Book Review: *Chip War*

Review by Jim Burch

Miller, Chris, *Chip War: The Fight for the World's Most Critical Technology*. Simon & Schuster, London, United Kingdom, 2022, ISBN: 9781398504097. 431 pp. About $21.00.

Chip War: The Fight for the World's Most Critical Technology, by Chris Miller takes the reader across the development of the computer chip from the 1950s and tracks the evolution of this fundamental technology into the present day. More importantly, he delves into the critical nature of these chips and how the control of this technology has been elevated to the exercise of national power and global dominance. Throughout his compelling and expansive narrative lies the key and underlying fact of the centralized nature of chip production, the intellectual capital necessary to enhance computer chips to advance modern technology, and the corporations that control much of the supply chain elements behind the development of computer chips and the integral component that these chips play in all elements of national power—diplomatic, informational, military, and economic. Additionally, Miller highlights the almost unspoken fact that much of the struggle and competition over the development and control of this critical technology has gone unnoticed not only by the global community but also by national security and intelligence professionals. Throughout his compelling narrative, he draws out these key concepts and points to highlight the critical role that this technology plays in global governance and politics.

Chip War begins with the background of the waning days of the Second World War and how the victors were able to overcome the Axis powers through what Japanese soldiers referred to as a *typhoon of steel*. In this case, the unmatched industrial output in terms of tanks, ships, aircraft, weapons, and other capabilities on the large part of the United States under the Arsenal of Democracy assured the eventual successful conclusion of the conflict on the side of the Allies. A key theme, however, embedded throughout Miller's narrative is the importance and vitality of the underlying industrial, manufacturing, academic, research, and innovation base necessary not only to mass produce these capabilities, but also to conceive and develop new technologies critical to winning the Second World War ranging from the development of the computer and radar to the atomic bomb. To support his premise, Miller highlights not only the advances in computing power to process advanced mathematical algorithms and calculations to improve the accuracy of weapons systems but also the limitations of

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vacuum-tubed technology. For example, the U.S. Army's ENIAC computer at the University of Pennsylvania, considered state-of-the-art at the time in 1945 required 18,000 vacuum tubes to calculate artillery trajectories. Perhaps more importantly, one vacuum tube experienced a malfunction on average every two days requiring a shutdown and replacement of the part. Clearly, the limitations and the reliability of early computers had reached their limit.

It is within this backdrop that Miller explores the development, evolution, and role of computer chip technology within the modern era. In this, he makes an excellent case for how the role of the computer chip has directly evolved into an integral component of wielding national power on the global stage. Under the guise of *diplomacy* and global power politics, Miller makes an excellent case for how after the initial breakthroughs in the development of the integrated computer chip and advances in photolithography—essential to the miniaturization of transistors—in the late 1950s and early 1960s were part of a concerted diplomatic strategy to bind Asia to the United States. Starting first with Japan and later other Asian countries, such as South Korea, Taiwan, Singapore, and Malaysia, outsourcing and licensing of computer chip manufacturing in these countries effectively tied Asia to the United States and the Western bloc at the height of the Cold War. The symbiotic relationship of lean manufacturing in Asia and the continued advances in intellectual development in Silicon Valley would effectively bind these countries to the West over the ensuing decades. This relationship is personified by the continued and central role that the Taiwan Semiconductor Manufacturing Company (TSMC) and its foundry capabilities to service global customers, which are still largely driven by U.S. intellectual capital.

Throughout *Chip War*, Miller also makes a significant contribution to the role of *information* and its uses within the perspective of national power. The wielding of information as an instrument of national power goes beyond effectively molding strategic communications or denying an adversary information access to achieve superiority. The information instrument of power also deals with the generation and exploitation of knowledge to advance a national agenda. In this respect, Miller illustrates several examples of the capacities necessary to generate knowledge and the information necessary to advance chip-making technology. The central role of Silicon Valley in the generation of the intellectual capital necessary to overcome the constraints of Moore's Law and the miniaturization of chips is continually illustrated throughout his narrative. Additionally, the continued dominance of the role that U.S. research and education plays in technological advances is emphasized throughout and continues into the present day. Interestingly, while technological acumen and industry are limited by the understanding of physics, chemistry, and engineering at key time periods throughout the narrative, Miller effectively highlights the creativity and innovation necessary to overcome these constraints to generate the next leap

forward. Whether Jack Kilby tackling the theory of transistors to produce the first integrated circuit, or chip, in 1958 to James B. Keller stating that he sees a future where computer chips will have a 50 percent greater density than what we have in the present illustrates the value and critical role that these leaps play in generating knowledge.

Beginning with the backdrop of the waning days of the Second World War, Miller draws out the significant role played by computer technology in the wielding of the *military* instrument of national power. It is not only the advanced military capabilities that are highlighted but also the challenges of being left behind by failing to master the development and mass production of computer chip technology. The military establishments of the United States and the Soviet Union were largely based on the use of unguided aerial and artillery bombings as witnessed in the Second World War. The early and exponential advances of computer chip technology within the United States and the Western bloc resulted in significant advances in the use of rocketry, precision-guided munitions, satellites, and space technologies. The "offset" strategy emphasized in the late 1970s by the Pentagon to focus on the transformative effects of military technology afforded by computer chips would effectively outweigh the sheer numbers posed by the Soviet Union. This "offset" strategy and the advances over decades within the Western bloc are effectively juxtaposed by Miller to contrast the limitations of the Soviet Union and the Eastern bloc. While the Soviet Union could point to impressive advances in the development of theoretical knowledge on computer chips, the failure to translate this knowledge into the innovative environment of the West typified by the diversity of research labs, universities, and corporations limited the Soviet's ability to effectively integrate this technology. Most importantly, Miller makes an effective case for how the Soviet fixation on developing a "copy it" strategy by focusing on espionage activities and the stealing of intellectual capital effectively condemned them to a technological backwater by not focusing on developing those capabilities indigenously. As highlighted in *Chip War*, Soviet Marshal Nikolai Ogarkov, Chief of the Soviet General Staff would acknowledge in 1983 that the Soviet Union had lost the Cold War.

Perhaps most profoundly, Miller's insights into the fundamental role of computer chip technology and its underpinning of the *economic* instrument of national power are no more self-evident. While the initial impetus for developing computer chip technology stemmed from the military and warfare, the realization that the use of integrated computer circuits could be used in every aspect of economic endeavor coupled with the clear profit motive drove early research efforts. Robert Noyce's vision for the development of personal computers and mobile devices in the 1960s not only drove innovation and miniaturization but also the need to radically cut production costs to make these technologies more amenable to the private sector. As highlighted by Miller, by the late 1960s, the industry was not only be-

coming less dependent on Defense contracts but the manufacturing of computer chips was offshored to Asia to offset production and labor costs. These economic relationships between the United States, Europe, and Asia would continue to define the role of the industry and the supply chain that frames this sector into the present day.

As the title suggests, *Chip War* is about an underlying conflict and vying for power within a critical industry. Miller effectively lays out the historical narrative to highlight some key aspects and challenges dealing with the rise and dominance of the United States and its Allies within this technological sector. He also highlights some of the key challenges facing the status quo that frame the present; namely, the rise of China. For many of the reasons outlining the role of computer chip technology and its linkage to the instruments of national power—diplomatic, informational, military, and economic—Miller is also able to draw out many of these concepts on how China is vying to control this critical sector. As he establishes, the role of computer chip technology and production has been nationalized and linked as part of a concerted strategy to tie manufacturing and the development of intellectual capital to China as opposed to the United States. For example, while China, much like the Soviet Union, engages in espionage activities to support its research efforts, they are also expending a significant number of resources to recruit, develop, and establish innovation and manufacturing to create a hold on this critical technology. The rise of Huawei, the establishment of national policies compelling the United States and other technological companies to disclose their intellectual property for the sake of market access, and the perceived vulnerabilities of the Chinese government's dependence on U.S. and Allied enabled computer chip technology are prominently introduced and evaluated within the broader discussion of national security. Additionally, the Trump Administration's weaponization of the supply chain to limit the export of advanced technologies to limit Chinese technological advances is also highlighted as China's "Sputnik" moment. The implication here is that China will redouble its efforts to become less dependent on a computer chip status quo largely defined by the United States.

Miller concludes *Chip War* by posing some key considerations for the future that focus largely on the industry itself. For example, will computer chip innovation still follow Moore's Law, or has the industry reached the limits of physics and technology in this field? Will new innovative techniques create the next leap in technology? These questions are necessary to consider given the history of the sector and the dependence of modern society on this technology. In terms of the contentious nature and vying for control of computer chip technology within the present-day friction between the United States and China, however, Miller is largely silent. This is perhaps because this issue is still being played out on the global stage. In terms of how this underlying conflict is manifested in the present and future represents an area for further national security and strategic intelligence analysis.