USER FRIENDLY

How the hidden rules of design are changing the way we live, work, and play

Cliff Kuang with Robert Fabricant

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For my wife and daughter

—CLIFF

To my family and friends
Hopefully this will explain once and for all
what I do every day, and why it matters

—ROBERT

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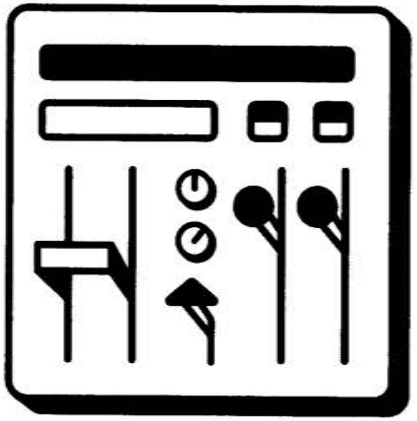
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B-17 Flying Fortress control panel (1936)

3

Error

World War II is at its height, but there's a profound ease that comes from floating in friendly waters in the South Pacific, with American steel in every direction for three hundred miles, cradled by the routines of ship life. Thunderclouds scroll across the horizon, but the sun's still shining. The tropical air is thick. Except, in the nerve center where the officers monitor the planes they've sent out, there's a crack opening up: a lost pilot, somewhere close but low on fuel and overdue to return.

At 1410, the pilot issues a call for a course back to the carrier. The officers hear it, but the pilot doesn't get a response. So he waits, checking his instruments, checking the fuel gauge. At last the receiver

crackles to life, but he can't make anything of it. "Static bad out here," he says. And then, for a moment, the fuzz coheres into a command to wait just a little more. The pilot waits. The fuel gauge ticks down ever so slightly.

The men using the ship's radar to find the errant plane operate on intuition. The job is to pick out "pips"—spikes in the wiggling green line of the radar display. But that wiggling green line is ruled by noise created by everything else that's out there: interference, clouds, birds. They call this jumpy pattern of fuzz "grass," and the radar's screen is filled with it; the pip they're looking for is just a single blade, standing a little bit taller. There's an art to being a good radar man, knowing before knowing which minute variations in flicker can distinguish a friendly plane from a foe. But today the operator is straining to make out anything at all, and the pilot can't make sense of his radio. So they keep issuing messages that breeze past each other.

"Radar can't see you yet, thunderstorms around," says the operator. "Thunderstorms north of here," says the pilot. "Static getting worse again."

Now thirty more minutes have passed, and the pilot's gaze must be darting frantically at a fuel gauge nearing empty. Back on the ship, a crowd forms around the radar console, and someone finally spots a telltale pip standing a bit taller amid a blurry patch—the thundercloud—on the radar. Relief. The pilot's close, just on the far side of the carrier. The duty officer seizes the microphone. "You're thirty miles from the ship," he cries. "Steer 357." At last, the homing course that the pilot needed all along. At thirty miles out, he can still make it, gliding the final few miles. "Say again?" says the pilot. "You are south of the ship," the officer shouts, desperation starting to creep into his voice. "Steer 357. I say again, steer 357." The pilot answers, "Gasoline low. Not hearing you anymore. Are you hearing me?"

The officer keeps shouting, in every register he can muster—loud and then soft, mouthing every syllable—like jiggling a key in a sticky lock, hoping that some lucky wiggle will open the door. A half hour later, the officer finally stops, exhausted. They know what's happened. A streak of steel and aluminum hitting the ruched surface of the ocean, a white geyser of sea spray, then the lapping waves closing in without memory. On any aircraft carrier like this one, men die. But as the lieutenant later says, a meaningless death such as this one whispers in the dark, haunts you in your bunk. Later that evening, in the wardroom, the ship's executive officer, wounded and gruff, is overheard saying, "Goddamn this business of trusting lives to radars a man can't see, and radios he can't hear." Goddamn this business of believing that machines would work for the people using them.[1]

The end of World War II made the captain's howl echo across the entire length of the American arsenal. Where World War I brought forth mass manufacturing at a previously unthinkable scale, World War II made even those capabilities seem quaint, while adding technical innovation at a blistering pace. Consider: Biplanes buzzed over the war's first battlefields; by war's end, contrails unfurled in the wake of the world's first stealth jets. Radar was perhaps the best example of how quickly technology was evolving. Its lifesaving reach increased on an almost month-to-month basis for six years, thus extending the capabilities of bombers and tanks and artillery shells and ships. And yet few of them performed nearly as well as the engineers had promised, because there simply wasn't any codified understanding of how to make those machines comprehensible to the men who used them. These fissures might appear in radios designed to emit speech in frequencies that the human ear couldn't make out—this is what happened to the pilot lost in the skies just

minutes from a safe landing—or radar that simply didn't separate signal from noise. There was precious little knowledge about how humans made sense of the machines around them. "Theoretically, we could drop bombs in a rain barrel," said one Air Force psychologist. "But in actual practice, we missed entire cities."[2] You could count the toll in lives: men who died in combat or even miles away from it, without any accounting for what really happened when their machines stopped making sense.

Among those laying blame there were two camps, shouting at each other. On one side were the soldiers who wailed about "people who design electro-mechanical marvels to be operated by a man with three arms and an ability to see around a corner in pitch darkness."[3] The people who designed those marvels, no less indignant, blamed the failures of their inventions either on poor training or deliberate misuse—they pictured the soldiers mashing buttons and yanking levers in a huff. For a time, during the war, this argument devolved into Kabuki, with engineers touting their newest gear to officers, careful to use only their own scientists as demonstrators in an effort to show that everything really could be used just as designed.[4] The problem was that it couldn't, because, as would happen again thirty years later at Three Mile Island, the performance of men under duress bore no resemblance to that of those operating a demonstration model.

This issue of real-world performance versus lab experiments hovered over the battlefield, a killer beyond reckoning. It was made worse by the fact that the war was being fought on a "sensory margin" exponentially more fine than that of just ten years before. S. S. Stevens, a psychologist at Harvard, was the one who reported that story of an airman lost at sea. He was horrified. As he put it in his seminal paper "Machines Cannot Fight Alone":

> The battle hangs on the power of the eyes or the ears to make a fine discrimination, to estimate a distance, to see or hear a signal which is just at the edge of human capacity. Radars don't see, radios don't hear, sonars don't detect, guns don't point without someone making a fine sensory judgment, and the paradox of it is that the faster the engineers and the inventors served up their "automatic" gadgets to eliminate the human factor the tighter the squeeze became on the powers of the operator—the man who must see and hear and judge and act with that margin of superiority which gives his outfit the jump on the enemy.[5]

Stevens notes that men would push this faulty equipment to its limits. Engineers might tout a new radar as being able to pip an enemy vessel at fifty miles on a good day, and there would soon enough be a submarine commander trying to descry amid the green haze a sampan at one hundred miles in a thunderstorm, because that was probably where you would find the sampan:

> The machine had to be built for *Homo sapiens* to operate. When it was he used it, and given a new leverage on the situation he promptly pushed his flights and his missiles and his electromagnetic beams out farther until he was again at the ragged edge of his sensory endowments, where he was left chafing anew at the dumb insentience of knobs and dials and gears and coils, stolid and stubborn in their indifference to serving a human will.

Contrast this with today. With a tap, we hail a car and watch it come to meet us; with another tap, we can call up the entire history of a conversation with someone else. We live in a sandbox of someone else's design, made more clever because the information on offer on our phones, on our computers, in our cars confines us within a simplified version of the world.

It has taken 150 years of shifting ideals to get there, and that journey represents a change in perspective as consequential as cubism or the uncertainty principle or any other paradigmatic idea of the twentieth century. But maybe even more so, because the tenets became so obvious that today they feel as if they'd always existed. One of the most consequential ideas to emerge from World War II was that machines might be bent around people, to better serve them, to better conform to the limits of their senses and minds—to be usable at a glance even in the worst conditions. From that crucible emerged the idea that you should be able to understand anything without ever thinking twice. Whether it's a handheld supercomputer that a child can use, or a nuclear reactor that's easy to troubleshoot, or a button that reinvents 911, these are things that take our limitations as the starting point and then build up from those assumptions, rather than assuming that we'll always be the idealized demonstrator, doing exactly what some engineer had intended.



Picture Paul Fitts as a handsome man with a soft Tennessee drawl, analytically minded but with a shiny wave of Brylcreemed hair, Elvis-like, which projects a certain suave nonconformity. Decades later, he'd become known as one of the Air Force's great minds, the person tasked with the hardest, weirdest problems, such as figuring out why people saw UFOs. For now, though, he's still trying to make his name. Fitts grew up in a tiny town but was carried north

over the years by his talents, first to grad school at Brown and the University of Rochester, then eventually finding his way into the service at the Aero Medical Laboratory at Wright-Patterson Air Force Base in Ohio. In the immediate aftermath of the war, his commanding offer sends him on a hunt to uncover what killed so many men in airplane crashes. It's unclear why he's the one called upon. At the time, having a doctorate in the nascent field of experimental psychology was a novel thing, and with that novelty came a certain authority. He's supposed to know how people think. His true talent is realizing that he doesn't.

When the thousands of reports about plane crashes landed upon Fitts's desk, he could easily have looked at them and concluded that they were all the pilots' fault—that these fools should never have been flying at all. That conclusion would have been in keeping with the times. The original incident reports themselves would typically say "pilot error," and for decades no more explanation was needed. It wasn't out of sheer ignorance: The very concept of pilot error itself was a marker of progress.

Around the time of World War I, psychologists such as Hugo Münsterberg, Walter Dill Scott, and Robert Mearns Yerkes were overthrowing the strict behaviorism promulgated by John Watson, who believed that you could teach a human being to do anything with the right incentives and punishments—just like you could a rat in a cage. Instead, as the historian Donna Haraway writes, "Yerkes and his liberal peers advocated studying traits of the body, mind, spirit, and character in order to fit 'the person' into the proper place in industry . . . *Differences were the essential subject for the new science.* Personnel research would provide reliable information for the employment manager and proper vocational counseling for the 'person.'" (Emphasis mine.) They called their discipline human engineering.[6]

A few years after Münsterberg published his ideas about

understanding the unique capabilities of men, industrialists in Britain were flummoxed by the nagging persistence of accidents in their factories. In response, a few psychologists influenced by Münsterberg's model set out not to retrain all those factory workers but to understand what was boggling those involved in all the accidents. Eventually, they concluded that there was a kind of person who was "accident prone"—clumsy and cocksure, or perhaps stubbornly inattentive. But in creating the idea of an accident-prone person, those psychologists had merely restated the problem. They were no longer simply blaming the man. Instead they had created a special class of person to blame.

There was progress in the idea that people were differently suited to different things—but in that progress was also the assumption that correctly operating a machine was about *finding the right person to operate it.* Paul Fitts was edging toward a new and different paradigm.[7] As he pored over the Air Force's crash data, he realized that if accident-prone pilots were the cause, there would be randomness in what went wrong in the cockpit. These kinds of people would get hung up on anything they operated. It was in their nature to take risks, to let their minds wander while their hands were about to be minced by a cogwheel. But Fitts looked at the avalanche of reports he'd gathered and didn't see noise. He saw a pattern. And when he went to talk to people about what actually had happened, he saw terror.

The examples he found slid back and forth on a scale from tragic to tragicomic: pilots who slammed their planes into the ground after misreading a dial; pilots who fell from the sky never knowing which direction was up; pilots who came in for smooth landings and yet somehow never deployed their landing gear. And others still who got trapped in a maze of absurdity:

> We had an alert one morning about 11 o'clock. About 35 Japanese planes had been picked up on the radar screen. In the mad scramble for planes, the one I happened to pick out was a brand new ship which had arrived about two days previously. I climbed in, and it seemed the whole cockpit was rearranged . . . I took a look at that instrument panel and viewed the gauges around me, sweat falling off my brow. Just then the first Japanese bomb dropped. I figured then and there I wasn't going to get my plane up, but I could run it on the ground. That's exactly what I did. Ran it all around the field, up and down the run-way, during the attack.[8]

This hapless ace stutters like a video-game glitch.

Fitts's work complemented that of his colleague at the Aero Medical Laboratory, Alphonse Chapanis, a newly minted Ph.D. from Yale. Chapanis started investigating the airplanes themselves, talking to people about them, sitting in the cockpits. He too didn't see evidence of poor training. He saw, instead, the impossibility of flying these planes at all. Instead of "pilot error," he saw what he called, for the first time, "designer error." This was the seed of the user-friendly world we know today; as Three Mile Island shows us, it took forty more years for this sensibility to fully wend its way through industry. But we can already see hints of how that would happen in the details of Chapanis's work.

Chapanis was quick to note that in the B-17 Flying Fortress, the four-engined workhorse of the American bombing effort, the toggle to engage the landing gear was exactly the same as that for the

wing flaps. They were right next to each other and looked exactly the same, and while pilots brought the airplane to the ground it was shockingly easy to retract the landing gear when they meant to lift the flaps. As a result, during a twenty-two-month period of the war, the Air Force reported an astounding 457 airplane crashes caused by the confusion of the flap and landing-gear controls.[9] Chapanis proposed an ingenious solution: to "shape-code" the knobs in an airplane cockpit so that a pilot could know what he was doing simply by feel. By law, that innovation governs landing gear and wing flaps in every airplane today. Moreover, an echo of the idea remains in the way that buttons all around you—on keyboards, remote controls, in cars, even digital ones on your smartphone—are shaped differently so that you can know them by touch or at a glance. We are still surrounded by two other foundational solutions that Chapanis came up with. The first, inspired by pilots like the one haplessly wheeling his plane around on the tarmac, was putting all the instruments in a plane into standardized positions. The second: making sure that controls move in a "natural" direction. If you want to go left, the lever should have to be moved left. Chapanis would later write that certain controls, in how they moved, were "psychologically natural": When you wanted to turn something on, it made sense to flip a switch "up" (for Americans, at least).[10] Of course, no one was born with these metaphors in mind—"up means on" or "turn left means go left"—but they were somehow embedded within our experience, beyond accounting, like a mother tongue.

The field would also take in the senses. One of the greatest accomplishments of "psychophysics," initiated by S. S. Stevens, was to recognize that speech could be made clearer over staticky lines by amplifying the consonants and tuning down the vowels—this single insight doubled the range of American radios, providing a crucial

edge by the war's end.[11] Even the Air Force insignia was changed, after the realization of how easy it was to mistake the rising sun on the wing of a Japanese Zero with the blue circle and white star on an American P-47. Testing what symbols pilots could recognize most quickly yielded the familiar circle, star, and bar insignia that still adorns American fighter jets today.[12] (Variations on these same tests would produce the familiar shapes of traffic signs.)[13] "We fought the last battles of the war with new earphones, new microphones, new helmets, new amplifiers, new oxygen masks, all of them engineered in the light of the all-important human factor," Stevens wrote.[14] The death of the anonymous pilot whose radio had failed him in the Pacific hadn't been in vain after all.

All these innovations responded to a dawning reality that was occurring as machines grew more powerful, more intricate, and more ubiquitous. In the war effort, battles were being fought at faster and faster speed—it might take eighteen seconds between seeing a target and firing at it, but your target could have flown five miles in that time.[15] The need to understand what was happening without having the time to think was growing. These problems weren't just limited to the war. In the cars of the time, it was common to have buttons and dials that all looked exactly the same, with none of them even labeled.[16] Moreover, as Chapanis hinted at in describing some controls being "psychologically natural," new technology turned the issue of "fitting the machine to the man" into something not just physical but mental. It was crucial to design a factory floor where the operators could reach all the dials. But with machines becoming more and more autonomous, it was perhaps even more important for the users to intuit what the machine was and the principles behind how it worked.

At the same time, the idea of finding the task to which every

person was perfectly suited was becoming self-evidently absurd. On the one hand, the draft was flooding the military with men of all different abilities, skills, and experiences. On the other, there were new, increasingly specialized machines rolling out from the factories and onto the battlefield. You couldn't fit fewer and fewer soldiers to more and more specialized tasks—even the military's vast and growing scale wouldn't sustain it. To achieve any improvement for the American war machine, the machines themselves had to become easier to use for more people, not fewer. Their operations had to be generalized, using some set of principles yet to be articulated. This was the beginning of the discipline called ergonomics and the beginning of an idea we live with still, that machines should be simple to use—so simple even that they're universal.

It cannot have been easy for people like Paul Fitts and Alfonse Chapanis to overturn the dominant assumption that humans could always be taught to perform better. But circumstances had forced them to invent a new perspective. The story of design is wrapped up in two world wars and the Great Depression because each of those eras presented such high-stakes problems—How do you get people to buy new things? How do you help a confused pilot keep his wits?—that they forced new ways of thinking. America couldn't keep relying on mankind to change with just a few more training courses. It would cost too many lives.

It took almost a century of progress to find the "user" in "user friendly," and that journey was advanced by war. Only with such high stakes could a radically different paradigm—of fitting the machine to the man—take hold so quickly. Along the winding path to a user-friendly world, Fitts and Chapanis laid the most important brick, the one that Don Norman would build a career around and that would teach entire generations how to think about our relationship with the things we build. They realized that as much as

humans might learn, they would always be prone to err. But if you understood why these errors occurred, they could be designed out of existence. This sensibility might have remained locked away like so many secrets in a military vault if not for the reentry of Henry Dreyfuss. It was Dreyfuss who saw the striking parallel between what people such as Fitts and Chapanis had done—shaping machines around men—and deference to human desire, which powered the burgeoning industry of design.



America's first generation of industrial designers might not have survived the war years but for the U.S. government. Raymond Loewy worked on camouflage suits and signage for the Army; William Dorwin Teague designed rocket launchers for the Navy.[17] Henry Dreyfuss's work as a military contractor placed him in the realm of Chapanis and Fitts and the new field of "human factors," which S. S. Stevens had helped invent. In an echo of the commonsense instrumentation of the Toperator washing machine, Dreyfuss's firm came up with the idea of clustering the radar controls aboard airplanes and ships based on their importance to the operator, rather than ease of manufacturing—a prelude to the humane reorientation of high technology that would become the ethos of user-friendly design.[18] But his most consequential wartime project would turn out to be the chairs for tank cockpits.

Dreyfuss brought his usual gonzo immersion to the problem. Debonair and dashingly dressed as always, he stuffed himself into a tank and learned to drive it. What he realized was that the driver needed a chair that could assume two positions: one while he leaned forward to peek out of the tank during normal driving, the other while he leaned back to look through a periscope during battle. The dynamic seat necessitated a primitive drawing of how

it could crane forward to support both postures—and how the human would be situated in the world of the machine. This was the seed of Dreyfuss's postwar obsession.[19] "The more involved the product is with human beings, the more it needs good design. So why not use man as the starting point for all design, even to the extent of drawing human figures into the blueprints?" he would write soon after.[20]

Dreyfuss's elegant facade hid a smoldering competitiveness and a quiet fury. (A partner in the firm asked him where he got his seemingly impregnable self-confidence in front of clients, which enabled him to stride into a room convinced his ideas should win the day. Dreyfuss, with an uncharacteristic candor, said, "I just walk in saying, to myself, you bastards, you bastards, you bastards.")[21] Dreyfuss was the youngest founder among the so-called Big Four design firms—the others were Raymond Loewy, Norman Bel Geddes, and Walter Dorwin Teague—and he wasn't in the lead. That position was probably held by Loewy or Teague, his seniors by over a decade each. After the war, Dreyfuss resolved to invent a new working method that might remake the profession and force his competitors to catch up. His inspiration rose from the human figures that were often drawn into blueprints for scale. Who were those humans? Did they really fit into that drawing? Spurred by a project for a flying car, Henry and Doris Dreyfuss first tried to define the average human body. Mostly they plumbed Army data, but they also called around to shoe stores, department stores, and clothing companies looking for whatever they could find. To turn all that data into something useful, they hired Alvin Tilley, who'd served in World War II as a design engineer.

Tilley would spend decades more perfecting his depiction of the average man and woman, "Joe" and "Josephine," as well as all their relations: short people and tall people, fat people and skinny people,

people with disabilities, kids, and every other variation of human being you might name. Those drawings were a catalog of human scale and movement, laying out in careful detail the proportions of every object that might be fitted around the human body, from the height of a chair to the depth of a cupboard. Moreover, Joe and Josephine represented a new view of the world, the design-world analogue of Leonardo's Vitruvian Man. This wasn't a coincidence.

Dreyfuss greatly admired Leonardo da Vinci, whom he dubbed the world's greatest industrial designer.[22] He idolized the Vitruvian Man. He saw it for what it was. Leonardo, by portraying the human body as an analogy for the clockwork precision of the heavens, put man at the center of the universe. So, too, were Joe and Josephine. In their most famous images, they're each sitting upright in a chair, in profile. The length and reach of their arms and legs is measured off with tick marks; every joint is depicted with an arc describing exactly their range of motion. Just as important as the data those drawings contained was the mere fact of the drawings themselves. With Joe and Josephine at the center of the designed universe, what wasn't at the center of that universe? The actual object of design itself, which was nowhere to be found in those drawings. They showed an abstracted world in which the human came first, and the objects in their lives flowed around them.[23] Joe and Josephine became the mascots of the Dreyfuss office, their images dominating the walls of the studio; more than just decoration, Joe and Josephine guided the form and proportion of everything Dreyfuss designed. And they arrived at precisely the point when the design profession would enjoy a stunning postwar boom. In the 1940s and '50s, American households had the money to buy new things, and American manufacturers had the technology to make things that had never been seen before. The combination of both brought about an entirely new pressure for industrial design.

Most design historians trace the origins of industrial design not to Henry Dreyfuss but to figures such as Josiah Wedgwood, grandfather to Charles Darwin. In the 1760s, Wedgwood invented ways to simplify pottery enough that trained laborers could make not just a few fine teacups but thousands of them in a day, at prices low enough that a new class of buyer could copycat the tastes of the rich. But Wedgwood represents a type of design focused on making slightly better versions of products that have always existed. Dreyfuss and his peers enjoyed a different opportunity after World War II: the chance to create entirely new classes of things that no one had ever realized they needed, and that no one had used before.

The designer became a mediator between the two competing influences of consumer demand and technological capability. As Henry Dreyfuss would later write, "Industrial design entered the American home through the back door . . . the kitchen and laundry held more mass-produced products than the rest of the house put together."[24] The point wasn't that mass manufacturing could make new stuff—it was that the new stuff carried with it new ideas for what life could be. Besides mass manufacturing, what also entered that "back door" was the idea of consumption as an engine of social progress and a strain of design, carried forward by designers such as Ray and Charles Eames and Dieter Rams—and also people working today. Sometimes, these designers get called on to make better versions of things that already exist, but they spend most of their time trying to create things that never existed before. When something hasn't existed before, how do you make it easy to use? And even after that new thing makes its way into the world, how do you improve it enough so that it disappears into daily life?

In the world today, there isn't much left of what Dreyfuss designed, but consider this: There is a piece of him within arm's reach, in the phone-call icon of your smartphone. Look closely at it. The facets of the handle, which Dreyfuss's designers had specified so carefully, are still there, descended from the studio's radically ergonomic design for the Model 500 telephone, released in 1953. The design of the handset itself, with the mouthpiece at one end and the earpiece at the other, made it possible to use a telephone with one hand, while a flat surface for resting the handset between your head and shoulder freed both hands entirely. Both details made talking on the telephone something that could be done while doing something else. They made phones and conversation a more natural part of everyday life. Dreyfuss's design for a headset might be the last phone icon ever designed. After all, what will ever replace it? What do we show when there is no one device that says "phone call" anymore? The icon has become more relevant than the object it refers to—simply because the product that birthed the icon was so natural to use that we eventually took it for granted.



One of the shortest stories that Jorge Luis Borges ever wrote, "On Exactitude in Science," runs exactly 145 words long. Yet it contains a world—or, more precisely, two worlds. It describes an empire so obsessed with mapmaking that its cartographers resolve to create the best map of all, "a Map of the Empire whose size was that of the Empire, and which coincided point for point with it." Eventually that map is forgotten, left to rot—and yet "in the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars."[25] The story contains a relevant lesson. Just as the denizens of that nameless empire had become obsessed with the map of their civilization, it's a constant and recurring theme that

designers, aiming to make something for the world we live in, instead end up designing for an idealized world that they've mapped for themselves. Henry Dreyfuss was one example.

Joe and Josephine did indeed put Dreyfuss's studio at the forefront of his profession, as he'd been hoping since the 1940s. At the time, there was no other compendium for ergonomic information; the masterwork that Dreyfuss and Tilley finally published in 1967, *The Measure of Man*, endures to this day. (In later editions, it was renamed *The Measure of Man and Woman*.) But Dreyfuss had become so obsessed with his maps of human difference that they lost sight of what had distinguished him all along. When Dreyfuss told the story about realizing that the theatergoers in Sioux City were too afraid of the plush red carpet to come in, he was pointing not to some physical characteristic, but a mental one. Likewise with the design he's most famous for, outside of the Bell Model 500: the Honeywell Round thermostat, unveiled in 1953. Thermostats of that era typically had a linear readout and a small, fussy little lever. The Honeywell Round was instead centered on a radial display of the temperature setting; to adjust it, you simply turned the outer ring, which mapped neatly to the display.[26] Thus, the entire form of it blended the information and the interaction into one thing—the insight behind it was about cognitive clarity, not merely ergonomics, and an intuition for what makes things easier in the real world. The ingenuity lay in reframing the problem and seeing more clearly to the life that surrounded it; ergonomics was merely one element of a broader ideal about product design. No wonder that the design became one of the most mass-produced of all time. (It was perfect enough that nearly sixty years later the startup Nest co-opted it for a thermostat imbued with sensors and artificial intelligence.) As to how that ingenuity had emerged, the Dreyfuss studio could point only to the mysterious inspirations of its designers—and the

schematics of the people it had been designed to fit. In focusing on people's physical measurements, Dreyfuss's studio missed the opportunity to create a repeatable process for immersing would-be inventors in a problem, and for seeing the humans who lived with that problem. Dreyfuss did it through his own intuition—and yet he was only one person.

Still, Dreyfuss had come far. Industrial design had waltzed onto center stage during the Depression as a way to reignite the consumer impulse, and took on a new importance in the booming economy of postwar America, when new technologies were introduced to the home at a breakneck pace. Design has grappled with those twin imperatives ever since. On one hand, stoking desire; on the other, a responsibility to teach new technologies. This new conception of design helped America overcome the insecurity of the 1930s, which had manufacturers assuming that they'd always be importing good taste from Europe. As Dreyfuss would later write, "By his selection of the right conveniences to be added to the items he works on; by the obvious ease of maintenance he builds into them; by the proper selection of form and line and color for them, [the designer] has given American products the distinction they so proudly wear throughout the world."[27] It is remarkable that Dreyfuss could say that at all, given the lack of faith in American design that had existed just a few decades before.

By the 1960s, Dreyfuss had found enormous success with such icons as the Honeywell Round thermostat and the Bell Model 500; his peers called him the "conscience" of American industrial design. And yet that eminence was tottering by the decade's end. The world had changed. The profusion of new inventions that filled the home had slowed; there was no more postwar boom forcing would-be manufacturers to figure out how to fit entirely new products into people's lives. There was less and less need for those like Henry

Dreyfuss, and the ethos that motivated what they made. Moreover, as the profession grew, it became more and more about churning out new styles, more responsive to consumer whim. As a result, the preeminence of the Big Four firms from the 1930s waned. By the 1970s, there were hundreds and hundreds of competing firms in the United States alone—a glut of industrial designers all too willing to take the easy path of merely designing whatever prettification the client had hoped for. Faced with such competition, the lock-jawed seriousness of Henry and Doris, which they imbued in the studio as a self-effacing ethos, eventually became a weakness—a stolidity in the face of change. The animating spirit of the studio had moldered. As Niels Diffrient, whom Dreyfuss had groomed to take over the practice, once said: "A lot of the stuff was too conservative, it didn't take advantage of the potential to put some life into it. I would guess that was probably at the bottom of my discontent there, that we didn't really struggle hard enough to go beyond just solving the problem, and give the thing some real life or excellence beyond the expected."[28]

In 1972, Dreyfuss, still always eager for press coverage and still always unhappy that the world wasn't better designed, got an assignment from one of the founders of the upstart *New York* magazine, Milton Glaser, to propose better street signs for the city. Dreyfuss hoped to publish his designs alongside an essay with his friend Ralph Caplan, editor of *Industrial Design* magazine. Dreyfuss went on vacation with Doris in Hawaii, and kept sending Caplan postcards asking if the essay was finished yet. Caplan had been dragging his feet on it. "I didn't know what his rush was. He said, 'We have to get going, we don't have time,'" Caplan told me.[29] "I said, 'There's plenty of time to waste!'" Caplan knew Doris had liver cancer, but Dreyfuss didn't talk about it. He certainly didn't tell anyone about the pact he and Doris had made. One evening in 1972,

Doris put on her best evening gown and Henry put on his custom brown tuxedo. They got a bottle of champagne and two glasses, and went out to the brown Mercedes in the garage, as if heading off to a party. They turned the car on. They popped the champagne, toasted, sipped, then went to sleep and never woke up again. Faced with a world that seemed to need him less and less, Dreyfuss left it.

In the seventy years after S. S. Stevens first limned the discipline of psychophysics and Alphonse Chapanis seeded the field of ergonomics, those disciplines have morphed, evolved, and branched, taking on new names and new applications. These came to be called "human factors," "human-machine interaction," and of course "cognitive psychology"—the field that Don Norman came to dominate in the late 1970s, when he was called upon to study the accident at Three Mile Island. And the ideas behind them created the field we know today as user-experience design—which Don Norman had coined to denote a shift in thinking away from the object of design and toward what surrounds it. Dreyfuss intuited what lay behind that new paradigm: that the artifacts in our lives can't make us happy unless they're designed to serve us, with our limitations and foibles and errors.

Seeing humans as they are, instead of as they're supposed to be, was one of the great, unappreciated intellectual shifts of the twentieth century. That worldview was a flat-out rebuke to the Enlightenment's faith in the perfectibility of mankind's reasoning, and the presiding metaphor that our minds worked like the precise gears of a clock. Instead, our culture came to view the mind as a contraption, whose inner workings we often misapprehended, when we appreciated them at all. It's not an accident that the same era that begat the first mentions of user-friendliness also birthed behavioral economics. By the 1970s, the latter had just begun to produce a series of startling studies that revealed just how shortsighted our

minds could be, and how many shortcuts we took to make sense of the world. What both user-friendliness and behavioral economics shared was an overriding sense that our minds could never be perfected, and that our imperfections made us who we are. This embrace of human limitation was nursemaid to the idea that machines had to be bent around humans. Don Norman's early papers are larded with references to the pathbreaking work of Amos Tversky and Daniel Kahneman, in which they laid the foundations of behavioral economics. Meanwhile, modern neuroscience was also beginning to discover that our brain wasn't built like a clock either, with neatly functioning units. Rather, it was composed of many separate evolutionary adaptations kludged together. By the 1980s, it wasn't a surprise that humans could be viewed as the sum of their foibles.

User-friendliness is simply the fit between the objects around us and the ways we behave. So while we might think that the user-friendly world is one of making user-friendly things, the bigger truth is that design doesn't rely on artifacts. As my collaborator Robert Fabricant likes to say, it relies on our patterns of behavior. All the nuances of designing new products can be reduced to one of two basic strategies: either finding what causes us pain and trying to eliminate it, or reinforcing what we already do with a new object that makes it so easy it becomes second nature. The truest material for making new things isn't aluminum or carbon fiber. It's behavior.[30]

