Gordon Moore never intended to state a law. He merely observed the deep scientific roots behind the accumulation of exponential improvements in silicon-based transistors. Asked to forecast the next decade, he ventured that progress would continue at the same rate. This was the unlikely origin of Moore’s law.

This is among the many engaging insights found in Moore’s Law: The Life of Gordon Moore, Silicon Valley’s Quiet Revolutionary, the new biography by Arnold Thackray, David C. Brock, and Rachel Jones (Basic Books, 2015). The subtitle—“Silicon Valley’s quiet revolutionary”—describes a common pattern in Moore’s career: he contributed to several canonical firms, and avoided flamboyance, while his colleagues enjoyed the limelight. The authors do not want readers to mistake visibility for impact.

And what an impact! Moore was an employee at Shockley Semiconductor Laboratory, the firm founded by the coinventor of the transistor, William Shockley. He left Shockley to cofound Fairchild Semiconductor International, which spawned and imprinted the West Coast integrated circuit industry. He is one of several fathers of semiconductor printing and manufacturing. He also cofounded Intel and served as a chief executive and chairman there.

A Native Californian

The book follows chronological order and mostly sticks to the story of Moore, his family, and his associates. The authors worked with Moore’s cooperation and compiled years of interviews, even having access to Moore’s own notebooks and business records. The book is an antithesis to CliffsNotes, as the authors have material about everything in Moore’s life—his relationships with his wife and children, his teenage adventures with nitroglycerin, and his memories of key moments in his career.

To their credit, the authors resist a hagiographic portrayal. Moore has many talents, which the authors showcase, but he also possesses many of the stereotypical character traits of an introverted chemist with a penchant for laconic statements and understated executive mandates. As a manager, he would avoid conflict even when a colleague’s errors persisted. Moore learned to let others take a high-profile role with employees, investors, and customers.

The book reads a bit like an episode of Star Trek—it’s clear it will turn out well, but not how. How could such a man become a billionaire from his entrepreneurial and industrial exploits?

The tale starts in Pescadero, a small coastal community where his father worked for the sheriff and his grandfather ran the town store. Moore benefited from the golden era of California public education, spending two years at San Jose State, then two at Berkeley. From there he went to Caltech for his graduate studies in chemistry.

Even at an early age, Gordon Moore possessed a combination of smarts, dedication, and resourcefulness, and as a student he showed signs of becoming a preternatural laboratory experimentalist, finishing his PhD in three years. He spent “most every non-classroom moment in a lab—handling the instruments, wiring vacuum tubes, blowing glass, and recording data in his laboratory notebooks.”

In retrospect, that graduate training was a great match for the needs of an entrepreneurial venture at the edges of science and production, although Moore took an unlikely path to that place. Moore was only a few years out from his graduate work when Shockley asked him to be the chemist at his new enterprise. Shockley started the firm in the Santa Clara Valley because his mother had retired there. The local military installations also provided ample demand. Although Moore was not a specialist in silicon, he had a reputation for hard work and resourcefulness.

Gordon and Betty Moore were living in Washington, DC at the time and wanted to go home, but the location was not the only reason for Moore to take the job. Supremely self-confident, Shockley desired to become the primary producer of transistors for the growing market—no small aspiration. The book gives
Moore’s reaction and remembrance of Shockley’s exact words. “Hello, this is Shockley.” As it happened, quite a few talented people heeded that call, and Shockley’s aspirations became a magnet for an extraordinary group of entrepreneurial PhDs.

Alas, Shockley’s talent for science did not correlate with any talent for managing others. At Bell Labs there had been signs of his faults, but they came to full blossom in Shockley’s eponymous enterprise. Like many others, Moore suffered as Shockley visited repeated indignities on his employees. Moore and seven others became fed up and eventually left to found Fairchild Instruments. Arnold Beckman, the financial backer of Shockley’s venture, branded the defectors as “the traitorous eight.”

This story has been told many times, but in this telling I came to appreciate and pity Beckman. Beckman had put up the money and aimed it at a great prize. Like many others, Moore suffered as Shockley visited repeated indignities on his employees. Moore and seven others became fed up and eventually left to found Fairchild Instruments. Arnold Beckman, the financial backer of Shockley’s venture, branded the defectors as “the traitorous eight.”

This story has been told many times, but in this telling I came to appreciate and pity Beckman. Beckman had put up the money and aimed it at a great problem. Beckman also had (correctly) given the team more financial backing as they made progress. Moore had tried to warn Beckman of Shockley’s problems, but it would have taken uncommon guts for Beckman to jettison Shockley. Beckman’s confusion and bitterness really comes through in this telling.

**Career**

Founding Fairchild took courage and fortitude, but the founders had the benefit of their experience with Shockley. Now they could pursue what Shockley had not supported. Nonetheless, it was an enterprise without a guidebook. Initially, the pioneers had to supply their own equipment. Moore even blew his own glass tubes for some of the earliest manufacturing at Fairchild, which needed them to supply gases to the diffusion furnaces.

Moore’s early career required precision and persistence, as he and others translated frontier chemistry into production. His laboratory training made Moore well suited for inventing and organizing the earliest designs and printing of semiconductors. Silicon was an experiment at one time, and Moore and his coworkers had to figure out the basic processes to utilize it.

Even after their initial successes, the authors stress, the group at Fairchild rarely got to catch their breath. No sooner was a process understood and routinized than some new wrinkle on the manufacturing process came along and required additional adjustments. It is another place where the details illustrate how “smaller, faster, better” became the competitive mantra of Fairchild and all its later competitors.

The authors give inventor’s credit to many, including some of Moore’s colleagues, such as Jean Hoerni, who created the planar process. I also enjoyed their narration of the founding of Intel. They provide just the right amount of detail about Fairchild’s rough straits, and how its Long Island-based parent company decided to change the leadership, unsettling its talented top managers, especially the charming and brilliant Robert Noyce. He agitated for departure, and, after several tries, eventually convinced Moore to take a chief role. The confrontation and hyperenergetic Andy Grove, whom Moore mentored and promoted, came along, too. What a trio!

The authors describe all the issues Intel faced as it tried to develop the memory market. The book also describes the microprocessor’s origins, more as a side project than a core part of the firm’s strategy. However, the book covered the early Intel days much better than the 1990s, a.k.a. the Grove era. The authors just do not paint a deep picture after the microprocessor takes over sales.

My biggest complaint is with their description of Intel’s monopoly. The authors explain how Intel got there, but not all the consequences. They recognize that it supported higher prices and secured unmatched scale economies, which certainly profited Intel. Yet, they write about monopoly only from Intel’s perspective. They do not make clear how that shaped the PC market in so many ways, or that it eventually enabled Andy Grove to push around OEMs. It also invited government scrutiny.

How did Moore’s law emerge out of this hullabaloo? It was partly by good fortune and partly the result of deep thought. Moore’s law is typically summarized as “the number of transistors that can be placed on an integrated circuit doubles every two years.” That common statement hides the deeper analysis supporting what became the law, and the book explains it all very well.

The analysis first emerged in 1965 in an article titled “Cramming More Components onto Integrated Circuits,” published in the journal *Electronics*. By the authors’ account, hardly anybody paid much attention at the time to the article. Why do we know it today? Moore revisited the analysis in 1975, updating it, and devoted public speeches to it. Others began to notice the deep foundations, and Carver Mead at Caltech coined the term, “Moore’s law.” It became a theory for forecasting the horizon, helping the entire industry coordinate their progress.

In addition to writing a biography, the authors give a history of Moore’s time, and that resonated with me. I grew up in the Bay Area in this era. My father is the same age as Moore and ran an accounting office in Fremont and Palo Alto, doing the books for many of the pioneers in Silicon Valley and their businesses (though not for Moore).

It is hard for fish to have perspective on the water they swim in. After reading this book, I understood something about those times. I recognized the places, the times, and the events. It all happened next door. My friends and I played in the grass fields that became converted into lots for houses. My friends worked for the firms that benefited from the magic enabled by silicon. Anybody raised in this era will appreciate this aspect of the book.

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