Chapter 10

How Failure Drives Innovation

I

The headquarters of Dyson are in a futuristic building about forty miles west of Oxford. Outside the front entrance is a Harrier jump jet—not a replica, a real one—and a high-speed landing craft. They both hint at the unconventionality of what goes on inside.

James Dyson, the chairman and chief engineer of the company, works in a glass-fronted office just above the entrance. Along the back wall are the beautifully conceived products that have turned him into an icon of British innovation: super-efficient vacuum cleaners, futuristic hand dryers, and other devices yet to roll off the production line. In all, he has applied for more than four thousand patents.[1]

Progress is often driven not by the accumulation of small steps, but by dramatic leaps. The television wasn't an iteration of a previous device, it was a new technology altogether. Einstein's general theory of relativity didn't tinker with Newton's law of universal gravitation, it replaced it in almost every detail. Likewise Dyson's dual-cyclone vacuum cleaner was not a marginal improvement on the conventional Hoover that existed at the time, it represented a shift that altered the way insiders think about the very problem of removing dust and hair from household floors.

Dyson is an evangelist for the creative process of change, not least because he believes it is fundamentally misconceived in the world today. As we talk in his office, he darts around picking up papers, patents, textbooks, and his own designs to illustrate his argument. He is tall, bright-eyed, and restless. A conversation scheduled for half an hour continues late into the evening, so that by the end the sun has gone down, and his expressive face

is lit only by a table lamp (designed, incidentally, by his son: it contains an LED light that lasts for 160,000 hours rather than the usual 2,000).

He says:

> People think of creativity as a mystical process. The idea is that creative insights emerge from the ether, through pure contemplation. This model conceives of innovation as something that happens to people, normally geniuses. But this could not be more wrong. Creativity is something that has to be worked at, and it has specific characteristics. Unless we understand how it happens, we will not improve our creativity, as a society or as a world.

Dyson's journey into the nature of creativity started while vacuuming his own home, a small farmhouse in the west of England, on a Saturday morning in his mid-twenties. Like everyone else he was struck by just how quickly his cleaner lost suction. "It was a top-of-the-range Hoover," he says. "It had one of the most powerful vacuum motors in the world. But it lost its suction within minutes. It started to let out this high-pitched scream. I had faced the problem before. Growing up, it had been my chore to vacuum the family home and the suction was a constant bugbear. But this time I just snapped."

Dyson strode into his garden and opened up the device. Inside he could see the basic engineering proposition of the conventional vacuum cleaner: a motor, a bag (which also doubled as a filter), and a tube. The logic was simple: dust and air is sucked into the bag, the air escapes through the small holes in the lining of the bag and into the motor, and the dust (thicker than the air) stays in the bag. He says:

> The bag was full of dust and so I assumed this was the reason that it had lost suction. So I ripped open the bag, emptied out the dust and Sellotaped it back up again. But when I went back to vacuum in the house, the efficiency was no better. The screaming started straight away. There was no suction.

> I suddenly realized that the real problem was not that the bag was full; it was the thin lining of dust on the inside of the bag. The walls of the bag were clogged. The fine dust was blocking the filter. And that is why performance in conventional vacuum cleaners dips so rapidly; it is the very first dust that blocks them up.

This realization triggered a new thought: What if there were no bag? What if you could make an entirely bagless vacuum cleaner? “If you could find a way of removing the dust from the air another way, without using a conventional bag, you would no longer lose suction because of a blocked filter,” he says. “It would revolutionize vacuum cleaning.”

This idea percolated in Dyson’s mind for the next three years. A graduate of the Royal College of Art, he was already a qualified engineer and was helping to run a local company in Bath. He enjoyed pulling things apart and seeing how they worked. He was curious, inquisitive, and willing to engage with a difficulty rather than just accepting it. But now he had a live problem, one that intrigued him.

It wasn’t until he went to a lumberyard that the solution powered into his mind like a thunderbolt.

> Nowadays you pick up wood from a merchant and just walk out. In the old days, they virtually had to cut and plane it for you. There was a lot of hanging about. As I stood there waiting I noticed this ducting going off the machines. It traveled along to this thing on the roof, thirty or forty foot tall.
>
> It was a cyclone [a cone-shaped device that changes the dynamics of the airflow, separating the dust from the air via centrifugal force]. It was made of galvanized steel. And although a ton of dust was coming off the machines as they cut the wood, there was no dust coming out of the chimney at the top. I was intrigued. This thing was collecting fine dust all day long and it didn’t look as though it was blocking at all.

Dyson rushed home. This was his moment of insight. “I vaguely knew about cyclones, but not really the detail. But I was fascinated to see if it

would work in miniature form. I got an old cardboard box and made a replica of what I had seen with gaffer tape and cardboard. I then connected it via a bit of hose to an upright vacuum cleaner. And I had my cardboard cyclone."

His heart was beating fast as he pushed it around the house. Would it work? "It seemed absolutely fine," he says. "It seemed to be picking up dust, but the dust didn't seem to be coming out of the chimney. I went to my boss and said: 'I think I have an interesting idea.'"

This simple idea, this moment of insight, would ultimately make Dyson a personal fortune in excess of £3 billion.

II

A number of things jump out about the Dyson story. The first is that the solution seems rather obvious in hindsight. This is often the case with innovation, and it's something we will come back to.

But now consider a couple of other aspects of the story. The first is that the creative process started with a *problem*, what you might even call a failure, in the existing technology. The vacuum cleaner kept blocking. It let out a screaming noise. Dyson had to keep bending down to pick up bits of trash by hand.

Had everything been going smoothly Dyson would have had no motivation to change things. Moreover, he would have had no intellectual challenge to sink his teeth into. It was the very nature of the engineering problem that sparked a possible solution (a bagless vacuum cleaner).

And this turns out to be an almost perfect metaphor for the creative process, whether it involves vacuum cleaners, a quest for a new brand name, or a new scientific theory. Creativity is, in many respects, a *response*.

Relativity was a response to the failure of Newtonian mechanics to make accurate predictions when objects were moving at fast speeds.

Masking tape was a response to the failure of existing adhesive tape, which would rip the paint off when it was removed from cars and walls.

The collapsible stroller was a response to the impracticality of unwieldy baby carriages (Owen Maclaren, the designer, came up with the idea after

watching his daughter struggling with a baby carriage while out with his granddaughter).

The wind-up radio was a response to the lack of batteries in Africa, something that was hampering the spread of educational information (Trevor Baylis came up with the idea after watching a television program on AIDS).

The ATM was a response to the problem of getting hold of cash outside of business hours. It was invented by John Shepherd-Barron while lying in the bath one night, worrying because he had forgotten to go to the bank.

Dropbox, as we have seen, was a response to the problem of forgetting your flash drive and thus not having access to important files.

This aspect of the creative process, the fact that it emerges in response to a particular difficulty, has spawned its own terminology. It is called the "problem phase" of innovation. "The damn thing had been bugging me for years," Dyson says of the conventional vacuum cleaner. "I couldn't bear the inefficiency of the technology. It wasn't so much a 'problem phase' as a 'hatred phase.'"

We often leave this aspect of the creative process out of the picture. We focus on the moment of epiphany, the detonation of insight that happened when Newton was hit by the apple or Archimedes was taking a bath. That is perhaps why creativity seems so ethereal. The idea is that such insights could happen anytime, anywhere. It is just a matter of sitting back and letting them flow.

But this leaves out an indispensable feature of creativity. Without a problem, without a failure, without a flaw, without a frustration, innovation has nothing to latch on to. It loses its pivot. As Dyson puts it: "Creativity should be thought of as a dialogue. You have to have a problem before you can have the game-changing riposte."

Perhaps the most graphic way to glimpse the responsive nature of creativity is to consider an experiment by Charlan Nemeth, a psychologist at the University of California, Berkeley, and her colleagues.[2] She took 265 female undergraduates and randomly divided them into five-person teams. Each team was given the same task: to come up with ideas about how to reduce traffic congestion in the San Francisco Bay Area. These five-person teams were then assigned to one of three ways of working.

The first group were given the instruction to brainstorm. This is one of the most influential creativity techniques in history, and it is based on the mystical conception of how creativity happens: through contemplation and the free flow of ideas. In brainstorming the entire approach is to *remove* obstacles. It is to minimize challenges. People are warned not to criticize each other, or point out the difficulties in each other's suggestions. Blockages are bad. Negative feedback is a sin.

As Alex Faickney Osborn, an advertising executive who wrote a series of best-selling books on brainstorming in the 1940s and 1950s, put it: "Creativity is so delicate a flower that praise tends to make it bloom, while discouragement often nips it in the bud."[3]

The second group were given no guidelines at all: they were allowed to come up with ideas in any way they thought best.

But the third group were actively encouraged to point out the flaws in each other's ideas. Their instructions read: "Most research and advice suggests that the best way to come up with good solutions is to come up with many solutions. Free-wheeling is welcome; don't be afraid to say anything that comes to mind. However, in addition, most studies suggest that *you should debate and even criticize each other's ideas* [my italics]."

The results were remarkable. The groups with the dissent and criticize guidelines generated 25 percent more ideas than those who were brainstorming (or who had no instructions). Just as striking, when individuals were later asked to come up with more solutions for the traffic problem, those with the dissent guidelines generated twice as many new ideas as the brainstormers.

Further studies have shown that those who dissent rather than brainstorm produce not just more ideas, but more productive and imaginative ideas. As Nemeth put it: "The basic finding is that the encouragement of debate—and even criticism if warranted—appears to stimulate more creative ideas. And cultures that permit and even encourage such expression of differing viewpoints may stimulate the most innovation."

The reason is not difficult to identify. The problem with brainstorming is not its insistence on free-wheeling or quick association. Rather, it is that when these ideas are not checked by the feedback of criticism, they have

nothing to respond to. Criticism surfaces problems. It brings difficulties to light. This forces us to think afresh. When our assumptions are violated we are nudged into a new relationship with reality. Removing failure from innovation is like removing oxygen from a fire.

Think back to Dyson and his Hoover. It was the flaw in the existing technology that forced Dyson to think about cleaning in a new way. The blockage in the filter wasn't something to hide away from or pretend wasn't there. Rather, the blockage, the failure, was a gilt-edged invitation to reimagine vacuum-cleaning.

Imagination is not fragile. It feeds off flaws, difficulties, and problems. Insulating ourselves from failures—whether via brainstorming guidelines, the familiar cultural taboo on criticism, or the influence of cognitive dissonance*—is to rob one of our most valuable mental faculties of fuel.

"It always starts with a problem," Dyson says. "I hated vacuum cleaners for twenty years, but I hated hand dryers for even longer. If they had worked perfectly, I would have had no motivation to come up with a new solution. But more important, I would not have had the context to offer a creative solution. Failures feed the imagination. You cannot have the one without the other."

Perhaps the most eloquent testimony to the creative power of error comes from a different experiment by Nemeth and a colleague.[4] In a typical free association study, we are given a word and have to respond with the first word that pops into our heads.

The problem is that when many of us free-associate, we come up with rather boring associations. If someone says "blue," most people reply "sky." If someone says "green," we say "grass." This is hardly the stuff of inspiration. In her free-association experiment, Nemeth showed slides to volunteers. As expected, they came up with conventional, banal associations.

But then she had a lab assistant call out the wrong color as part of the experiment. When a blue slide was shown, the assistant called out "green." And this is when something odd happened. When Nemeth then asked these volunteers to free-associate on the colors that had been wrongly identified, they suddenly became far more creative. They came up with associations

that reached way beyond tired convention. Blue became “jeans” or “lonely” or “Miles Davis.”[5]

What was going on? We should now be able to glimpse an answer. Contradictory information *jars*, in much the same way that error jars. It encourages us to engage in a new way. We start to reach beyond our usual thought processes (why would you think differently when things are going just as expected?). When someone shouts out the wrong color, our conventional mental operations are disrupted. That is when we find associations, connections, that might never have occurred to us.

And this takes us to the second crucial aspect of the Dyson story. You’ll remember that in his moment of insight he essentially brought two disparate ideas together: a vacuum cleaner and a sawmill. These were two different things. They existed in two different places of vastly different scale: in the home and in the sawmill. You could almost say that they inhabited separate conceptual categories.

Dyson’s innovation, stripped down to its essentials, was to merge them. He was a *connecting agent.* The act of creativity was an act, above all, of synthesis. “I think the fact that I had so many years of frustration probably made me the perfect person to glimpse a possible solution,” he says. “But the solution was really about combining two existing technologies.”

And it turns out that this act of connectivity is another central feature of innovation. Johannes Gutenberg invented mass printing by applying the pressing of wine (the technology of which had existed for many centuries) to the pressing of pages.[6]

The Wright brothers applied their understanding of manufacturing bicycles to the problem of powered flight.

The rank algorithm behind the success of Google was developed by Sergey Brin and Larry Page from an existing method of ranking academic articles.

Sellotape, a staggeringly successful commercial innovation, was developed by merging glue and cellophane.

The collapsible stroller was created by fusing the folding undercarriages for Spitfires in the Second World War with an existing technology for transporting children.

Little wonder that Steve Jobs, a master in the art of merging concepts, once said: “Creativity is just connecting things.”

If failure sparks creativity into life, the moment of insight invariably emerges from the attempt to bridge the problem with previously unconnected ideas or technologies. It is about finding a hidden connection in order to solve a problem with meaning. But the crucial point to realize is that these processes are intimately intertwined. It is precisely because we have been hit by jarring information that we are nudged into looking for unusual connections, as we saw in the free association experiment.

To put it simply, failure and epiphany are inextricably linked. When we come up with a brilliant idea, when it pops into our mind, it has often emerged from a period of gestation. It is a consequence of engaging with a problem, sometimes, as in the case of Dyson, for many years.

As the neuroscientist David Eagleman says in his book *Incognito: The Secret Lives of the Brain*: “When an idea is served up from behind the scenes, the neural circuitry has been working on the problems for hours or days or years, consolidating information and trying out new combinations. But you merely take credit without further wonderment at the vast, hidden political machinery behind the scenes.”[7]

Much of the literature on creativity focuses on how to trigger these moments of innovative synthesis; how to drive the problem phase toward its resolution. And it turns out that epiphanies often happen when we are in one of two types of environment.

The first is when we are switching off: having a shower, going for a walk, sipping a cold beer, daydreaming. When we are too focused, when we are thinking too literally, we can’t spot the obscure associations that are so important to creativity. We have to take a step back for the “associative state” to emerge. As the poet Julia Cameron put it: “I learned to get out of the way and let that creative force work through me.”[8]

The other type of environment where creative moments often happen, as we have seen, is when we are being sparked by the dissent of others. When Kevin Dunbar, a psychologist at McGill University, went to look at how scientific breakthroughs actually happen, for example (he took cameras into four molecular biology labs and recorded pretty much

everything that took place), he assumed that it would involve scientists beavering away in isolated contemplation.

In fact, the breakthroughs happened at lab meetings, where groups of researchers would gather around a desk to talk through their work. Why here? Because they were forced to respond to challenges and critiques from their fellow researchers. They were jarred into seeing new associations.

As the author Steven Johnson puts it: “Questions from colleagues forced researchers to think about their experiments on a different scale or level. Group interactions challenged researchers” assumptions about their more surprising findings . . . The ground zero of innovation was not the microscope. It was the conference table.”[9]

And this helps to explain why cities are so creative, why atriums are important; in fact why any environment that allows disparate people, and therefore ideas, to bump into each other, is so conducive. They facilitate the association of diverse ideas, and bring people face-to-face with dissent and criticism. All help to ignite creativity.

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This brief jaunt through the literature on creativity reveals one thing above all else: innovation is highly *context-dependent*. It is a response to a particular problem at a particular time and place. Take away the context, and you remove both the spur to innovation, and its raw material.

The best way to see this truth is through the phenomenon of *the multiple*. Steven Johnson runs through an entire list of breakthroughs that were conceived by different people, working independently, at almost precisely the same time.[10]

Sunspots, for example, were discovered by four scientists in four different countries in 1611. The mathematical calculus was developed by both Sir Isaac Newton and Gottfried Leibniz in the 1670s. The forerunner to the first electric battery was invented by Ewald Georg von Kleist in 1745 and Andreas Cuneus of Leyden in 1746.

Four people independently proposed the law of the conservation of energy in the 1840s. The theory of evolution through natural selection was proposed independently by Charles Darwin and Alfred Russel Wallace (an

extraordinary, unsung polymath) in the mid-nineteenth century.[11] S. Korschinsky in 1889 and Hugo de Vries in 1901 independently established the significance of genetic mutation.

Even Einstein's pioneering work has echoes in the work of his contemporaries. The French mathematician Henri Poincaré wrote about the "Principle of Relativity" in 1904, a year before Einstein published his landmark paper on the Special Theory.

In the 1920s William Ogburn and Dorothy Thomas, two academics from Columbia University, found as many as 148 examples of independent innovation. Multiples are the norm; not the exception. They entitled their paper "Are Inventions Inevitable?"*

The reason harks back to the "responsive" nature of creativity. The failures of Newton's Laws created a specific problem. It invited particular solutions. It wasn't just Einstein and Poincaré, but also Hendrik Lorentz and David Hilbert who were working on a possible remedy.[12] Indeed, the so-called relativity priority dispute is about who invented what, when.[13]

And that is why the seductive idea that if Einstein had been born three hundred years earlier, we could have had the benefit of the theory of relativity in the seventeenth century is so flawed. Relativity *couldn't* have happened back then, largely because the problems that it responded to were not yet visible.

Einstein may have seen further and deeper than his contemporaries (there is still a large role for individualism: Einstein really was a creative genius), but he wasn't pulling insights out of the ether. As Johnson writes: "Good ideas are not conjured out of thin air."

Dyson is well aware of this aspect of creativity. "Every time I have gone for a patent in a particular field, someone else has got there first," he says. "I don't think there has been a single time in all the thousands of patents we have applied for where we were the first. With the vacuum cyclone, there were already a number of patents lodged."

But this raises a rather obvious question. Why didn't the person who came up with the original idea for a vacuum cyclone go on to make a fortune (the first cyclone vacuum-cleaner patent was lodged as early as 1928[14])? Why did Dyson, rather than his predecessors, change the world of domestic cleaning?

We noted earlier that we tend to overlook what happens *before* the moment of epiphany. But, if anything, we are even more neglectful of what happens afterward. This is a serious oversight because it obscures the reason why some people change the world while others are footnotes in the patent catalog.

The eureka moment is not the endpoint of innovation, it is the start of perhaps the most fascinating stage of all.

III

Dyson strode into his workshop. He had come up with his big idea: a bagless vacuum cleaner where dust is removed from the air by the geometry of the airflow rather than a filter. But he was pretty much alone. The directors at his company didn't back his idea (the response he received was: "If that is such a good concept, how come Hoover and Electrolux aren't doing it already?"), so he started his own business along with a silent partner, who had provided half the capital.

Dyson's workshop was a tiny former coach house. It had no windows and no heating. At the beginning he had no tools and precious little money. He also had huge debts, having remortgaged his house in order to start the business. But the then thirty-three-year-old (who also had three young children—and a very understanding wife) was nothing if not determined.

His first prototype, as we have seen, was the cardboard-and-gaffer-tape cyclone that he made after returning from the lumberyard. It seemed to work well. But although no dust was visible to the naked eye coming out of the top of the makeshift cyclone, he had to check whether he was getting rid of *all* the dust.

This was one of his first post-epiphany tasks. He bought some black cloth and obtained a quantity of fine white dust. Then he placed the cloth above his makeshift cyclone, vacuumed the dust, and noticed that some of it was, indeed, getting through. He could see white residue on the cloth.

So he altered the dimensions of the cyclone to see if it would improve the efficiency. He tried new sizes, new shapes. Each time he would note how a small change in one dimension would impact the overall engineering

solution. The key challenge was to balance airflow with separation efficiency.

With each iteration he was learning new things. He was seeing what worked. Most of the time he was failing. “A cyclone has a number of variables: size of entry, exit, angle, diameter, length: and the trying thing is that if you change one dimension, it affects all the others.”

His discipline was astonishing. “I couldn’t afford a computer, so I would hand-write the results into a book,” he recalls. “In the first year alone, I conducted literally hundreds of experiments. It was a very, very thick book.”

But as the intensive, iterative process gradually solved the problem of separating ultra-fine dust, Dyson came up against another problem: long pieces of hair and fluff. These were not being separated from the airflow by the cyclone dynamics. “They were just coming out of the top along with the air,” he says. “It was another huge problem and it didn’t seem as if a conventional cyclone could solve it.”

The sheer scale of the problem set the stage for a second eureka moment: the dual cyclone. “The first cyclone gets rid of the awkward strands of cotton or hair, before the air is pushed into the second cyclone, which gets rid of the finer dust,” he went on. “You need both to make the device work properly.”

In all, it took an astonishing 5,127 prototypes before Dyson believed the technology was ready to go in the vacuum cleaner. The creative leap may have been a crucial and precious thing, but it was only the start of the creative process. The real hard yards were done patiently evolving the design via bottom-up iteration. To put it another way, with the epiphany he had vaulted onto a taller mountain in a new landscape; now he was systematically working toward this new summit.

According to Dyson:

> When you file a patent, somebody is almost always there before you. A lot of your argument with the patent examiner is to say: “Look, they may have had the eureka moment when they came back from the timber yard. They may even have created an early prototype.” But none of my forebears had made their prototypes

work. Mine is statistically different. That was my decisive advantage.

Creativity, then, has a dual aspect. Insight often requires taking a step back and seeing the big picture. It is about drawing together disparate ideas. It is the art of *connection*. But to make a creative insight work requires disciplined focus. As Dyson puts it: “If insight is about the big picture, development is about the small picture. The trick is to sustain both perspectives at the same time.”

And this turns out to be the very cornerstone of understanding how creative success happens in the world today, as alluded to at the end of the last chapter. It is often said that in a rapidly changing world innovative companies will dominate. But this is, at best, only partly true. In their book *Great by Choice*, Jim Collins and Morten Hansen show that innovation may indeed be a *necessary* condition for success, but it is by no means sufficient.[15]

Genentech, the U.S.-based biotechnology corporation, for example, outpaced Amgen, a major competitor, by more than two times in patent productivity between 1983 and 2002 (they also outpaced Amgen in terms of the impact of their patents as measured by the number of citations) but Amgen’s financial performance outperformed that of Genentech by more than thirty to one.

This finding is by no means unusual. In their book *Will and Vision*, Gerard J. Tellis and Peter N. Golder looked at the relationship between long-term market leadership and pioneering innovation in sixty-six different commercial sectors. They found that only 9 percent of the pioneers ended up as the final winners. They also found that 64 percent of pioneers failed outright.[16]

Jim Collins writes: “Gillette didn’t pioneer the safety razor, Star did. Polaroid didn’t pioneer the instant camera, Dubroni did. Microsoft didn’t pioneer the personal computer spreadsheet, VisiCorp did. Amazon didn’t pioneer online bookselling and AOL didn’t pioneer online Internet service.”[17]

What was the key ingredient that characterized the winners, the companies that may not have come up with an idea first, but who made it

work? The answer can be conveyed in one word: *discipline*. This is not just the discipline to iterate a creative idea into a rigorous solution; it is also the discipline to get the manufacturing process perfect, the supply lines faultless, and delivery seamless.*

Dyson was not the first to come up with the idea of a cyclone vacuum cleaner. He was not even the second, or the third. But he was the only one with the stamina to "fail" his concept into a workable solution. And he had the rigor to create an efficient manufacturing process, so he could sell a consistent product.

His competitors confronted the same problem and had the same insight. But they didn't have the same resilience to make their idea work, let alone take it on to a working production line.

Collins takes the battle between Intel and Advanced Memory Systems as symbolic of this crucial distinction. Intel was months behind its fierce competitor in the race for the 1,000-bit memory chip. In the rush to introduce the 1103 chip, it hit major problems, including one that could actually erase data from the chip. It was so far behind the game that the outcome seemed like a foregone conclusion.

And yet Intel destroyed Advanced Memory Systems in the marketplace. They worked around the clock, creating new prototypes, iterating the chip into a workable solution. But they also insured that they nailed all the surrounding supply issues crucial for success. As Collins puts it: "Intel obsessed over manufacturing, delivery and scale."

By 1973, everyone was using Intel. Its slogan is not "Intel Creates," it is "Intel Delivers."

Dyson says:

> It is no good creating the most beautiful products if you produce them shoddily. It is no good having the most innovative engineering solution if the consumers can't be certain it will be delivered on time. It is no good if inconsistent production means that a great idea is not translated into a polished product. The original idea is only 2 percent of the journey. You mustn't neglect the rest.

Collins writes:

> We concluded that each environment has a level of "threshold innovation" that you need to meet to be a contender in the game . . . Companies that fail even to meet the innovation threshold cannot win. But—and this surprised us—once you're above the threshold, especially in a highly turbulent environment, being more innovative doesn't seem to matter very much.[18]

Winners require innovation *and* discipline, the imagination to see the big picture and the focus to perceive the very small. "The great task, rarely achieved, is to blend creative intensity with relentless discipline so as to amplify the creativity rather than destroy it," Collins writes. "When you marry operating excellence with innovation, you multiply the value of your creativity."[19]

IV

Let us conclude our study of creativity by looking at Pixar, an animation company that draws together many of these strands. As an institution it has almost no peers in its reputation for innovation. When Ed Catmull, the company's long-serving president, wrote his autobiography he entitled it *Creativity Inc*.

Pixar blockbusters include *Toy Story*, *Monsters, Inc.*, and *Finding Nemo*. The films have generated an average worldwide gross of over $600 million. They have been critical successes, too, winning Oscars in multiple categories. *Toy Story* and *Toy Story 2* both received 100 percent scores on Rotten Tomatoes.

Naturally Pixar has a lot of clever, creative people working in its offices. Lead authors come up with terrific story lines for the latest film. They are presented to the wider group at large meetings. They are often applauded afterward. A good storyline is an act of creative synthesis: bringing disparate narrative strands together in novel form. It is a crucial part of the Pixar process.

But now consider what happens next. The story line is pulled apart. As the animation gets into operation, each frame, each strand of the story, each scene is subject to debate, dissent, and testing. All told, it takes around twelve thousand storyboard drawings to make one ninety-minute feature, and because of the iterative process, story teams often create more than 125,000 storyboards by the time the film is actually delivered.

Monsters, Inc. is a perfect illustration of a creative idea adapted in the light of criticism. It started off with a plot centered on a middle-aged accountant who hates his job and who is given a sketchbook by his mother. As a child he had drawn some monsters in the sketchbook and that night they turn up in his bedroom, but only the accountant can see them. These monsters become the fears he had never confronted, and over time he learns to understand them, and thus overcome them.

The final version, which would wow the world (and take $560 million at the box office), is rather different. It tells the story of Sulley, a rather unkempt monster, and his unlikely friendship with a little girl nicknamed Boo. Over the period of the film's development it was altered in the light of criticism and the testing of ideas. Even after the main protagonist had changed to a little girl rather than a middle-aged accountant, the plot continued to evolve. Catmull has written:

> The human protagonist was a six-year-old named Mary. Then she was seven, named Boo, and bossy—even domineering. Finally Boo was turned into a fearless, preverbal toddler. The idea of Sulley's buddy character—the round, one-eyed Mike, voiced by Billy Crystal—wasn't added until more than a year after the first treatment was written. The process of determining the rules of the incredibly intricate world Pete [the director of the film] created also took him down countless blind alleys—until eventually those blind alleys converged on a path that led the story where it needed to go.[20]

Toy Story 2 is another archetype of the Pixar creative process. Just a year out from its theatrical release, the narrative was not right. The story is about whether Woody, a toy cowboy, will leave the pampered life he enjoys

on the shelf of a collector to go back to Andy, whom he loves. The problem is that this is a Disney movie, and so the audience knows at the outset that it will have a happy ending: Woody will reunite with Andy.

"What the film needed were reasons to believe that Woody was facing a real dilemma, and one that viewers could relate to. What it needed, in other words, was drama," Catmull writes in his memoir. With the clock ticking, the process of iteration took on an urgent feel. People were working overtime, late into the night, testing ideas.

One artist turned up at work with his small child, intending to take him to day care, but forgot. After he had been at work a couple of hours, his wife phoned to ask how the drop-off had gone. Suddenly he realized that he'd left the child in the boiling-hot parking lot. They rushed out and poured cold water on the unconscious child. Thankfully he was OK, but the episode revealed how stretched the staff had become.

Hundreds of small changes were made to the film. Dozens of larger changes were made too. There was also one major alteration to the plot: the story had always started with Woody suffering a rip in his arm that meant Andy left him behind when going to cowboy camp. At this point there was a decision to add a new character.

"[We] added a character named Wheezy the penguin, who tells Woody that he has been on that same shelf for months because of a broken squeaker," Catmull says. "Wheezy introduces the idea early on that no matter how cherished, when a toy gets damaged, it is likely to be shelved, tossed aside—maybe for good. Wheezy, then, establishes the emotional stakes of the story."

The plot now had real tension. Will Woody stay with someone he loves, knowing he will eventually be discarded, or choose a world where he can be pampered forever? It is a theme with high crossover and moral seriousness. Ultimately, Woody chooses Andy but in the foreknowledge that the decision will lead to future unhappiness. "I can't stop Andy from growing up," he says to Stinky Pete. "But I wouldn't miss it for the world."

Catmull says:

> Early on, all of our movies suck. That's a blunt assessment, I know, but I . . . choose that phrasing because saying it in a softer way fails

> to convey how bad the first versions of our films really are. I'm not trying to be modest or self-effacing by saying this. Pixar films are not good at first, and our job is to make them go . . . from suck to non-suck . . .
>
> We are true believers in the power of bracing, candid feedback and the iterative process—reworking, reworking and reworking again, until a flawed story finds its throughline or a hollow character finds its soul.

Does this sound familiar? It is an almost perfect description of the dissent guidelines in the Nemeth experiment.

It is sometimes said that testing may be important for engineers and hard items like vacuum cleaners, nozzles, and curtain rods, but it doesn't apply to soft, intangible problems like writing novels or scripts for children's animations. In fact, iteration is vital for both. It is not an optional extra; it is an indispensable aspect of the creative process.

Consider what happened when Pixar considered abandoning its iron discipline; when they tried to go from epiphany to final product in one large, mystical leap. "This then became our goal—finalize the script *before* we start making the film," Catmull writes about *Finding Nemo*. "We were confident that locking in the story early would yield not just a phenomenal movie but a cost-efficient production."

It didn't work. The initial idea by Andrew Stanton, one of Pixar's most respected directors, was about an overprotective clownfish called Marlin, looking for his son. His pitch to the team was superb. "The narrative, as he described it, would be intercut with a series of flashbacks that explained what had happened to make Nemo's father such an overprotective worrywart when it came to his son," Catmull writes. "He seamlessly wove together two stories: what was happening in Marlin's world, during the epic search after Nemo is scooped up by a scuba diver, and what was happening in the aquarium in Sydney, where Nemo had ended up with a group of tropical fish called 'the Tank Gang.'"

The response in the room was one of stunned admiration. But once the creative blueprint was put into production, flaws began to emerge. The flashbacks proved confusing to test audiences. Marlin seemed unlikable

because it took so long to see why he had been so overprotective. When Michael Eisner of Disney saw the rough cut he was not impressed. “Yesterday we saw for the second time the next Pixar movie *Finding Nemo*. It’s OK, but nowhere near as good as their previous films.”

At this point Pixar reverted to disciplined iteration. First they adapted the narrative to a more chronological approach—and it began to align. The tale of the Tank Gang became a subplot. Other changes, smaller, but cumulatively significant, began to emerge. By the end, the film had gone from suck to non-suck. Catmull writes:

> Despite our hopes that *Finding Nemo* would be the film that changed the way we did business, we ended up making as many adjustments during production as we had on any other film we had made. The result, of course, was a movie we’re incredibly proud of, one that went on to become the highest grossing animated film ever.
>
> The only thing it didn’t do was transform our production process.[21]

V

Dyson, Catmull, and the other innovators we have encountered offer a powerful rebuke to the way we conventionally think about creativity. To spark the imagination and take our insights to their fullest expression, we should not insulate ourselves from failure; rather, we should engage with it.

This perspective does not only have large implications for innovation, it also has direct implications for the way we teach. Today education is conceived as providing young people with a body of knowledge. Students are rewarded when they apply this knowledge correctly. Failures are punished.

But this is surely only one part of how we learn. We learn not just by being correct, but also by being wrong. It is when we fail that we learn new

things, push the boundaries, and become more creative. Nobody had a new insight by regurgitating information, however sophisticated.

Dyson says:

> We live in a world of experts. There is nothing particularly wrong with that. The expertise we have developed is crucial for all of us. But when we are trying to solve new problems, in business or technology, we need to reach beyond our current expertise. We do not want to know how to *apply* the rules; we want to *break* the rules. We do that by failing—and learning.

Dyson advocates that we provide children with the tools they need not just to answer questions, but to ask questions. “The problem with academia is that it is about being good at remembering things like chemical formulae and theories, because that is what you have to regurgitate. But children are not allowed to learn through experimenting and experience. This is a great pity. You need both.”

One of the most powerful aspects of the Dyson story is that it evokes a point that was made in chapter 7; namely, that technological change is often driven by the synergy between practical and theoretical knowledge. One of the first things Dyson did when he had the insight for a cyclone cleaner was to buy two books on the mathematical theory of how cyclones work. He also went to visit the author of one of those books, an academic named R. G. Dorman.[22]

This was hugely helpful to Dyson. It allowed him to understand cyclone dynamics more fully. It played a role in directing his research and gave him a powerful background on the mathematics of separation efficiency. But it was by no means sufficient. The theory was too abstract to lead him directly to the precise dimensions that would deliver a functional vacuum cleaner.

Moreover, as Dyson iterated his device, he discovered that the theory had flaws. Dorman’s equation predicted that cyclones would only be able to remove fine dust down to a lower limit of 20 microns. But Dyson quickly broke through this theoretical limit. By the end, his cyclone could separate dust smaller than 0.3 micron (this is approximately the size of the particles

in cigarette smoke). Dyson's practical engagement with the problem had forced a change in the theory.

And this is invariably how progress happens. It is an interplay between the practical and the theoretical, between top-down and bottom-up, between creativity and discipline, between the small picture and the big picture. The crucial point—and the one that is most dramatically overlooked in our culture—is that in all these things, failure is a blessing, not a curse. It is the jolt that inspires creativity and the selection test that drives evolution.

Failure has many dimensions, many subtle meanings, but unless we see it in a new light, as a friend rather than a foe, it will remain woefully underexploited. Andrew Stanton, director of *Finding Nemo* and *WALL-E*, has said:

> My strategy has always been: be wrong as fast as we can . . . which basically means, we're gonna screw up, let's just admit that. Let's not be afraid of that. But let's do it as fast as we can so we can get to the answer. You can't get to adulthood before you go through puberty. I won't get it right the first time, but I will get it wrong really soon, really quickly.

As our conversation draws to a close, I wonder why Dyson still comes into his office every day, rather than enjoying his wealth. "A lot of people ask me that. They seem to assume that I spend my life with my feet up," he says, smiling.

> But the answer is simple: I love the creative process. I love coming in here every day and testing new ideas. We have plans for many new products in the coming years.
>
> But we are also still developing the vacuum cleaner. We didn't stop at the 5,127th prototype, you know. Today, we have forty-eight cyclone technology, which spins the dust at 200,000 Gs. It exerts a huge centrifugal force, which is why it can separate the tiniest particles. But even this isn't the end. What excites me most is that we are still only at the beginning.

Chapter 14

Redefining Failure

I

We have arrived at a conclusion that was hinted at in the opening pages: if we wish to fulfill our potential as individuals and organizations, we must redefine failure. In many ways, that has been the purpose of this book. We have taken a journey through the rich and diverse literature on failure in an attempt to offer a new perspective on what it means, and how it should be handled.

At the level of the brain, the individual, the organization and the system, failure is a means—sometimes the only means—of learning, progressing, and becoming more creative. This is a hallmark of science, where errors point to how theories can be reformed; of sports, where practice could be defined as the willingness to clock up well-calibrated mistakes; and of aviation, where every accident is harnessed as a means of driving system safety.

Errors have many different meanings, and call for different types of response depending on context, but in all of their guises they represent invaluable aids with the potential to help us learn.

Can so much turn on the basis of a reinterpretation of error? Can a new approach to success emerge by flipping the way we think about failure? The evidence for such a claim is contained in every example we have looked at: the contrast between science and pseudoscience, between health care and aviation, between centrally planned and well-regulated market systems. It is revealed, too, in the differences that emerge from the Fixed and Growth Mindsets.

When we see failure in a new light, success becomes a new and exhilarating concept. Competence is no longer a static phenomenon,

something reserved for great people and organizations on the basis of fixed superiority. Rather, it is seen as dynamic in nature: something that grows as we strive to push back the frontiers of our knowledge. We are motivated not to boast about what we currently know, and to get defensive when people point to gaps in our knowledge.

Rather, we look in wonder at the infinite space beyond the boundaries of what we currently understand, and dare to step into that unbounded terrain, discovering new problems as we find new solutions, as great scientists do. As the philosopher Karl Popper put it: “It is part of the greatness and beauty of science that we can learn through our own critical investigations that the world is utterly different from what we ever imagined—until our imagination was fired by the refutation of our earlier theories.”[1]

Many progressive institutions have attempted to inspire precisely this kind of redefinition of failure. James Dyson spends much of his life working to reform educational culture. He wants students to be equipped with a new way of thinking about the world. He rails against the prevailing conception of education that overemphasizes perfection on exams while penalizing students for their mistakes. He worries that this leads to intellectual stagnation. The Dyson Foundation works, above all, to destigmatize failure. He wants youngsters to experiment, to try new things, to take risks.

Innovative school principals are engaged in precisely the same terrain. Heather Hanbury, the former headmistress of Wimbledon High School in southwest London, for example, created an annual event for her students called “failure week.” She was aware that her students were performing well in exams, but she also realized that many were struggling with nonacademic challenges, and not reaching their creative potential, particularly outside the classroom.

For one week she created workshops and assemblies where failure was celebrated. She asked parents and tutors and other role models to talk about how they had failed, and what they had learned. She showed YouTube clips of famous people practicing: i.e., learning from their own mistakes. She told students about the journeys taken by the likes of David Beckham and James

Dyson so they could have a more authentic understanding of how success really happens.

Hanbury has said:

> You're not born with fear of failure, it's not an instinct, it's something that grows and develops in you as you get older. Very young children have no fear of failure at all. They have great fun trying new things and learning very fast. Our focus here is on failing well, on being good at failure. What I mean by this is taking the risk and then learning from it if it doesn't work.
>
> There's no point in failing and then dealing with it by pretending it didn't happen, or blaming someone else. That would be a wasted opportunity to learn more about yourself and perhaps to identify gaps in your skills, experiences or qualifications. Once you've identified the learning you can then take action to make a difference.[2]

Other organizations have undertaken similar projects of redefinition. W. Leigh Thompson, the chief scientific officer at pharmaceutical giant Eli Lilly, initiated "failure parties" in the 1990s to celebrate excellent scientific work that nevertheless resulted in failure. It was about destigmatizing failure and liberating staff from the twin dangers of blame and cognitive dissonance.

But can these kinds of interventions have real effects? Do they really change behavior and boost performance and adaptation?

Consider an experiment involving a group of schoolchildren who had shown difficulty in dealing with failure. In that respect they were like many of us. Half of these students were then given a course where they experienced consistent success. The questions posed during these sessions were easy and the students were delighted to ace them. They began to develop intellectual self-confidence, as you would expect.

The second group were not given successes, but training in how to reinterpret their failures. They were sometimes given problems that they couldn't solve, but they were also taught to think that they could improve if they expended effort. The failures were positioned not as indications of

their lack of intelligence, but as opportunities to improve their reasoning and understanding.

At the end of these training courses, the two groups were tested on a difficult problem. Those who had experienced consistent success were as demoralized by failing to solve this problem as they had been before the training. They were so sensitive to failure that their performance declined and it took many days for them to recover. Some were even more afraid of challenges and didn't want to take risks.

The group that had been taught to reinterpret failure were quite different. They significantly improved in their ability to deal with the challenging task. Many actually demonstrated superior performance after failure and when they went back to class began asking their teachers for more challenging work. Far from ducking out of situations where they might fail, they embraced them.

This hints at one of the great paradoxes about school and life. Often it is those who are the most successful who are also the most vulnerable. They have won so many plaudits, been praised so lavishly for their flawless performances, that they haven't learned to deal with the setbacks that confront us all. This has been found to be particularly true of young girls. Female students who go through primary school getting consistently high grades, and who appear to their teachers as highly capable, are often the most devastated by failure.[3]

In one famous experiment a group of schoolgirls were measured for their IQ and then given a task that began with a really challenging section. You might have expected the girls with the higher IQs to perform better on the test. In fact, the results were the other way around. The high-IQ girls, who had always succeeded in life, were so flustered by the initial struggle that they became "helpless." They hardly bothered with the later problems on the test. The relationship between IQ and outcome was actually *negative*.[4]

And this is why "failure week" at Wimbledon High School was such an enlightened idea. Heather Hanbury was trying to give her high-achieving students a lesson that would help them not merely at school or university but in later life. She was taking them outside their comfort zone and helping them to develop the psychological tools that are so vital in the real world.

“Our pupils are hugely successful in their exams, but they can overreact when things go wrong,” she said. “We want them to be courageous. It sounds paradoxical, but we dare them to fail.”

II

Let us move beyond the classroom and consider some of the differences in attitudes to failure that exist in the real world. Specifically, let us take the issue of entrepreneurship, something that is widely regarded as crucial to success in the global economy.

In the United States the culture is one where entrepreneurs take risks and rarely give up if their first venture fails. Henry Ford, the car entrepreneur, is a case in point. His first enterprise, the Detroit Automobile Company, collapsed, as did his involvement with the second, the Henry Ford Company. But these failures taught him vital lessons about pricing and quality. The Ford Motor Company, his third venture, changed the world. “Failure is simply the opportunity to begin again, this time more intelligently,” he said.

In Japan, on the other hand, the culture is very different. For complex reasons of social and economic history,[5] failure is more stigmatizing. The basic attitude is that if you mess up you have brought shame on yourself and your family. Failure is regarded not as an opportunity to learn, but as a demonstration that you do not have what it takes. These are classic Fixed Mindset attitudes. Blame for business failure is common and, often, intense.

Now take a look at the data on entrepreneurship. According to the World Bank, Japan has the lowest annual entry rate for new enterprises among the OECD nations. As of 2013 it had slumped to only a third of that in the United States. On the OECD Science, Technology and Industry Scoreboard in 2008, Japan had the lowest quantity of venture capital invested: American investment was twenty times higher as a percentage of GDP.

Other studies reveal similar findings. According to the Global Entrepreneurship Monitor only 1.9 percent of adults between the ages of eighteen and sixty-four are working actively to establish new businesses in

Japan. In the United States, the figure is more than 250 percent higher. According to the Kauffman Foundation, nearly one in every eight American adults (11.9 percent) is currently engaged in “entrepreneurial activity.” This is near the top of the developed world.

It goes without saying that these differences have real effects, not only on entrepreneurs, but on the wider economy. As a paper for the Wharton Business School put it: “In Japan, the relative dearth of opportunity-driven entrepreneurship has contributed to the nation’s economic malaise over the past two decades.” As for America, entrepreneurs are considered a cornerstone of the nation’s success: “Empirical research has shown that ‘opportunity-driven’ entrepreneurship is the wellspring of growth in the modern market economy.”[6]

But can these differences in the hard data really hinge on something as soft and intangible as differing conceptions of failure? In 2009, the Global Entrepreneurship Monitor carried out a major survey to find out. They looked at attitudes toward entrepreneurship in twenty innovation-based advanced economies. The results were emphatic. Japanese citizens demonstrated the highest fear of failure. Americans, meanwhile, displayed one of the lowest levels.[7]

Five years later the same attitudes prevailed. In a survey of seventy different countries, at different stages of development, and facing different challenges, Japan had the highest fear of failure of all of them with the exception of Greece, which was going through the trauma of an externally imposed fiscal consolidation. The United States remained among the lowest.[8] In a 2013 survey Japan was rated the lowest in the world in terms of believing that the skills associated with entrepreneurship can be improved over time.

Fear of failure is not an inherently bad thing. It is smart to consider the risks and to exercise caution if they are deemed severe. Fear can also spark great creative energy, a point that the entrepreneur Richard Branson has made.[9] The problem arises, though, when opportunities exist and it remains psychologically impossible to even engage with them. The problem is when setbacks lead not to learning, but to recrimination and defeatism.

This isn’t just about entrepreneurship; it is about life. Let us take a different example that reveals the same underlying truth, but in the opposite

direction. In mathematics, China and Japan rank among the best in the world. In the Programme for International Student Assessment (PISA) league table, which measures attainment among fifteen-year-olds, China rates first and Japan seventh in math. The United Kingdom and the United States lag well behind, in twenty-sixth and thirty-sixth positions, respectively.[10]

Now, consider the differing attitudes toward mathematics between these nations. In the UK and the United States, math is widely considered to be something you either can or can't do. When children struggle they assume they are not cut out for it. At schools up and down these nations, you hear youngsters say things like: "I just don't have a brain for numbers." As the Stanford academic Jo Boaler put it: "The idea that only some people can do math is deep in the American and British psyche. Math is special in this way, and people have ideas about math that they don't have about any other subject."[11]

In China and Japan the attitude is radically different. Math is thought of as a bit like a language: as you persevere you become more articulate. Mistakes are held up not as evidence of a fixed inferiority, or as showing that you have "the wrong kind of brain," but as evidence of learning. Some individuals are better than others at math, but there is a presumption that everyone has the capacity to master basic mathematical concepts with perseverance and application.

Boaler talks of a visit to Shanghai, the area of China and the world that scores highest in math. "The teacher gave the students . . . problems to work on and then called on students for their answers. As the students happily shared their work the interpreter leaned across to me and told me that the teacher was choosing students who had made mistakes. The students were proud to share their mistakes as mistakes were valued by the teacher."[12]

Again and again, differences in mindset explain why some individuals and organizations grow faster than others. Evolution, as we noted in chapter 7, is driven by failure. But if we give up when we fail, or if we edit out our mistakes, we halt our progress no matter how smart we are. It is the Growth Mindset fused with an enlightened evolutionary system that helps to unlock our potential; it is the framework that drives personal and organizational adaptation.

III

For one final insight into how our misguided attitudes can undermine progress, let us take one of the most astonishing behaviors of all: self-handicapping. This has been studied in businesses, in schools, and in family life. It reveals just how far people are prepared to go to protect their ego at the expense of their own long-term success.

I first saw self-handicapping in action during my final year at Oxford University. We were about to take our final exams and we had all prepared well for the big day. Most of us were apprehensive, but also relieved that the waiting was finally over. And the majority of us spent the previous twenty-four hours going through our revision notes for a final time.

But one group of students did something very different. They sat outside in the garden area frolicking and drinking cocktails, didn't take a single look at their notes, and made sure that everyone knew that they were going to a nightclub later that evening. They all looked pretty relaxed, joking about the coming exams.

To me, it didn't make sense. Why jeopardize three years of work for the sake of a night on the town? What could they possibly hope to gain by arriving at the first exam, one of the most important days of their lives, with a hangover? The most surprising thing of all was that many were among the brightest students, who had worked diligently for the preceding three years.

It was only years later, when reading about cognitive dissonance and the Fixed Mindset, that the pieces fell into place: they were so terrified of underperforming, so worried that the exam might reveal that they were not very clever, that they needed an alternative explanation for possible failure. They effectively sabotaged their own chances in order to gain one.

Excuses in life are typically created retrospectively. We have all pointed to a bad night's sleep, or a cold, or the dog being sick, to justify a poor performance. But these excuses are so obvious and self-serving that people see through them. We see through our own excuses too. They don't reduce dissonance because they are too blatant.

But self-handicapping is more sophisticated. This is where the excuse is not cobbled together after the event, but actively engineered beforehand. It is, in effect, a preemptive dissonance-reducing strategy. If these students

flunked their crucial exam, they could say: “It wasn’t me who messed up, it was the booze!” It served another purpose, too: if they *did* pass the exam, they could still point to alcohol in mitigation for why they didn’t get an even higher grade.

The phenomenon of self-handicapping seems, on the surface, perplexing: young athletes who stop training hard in the crucial few weeks before a big event; executives who breeze into a vital sales pitch without reading the relevant material; brilliant university students who suddenly decide to get drunk before a crucial exam.

But viewed through the prism of the Fixed Mindset it makes perfect sense. It is precisely because the project really matters that failure is so threatening—and why they desperately need an alternative explanation for messing up. As one psychologist put it: “One can admit to a minor flaw [drinking] in order to avoid admitting to a much more threatening one [I am not as bright as I like to think].”[13]

In a seminal 1978 study into self-handicapping by psychologists Steven Berglas and Edward Jones, students were given an exam.[14] Before taking the exam students were asked whether they would like to take a drug that would inhibit their performance. This wasn’t really a choice at all. After all, why would anyone wish to actively undermine their chances of success? But, as it turned out, a large proportion chose to take it.

To some observers it seemed crazy, but to Dr. Berglas it made perfect sense. He had himself experimented with drugs for the first time just before he took the crucial SAT examinations in high school. He was expected to get a perfect score. His self-image was bound up in the performance. The drug-taking gave him the perfect cover story if things went wrong.[15]

Some psychologists have argued that self-handicapping can have short-term benefits. If you can pin a particular failure on, say, drinking too much, it cushions your self-esteem in the event of a poor result. But this misses the real lesson in all of this. What is the point of preserving self-esteem that is so brittle that it can’t cope with failure?

Think back to the surgeons earlier in the book. They had healthy egos. They had enjoyed expensive educations and owned impressive certificates. They were widely revered by colleagues and patients. But this is precisely

why the culture was so dangerous. Surgeons are often so keen to protect their self-esteem that they can't admit their fallibility.

Self-esteem, in short, is a vastly overvalued psychological trait. It can cause us to jeopardize learning if we think it might risk us looking anything less than perfect. What we really need is resilience: the capacity to face up to failure, and to learn from it. Ultimately, that is what growth is all about.

• • •

On the afternoon of June 30, 1998, David Beckham's life changed forever. He was twenty-three years old and playing for England in his first World Cup in Saint-Étienne in central France. It was a crucial knockout match against Argentina for a place in the quarter-finals.

The score was even at 2–2. More than 20 million of his countrymen were tuning in on television back home and tens of thousands more were watching in the stadium. For Beckham it was a dream to be out on the field of play representing his country.

Two minutes into the second half, Beckham was in the middle of the pitch when he was hit hard from behind by Diego Simeone, an Argentinian player. He felt a knee go into his back and he was knocked flat. As Simeone got up, he tugged Beckham's hair, and then patted him on the head.

Beckham reacted immediately, flicking his leg toward his opponent. His foot traveled less than two feet, and made minimal contact with Simeone, but the Argentinian went down, clutching his thigh. Beckham instantly knew he had made a terrible mistake, and prepared for the worst. His stomach turned to ice as the referee raised a red card into the air.

England would go on to lose the match on penalties. Beckham, who had been sent off and spent the rest of the game in the dressing room, knew that he would be in the line of fire from the British press. But nothing prepared him for the storm that was about to engulf him and his family.

When the team arrived back at Heathrow Airport the next day, the twenty-three-year old was pursued relentlessly by cameras and journalists. He received bullets in the mail, his effigy was burned from a lamppost, and one national newspaper turned his face into a dartboard.

The first match of the following season, he had to be escorted into the ground under police guard. Every time he touched the ball for Manchester

United, opposing fans erupted in booing. He had made a small mistake in reacting to a poor challenge from an opponent at the World Cup, but he was treated almost like a criminal. Many commentators doubted he would last the season. As one journalist put it: “You have to fear for Beckham’s career. Nobody can expect him to come back from something like this.”

As it turned out, Beckham had the finest season of his career. Manchester United won the Treble (the Premier League, the FA Cup and the Champions League), the first, and so far only, English club to achieve that feat. Beckham played in almost every game. At the end of the season he was voted second in the FIFA World Player of the Year awards behind Rivaldo of Brazil and Barcelona, and ahead of Batistuta, Zidane, Vieri, Figo, Shevchenko, and Raúl.

His contributions were remarkable. He made sixteen assists in the league and seven in the Champions League. He scored vital goals, not least the opening strike in the historic FA Cup semifinal reply against Arsenal and an equalizer in the final game of the Premier League season against Spurs. He also took both corners when United scored twice during extra time to clinch the Champions League title from under the noses of Bayern Munich. It was a superb set of performances.

But let us rewind to the very first game of that season, against Leicester. United were trailing 2–1 when they were awarded a free kick, just outside the area. It was a huge moment given what had happened just a few weeks earlier at Saint-Étienne. Beckham had been booed throughout the game by opposing fans. He would later say that his stomach tightened as he strode over to place the ball. But as he walked back to take the shot, he felt everything change. He said:

> It was only as I stepped up to take the free kick that I felt my willpower hardening. It would have been easy to be negative, to worry about the consequences, but I just felt that little bit of steel inside. Partly, it was the extraordinary support I had received [from United fans]. But it was also all the practice over the years: the thousands of free kicks I had taken in rain, sleet and snow. It gave me confidence.

Adversity rarely comes in as public a form as that endured by Beckham in Saint-Étienne. But responding to adversity, coming back from failure, absolutely depends on how we regard the setback. Is it evidence that we lack what it takes? Does it mean we are not up to the job? This is the kind of response offered by those in a Fixed Mindset. They are sapped by impediments, and often lose willpower. They try to avoid feedback, even when they can learn from it.

But when you regard failure as a learning opportunity, when you trust in the power of practice to help you grow through difficulties, your motivation and self-belief are not threatened in anything like the same way. Indeed, you embrace failure as an opportunity to learn, whether about improving a vacuum cleaner, creating a new scientific theory, or developing a promising soccer career.

“It was tough to get sent off, but I learned a valuable lesson,” Beckham told me. “Isn’t that what life is about?”