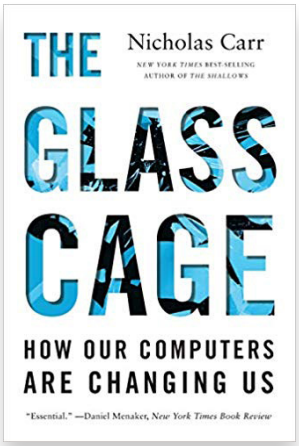

ABOUT THE AUTHOR

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Nicholas Carr is a Pulitzer Prize finalist and a New York Times bestselling writer on technology and culture.

The Glass Cage

THE SUMMARY

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INTRODUCTION: ALERT FOR OPERATORS

This is a book about automation, about the use of computers and software to do things we used to do ourselves. It's about automation's human consequences.

Computer automation makes our lives easier, our chores less burdensome. We're often able to accomplish more in less time—or to do things we simply couldn't do before. But automation also has deeper hidden effects. Not all of them are beneficial. Automation can take a toll on our work, our talents, and our lives. It can narrow our perspectives and limit our choices. It can open us to surveillance and manipulation. As computers become our constant companions, our familiar, obliging helpmates, it seems wise to take a closer a look at exactly how they're changing what we do and who we are.

CHAPTER ONE: PASSENGERS

The trouble with automation is that it often gives us what we don't need at the cost of what we do. To understand why that's so, and why we're eager to accept the bargain, we need to take a look at how certain flaws in the way we think can distort our perceptions. When it comes to assessing the value of labor and leisure, the mind's eyes can't see straight.

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The results of research on "the paradox of work" in the 1980s were surprising. People were happier and felt more fulfilled by what they were doing while they were at work than during their leisure hours. In their free time, they tended to feel bored and anxious. Yet they didn't like to be at work. While they were on the job, they expressed a strong desire to be off the job, and when they were off the job, the last thing they wanted was to go back to work. "We have the paradoxical situation of people having many more positive feelings at work than in leisure, yet saying that they 'wish to be doing something else' when they were at work, not when they are in leisure." Psychologists have bestowed the poetic name *miswanting*. We're inclined to desire things we don't like and to like things we don't desire.

Is it any wonder we're enamored of automation? By offering to reduce the amount of work we have to do, by promising to imbue our lives with greater ease, comfort, and convenience, computers and other labor-saving technologies appeal to our eager but misguided desire for release from what we perceive as toil. Deployed wisely, automation can relieve us of drudge work and spur us on to more challenging and fulfilling endeavors.

The point is not that automation is bad. The point is that we're not very good about thinking rationally about automation or understanding its implications. We don't know when to say "enough" or even "hold on a second." The deck is stacked, economically and emotionally, in automation's favor. The benefits of transferring work from people to machines and computers are easy to identify and measure.

Businesses can run the numbers on capital investments and calculate automation's benefits in hard currency: reduced labor costs, improved productivity, faster throughputs and turnarounds, higher profits. In our personal lives, we can point to all sorts of ways that computers allow us to save time and avoid hassles. Thanks to our bias for leisure over work, ease over effort, we overestimate automation's benefits.

The costs are hard to pin down. We know computers makes certain jobs obsolete and put some people out of work, but history suggests and economists assume, over the long haul, productivity-boosting technology will raise standards of living. The personal costs are even hazier. How do you measure the expense of an erosion of effort and engagement, or a waning of agency and autonomy, or a subtle deterioration of skill? You can't. Those are the kinds of shadowy, intangible things that we rarely appreciate until after they're gone, and even then we may have trouble expressing the losses in concrete terms. The costs are real so automation confronts us with the most important question of all: What does *human being* mean?

CHAPTER TWO: THE ROBOT AT THE GATE

We love our machines not just because they're useful to us, but because we find them companionable and even beautiful. In a well-built machine, we see some of our deepest aspirations take form. We see the desire to understand the world and its workings, the desire to turn nature's power to our own

purposes, the desire to add something new and of our own fashioning to the cosmos, the desire to be awed and amazed. An ingenious machine is a source of wonder and pride.

On the other hand, machines are ugly, and we sense in them a threat to things we hold dear. Machines may be a conduit of human power, but that power has usually been wielded by the industrialists and financiers who own the contraptions, not the people paid to operate them. Machines are cold and mindless, and in their obedience to scripted routines we see an image of society's darker possibilities. If machines bring something human to the alien cosmos, they also bring something alien to the human world. Bertrand Russell said, "Machines are worshipped because they are beautiful and valued because they confer power; they are hated because they are hideous and loathed because they impose slavery."

It might be assumed that jobs aren't disappearing but simply migrating to countries with low wages. That's not so. The total number of worldwide manufacturing jobs has been falling for years, even in industrial powerhouses like China, while overall manufacturing output has grown sharply. Machines are replacing factory workers faster than economic expansion creates new manufacturing positions. As industrial robots become cheaper and more adept, the gap between lost and added jobs will almost certainly widen.

Even the news that companies like GE and Apple are bringing some manufacturing work back to the United States is bittersweet. One of the reasons the work is returning is that most of it can be done without human beings. A company doesn't have to worry about labor costs if it's not employing laborers. Machines, unlike workers, don't demand a share of the returns on capitalist's investments. They don't get sick or expect paid vacations or demand yearly raises. For the capitalist, labor is a problem that progress solves.

Robots may have been at the factory gate in the 1950s, but it's only recently that they've marched, on our orders, into offices, shops, and homes. Today, as software of "the judgment-replacing type" moves from our desks to our pockets, we're at last beginning to experience automation's true potential for changing what we do and how we do it. Everything is being automated. As Netscape founder Marc Andreessen puts it, "Software is eating the world."

Technology changes more quickly than human beings change, but even the most powerful supercomputer evidences no more consciousness than a hammer. It means that our software and our robots will, with our guidance, continue to find new ways to work faster, chapter, and better. So we'll be compelled to adapt our own work, behavior, and skills to the capabilities and routines of the machines we depend on.

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CHAPTER THREE: ON AUTOPILOT

If you want to understand the human consequences of automation, the first place to look is up. Airlines and plane manufacturers, as well as government and military aviation agencies, have been particularly aggressive and especially ingenious in finding ways to shift work from people to machines. A single mistake in a cockpit can cost scores of lives and many millions of dollars so a great deal of private and public money has gone into funding psychological and behavior research on automation's effects. Much of what we know about what happens when people work in concert with computers comes out of this research.

On a typical passenger flight these days, the pilot holds the controls for a grand total of three minutes which includes a minute or two when taking off and another minute or two when landing. What the pilot spends a whole lot of time doing is checking screens and punching in data. The commercial pilot has become a computer operator and that, many aviation and automation experts have to come believe, is a problem. When onboard computer systems fail to work as intended or other unexpected problems arise during a flight, pilots are forced to take manual control of the plane. Thrust abruptly into a now rare role, they too often make mistakes. The consequences, as the Continental Connection and Air France disaster show, can be catastrophic. Thirty years of study show a heavy reliance on computer automation can erode pilot's expertise, dull their reflexes, and diminish their attentiveness.

The computer not only changed the character of flight, it changed the character of automation. It circumscribed the pilot's role to the point where the very idea of "manual control" began to seem anachronistic. If the essence of a pilot's job consists in sending digital inputs to computers and monitoring computer's digital outputs while the computers govern the plane's moving parts and chose its course, where exactly is the manual control? Even when pilots in computerized planes are pulling yokes or pushing sticks, what they're often really involved in is a simulation of manual flight. Every action is mediated, filtered through microprocessors. That's not to say that there aren't still important skills involved. There are. But the skills have changed, and they're now applied at a distance, from behind a scrim of software. In many of today's commercial jets, the flight software can even override the pilot's inputs during extreme maneuvers. The computer gets the final say.

The transformation that aviation has gone through over the last few decades offers a roadmap for the much broader transformation that society is going through now. The glass cockpit can be thought of as a prototype of a world where there is computer functionality everywhere. The experience of pilots also reveals the subtle but often strong connection between the way the minds and bodies of the people using the systems work. The mounting evidence of an erosion of skills, a dulling of perceptions and a slowing of reactions should give us all pause. As we begin to live our lives inside glass cockpits, we seem fated to discover what pilots already know. A glass cockpit can also be a glass cage.

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CHAPTER FOUR: THE DEGENERATION EFFECT

Without lots of practice, lots of repetition and rehearsal of a skill in different circumstances, you and your brain will never get really good at anything, at least not anything complicated. Without continuing practices, any talent you do achieve will get rusty.

It's popular now to suggest that practice is all you need. Work at a skill for ten thousand hours or so, and you'll be blessed with expertise. You'll become the next great pastry chef or power forward. That, unhappily, is an exaggeration. But automaticity, as its name makes clear, can be thought of as a kind of internalized automation. It's the body's way of making difficult but repetitive work routine. Physical movements and procedures get programmed into muscle memory. Without automaticity, our consciousness would be perpetually overloaded. Even very simple acts, such as reading a sentence in a book or cutting a piece of steak with a knife and fork, would strain our cognitive capabilities. Automaticity gives us more headroom.

With a simple pocket calculator, you can automate very complicated mathematical procedures and free up your conscious mind to consider all that math adds up. That only works if you've already mastered basic arithmetic through study and practice. If you use the calculator to bypass learning, to carry out procedures that you haven't learned and don't understand, the tool will not open up new horizons. It won't help you gain new mathematical knowledge and skills. It will simply be a black box, a mysterious number-producing mechanism. It will be a barrier to higher thought, rather than a spur to it. That's what computer automation often does today. Rather than extending the brain's innate capacity for automaticity, automation too often becomes an impediment to automaticity. In relieving us of repetitive mental exercise, it also relieves us of deep learning.

INTERLUDE, WITH DANCING MICE

Researchers placed 40 mice, one by one, in a wooden box with a white tunnel and a black tunnel. Mice entering the black tunnel received "a disagreeable electric shock." Tests revealed that a heavy shock impeded their ability to learn. In something of a Goldilocks effect, a moderate stimulus inspired the best performance.

The results are the same when people are tested. At low levels of stimulation, a person is so unengaged and uninspired that performance flat-lines. As the stimulus increases, performance increases. When stimulation reaches its most intense level, the person essentially becomes paralyzed with stress and performance again flat-lines.

Automation also has a sometimes tragic tendency to increase the complexity of a job at the worst possible moment, adding more stress when workers already have too much to handle. Anyone who's gone off course while following directions from a mapping app knows firsthand how computer automation can cause sudden spikes in workload. It's not easy to fiddle with a smartphone while driving a car. The computer, introduced as an aid to reduce the chances of human error, ends up making it more likely that people, like shocked mice, will make the wrong move.

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CHAPTER FIVE: WHITE-COLLAR COMPUTER

When a metalworker uses simple manual tools, such as files and shears, the main skill requirements are job knowledge, including in this case an appreciation of the qualities and uses of metal and physical dexterity. When power tools are introduced, the job grows more complicated and the cost of errors is magnified. The worker is called on to display more dexterity and decision-making as well as greater attentiveness. He becomes a "machinist."

When hand tools are replaced by mechanisms that perform a series of operations (such as milling machines that cut and grind blocks of metal into precise three-dimensional shapes) attention, decision-making, and machine control responsibilities are reduced, and technical knowledge of machine functioning and adjustment are reduced tremendously. The machinist becomes a "machine operator."

When mechanization becomes truly automatic, meaning when machines are programmed to control themselves, the worker contributes little or no physical or mental effort. He doesn't even require much job knowledge, as that knowledge has effectively gone into the machine through its design and coding. His job, if it still exists, is reduced to "patrolling." The metalworker becomes a watchman, a monitor, a helper. He might best be thought of as a liaison between machine and operating management.

Automation first relieves the worker of the need for manual effort, and then relieves him of the need for mental effort. The "skill" is built into the machine.

It may seem as through a factory worker operating a noisy industrial machine has little in common with a highly-educated professional entering esoteric information through a touchscreen or keyboard in a quiet office. But in both cases, the sophistication of the system determines how roles and responsibilities are divided and, in turn, the set of skills each party is called upon to exercise. As more skills are built into the machine, it assumes more control over the work, and the worker's opportunity to engage in and develop deeper talents, such as those involved in interpretation and judgment, dwindles. When automation reaches its highest levels, when it takes command of the job, the worker has nowhere to go but down. George Dyson asks, "What if the cost of machines that think is people who don't?"

As templates and guidelines have become more elaborate, medical doctors are already facing increasing pressure to cede more control over diagnoses and treatment decisions to software. To put it into uncharitable but not inaccurate terms, many doctors may soon find themselves taking on the role of human sensors who collect information for a decision-making computer. The doctors will examine the patient and enter data into electronic forms, but the computer will take the lead in suggesting diagnoses and recommending therapies. Physicians seem destined to experience, at least in some areas of their practice, the same de-skilling effect that was once restricted to factory hands.

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If we are not careful, the automation of mental labor, by changing the nature and focus of intellectual endeavor, may end up eroding one of the foundations of culture itself which is our desire to understand the world. Predictive algorithms may be supernaturally skilled at discovering correlations, but they're indifferent to the underlying causes of traits and phenomena. Computers are eminently practical and productive and entirely lacking in curiosity, imagination, and worldliness.

CHAPTER SIX: WORLD AND SCREEN

The world is a strange, changeable, and dangerous place. Getting around in it demands of any animal a great deal of effort, mental and physical. For ages, human beings have been creating tools to reduce the stain of travel. History is, among other things, a record of the discovery of ingenious new ways to ease our passage through our environs, to make it possible to cross greater and more daunting distances without getting lost, roughed up, or eaten. Simple maps and trail markers came first, then star maps and nautical charts and terrestrial globes, then instruments like sounding weights, quadrants, astrolabes, compasses, octants and sextants, telescopes, hourglasses, and chronometers. Lighthouses were erected along shorelines, buoys set in coastal waters. Roads were paved, signs posted, highways linked and numbered. It has, for most of us, been a long time since we've had to rely on our wits to get around.

GPS receivers and other automated mapping and direction-plotting devices are the latest additions to our navigational toolkit. They also give the old story a new and worrisome twist. Earlier navigational aids, particularly those available and affordable to ordinary folks, were just aids. They were designed to give travelers a greater awareness of the world around them by sharpening their sense of direction, providing them with advance warning of danger, highlighting nearby landmarks and other points of orientation, and in general helping them situate themselves in both familiar and alien settings. Satellite navigation systems can do all of those things, and more, but they're not designed to deepen our involvement in our surroundings. They're designed to relieve us of the need of such involvement. By taking control of the mechanics of navigation and reducing our own role to following routine commands—turn left in five hundred yards, take the next exit, stay right, destination ahead—the systems, whether running through a dashboard, a smartphone, or a dedicated GPS receiver, end up isolating us from the environment.

As tales of discombobulated pilots, truck drivers, and hunters demonstrate, a loss of navigational acumen can have dire consequences. Most of us, in our daily routines of driving and walking and otherwise getting around, are unlikely to find ourselves in such perilous spots. This raises the obvious question, *who cares?* As long as we arrive at our destination, does it really matter whether we maintain our navigational sense or offload it to a machine? An Inuit elder on Igloolik may have good reason to bemoan the adoption of GPS technology as a cultural tragedy, but those of us living in lands crisscrossed by well-marked roads and furnished with gas stations, motels, and 7-Elevens long ago lost both the custom of and the capacity for prodigious feats of wayfaring. Our ability to perceive

and interpret topography, especially in its natural state, is already much reduced. Paring it away further or dispensing with it altogether doesn't seem like such a big deal, particularly if in exchange we get an easier go of it.

The automation of way-finding distances us from the environment that shaped us. It encourages us to observe and manipulate symbols on screens rather than attend to real things in real places. The labors our obliging digital deities would have us see as mere drudgery may turn out to be vital to our fitness, happiness, and well-being. So *who cares?* Probably isn't the right question. What we should be asking ourselves is, *How far from the world do we want to retreat?*

CHAPTER SEVEN: AUTOMATION FOR THE PEOPLE

The question, in one rhetorical form or another, comes up frequently in discussions of automation. If computers are advancing so rapidly, and if people by comparison seem slow, clumsy, and error prone, why not build immaculately self-contained systems that perform flawlessly without any human oversight or intervention. Why not take the human factor out of the equation altogether?

Designers often assume human beings are "unreliable and inefficient," at least when compared to a computer, so they strive to give them as small a role as possible in the operation of systems. People end up functioning as mere monitors, passive watchers of screens. That's a job that humans, with our notoriously wandering minds, are particularly bad at.

As individuals, too, we almost always seek efficiency and convenience when we decide which software application or computing device to use. We pick the program or gadget that lightens our load and frees up our time, not the one that makes us work harder and longer. Technology companies naturally cater to such desires when they design their wares. They compete fiercely to offer the product that requires the least effort and thought to use. "At Google and all these places," says Google executive Alan Eagle, "we make technology as brain-dead easy to use as possible." Abstract concerns about the fate of human talent can't compete with the prospect of saving time and money.

INTERLUDE, WITH GRAVE ROBBER

Video games tend to be loathed by people who have never played them. That's understandable, but it's a shame. To master a video game, a player has to struggle through challenges of increasing difficulty, always pushing the limits of his talent. Every mission has a goal, there are rewards for doing well, and the feedback is immediate and often visceral. When it comes to the software we use in our personal lives, video games are an exception.

In its original form, Google's search engine presented you with an empty text box. It required you to think about your query, to consciously compose and refine a set of keywords to get the best results. In 2008, the company introduced Google Suggest, an auto-complete routine that uses prediction

algorithms to anticipate what you're looking for. Underlying the company's hyperactive solicitude is a dogged, almost monomaniacal pursuit of efficiency.

Social networks like Facebook, through the statistical "discovery" of potential friends, the provision of the "Like" buttons and other clickable tokens of affection and the automated management of many of the time-consuming aspects of personal relations, seek to streamline the messy process of affiliation. They celebrate "frictionless sharing" by removing conscious effort from socializing.

Like meddlesome parents who never let their kids do anything on their own, Google, Facebook, and other makers of personal software end up demeaning and diminishing qualities of character that, at least in the past, have been seen as essential to a full and vigorous life. These qualities include ingenuity, curiosity, independence, perseverance, and daring. It may be that in the future we'll only experience such virtues vicariously through the exploits of action figures in the games and fantasy worlds we enter through screens.

CHAPTER EIGHT: YOUR INNER DRONE

It's a cold, misty Friday night in mid-December and you're being driven home from your office holiday party along the icy streets by your Google-programmed eSmart autonomous car. As you pass through a densely wooded stretch of road, just a few hundred yards from your driveway the neighbor's beagle darts into the street.

What does your robot driver do? Does it slam on the brakes, in hopes of saving the dog but at the risk of sending the car into an uncontrolled skid, or does it keep its virtual foot off the brake, sacrificing the beagle to ensure that you and your vehicle stay out of harm's way? If its algorithms calculate that hitting the brakes would give the dog a 53 percent chance of survival but would entail an 18 percent chance of damaging the car and a 4 percent chance of causing injury to you, does it conclude that trying to save the animal would be the right thing to do? How does the software, working on its own, translate a set of numbers into a decision that has both practical and moral consequences?

What if the animal in the road isn't your neighbor's pet but your own? What, for that matter, if it isn't a dog but a child? What if you are crossing a bridge and group of schoolchildren on the pedestrian walkway is also crossing that bridge—and suddenly there's a tussle, and a little boy is pushed out into the road. Your car has to make the decision. Either it swerves out of its lane and goes off the opposite side of the bridge, possibly killing you, or it hits the child. What does the software instruct the steering wheel to do?

Would the program make a different choice if it knew that one of your own children was riding with you, strapped into a sensor-equipped car seat in back? What if there was an oncoming vehicle in the other lane? What if that vehicle was a school bus? Isaac Asimov's first law of robot ethics which says "a robot may not injure a human being, or, through inaction, allow a human being to come to harm" sounds reasonable and reassuring, but it assumes a world far simpler than our own.

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When an inscrutable technology becomes an invisible technology, we would be wise to be concerned. At that point, the technology's assumptions and intentions have infiltrated our own desires and actions. We no longer know whether the software is aiding us or controlling us. We're behind the wheel, but we can't be sure who's driving.

CHAPTER NINE: THE LOVE THAT LAYS THE SWALE IN ROWS

Technology is as crucial to the work of knowing as it is to the work of production. The human body quickly reaches the limits of what it can do. But the body encompasses a mind that can imagine, desire, and plan for achievements the body alone can't fulfill. Technology isn't what makes us "post-human" or "trans-human," as some scholars have recently suggested. It's what makes us human. Technology is in our nature. Through our tools we give our dreams form. We bring them into the world. The practicality of technology may distinguish it from art, but both spring from a similar, distinctly human yearning.

Technology, by enabling us to act in ways that go beyond our bodily limits, also alters our perception of the world and what the world signifies to us. Technology's transformative power is most apparent in the tools of discovery, from the microscope and the particle accelerator of the scientist to the canoe and the spaceship of the explorer, but the power is there in all tools, including the ones we use in our everyday lives. Whenever an instrument allows us to cultivate a new talent, the world becomes a different and more intriguing place, a setting of even greater opportunity. To the possibilities of nature are added the possibilities of culture.

The value of a well-made and well-used tool is not only in what it produces for us but what it produces in us. At its best, technology opens fresh ground. It gives us a world that is at once more understandable to our senses and better suited to our intentions, a world in which we're more at home. Used thoughtfully and with skill, technology becomes much more than a means of production or consumption. It becomes a means of experience. It gives us more ways to lead rich and engaged lives.

Technology has always challenged people to think about what's important in their lives, to ask themselves, as I suggested at the outset of this book, what *human being* means. Automation, as it extends its reach into the most intimate spheres of our existence, raises the stakes. We can allow ourselves to be carried along by the technological current, wherever it may be taking us, or we can push against it.

To resist invention is not to reject invention. It's to humble invention, to bring progress down to earth. Resistance is never futile. If the source of our vitality is, as Emerson taught us, "the active soul," then our highest obligation is to resist any force, whether institutional or commercial or technological, that would enfeeble or enervate the soul. When we enter the glass cage, we're required to shed much of our body. That doesn't free us; it emaciates us.

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One of the most remarkable things about us is also one of the easiest to overlook. Each time we collide with the real, we deepen our understanding of the world and become more fully a part of it. By reclaiming our tools as part of ourselves, as instruments of experience rather than just means of production, we can enjoy the freedom that congenial technology provides when it opens the world more fully to us.