BOOK
Range: Why Generalists Triumph in a Specialized World

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SYNOPSIS [From the publisher]
"Plenty of experts argue that anyone who wants to develop a skill, play an instrument, or lead their field should start early, focus intensely, and rack up as many hours of deliberate practice as possible. If you dabble or delay, you'll never catch up to the people who got a head start. But a closer look at research on the world's top performers, from professional athletes to Nobel laureates, shows that early specialization is the exception, not the rule.

"David Epstein examined the world's most successful athletes, artists, musicians, inventors, forecasters and scientists. He discovered that in most fields—especially those that are complex and unpredictable—generalists, not specialists, are primed to excel. Generalists often find their path late, and they juggle many interests rather than focusing on one. They're also more creative, more agile, and able to make connections their more specialized peers can't see."

"'And he refused to specialize in anything, preferring to keep an eye on the overall estate rather than any of its parts. . . . And Nikolay's management produced the most brilliant results.'
—Leo Tolstoy, War and Peace"

"'No tool is omnicompetent. There is no such thing as a master-key that will unlock all doors.'
—Arnold Toynbee, A Study of History"

"The contrast was not lost on Federer. '[Tiger's] story is completely different from mine,' he told a biographer in 2006. 'Even as a kid his goal was to break the record for winning the most majors. I was just dreaming of just once meeting Boris Becker or being able to play at Wimbledon some time.'"

"The response, in every field, to a ballooning library of human knowledge and an interconnected world has been to exalt increasingly narrow focus. Oncologists no longer specialize in cancer, but rather in cancer related to a single organ, and the trend advances each year. Surgeon and writer Atul Gawande pointed out that when doctors joke about left ear surgeons, 'we have to check to be sure they don't exist.'"

"When I began to write about these studies, I was met with thoughtful criticism, but also denial. 'Maybe in some other sport,' fans often said, 'but that's not true of our sport.' The community of the world's most popular sport, soccer, was the loudest. And then, as if on cue, in late 2014 a team of German scientists published a study showing that members of their national team, which had just won the World Cup, were typically late specializers who didn't play more organized soccer than amateur-league players until age twenty-two or later. They spent more of their childhood and adolescence playing nonorganized soccer and other sports."

"In reality, the Roger path to sports stardom is far more prevalent than the Tiger path, but those athletes' stories are much more quietly told, if they are told at all."

"I also began to realize that some of the people whose work I deeply admired from afar—from Duke Ellington (who shunned music lessons to focus on drawing and baseball as a kid) to Maryam Mirzakhani (who dreamed of becoming a novelist and instead became the first woman to win math's most famous prize, the Fields Medal)—seemed to have more Roger than Tiger in their development stories . . . All were late specializers or career changers, and as they filed up one after another to introduce themselves after the talk, I could tell that all were at least moderately concerned, and some were borderline ashamed of it . . . Their LinkedIn profiles didn't show the linear progression toward a particular career they had been told employers wanted."

"I read more studies and spoke with more researchers and found more evidence that it takes time—and often forgoing a head start—to develop personal and professional range, but it is worth it."

"Mark Zuckerberg famously noted that 'young people are just smarter' . . . Researchers at Northwestern, MIT, and the U.S. Census Bureau studied new tech companies and showed that among the fastest-growing start-ups, the average age of a founder was forty-five when the company was launched."

"Zuckerberg was twenty-two when he said that. It was in his interest to broadcast that message, just as it is in the interest of people who run youth sports leagues to claim that year-round devotion to one activity is necessary for success, never mind evidence to the contrary. But the drive to specialize goes beyond that. It infects not just individuals, but entire systems, as each specialized group sees a smaller and smaller part of a large puzzle."

"Overspecialization can lead to collective tragedy even when every individual separately takes the most reasonable course of action."

"I began worrying that I was a job-commitment-phobic drifter who must be doing this whole career thing wrong. Learning about the advantages of breadth and delayed specialization has changed the way I see myself and the world."

"The challenge we all face is how to maintain the benefits of breadth, diverse experience, interdisciplinary thinking, and delayed concentration in a world that increasingly incentivizes, even demands, hyperspecialization . . . we also need more Rogers: people who start broad and embrace diverse experiences and perspectives while they progress. People with range."

"The powerful lesson is that anything in the world can be conquered in the same way. It relies on one very important, and very unspoken, assumption: that chess and golf are representative examples of all the activities that matter to you."

"One of Klein's colleagues, psychologist Daniel Kahneman, studied human decision making from the 'heuristics and biases' model of human judgment. His findings could hardly have been more different from Klein's. When Kahneman probed the judgments of highly trained experts, he often found that experience had not helped at all. Even worse, it frequently bred confidence but not skill."

"High-powered consultants from top business schools . . . did really well on business school problems that were well defined and quickly assessed. But they employed what Argyris called single-loop learning, the kind that favors the first familiar solution that comes to mind. Whenever those solutions went wrong, the consultant usually got defensive. Argyris found their 'brittle personalities' particularly surprising given that 'the essence of their job is to teach others how to do things differently.'"

"Flynn's great disappointment is the degree to which society, and particularly higher education, has responded to the broadening of the mind by pushing specialization, rather than focusing early training on conceptual, transferable knowledge."

"Fortunately, as an undergrad, I did have a chemistry professor who embodied Flynn's ideal. On every exam, amid typical chemistry questions, was something like this: 'How many piano tuners are there in New York City?' Students had to estimate, just by reasoning, and try to get the right order of magnitude. The professor later explained that these were 'Fermi problems,' because Enrico Fermi—who created the first nuclear reactor beneath the University of Chicago football field—constantly made back-of-the-envelope estimates to help him approach problems.* The ultimate lesson of the question was that detailed prior knowledge was less important than a way of thinking."

"In the genre of modern self-help narratives, music training has stood beside golf atop the podium, exemplars of the power of a narrowly focused head start in highly technical training. Whether it is the story of Tiger Woods or the Yale law professor known as the Tiger Mother, the message is the same: choose early, focus narrowly, never waver."

"Psychologists highlighted the variety of paths to excellence, but the most common was a sampling period, often lightly structured with some lessons and a breadth of instruments and activities, followed only later by a narrowing of focus, increased structure, and an explosion of practice volume."

"It isn't bad to get an answer right while studying. Progress just should not happen too quickly . . ."

"Over the past forty years, Americans have increasingly said in national surveys that current students are getting a worse education than they themselves did, and they have been wrong."

"Education economist Greg Duncan, one of the most influential education professors in the world, has documented this trend. Focusing on 'using procedures' problems worked well forty years ago when the world was flush with jobs that paid middle-class salaries for procedural tasks, like typing, filing, and working on an assembly line. 'Increasingly,' according to Duncan, 'jobs that pay well require employees to be able to solve unexpected problems, often while working in groups. . . . These shifts in labor force demands have in turn put new and increasingly stringent demands on schools.'"

"Interleaving has been shown to improve inductive reasoning. When presented with different examples mixed together, students learn to create abstract generalizations that allow them to apply what they learned to material they have never encountered before."

"And yet interleaving tends to fool learners about their own progress. In one of Kornell and Bjork's interleaving studies, 80 percent of students were sure they had learned better with blocked than mixed practice, whereas 80 percent performed in a manner that proved the opposite. The feeling of learning, it turns out, is based on before-your-eyes progress, while deep learning is not. 'When your intuition says block,' Kornell told me, 'you should probably interleave' . . . Whether the task is mental or physical, interleaving improves the ability to match the right strategy to a problem."

"Desirable difficulties like testing and spacing make knowledge stick. It becomes durable. Desirable difficulties like making connections and interleaving make knowledge flexible, useful for problems that never appeared in training. All slow down learning and make performance suffer, in the short term. That can be a problem, because like the Air Force cadets, we all reflexively assess our progress by how we are doing right now. And like the Air Force cadets, we are often wrong."

"The researchers found a pervasive 'fadeout' effect, where a temporary academic advantage quickly diminished and often completely vanished. On a graph, it looks eerily like the kind that show future elite athletes catching up to their peers who got a head start in deliberate practice."

"Before-our-eyes progress reinforces our instinct to do more of the same, but just like the case of the typhoid doctor, the feedback teaches the wrong lesson. Learning deeply means learning slowly. The cult of the head start fails the learners it seeks to serve."

"Knowledge with enduring utility must be very flexible, composed of mental schemes that can be matched to new problems."

"Most problems, of course, are not new, so we can rely on what Gentner calls 'surface' analogies from our own experience. 'Most of the time, if you're reminded of things that are similar on the surface, they're going to be relationally similar as well,' she explained. Remember how you fixed the clogged bathtub drain in the old apartment? That will probably come to mind when the kitchen sink is clogged in the new one."

"Like kind learning environments, a kind world is based on repeating patterns. "It's perfectly fine," she said, "if you stay in the same village or the same savannah all your life." The current world is not so kind; it requires thinking that cannot fall back on previous experience. Like math students, we need to be able to pick a strategy for problems we have never seen before. "In the life we lead today," Gentner told me, "we need to be reminded of things that are only abstractly or relationally similar. And the more creative you want to be, the more important that is."

"College football coaches rated the same player's potential very differently depending on what former player he was likened to in an introductory description, even with all other information kept exactly the same."

Psychologists have shown repeatedly that the more internal details an individual can be made to consider, the more extreme their judgment becomes. For the venture capitalists, they knew more details about their own project, and judged that it would be an extreme success, until they were forced to consider other projects with broad conceptual similarities.

"As education pioneer John Dewey put it in Logic, The Theory of Inquiry, 'a problem well put is half-solved.'"

"In each country, every college course that a student took provided skills that could be applied in a specific field, as well as information about their match quality with the field itself. If students focused earlier, they compiled more skills that prepared them for gainful employment. If they sampled and focused later, they entered the job market with fewer domain-specific skills, but a greater sense of the type of work that fit their abilities and inclinations. Malamud's question was: Who usually won the trade-off, early or late specializers?"

"It should come as no surprise that more students in Scotland ultimately majored in subjects that did not exist in their high schools, like engineering. In England and Wales, students were expected to pick a path with knowledge only of the limited menu they had been exposed to early in high school. That is sort of like being forced to choose at sixteen whether you want to marry your high school sweetheart. At the time it might seem like a great idea, but the more you experience, the less great that idea looks in hindsight. In England and Wales, adults were more likely to get divorced from the careers they had invested in because they settled down too early. If we treated careers more like dating, nobody would settle down so quickly."

“Winston Churchill’s ‘never give in, never, never, never, never’ is an oft-quoted trope. The end of the sentence is always left out: ‘except to convictions of honor and good sense.’”

“Switchers are winners. It seems to fly in the face of hoary adages about quitting, and of far newer concepts in modern psychology.”

“Seth Godin, author of some of the most popular career writing in the world, wrote a book disparaging the idea that ‘quitters never win.’ Godin argued that ‘winners’—he generally meant individuals who reach the apex of their domain—quit fast and often when they detect that a plan is not the best fit, and do not feel bad about it. ‘We fail,’ he wrote, when we stick with ‘tasks we don’t have the guts to quit.’”

“The [West Point] academy’s leaky officer pipeline began springing holes en masse in the 1980s, during the national transition to a knowledge economy. By the millennium, the leaks formed a torrent. The Army began offering retention bonuses—just cash payments to junior officers if they agreed to serve a few more years. It cost taxpayers $500 million, and was a massive waste. Officers who had planned to stay anyway took it, and those who already planned to leave did not. The Army learned a hard lesson: the problem was not a financial one; it was a matching one.”

“In the industrial era, or the “company man” era, as the monograph authors called it, “firms were highly specialized,” with employees generally tackling the same suite of challenges repeatedly. Both the culture of the time—pensions were pervasive and job switching might be viewed as disloyal—and specialization were barriers to worker mobility outside of the company.”

“’I’ve yet to meet a classmate who left the Army and regretted it,’ said Ashley Nicolas, the former intelligence officer. She went on to become a math teacher and then a lawyer. She added that all were grateful for the experience, even though it didn’t become a lifelong career.”

“When Defense Secretary Ash Carter visited West Point in 2016 for student meetings, he was flooded with concerns from very gritty cadets about rigid career paths that did not allow them to adjust to their own development. Carter had pledged to drastically reshape the Army’s “industrial era” personnel management from the strict “up-or-out” model to one that allows officers a shot to improve their own match quality as they grow.”

“Hilariously, I was awarded the Gustave A. Jaeger Memorial Prize for the athlete who ‘achieved significant athletic success in the face of unusual challenge and difficulty’—my “unusual challenge and difficulty” just being that I epically stunk at first.”

“Steven Naifeh spent a decade researching Van Gogh’s life, so I asked him to fill out the grit questionnaire on the painter’s behalf. Van Gogh’s work ethic stretched belief. He was intoxicated with an image his father had used in a sermon of the sower, who must put in work now so that he can reap later. “Think of all the fields that were turned down by shortsighted people,” Dorus van Gogh preached. He invoked that image, Naifeh and Smith wrote, as “a paragon of persistence in the face of adversity.” At every job he had, Vincent was convinced that if he outworked everyone around him, he would succeed. But then he would fail. His interests whipsawed constantly. Even once he’d set himself on being an artist, he would devote all his energy to one style or medium only to completely disavow it soon thereafter.”

“No one in their right mind would argue that passion and perseverance are unimportant, or that a bad day is a cue to quit. But the idea that a change of interest, or a recalibration of focus, is an imperfection and competitive disadvantage leads to a simple, one-size-fits-all Tiger story: pick and stick, as soon as possible.”

"Responding to lived experience with a change of direction, like Van Gogh did habitually, like West Point graduates have been doing since the dawn of the knowledge economy, is less tidy but no less important. It involves a particular behavior that improves your chances of finding the best match, but that at first blush sounds like a terrible life strategy: short-term planning."

"Our work preferences and our life preferences do not stay the same, because we do not stay the same."

Ibarra's advice is nearly identical to the short-term planning the Dark Horse researchers documented. Rather than expecting an ironclad a priori answer to "Who do I really want to become?," their work indicated that it is better to be a scientist of yourself, asking smaller questions that can actually be tested—"Which among my various possible selves should I start to explore now? How can I do that?" Be a flirt with your possible selves.* Rather than a grand plan, find experiments that can be undertaken quickly. "Test-and-learn," Ibarra told me, "not plan-and-implement."

"It might seem that nothing would be easier than deciding what you like, but it turns out to be hard, partly because it's hard to get an accurate picture of most jobs. . . . Most of the work I've done in the last ten years didn't exist when I was in high school. . . . In such a world it's not a good idea to have fixed plans."

"And yet every May, speakers all over the country fire up the Standard Graduation Speech, the theme of which is: don't give up on your dreams. I know what they mean, but this is a bad way to put it, because it implies you're supposed to be bound by some plan you made early on. The computer world has a name for this: premature optimization. . . . "

"Art historian William Wallace showed that Michelangelo was actually a test-and-learn all-star. He constantly changed his mind and altered his sculptural plans as he worked. He left three-fifths of his sculptures unfinished, each time moving on to something more promising. The first line of Wallace's analysis: "Michelangelo did not expound a theory of art." He tried, then went from there."

"Bingham calls it 'outside-in' thinking: finding solutions in experiences far outside of focused training for the problem itself. History is littered with world-changing examples."

"Sometimes you just slap your head and go, 'Well why didn't I think of that?' If it was easily solved by people within the industry, it would have been solved by people within the industry," Pegau said. "I think it happens more often than we'd love to admit, because we tend to view things with all the information we've gathered in our industry, and sometimes that puts us down a path that goes into a wall. It's hard to back up and find another path."

"According to Lakhani. 'Big innovation most often happens when an outsider who may be far away from the surface of the problem reframes the problem in a way that unlocks the solution.'"

"Pedro Domingos, a computer science professor and machine learning researcher, told me. 'Knowledge is a double-edged sword. It allows you to do some things, but it also makes you blind to other things that you could do.'"

"Swanson became concerned about increasing specialization, that it would lead to publications that catered only to a very small group of specialists and inhibit creativity. "The disparity between the total quantity of recorded knowledge . . . and the limited human capacity to assimilate it, is not only enormous now but grows unremittingly," he once said. How can frontiers be pushed, Swanson wondered, if one day it will take a lifetime just to reach them in each specialized domain?"

"During two centuries of closed-borders isolation, Japan banned hanafuda—"flower cards," so called because the twelve different suits are represented by flowers. The playing cards were associated with gambling and unwanted Western cultural influence. By the late nineteenth century, Japan was reintroducing itself to the world, and the ban was finally lifted. So it was in the fall of 1889 that a young man opened a tiny wooden shop in Kyoto and hung a sign in the window: "Nintendo." . . . The Game Boy became the Sony Walkman of video gaming, forgoing top-of-the-line tech for portability and affordability. It sold 118.7 million units, far and away the bestselling console of the twentieth century. Not bad for the little company that was allowed to sell hanafuda."

"Even though he was revered by then, Yokoi had to push and shove internally for his "lateral thinking with withered technology" concept to be approved for the Game Boy. "It was difficult to get Nintendo to understand," he said later. Yokoi was convinced, though, that if users were drawn into the games, technological power would be an afterthought. "If you draw two circles on a blackboard, and say, 'That's a snowman,' everyone who sees it will sense the white color of the snow," he argued."

"There is, to be sure, no comprehensive theory of creativity. But there is a well-documented tendency people have to consider only familiar uses for objects, an instinct known as functional fixedness. The most famous example is the "candle problem," in which participants are given a candle, a box of tacks, and a book of matches and told to attach the candle to the wall such that wax doesn't drip on the table below. Solvers try to melt the candle to the wall or tack it up somehow, neither of which work. When the problem is presented with the tacks outside of their box, solvers are more likely to view the empty box as a potential candle holder, and to solve the problem by tacking it to the wall and placing the candle inside."

"Yokoi's greatest triumphs occurred when he thought laterally. He needed specialists, but his concern was that as companies grew and technology progressed, vertical-thinking hyperspecialists would continue to be valued but lateral-thinking generalists would not. "The shortcut [for a lack of ideas] is competition in the realm of computing power," Yokoi explained. "When it comes to that . . . the screen manufacturers and expert graphics designers come out on top. Then Nintendo's reason for existence disappears." He felt that the lateral and vertical thinkers were best together, even in highly technical fields."

"Specialization is obvious: keep going straight. Breadth is trickier to grow."

"University of Utah professor Abbie Griffin has made it her work to study modern Thomas Edisons—"serial innovators," she and two colleagues termed them. Their findings about who these people are should sound familiar by now: "high tolerance for ambiguity"; "systems thinkers"; "additional technical knowledge from peripheral domains"; "repurposing what is already available"; "adept at using analogous domains for finding inputs to the invention process"; "ability to connect disparate pieces of information in new ways"; "synthesizing information from many different sources"; "they appear to flit among ideas"; "broad range of interests"; "they read more (and more broadly) than other technologists and have a wider range of outside interests"; "need to learn significantly across multiple domains"; "Serial innovators also need to communicate with various individuals with technical expertise outside of their own domain." Get the picture?"

"Hamilton creator Lin-Manuel Miranda painted the same idea elegantly: 'I have a lot of apps open in my brain right now.'"

"Facing uncertain environments and wicked problems, breadth of experience is invaluable. Facing kind problems, narrow specialization can be remarkably efficient. The problem is that we often expect the hyperspecialist, because of their expertise in a narrow area, to magically be able to extend their skill to wicked problems. The results can be disastrous."

Ideally, intellectual sparring partners "hone each other's arguments so that they are sharper and better," Yale historian Paul Sabin wrote. "The opposite happened with Paul Ehrlich and Julian Simon." As each man amassed more information for his own view, each became more dogmatic, and the inadequacies in their models of the world more stark.

"There is a particular kind of thinker, one who becomes more entrenched in their single big idea about how the world works even in the face of contrary facts, whose predictions become worse, not better, as they amass information for their mental representation of the world."

ABOUT KEPLER

"Spirits may have been driving, but the planets also needed a vehicle for motion, so they were assumed to be riding on pure crystalline spheres. The spheres were invisible from Earth and interlocked, like the gears of a clock, to produce collective motion at a constant speed for all eternity. Plato and Aristotle had laid the foundation for the accepted model, and it dominated for two thousand years. That clockwork universe was the one German astronomer Johannes Kepler inherited. He accepted it, at first."

"By 1596, when he turned twenty-five, Kepler had accepted the Copernican model of planets orbiting the sun, and now he posed another profound question: Why do planets that are farther away from the sun move more slowly?"

"He eventually decided that celestial bodies pulled one another, and larger bodies had more pull. That led him to claim (correctly) that the moon influenced tides on Earth. Galileo, the embodiment of bold truths, mocked him for the ridiculous idea of 'the moon's dominion over the waters.'"

"Kepler's intellectual wanderings traced a staggering journey, from planets imbued with souls and riding on interlocking crystalline spheres in perfect circles around the stationary Earth, to his illumination of the laws of planetary motion, which showed that the planets move in ellipses that are predictable based on their relation to the sun."

"In an age when alchemy was still a common approach to natural phenomena, Kepler filled the universe with invisible forces acting all around us, and helped usher in the Scientific Revolution. His fastidious documentation of every meandering path his brain blazed is one of the great records of a mind undergoing creative transformation. It is a truism to say that Kepler thought outside the box. But what he really did, whenever he was stuck, was to think entirely outside the domain. He left a brightly lit trail of his favorite tools for doing that, the ones that allowed him to cast outside eyes upon wisdom his peers simply accepted. "I especially love analogies," he wrote, "my most faithful masters, acquainted with all the secrets of nature. . . . One should make great use of them."

"Mention Kepler if you want to get Northwestern University psychologist Dedre Gentner excited. She gesticulates. Her tortoiseshell glasses bob up and down. She is probably the world's foremost authority on analogical thinking. Deep analogical thinking is the practice of recognizing conceptual similarities in multiple domains or scenarios that may seem to have little in common on the surface. It is a powerful tool for solving wicked problems, and Kepler was an analogy addict, so Gentner is naturally very fond of him."

"In my opinion," Gentner told me, "our ability to think relationally is one of the reasons we're running the planet. Relations are really hard for other species." Analogical thinking takes the new and makes it familiar, or takes the familiar and puts it in a new light, and allows humans to reason through problems they have never seen in unfamiliar contexts."

Kepler was facing a problem not just new to himself, but to all humanity. There was no experience database to draw on. To investigate whether he should be the first ever to propose "action at a distance" in the heavens (a mysterious power invisibly traversing space and then appearing at its target), he turned to analogy (odor, heat, light) to consider whether it was conceptually possible. He followed that up with a litany of distant analogies (magnets, boats) to think through the problem.

"What matters to me," Kepler wrote, "is not merely to impart to the reader what I have to say, but above all to convey to him the reasons, subterfuges, and lucky hazards which led me to my discoveries."

"The assignment no one wanted became Kepler's keyhole view into a new understanding of the universe. He was in uncharted territory. The analogies began in earnest, and he reinvented astronomy. Light, heat,

smells, boats, brooms, magnets—it began with those pesky observations that didn't quite fit, and ended in the complete undoing of Aristotle's clockwork universe."

"Faced with an unexpected finding, rather than assuming the current theory is correct and that an observation must be off, the unexpected became an opportunity to venture somewhere new—and analogies served as the wilderness guide."