

DEPARTMENT: REVIEWS

Review of Luc Olivier Bauer and E. Marshall Wilder, *The Microchip Revolution: A Brief History* (Amazon, 2020)

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Semiconductor engineers and executives do not produce memoirs on their careers in microelectronics. They commission biographies or they write histories of the semiconductor industry. The latest example in this genre is *The Microchip Revolution* by Luc Olivier Bauer and E. Marshall Wilder. Bauer and Wilder are both industry veterans. They have been active in microelectronics since 1960s, Bauer at Hughes, Intersil, Eurosil, and Integrated Device Technology, and Wilder at Fairchild and AMD. At these corporations, Bauer and Wilder worked as process engineers and fab managers. It is from this unique perspective that they write the history of the industry. Their book also benefits from their network of professional contacts, which enabled them to interview key engineers and entrepreneurs and access their troves of historical documents. Oral histories and private collections are essential for reconstructing the history of semiconductors, because rare are the papers of corporations and individual engineers and managers currently in public repositories.

Bauer and Wilder's book has a dual focus: the histories of nine innovative firms (Fairchild, Hughes, Intersil, Eurosil, Intel, AMD, Integrated Device Technology, Cypress, and Micron) and the critical manufacturing processes (silicon gate, ion implantation, NMOS, CMOS, and high-speed CMOS) they developed and brought to production from the late 1950s to the 1990s. The authors argue that the first generation of firms, corporations such as Fairchild, Hughes, and Intersil, gained a competitive advantage through their process prowess, and that, since demand for

integrated circuits was still limited, they engineered a multitude of products for niche markets. In contrast, the firms that followed were much more focused. They also developed other sources of competitiveness. Some, like Intel and AMD, were product and process driven. Others, such as Eurosil, engineered unique processes to address large markets with relatively simple microchips. Integrated Device Technology and Cypress Semiconductor competed through process performance. Still others, especially Micron and SanDisk, focused on the continuous reduction of manufacturing costs.

The Microchip Revolution is especially novel in its discussion of the introduction of high-speed CMOS, a process invented at Hitachi, into the US semiconductor industry in the first half of 1980s. The larger firms such as Intel and AMD were at first reluctant to adopt it, since CMOS required more process steps than NMOS and was, therefore, more expensive. It was two Silicon Valley start-ups, Integrated Device Technology and Cypress Semiconductor, which made the jump. Established by former Hewlett-Packard engineers, Integrated Device Technology reverse engineered Hitachi's pioneering chip and developed a variant of its high-speed CMOS process. At Cypress, its founder, the notorious T. J. Rodgers, built his own high-speed CMOS process by adapting Intel and AMD's NMOS processes. Intel and AMD later converted to high-speed CMOS, because their NMOS chips became intolerably hot as they incorporated more and more transistors in them. Bauer and Wilder's book is also particularly rich on the transformations of semiconductor manufacturing in the United States in the 1980s and early 1990s. In response to fierce Japanese competition, microelectronics firms based in Silicon Valley adopted statistical process control, cleaned up their manufacturing processes, and reformed their testing procedures. Micron went further down the road of efficient manufacturing by systematically

minimizing the number of process steps, constantly shrinking its chips, and reducing the time it took from wafer start to shipping by a factor of six.

Bauer and Wilder's book is aimed at fellow microelectronics engineers and managers. Its technical discussions (that are many and very detailed) require extensive prior knowledge of semiconductor processes from the reader. But those curious about microelectronics will find it a most interesting read. *The Microchip Revolution* covers new historical ground. It brings a sensibility rarely seen in the literature: an attention to people and their personalities, including the workers

toiling in the fabs. It discusses at some length the character and management style of Jean Hoerni, the inventor of the planar process and the founder of Fairchild, Intersil, and Eurosil, a charming and cantankerous man, but also an inveterate philanderer. The authors grant a significant place in their narrative to operators, their relations with management, and their deep understanding of the manufacturing process. Overall, Bauer and Wilder show that production and process innovations do really matter in microelectronics. The digital revolution, they tell us, is based on miracles of manufacturing.



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