Albert-László Barabási

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The Formula

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The Science Behind Why People Succeed or Fail

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THE SCIENCE BEHIND WHY PEOPLE SUCCEED OR FAIL

Albert-László Barabási

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Success Isn't About You. It's About Us.

My wife says she fell in love with me because I knew the temperature of the sun. I met her in a coffee shop while preparing to teach my students the basics of thermodynamics. "How could we possibly know such a thing?" she asked. The idea that I could pin a number — 5,778 kelvin, to be precise — on something so far away, something so untouchable, so violently, immeasurably incendiary — seemed like a magic trick. It's the kind of answer any parent would love to supply to the questions kids tend to ask. Instead, we admit, "I don't know," or speak in vague terms. "The sun is hot. Really hot." But we're talking about the glowing orb that illuminates our lives, the source of life as we know it. I found it baffling as a child that adults knew precious little about something so big.

My grandfather owned a fleet of trucks in his small Transylvanian village, but by the time I came along, all he had left of his business was his machine shop, a cavernous wooden shack where I spent every one of my vacation days. I loved that shop, which was in some ways my first laboratory, a place where I could safely break something down to its nuts and bolts, study its gears, and see exactly how it operated. Understanding what made something work — that was the fascination. It still is.

I come from a family of tinkerers. After Communism robbed my grandfather of his fleet of trucks, he fixed appliances for the whole neighborhood, examining the innards of an iron or a radio with patient confidence. My dad, a truck driver for the family business at a mere ten years old, could crawl underneath an ailing car, poke around for a few minutes, and emerge with blackened fingers and a pleased expression, the problem fixed. He spent his life always running something — a school, a museum, a company — approaching each job with the mind-set of a tinkerer, rolling up his sleeves and making it work no matter the circumstance.

Maybe it's a tinkerer's curiosity that turned me into a scientist. Early on, physics allowed me to explore the sprockets and gears of the universe and the very forces that control our lives. Looking for more challenges, I turned later to the complexities of networks and data. For a vigilant asker-of-questions, I've chosen the right corner of the scientific world to call home. As long as a line of inquiry is based on numbers — the more the merrier — I can pursue it doggedly, following its scent through the maze of data now available to researchers in our hyper-connected, technological world. Hunting down an answer inevitably leads to more questions, new possibilities that hover like gnats on the periphery of any research I conduct. I try to swat them away and stay focused on the task at hand, but I'm not that different from the kid I once was, stubbornly asking "Why?" in response to . . . well, pretty much anything. It is the quest for answers that gets me up in the morning and keeps me up at night.

These days I run the Center for Complex Network Research, in Boston, where my job is exploring the "why" behind topics as varied as how people or molecules interact, where and how links form, and what our interconnectedness can tell us about society or our biological origins. We've examined the topology of the World Wide Web. We're looking at how tiny hiccups in our genetic networks lead to disease. We're exploring how our brains control their billions of neurons and how molecules in food attach to our proteins, ensuring our long-term health.

I love this kind of stuff — the math behind our social fabric, the way numbers provide a framework for understanding the essence of our connectedness. When I use models and tools to delve into unlikely topics for scientific analyses, these frameworks inevitably deepen our knowledge.

That's precisely what we did with success. It took a few years, but after harvesting mountains of data on human accomplishment, we figured out a way to break the concept down to its constituents and study its gears. Our goal was to formulate success as a mathematical problem that computer scientists and physicists, using the unforgiving tools of quantitative science, could address in a definite fashion. It wasn't that different from pulling apart a bike, or using thermodynamics to fathom solar heat. Once we started seeing the mechanisms that create success, we began to answer the kinds of impossible questions I tortured my parents with as a child.

Exactly how, for instance, did we decide that *this* — the blurry, unremarkable photo hanging in the Museum of Modern Art — is a masterpiece?

Why is *Carousel,* not *Cats,* the best musical ever?

Are expensive schools worth it?

Why are there a mere handful of superstars in any field?

Add these to the hundreds of other questions about success, achievement, and reputation that seem, like the sun's temperature, impossible to pin down. Is it our performance that pushes us up the corporate ladder? Do we get less or more creative over our lifetimes? Should we collaborate or compete with superstars? How do networks — social and professional — affect our access to success?

Believe it or not, quantitative answers can be found for all these seemingly unquantifiable questions. By examining the patterns in the data and identifying the mechanisms that produce success, we determined that we could address each of the questions head-on. Once we began to comprehend the universal forces at work behind our individual successes and failures, fascinating findings started to emerge.

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We started with disaster, backhandedly landing on success. At the time, my lab was analyzing cell phone data to understand how people react to major catastrophes. Recognizing that this was a good opportunity for one to learn by doing, I assigned Dashun Wang, a gregarious, Chinese-born Ph.D. student, to help with the ongoing project. The endeavor resulted in a truly fascinating paper, one that I was certain would have a major impact on disaster relief efforts worldwide.

Except . . . no one else thought so. Try as we might, we couldn't get it published. The highest-tier and then some of the lowest-tier journals rejected it. We joked that we should have removed the word "disaster" from the title, since that likely destined it for failure.

A lifelong basketball player, Dashun shrugged off our disastrous paper as if it were a setback on the court. The ironies amused him. But when he and I met one night to discuss his next project, he was eager to move on.

"I'll do pretty much anything but work on another disaster," he said with a chuckle.

"Then let's make your next project a success," I said. "How about the Science of Success?"

I'd meant the question to be tongue-in-cheek. Except as soon as I said it, we both knew that we'd stumbled onto something interesting. Why *not* apply our methods to the study of success? It seemed that studying success would not be all that different from studying catastrophe. We can accurately predict the trajectory of a hurricane by examining a big pile of data points and using them as input for weather models. These predictions are hugely valuable in developing a response plan. Communities that lie in a hurricane's projected path prepare to batten down the hatches; the rest get ready for sprinkles and buy umbrellas. We don't question the validity of the forecast, though a century ago prophesying a monumental storm would have seemed like witchcraft. Why, then, couldn't we do something similar with success? Data collected in unexpected realms and filtered through sophisticated mathematical models, after all, can seem like a kind of magic.

We started out small and focused on a specific area: success in science. We realized that in the digitized era we now live in, we had troves of detailed records about our own discipline — catalogues of research papers going back over a century. Why not put science itself under our data microscope? The project sought to answer some of my most puzzling, fundamental questions: How does success emerge? How can it be measured? Why are some of my biggest heroes — remarkable scientists whose discoveries have enriched my life — so doomed to invisibility that they hardly appear in a Google search? And why are others whose work is not any more remarkable or novel propelled to stardom?

In no time, we started seeing patterns in the data, which turned into formulae we could use to *predict future outcomes* for ourselves, our colleagues, and even our professional rivals. As I'll discuss later in the book, we could actually fast-forward a scientist's career to determine her future academic impact, gauging her chances of making it big or having her contribution appreciated by only a few kindred souls within an already esoteric discipline. We also developed an algorithm to predict precisely who, among hundreds of contributors to a discovery, would get most of the credit, and — spoiler! — it was rarely the person doing the lion's share of the work.

The most unexpected outcome? Finding a courtesy-van driver at a Toyota dealership in Alabama who had inexplicably been overlooked for a Nobel Prize. And he's just one in the collection of characters we met on our journey toward understanding success. Among them were also the guy who crowdfunded $10,000 in eight minutes, a Harley-riding success researcher with a passion for Broadway musicals, and a former oceanographer turned winemaker whose discovery of ugly truths has changed the way I buy wine.

Our first Science of Success project took two years to complete, and its findings opened up a new realm of inquiry ripe for further exploration. The resulting paper, Dashun's first as lead author, was published in *Science,* the most prestigious journal out there. He and I were both a bit stunned. In running from disaster, we stumbled across success.

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What I was learning about my own field of science captivated me, and it quickly became clear that we could use the same approach to examine success in other realms. Did the same patterns apply to accomplishment in sports, to rewards in art, to high achievement in sales? Could we foresee which TV show or book would become a sensation just as we could forecast the success of new scientific discoveries? Could we predict a career in business in the same way we could now anticipate an unfolding academic one? What if the patterns and regularity that we saw in the way scientists succeed and fail reflected some deeper truths that apply to all of us? What if our mathematical tool kit showed that success in all realms obeys the same universal laws?

To be honest, it was a risky proposition. A glance at the existing success-related literature, which lines an entire wall at my favorite bookstore, told me that most writing about the topic relied on inspirational messages and anecdotal evidence, a far cry from the hard theorems and flinty empirical data to be found on the science shelves.

But what those books also tell me is that people have a deep hunger to understand what contributes to success. It's a topic that obsesses many of us. And well it should. Success is not only a fundamental aspect of human experience, both practical and existential, but is also often a fundamental marker by which we measure the life we are leading. Whether we'll fail or thrive in our chosen careers or even hobbies matters deeply. When we make a discovery, produce a piece of art, or design a new gadget, we want to make sure it will have an impact on the world. We puzzle over the fine line between success and failure daily as we envision our own future trajectory or as we steer our children into adulthood. If only we could find patterns of success in a whole range of fields, perhaps we might be able to make sense of what we far too often attribute to chance.

Propelled by this possibility, I challenged my lab members to discover the quantitative laws that govern success. Each success

story is bound to leave a trail of data points behind. I hoped not only to capture these trails but also to identify the patterns that success obeys and the drivers behind them. And we did just that, meticulously gathering data from multiple fields — the arts, academia, sports, and business — and analyzing it on a large scale. We purchased massive databases containing all the research papers ever written, allowing us to rebuild the careers of every published scientist going back a century or more. We bought access to the weekly sales patterns of all books sold in the United States, data that helped us examine the commercial success of each author independent of the genre they worked in. We were given access to information about global gallery and museum exhibits, which allowed us to rebuild the careers of all contemporary artists, identifying the invisible networks that guaranteed success for some of them. We scoured massive data sets pertaining to success in sports, business, and innovation. Then we put all of it under the quantitative microscope that our lab and others have developed over the past two decades. We took these tools — hardened by decades of work by computer scientists, physicists, and mathematicians interested in unveiling the secrets of the universe, curing genetic diseases, or finding valuable information in milliseconds among billions of Web pages — and the mathematical rigor behind them and applied them to the massive data sets that capture how we encounter and experience success. And to better survey the potential behind this new field, we also organized a symposium on the Science of Success, held at Harvard University in May 2013. Over a hundred researchers, everyone from sociologists to business professors, came to share their findings. As we put our heads together, we were suddenly seeing a *series of recurring patterns that drive success in most areas of human performance.*

Because the patterns that began to emerge were so universal, we started to call them the Laws of Success. Given that scientific laws are immutable, doing so probably seemed brash to outside researchers. But the more we explored and tested them, the more solid and general they appeared. Crucially, like the laws of gravitation or of motion, the Laws of Success can't be rewritten to fit

our needs or beliefs, no matter how righteous or strongly held. And outright resisting them is about as futile as trying to fly by flapping our arms up and down. But — just as engineers use their understanding of fluid mechanics and plenty of tinkering to improve airplane technology — we can take advantage of the Laws of Success to invent our futures.

In the upcoming chapters, I will delve into the far-reaching scientific inquiries that support each law. My goal with *The Formula* is to outline our discoveries so that readers, aware of the complex but consistently reproducible mechanisms that generate success, can use this knowledge in their own lives. But this is not a self-help book. I like to think of it, instead, as "science help," a framework that uses science to understand and orchestrate outcomes. Scientific analysis can illuminate seemingly deeply irrational puzzles, turning our assumptions on their heads. In other words, science can help us make sense of the randomness of the human world — unveiling the mechanisms at work when we're passed over for a job, the underlying pattern that explains why some artists thrive while others fail, the lingering hunch that success is about more than just talent or how well we perform.

As I'll discuss in the conclusion, despite his evident genius, even Einstein's success was no foregone conclusion. In fact, much of his rampant recognition hinges on events completely divorced from his contributions to science. Across the board, the research indicates that we can't rely on sheer instinct, strong performance, or all the old inspirational clichés if we want our work to be appreciated, our accomplishments to be noticed, and our legacies to endure.

In fact, for the purposes of this book, we'll be defining success along these lines: it is the rewards we earn from the communities we belong to. In the case of Einstein — the "Man of the Century," according to *Time* — that reward is fame. But it can be recognition if you're a collaborator, visibility if you're a brand, renown if you're an artist, album or ticket sales if you're a musician, revenue if you're in business or sales, earnings if you're a banker, audience if you're a playwright, citations if you're a scientist, endorsements if you're an athlete, and impact if you hope to make a difference in virtually any

field. These success measures all have one thing in common: they are external, not internal; collective, not individual.

This is not to say that we can't experience success as something deeply individual. Personal growth, satisfaction, and depth of experience are powerful and significant. Our framework for success doesn't preclude such measurements, nor should they be regarded as mutually exclusive from success as I'm defining it. They often go hand in hand, our satisfaction growing with the impact we've made. But as a scientist, I can't measure individual fulfillment any more than I can assign a number to happiness. Private definitions of success are unique to each of us, so they're invisible to our approach to big data. A perfectionist may perceive even a much-praised performance as a failure and argue that true success comes only when she feels genuinely satisfied with her labors. She wouldn't be wrong. Nor would the guy who finishes his unpublishable novel but considers it a success because he met a personal goal by completing it. These are triumphs essential to who we are and why we get out of bed in the morning. My life, too, is full of personal goals — to be a good father, an insightful mentor, and an astute speaker paramount among them. I'd love to find a way to explore success through this far more personal lens. Sadly, I haven't found a way to do so, since individual aims remain stubbornly inaccessible to our methods of research. They've proven to be unmeasurable so far.

Let's say you're a talented skater recovering from knee surgery. You work with your physical therapist; you toil through repetitive exercises. You set goals and make painful but incremental progress. Then the day comes when you don't need crutches. You take three steps. Ten. You eventually lace up your skates and get back in the rink, a moment of victory. This is when the triumphant music sounds, should Hollywood tell your story. Call it the biggest success of your life, and I'd fully agree with you.

Yet in this book we'll refrain from calling this "success." It's not that we'll ignore this kind of achievement. Rather, we'll call it performance. You reached an important goal through hard work. But the rewards were internal, centered on personal satisfaction and fulfillment. They matter, of course. They matter a great deal. They

matter to you and to your physical therapist; they matter to your coach and to your family, just as achieving a milestone at work is significant to you and your boss. They may even enhance your future performance. But when I talk about success being collective and not individual, requiring a *community's* response, I mean that we need to be able to observe the ripple of impact your performance has on the people and environments you move within. We need to see how your performance matters to us.

Remember the old philosophical chestnut: If a tree falls in the woods and no one is around to hear it, does it make a sound? According to our new understanding of success, the answer is a resounding no. Audiences won't applaud your earth-shattering, disruptive achievement unless they can witness its impact. In an era when we can track human behavior with almost topographic accuracy, big data allows us to map success by measuring collective response to your performance. In the highly technological, plugged-in present, not only can we examine the circumstances through which success emerges, we can see how it spreads through the networks that connect us, touching faraway communities.

So while I recognize the importance of personal fulfillment, it's not a factor I can consider in my work as a researcher. Respecting that boundary has been oddly freeing. The popular definition of success reinforces the perception that "success" is as loose a concept as "love." The topic's vagueness kept scientists away — they assumed that it couldn't be studied. Realizing that success is a collective phenomenon throws that perception out the window. Once we defined success along external lines, a whole new set of possibilities opened up. We could measure and quantify it, using tools of scientific inquiry. And once we did that, we could unveil the laws that govern our success.

These laws are what separate the best seller from the bargain bin and the billionaires from the bankrupt. They illuminate how flawed competition protocols are, many of which effectively determine a winner by lottery. They show how "experts" — professionals who assess wine, classical music performances, figure skaters, or even other judges — are often no better at ascertaining quality than you

or me. They explain why that guy who dominates staff meetings but shows up late and unprepared on all other occasions somehow becomes your boss. They show us that taking a risk on an underdog can have enormous impact, or that a single, initial donation can make or break a fundraising campaign. They even elucidate how a thoroughly terrible song — insert your nomination here — mystifyingly becomes a hit. The Laws of Success have governed our lives and careers as immutably as gravity through the centuries, and yet, until recently, we did not know they existed.

Before big data and the Science of Success, we assumed luck or hard work or talent, mixed together in some magic, unknowable proportion, were all that mattered — myself included. As an immigrant from Transylvania, first a political refugee within Europe and then a hopeful student, I believed that hard work alone was my best strategy. I was doubly committed to showing that I could succeed in America. But my only game plan for making it in science was to perform exceptionally, to make a discovery with lasting impact, to conduct research so groundbreaking that it couldn't be ignored. Years ago, my lab members taped a picture of the Energizer Bunny on my office door, with my face superimposed over its furry pink jowls. And even now I can't stop. I continue to work with a single-mindedness that can be infuriating to the people I'm closest to. These are things I can't really change about myself, though I've certainly tried. I believed in hard work as a child, and I believe in hard work now. But as the Laws of Success started to unfold before my eyes — as I saw patterns on a large scale that in individual cases seemed random — I was shocked by my own ignorance.

While I now know that performance remains crucial, I also know that it's only *one variable* in the formula for success. Other variables that we will unveil in the coming chapters are just as indispensable. When we break down and demystify the ingredients of success, we grasp what we can control in our lives — and what we can't. Because just like the laws of nature, the Laws of Success don't necessarily apply to all of us all the time. But they do come into play when we engage in specific activities. Aerodynamics are crucial if you're flying, friction if you're driving, and fluid dynamics if you take

a boat. Different laws and formulas apply depending on what means of transportation you choose. The Laws of Success are similar — our insights into team success aren't going to illuminate the triumphs of an artist who works exclusively alone.

But we can use the laws to understand how invisible forces shape our successes and failures, knowledge I've found truly revelatory. As a kid, I was more of an artist than a scientist. Then, a few weeks into my first high school physics class, I earned an eight out of ten on a pop quiz that everyone else failed. I beamed in astonished pride when the teacher praised me. I don't think I was particularly gifted at physics, and I certainly wasn't passionate about it yet. The only reason I'd earned a decent 80 percent score was because a friend of my parents', an engineer, happened to be staying with us, and the night before the quiz he'd coached me through my homework.

Oblivious to the forces that had boosted my performance, I left the classroom that day with newfound confidence. It was the first success I experienced in science, and it stayed with me long after I'd graduated. It's fair to say that the rest of my life hinged on that moment. Because, without fully realizing it, I'd encountered the first of the many complex mechanisms at work that shaped my career. What underlies that experience — and all my later moments of personal triumph — are captured by the Laws of Success.