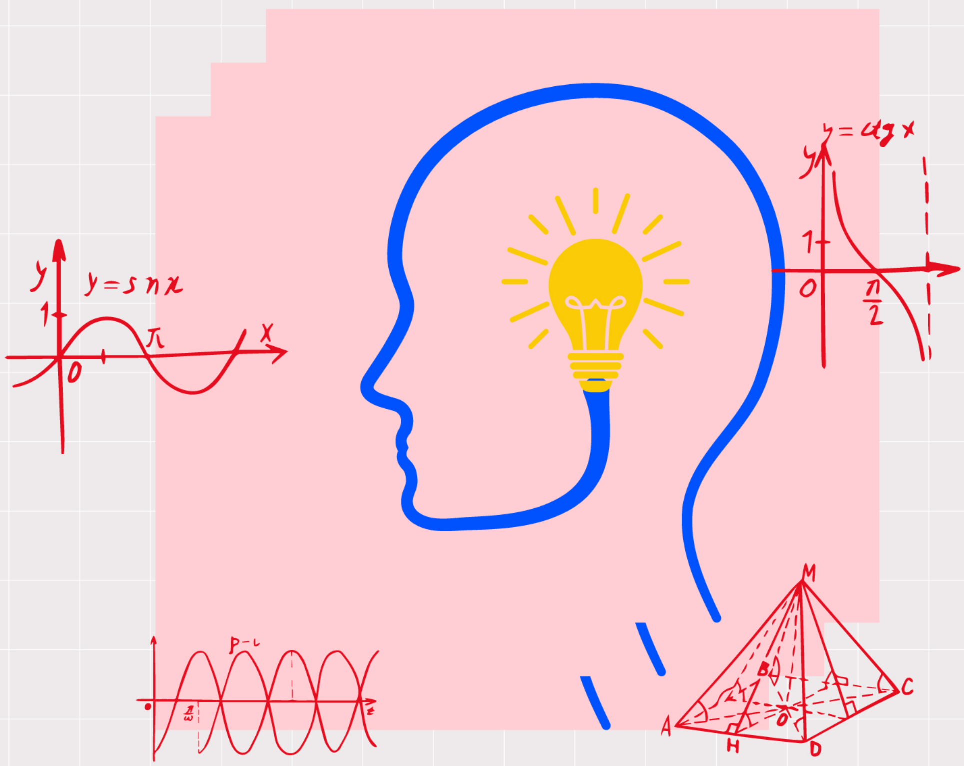
SUMMARY

GENIUS

JAMES GLEICK



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Summary of “Genius” by James Gleick

Written by Alyssa Burnette

Learn about the life and work of America’s underrated genius.

Introduction

When you think of the word "genius," whose name comes to mind? Most people think of Albert Einstein-- and with good reason. There's no doubt about it: Einstein's inventions and discoveries forever changed the future of science. However, as a result of his notoriety, Einstein has eclipsed some other notable scientists, all but erasing them from our memory. And that's why Genius was written. James Gleick writes to connect us with the story of Richard Feynman, a theoretical physicist whose own contributions paved the way for the future of modern science. Over the course of this summary, we'll explore his life and discoveries and what we can learn from them.

The Origin Story of a Great Scientist

Every superhero has an origin story. Spider Man was bitten by a radioactive spider. The tragic loss of his parents inspired Batman to become a great crusader for justice. And Richard Feynman's parents encouraged him to think like a scientist from an early age. Now, of course scientists aren't superheroes, but they do have a pretty super ability to discover new things and help us see the world in a different light. So, just like every superhero, every scientist has an origin story: a moment, a passion, or a mentor that inspired them to fall in love with science. And Richard Feynman's story is no different.

Feynman was born on May 11th, 1918 in New York. His parents had immigrated from Russia and Poland with the hopes of building a better life in America. So, when they had a child, they poured all their hopes and dreams into him, encouraging him to explore, create, and ask questions. They wanted him to grow up believing that he could do anything he set his mind to and that he could be whoever he wanted to be. And fortunately, young Richard internalized their encouragement. He felt free to pursue his passion for mathematics and so he channeled all of his brain power and energy into school.

However, Feynman had an interesting relationship with learning from an early age. Although his IQ was recorded as being only 125 (Einstein's has famously been reported as 160), it was readily apparent that standardized tests did not adequately reflect his intelligence or his accomplishments. That's because Feynman was already an exceptionally fast thinker and his mental processes were too fast and advanced to fit within the confines of standardized testing. For example, if you've ever done a high-school-- or even elementary school!-- math problem, you know that the curriculum is all about documenting your process. It's not enough to simply get the answer or even to get the answer right on the first try.

But Feynman didn’t want to do it that way. Because the answers came so quickly and easily to him, he felt that documenting the process was an extraneous distraction. This was primarily because his parents had taught him to use visualization to transcend the dry, textbook way of processing information. They believed that the language employed in textbooks was often unnecessarily clunky and confusing and that it prevented learners from properly accessing the material. In fact, you’ve probably felt the same way if you’ve ever encountered a math problem that said something like, “If a train is moving at 100 miles an hour, how fast is…?” Although these problems are meant to encourage students to solve an equation and discover the missing variable, they’re often ineffective because they introduce concepts that most children are not familiar with. After all, what kid has genuinely considered the velocity of a train? It’s easy to get confused as you work through such a problem.

And that’s exactly why the Feynmans stressed the importance of visualization. Instead of getting lost in the boring textbook wording, what if you really tried to envision the problem in your mind? What if you could really see the train hurtling down the track? What if you could feel the wind gushing past you? Would that improve your understanding of math and physics? Would you feel like you’re truly able to grasp the concepts? You probably would! The young Feynman found this to be true as well and employing visualization allowed him to develop a thorough and meaningful understanding of mathematics and physics. As a result, he often solved equations in his head at record speeds, leaving his fellow students to marvel at his mental agility. His unique understanding and use of visualization would only continue to grow and flourish throughout his life.

Feynman’s Mental Processes Advanced His Career

As an elementary and high school student, Feynman found the process of visualization extremely useful for winning math competitions hosted by his school’s Algebra League. But when he was older, this process helped him achieve something far more substantial: winning a Nobel Prize for physics. His love affair with physics began in college when he realized that he was far more suited to the study of physics than to the pursuit of mathematics.

Although he excelled at math, he ultimately found that it was too easy for him; he could work through the problems in his head so quickly that they offered him little in the way of mental stimulation. Feynman wanted to pursue a career that would give him the joy and exertion of a mental challenge. But most of all, he wanted to spend his life figuring things out because he adored the mental process of solving complex problems and arriving at a satisfying conclusion. In a heartfelt reminiscence entitled, “My Time with Richard Feynman,” a former student named Stephen Wolfram recounted his amazement at witnessing Feynman’s mental processes in action. Wolfram wrote:

“Some scientists (myself probably included) are driven by the ambition to build grand intellectual edifices. I think Feynman — at least in the years I knew him — was much more driven by the pure pleasure of actually doing the science. He seemed to like best to spend his time figuring things out, and calculating. And he was a great calculator. All around perhaps the best human calculator there’s ever been.

I always found it incredible. He would start with some problem, and fill up pages with calculations. And at the end of it, he would actually get the right answer! But he usually wasn’t satisfied with that. Once he’d gotten the answer, he’d go back and try to figure out why it was obvious. And often he’d come up with one of those classic Feynman straightforward-sounding explanations. And he’d never tell people about all the calculations behind it. Sometimes it was kind of a game for him: having people be flabbergasted by his seemingly instant physical intuition, not knowing that really it was based on some long, hard calculation he'd done. He always had a fantastic formal intuition about the innards of his calculations. Knowing what kind of result some integral should have, whether some special case should matter, and so on. And he was always trying to sharpen his intuition."

It was precisely this intuition and comfort with physics that earned Feynman his Nobel Prize. It also opened a number of doors for him and enabled him to work on some very prestigious collaborations. For example, he received his undergraduate degree from MIT and his doctorate from Princeton in 1942. And he was only twenty-five when he was recruited to work on a top-secret government project known as The Manhattan Project. Because Feynman graduated at the beginning of the second World War, national security was the number-one interest of American scientists at that time. Chief among their interests was the question of how to build a nuclear bomb.

With his quick thinking and his outlandish ingenuity, Feynman brought something unique to the team that made him an invaluable asset in the development of the atomic bomb. But surprisingly, his work on The Manhattan Project was not what earned him his Nobel Prize! In fact, he was ultimately awarded the Nobel Prize in physics for his own highly original theories. This theory is often summarized by the vague and simple statement that Feynman won his prize for "successfully resolving problems related to the theory of quantum electrodynamics." But this language is annoyingly reminiscent of the language Feynman himself hated most. Although highly appropriate for a textbook, it is neither practical nor particularly accessible. And it tells you nothing at all about what he actually did!

Therefore, a more accurate explanation might state that Feynman was awarded the Nobel Prize in physics in 1965 for the invention of the Feynman Diagram. Feynman's colleague, Frank Wilczek, once wrote an entire magazine article in which he attempted to explain the function of the Feynman Diagram. Feynman started from scratch, drawing pictures whose stick-figure lines show links of influence between particles. He began by explaining that "to understand how one electron influences another, using Feynman diagrams, you have to imagine that the electrons, as they move through space and evolve in time, exchange a photon, labeled "virtual quantum" in the diagram. This is the simplest possibility. It is also possible to exchange two or more photons, and Feynman made similar diagrams for that. Those diagrams contribute another piece to the answer, modifying the classical Coulomb force law. By sprouting another squiggle, and letting it extend freely into the future, you represent how an electron radiates a photon. And so, step by step, you can describe complex physical processes, assembled like Tinker Toys from very simple ingredients.

Feynman diagrams look to be pictures of processes that happen in space and time, and in a sense they are, but they should not be interpreted too literally. What they show are not rigid geometric trajectories, but more flexible, "topological" constructions, reflecting quantum uncertainty. In other words, you can be quite sloppy about the shape and configuration of the lines and squiggles, as long as you get the connections right. Feynman found that he could attach a simple mathematical formula to each diagram. The formula expresses the likelihood of the process the diagram depicts. He found that in simple cases he got the same answers that people had obtained much more laboriously using fields when they let froth interact with froth."

As you can see, Wilczek's interpretation uses very vivid and visual language to articulate Feynman's theories. That's because the Feynman diagram cannot be explained without engaging with Feynman's own process of visualization. Therefore, it can be said that the Feynman diagrams attempt to simplify some highly complex processes of quantum physics. Prior to the invention of the Feynman diagrams, physicists had been forced to write out complicated notes that went over the heads of most students. These notes also relied heavily on two things Feynman hated: inaccessible language and a lack of visualization. For example, most of them would have contained descriptions similar to the phrase we discussed earlier in this chapter: "Feynman was awarded the Nobel Prize for successfully resolving problems related to the theory of quantum electrodynamics." After reading this sentence, you still don't know much at all about what Feynman did. But if you can interact with a diagram that requires you to visualize quantum physics in action, then you can learn a lot more!

However, that's not to say that Feynman's theories could be easily understood! In fact, he is often referred to as both "the smartest man in the world" and "the physicist who couldn't understand his own theories." The latter phrase, however, is primarily for clickbait purposes; a more accurate wording would affirm that Feynman struggled to explain his own theories. Indeed, he possessed an intimate understanding of his theories. But it was often difficult to explain them in language simple enough for the average person to understand. For example, during a famous press conference at Cornell University in 1964, he remarked, "I think I can safely say that nobody understands quantum mechanics." But this was simply a kind fib; the author observes that Feynman "seemed to possess a frightening ease with the substance behind the equations." By virtue of his tremendous intelligence, many concepts seemed simple and obvious to him while they went over everyone else's heads. Sadly, this factor is the primary reason why his research is not more well known.

Final Summary

Richard Feynman is not a household name. You might be able to identify him in a video; you might remember him as a physicist from the 1960s. But most people would be unable to articulate his contributions to science. In this respect, the modern public is no different from the people Feynman encountered in his own day. Although we can appreciate the value of his work, the truth remains that most of his findings are too abstruse to resonate with the average person.

However, Feynman's memory lives on within the scientific community and his inventions (particularly the Feynman Diagrams) are cherished. In fact, many of his colleagues have referred to him as "the smartest man in the world" and credited his diagrams with "saving the future of space!" For this reason, we can still appreciate the life and work of a brilliant mind.