That geographical stress translated into a social value: the center as a place where people are most likely to share. In modern planning this has meant that efforts to strengthen community life seek to intensify life at the center. But is the center, as a space and as a social value, a good place in which to mix the cocktail of cultural diversity?

It is not, as I discovered some years ago in helping create a market to serve Spanish Harlem in New York. This community, then one of the poorest in the city, lay above 96th Street on Manhattan's Upper East Side. To the south, in an abrupt shift, was one of the richest communities in the world, comparable to Mayfair in London or the Seventh Arrondissement in Paris. We chose to locate La Marqueta in the center of Spanish Harlem and to regard 96th Street as a dead edge where little would happen. We chose wrongly. We should have treated this street itself as an important border; locating the market here would have encouraged activity that brought rich and poor into daily commercial contact. (Wiser planners have learned from this mistake; at the southwestern edge of Afro-American Harlem, they have sought to locate new community resources at the borders between communities.)

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In all craftwork, we want to follow the urbanist's impulse to work *with* resistance in borderline conditions. We develop skill at the live edge. The planning mistake made in Spanish Harlem embodies, though, a danger facing labor. Many managers harbor a mental map of the work done in their organizations: boxes containing specialized activities, arrows and flow charts connecting them. On this mental map—so beloved of personnel experts—the important work usually occupies a prominent, central position, the more minor or self-contained tasks pushed to the bottom or sides of the chart; the work environment is visualized in the same way as a city or a community. The map frequently misleads, because real issues can be missed, having been pushed to the periphery. Moreover, the arrows and flow diagrams in this mental map often misrepresent the kind of work that can only be done in a border zone. That's where repair occurs as technicians, nurses, or salespeople deal with difficult and ambiguous problems; the arrows from box to box are most likely to depict only who reports to whom.

If only such organizational charts were the office furnishings of the capitalist dogs. Unfortunately, most people at work make similar mental maps, charting the parts of their labor rather than its processes. A more accurate if rather more complex process of visualization is required particularly at the edge, the zone in which people have to deal with difficulty; we need to visualize what is difficult in order to address it. This is probably the greatest challenge facing any good craftsman: to see in the mind's eye where the difficulties lie.

Thus, the tilt of the palm seems peripheral to the mental map a musician makes for a chord stretch yet turns out to be a zone for productive work with finger resistance; the palm becomes a working space. So too, in hammering a nail, we have to establish that border zone on the hammer shaft in which secure grip interacts with freedom of the elbow; this fulcrum point is our working space. In evaluating the fleshy firmness of a slaughtered chicken, the fingertip becomes a sensate border. In goldsmithy, the moment of truth in the assay is a border zone both physically and mentally, the fingertips probing the texture of a problematic substance, seeking to name it. These are ways to *see* work, especially work that is difficult.

This challenge forms a fitting cap to the problem with which we begin, trying to pin down the "site of resistance." The phrase has two meanings: it denotes either a boundary, resisting contamination, excluding, deadening, or a border, a site of exchange as well as of separation. Walls in cities have embodied both meanings. In the context of a multicultural city, the second kind of site is both more challenging and more necessary. In labor, too, the boundary is a space of containment; the more productive environment for working with resistance is a border.

Ambiguity

The literary critic William Empson wrote a famous study about seven types of ambiguity in language, spanning the gamut from blatant contradiction to sheer fuzziness. Any skilled writer doles out any sort of ambiguity like very good wine—that is, sparingly. We can make an expressive point about hanging stories or unresolved characters if we do not leave them hanging or resolved too often. How should we then set about making matters imprecise?

Anticipating Ambiguity

Making an Edge

This is first of all making a move that we know will produce an ambiguous result. That event occurred, for instance, when the young violinist first removed the Suzuki tapes; he or she didn't quite know what would come next, but still, it was a decisive step. Ambiguity can also be mechanically created, as in the "fuzzy logic" built into many computational programs; in them the organizing principle is delay. A fuzzy logic program is sophisticated enough to delay resolving one set of problems until it works in another realm, searching for useful inputs; the modern computer is able to hold in its memory a huge number of these provisional solutions. Though in terms of human time the wait in fuzzy logic may be imperceptible, as little as a few microseconds, still, within the computer's time-scale the machinery is pausing, the application momentarily unresolved.

In urban design, too, we can decisively plan for ambiguity by contriving places where people don't know quite where they are, places where they feel lost. The maze is such a space. Planned ambiguity acquires more value if the designer intends that others learn something from momentary disorientation, become skilled in dealing with ambiguity. Amsterdam offers a graphic instance of such instructive ambiguity made by design, in a particular kind of live edge.

In the years immediately after the Second World War, the architect Aldo van Eyck began filling up Amsterdam's empty spaces with playgrounds—in trash-filled backyards, at traffic circles, on forlorn corners and the edges of streets. Van Eyck cleaned out the trash and graded the ground; his team sometimes painted the walls of adjoining buildings; the architect himself designed playground equipment, sandpits, and wading pools. Unlike school playgrounds, these street pocket-parks invited adults in as well. Many had comfortable benches or were located next to cafés and bars, allowing adult child-minders to nip inside for a quick drink to steady their nerves. Van Eyck built many urban playgrounds of this sort by the mid-1970s; the urban historian Liane Lefaivre puts their total number in the hundreds, as other Dutch cities imitated Amsterdam.[12] Few, unfortunately, have survived.

The designer's aim for these small parks was to teach children how to anticipate and manage ambiguous transitions in urban space. Infants taken to the Hendrikplantsoen playground, in its 1948 form, could for instance wallow in sandpits that had no neat separation from grassy areas.[13] The lack of a clear boundary between sand and grass was by design, providing the toddler an opportunity to puzzle through this tactile difference. Next to the sandpits were places for older children to climb and adults to sit. The architect enabled the passage from toddling to climbing by putting stones of different heights close together—but not in a straight-line sequence; rather, the young child had to test a kind of forest of stepping-stones against his or her body. The lack of clear physical definition again provided a challenge; there were edges, but not sharp separations; probing that condition was meant to stimulate inquiry.

Van Eyck intuited that such spatial ambiguities would also provoke children to engage with one another, toddlers tending to help each other crawl and totter about. This intuition was elaborated in the making of the Buskenblaserstraat park.[14] Here a park was contrived from empty space at a street corner, with cars flowing past. While the sandpit here is well marked and set well back from the streets, equipment for children to climb on has not been so protected. Cooperative activity—looking out for cars, shouting, lots of shouting—becomes a matter of keeping safe; from its inception, this has been a noisy park. If when playing around these tubular frames kids need to watch out for each other as cars approach, they moreover need to define rules about how to use the play furniture itself. Like the anatomist with his scalpel, Van Eyck favored simple forms of play furniture that give few directions for use. And just because in the Buskenblaserstraat there is enough room for tossing and kicking balls around, kids have had to come up with game rules that permit play without their being hit by cars. The architect, then, designed a park using the simplest, clearest elements that invite its young users to develop the skill of anticipating danger and managing it; he did not seek to protect them through isolation.

Van Eyck's park at Van Boetzelaerstraat is his most ambitious.[15] Another found space at a corner in a densely built section of Amsterdam, here the architect put in his climbing stones and tubular equipment, but also tried to include buildings fronting one side and shops across the street in the design—a risky idea because traffic flows here could be intense. Moreover, teenagers took over the corner at night, hanging around and hoping something would happen, when adults sitting on benches hoped nothing would.

What's interesting about the park at Van Boetzelaerstraat is how its children, adolescents, and adults learned to use it together. The design provides subtle guidance; the benches are placed so that parents can supervise small children playing near the edge of the street. Once the park was finished, knots of adolescents colonized the sidewalk across the street; resting shoppers tended to watch but not interfere with children cavorting on the edge of traffic; active shoppers cut across the space to pass from store to store, violating the turf of those dwelling in the playground. In this public realm, people physically mingled rather than verbally interacted. Yet the public realm was not neutral or indifferent; it drew young and old in the neighborhood.

Here, then, were projects that realized concretely the goal of making a live edge, a porous membrane. Van Eyck found simple, clear ways to make the users of his parks, young and old, more skilled in anticipating and managing ambiguity at the edge. Of course, there is a paradox. Van Eyck thought through clearly how best visually to achieve this; his visual logic is hardly "fuzzy" in the ordinary sense of that word. And the children who learned how to deal well with the ambiguity built into his park designs emerged with rules of behavior for themselves. These parks make a point about security opposed to the health-and-safety regulation of most park design today, which cocoons and isolates children.

The practitioner's skill in these designs can be likened to the "uncle logic" that lay in Elizabeth David's recipe, a conclusion left intentionally unstated, or, more concretely, to the use in writing of the ellipsis (. . .). As in writing, the designer uses such a device best by following the modernist principle that less is more. That is, effectively using an ambiguity forces its maker to think about economy. Ambiguity and economy seem unlikely bedfellows, but they take their place in the larger family of craft practices if we think of creating ambiguity as a special instance of applying minimum force. Van Eyck was thus quite selective about where he placed blurred edges in his playgrounds; usually the relation of playground space to the doorways of buildings is by contrast sharp, highly defined. So too would I have misled if conveying that David's recipes have no sharp edges. They are filled with do's and don'ts about bird flesh; the gaps that occur in the scene narrative stand out against these commands. In writing, the strategic economy of the ellipsis should be located precisely where the reader wants the release from tension that an explicit conclusion might provide but where the writer wants to hold the reader . . . to keep the reader going.

Van Eyck's great antagonist was Le Corbusier—Le Corbusier as urbanist rather than as the architect of individual buildings. Le Corbusier was the enemy of street life; he thought it was at best clutter, at worst irrational confusion on the ground plane. His Plan Voisin for Paris, conceived in the 1920s for the Marais district, sweeps its streets empty of human beings, leaving the arteries and veins as a purified space of traffic flows. Van Eyck expressed the contrast between Le Corbusier and himself as that between making space and making place—in a memorable essay called "Whatever Space and Time Mean, Place and Occasion Mean More."[16] Whereas Corbusier relegated streets to traffic functions, the ground plane represented to Van Eyck the realm in which people "learn" cities. The placement of benches and bollards, the height of stepping-stones, the ill-defined separations of sand, grass, and water are all tools in that learning, an education in ambiguity.

Improvising
Steps

The tenements of New York's Lower East Side furnish an example of how people can become skilled in ambiguity without benefit of instructive designs like Aldo van Eyck's. Here people have improvised. The buildings in this poor part of New York took on a uniform look in three generations of tenement acts, from 1867 to 1879 to 1901, the building codes designed to provide light and fresh air to new, dense housing for the poor. Immigrant dwellers ignored the laws' promptings. The raised front stoops of the tenements, usually made of brownstone, were designed to be functional passages in and out of the buildings. Tenement dwellers early on began to use the stair treads as seats; the side walls to the stairs became armatures on which goods for sale were displayed and clothes were dried. Rather than a passage, the stoop became an inhabited public space, people hanging around, gossiping and selling, a street life that relieved the crowding within the tenement interiors.

The architect Bernard Rudofsky was inspired by the example of these steps. In *Architecture without Architects* he documented the ways in which most cities were mostly built by improvisation, following no consistent formal design. Building was added to building, street to street, their forms adapting to different site conditions in the process of extension: this is how central cities like Cairo, or the vast peripheries of Mexico City, have developed.

Improvisation is a user's craft. It draws on the metamorphoses of type-form over time. In the microenvironment of the New York tenement stoop, from block to block on the Lower East Side, changes occurred in what goods were displayed and how they were displayed on clotheslines. The ethnic shadings of different neighborhoods also worked changes in type-form. One can still see this today; the chairs in Asian neighborhoods tend to face the street in parallel, whereas the chairs in old Italian neighborhoods are placed at right angles to the street so that people can see their neighbors on other stoops.

The making of these territories would be misunderstood if called spontaneous, if "spontaneous" represents a mindless occurrence. On the steps of the tenements, the improvisers observe and experiment with stoops in relation to their own bodies. Like a jazz musician, a tenement dweller who improvises follows rules. The physical materials at hand in the street are givens, like the written melody and fundamental harmonies spelled out for each number in a jazz musician's "cheat book" (cheating because many of these songs are lifted illegally out of copyright). Good jazz improvisation follows rules of economy; variations pick out an element to explore, otherwise they lose focus; the harmonic reversals are disciplined by what came before. Above all, the jazz musician has to select elements for his or her own instrument that someone playing a different instrument can respond to. A successful improvisation will avoid sounding like the equivalent of a visual maze.

So too for people who improvise street use. In the surviving street cultures of the Lower East Side, booksellers clump together but display wares that separate themselves from their neighbors, like a musical theme and variations; hawkers using the steps choreograph themselves so that browsers can move from stoop to stoop; tenants hang out laundry from house to house so that key windows are not blocked. To the casual visitor it may look a mess, but in fact the street dweller has improvised a coherent, economical form. Rudofsky thought that this hidden order is how most settlements of poor people develop and that the work of improvising street order attaches people to their communities, whereas "renewal" projects, which may provide a cleaner street, pretty houses, and large shops, give the inhabitants no way to mark their presence on the space.

Improvisation occurs in workshops, offices, and laboratories as much as on streets. As in jazz, other forms of improvisation involve skills that can be developed and improved. Anticipation can be strengthened; people can become better at negotiating borders and edges; they can become more selective about the elements they choose to vary. In the next chapter we shall explore just how organizations could become like good streets, but at this point we might want to summarize the path we have so far traveled.

A Summary of Part Two

The thread through all the twists and turns of subject in Part Two is *progress* in the development of skill—a word that needs no apology. In craftwork, people can and do improve. The twists and turns in Part Two have occurred because progress is not linear. Skill builds by moving irregularly, and sometimes by taking detours.

Development of an intelligent hand does show something like a linear progression. The hand needs to be sensitized at the fingertip, enabling it to reason about touch. Once this is achieved, problems of coordination can be addressed. Integration of hand, wrist, and forearm then teaches lessons of minimum force. Once these are learned, the hand can work with the eye to look ahead physically, to anticipate and so to sustain concentration. Each stage, though challenging, grounds moving on to the next; but each is also an independent challenge.

Taking guidance from expressive directions aids this process in ways that more denotative directions would not. Expressive directions provide guidance about the sense of a practice whole. I've described, among many possibilities, three expressive tools that can provide this guidance: sympathetic illustration, which identifies with the difficulties a neophyte encounters; scene narrative, which places the learner in a strange situation; and instruction through metaphor, which encourages the apprentice to reframe imaginatively what he or she is doing.

The necessity of imagination appears in the use of tools. If these tools prove limited or difficult to use, still inventiveness enables a certain kind of repair work, one that I've called a dynamic repair. And imagination is required to make sense of potent tools, or all-purpose tools, full of untapped and perhaps dangerous possibilities. I have tried to take some of the mystery out of the imaginative use of tools by explaining the structure of an intuitive leap.

No one draws on all these resources all the time, and in labor as in love, progress occurs in fits and starts. But people can and do get better. We might wish to simplify and rationalize skills, as teaching manuals often do, but this is not possible because we are complex organisms. The more a person draws on these techniques, the more he or she plumbs them, the more will that person gain the craftsman's emotional reward, the sentiment of competence.