

Artificial Intelligence and Japan's Fifth Generation

The Information Society, Neoliberalism, and Alternative Modernities

ABSTRACT In 1982, Japan launched its Fifth Generation Computer Systems project (FGCS), designed to develop intelligent software that would run on novel computer hardware. As the first national, large-scale artificial intelligence (AI) research and development (R&D) project to be free from military influence and corporate profit motives, the FGCS was open, international, and oriented around public goods. Although the FGCS did not plan any commercialized technologies, many American computer experts portrayed it as an economic threat to U.S. dominance in computing and the global economy—and policy-makers around the developed world believed them and funded AI projects of their own. Later, however, the FGCS was remembered as a failure. Why? This article recasts the FGCS as an interstice in the shift from a state-funded regime of American science organization to the neoliberal privatized regime of R&D now ascendant around the world. By exploring how notions of economic competitiveness and national security shaped R&D, this article reveals AI to be a product of contingent choices by multiple actors—nation-states, government bureaucracies, corporations, and individuals—rather than the outcome of deterministic technological forces. **KEYWORDS** Fifth Generation Computer Systems (FGCS), artificial intelligence (AI), Japan, neoliberalism, information society, AI arms race, Ministry of International Trade and Industry (MITI)

Talk of an “arms race” in artificial intelligence (AI) between the U.S. and China has grown considerably since China announced its intention to become the world leader in AI by 2030.¹ Spurred by the competition, Europe and the United Kingdom have both entered the race.² China's plan was apparently triggered by the nation's collective shock at the defeat of the

1. Julian E. Barnes and Josh Chin, “The New Arms Race in AI,” *Wall Street Journal*, March 2, 2018, <https://www.wsj.com/articles/the-new-arms-race-in-ai-1520009261>; Michael Woolridge, “China Challenges the US for Artificial Intelligence Dominance,” *Financial Times*, March 15, 2018, <https://www.ft.com/content/b799cbo4-2787-11e8-9274-2b13fccdc744>.

2. Tania Rabesandratana, “Europe Moves to Compete in Global AI Arms Race,” *Science* 360, no. 6388 (May 4, 2018): 474.

reigning world champion of the boardgame *Go* by an American company's AI program—described as China's "Sputnik moment."³ AI—meaning both the technologies that make possible "intelligent" behavior in machines and the field of people who study them—is thus seen to be of tremendous economic and political importance. Although the United States and China lead, the competition over AI is expected to have serious consequences for nations around the globe. At the heart of this trans-Pacific conflict is a clash between culturally situated visions of modernity, each hinged on AI's productive capacities, social consequences, and promise of geopolitical power. Can Western democracies and free market ideologies prevail, or will AI spell, in the words of one Chinese intellectual, "the end of capitalism" and the rise of "Socialism with Chinese Characteristics"?⁴

Today's AI race is not the first time that an Asian economic power's computing initiative has sparked trans-Pacific competition with the United States and globally.⁵ As the 1980s dawned, Japan launched its Fifth Generation Computer Systems project (FGCS), a national program to develop intelligent software that would run on novel computer hardware.⁶ Many computer scientists, engineers, politicians, and other members of the U.S. military-industrial-university complex came to fear the project would produce AI systems capable of dominating the global economy. The threat of the Japanese Fifth Generation was thus used to justify a wave of large-scale, AI-focused, national computing projects in developed nations around the world. Following a drop in the 1970s, these projects funded much of the research and development (R&D) conducted during the second major boom of AI activity in the 1980s.⁷

3. Paul Mozur, "Beijing Wants A.I. to Be Made in China by 2030," *The New York Times*, July 20, 2017, <https://www.nytimes.com/2017/07/20/business/china-artificial-intelligence.html>.

4. Feng Xiang, "AI Will Spell the End of Capitalism," *Washington Post*, May 3, 2018, <https://www.washingtonpost.com/news/theworldpost/wp/2018/05/03/end-of-capitalism/>.

5. Michael Schrage, "5th Generation' Spurs a Global Computer Race," *The Washington Post*, July 12, 1984, <https://www.washingtonpost.com/archive/business/1984/07/12/5th-generation-spurs-a-global-computer-race/bbaebc1a-19d5-4b2d-9ba7-7f676849bdc/>; Louise Lucas and Richard Waters, "The AI Arms Race: China and US Compete to Dominate Big Data," *The Financial Times*, May 1, 2018, <https://www.ft.com/content/e33a6994-447e-11e8-93cf-67ac3a6482fd>.

6. Throughout the text, I use "FGCS" to refer specifically to the project itself, and "Fifth Generation" to refer more broadly to the concept that motivated the project and its image abroad.

7. The periodization of AI history into three "booms" is borrowed from the Japanese AI community. See for example Yutaka Matsuo, *Jinkō Chinō Wa Ningen o Koeru Ka: Dōpu Rāningu No Saki Ni Aru Mono* (Tōkyō-to Chiyoda-ku: Kabushiki Kadokawa, 2015).

Though motivated by nationalistic competition, the Western AI programs were not “national projects” as had been conducted under the postwar state-funded and military-managed regime of R&D, but rather neoliberal prototypes for the commercialization of science and technology then underway.⁸ The FGCS was different, but this difference has been overlooked in the English-speaking world. Despite having played this central role in animating the first global AI arms race, Japan’s Fifth Generation is typically either forgotten or regarded as a failure. This article’s excavation of the project challenges that view. It recasts the FGCS as a critical interstice in the shift from a state-funded Cold War regime of American science organization—a form imposed on Japan during the Occupation—to the neoliberal “globalized privatization regime” of R&D now ascendant around the world.⁹

Things could have been otherwise. I argue Japan’s Fifth Generation offers a glimpse of what the philosopher of technology Andrew Feenberg calls an “alternative modernity,” a unique vision of a *Japanese* information society, pursued under a distinct regime of science and technology organization in operation in Japan from the late 1970s to the early 1990s.¹⁰ In contrast to the Western projects responding to it, the Fifth Generation displayed many of the characteristics now described as essential to ethical, socially responsible AI.¹¹ The first national, large-scale AI R&D project to be free from military influence and corporate profit motives, the FGCS was deliberative, open, international, and oriented around public goods and the needs of laypeople. As an exemplar of Japan’s alternative modernity, the Fifth Generation realized, in many ways, the norms of science often proclaimed—but rarely lived up to—by Western democracies.¹²

In this light, the fact that Americans perceived Japan’s Fifth Generation project as a threat presents a puzzle. Pacifist Japan obviously posed no martial

8. Philip Mirowski, *Science-Mart: Privatizing American Science* (Cambridge: Harvard University Press, 2011); Martin J. Collins, *A Telephone for the World: Iridium, Motorola, and the Making of a Global Age* (Baltimore: Johns Hopkins University Press, 2018).

9. Mirowski, *Science-Mart*.

10. Andrew Feenberg, *Alternative Modernity: The Technical Turn in Philosophy and Social Theory* (Berkeley: University of California Press, 1995).

11. Eric Horvitz, “AI, People, and Society,” *Science* 357, no. 6346 (July 7, 2017): 7; Luciano Floridi et al., “AI4People—An Ethical Framework for a Good AI Society: Opportunities, Risks, Principles, and Recommendations,” *Minds and Machines* 28, no. 4 (December 1, 2018): 689–707.

12. See Robert K. Merton, “The Normative Structure of Science [1942],” in *The Sociology of Science: Theoretical and Empirical Investigations*, ed. Norman W. Storer (Chicago: University of Chicago Press, 1973); David J. Hess, *Science Studies: An Advanced Introduction* (New York: New York University Press, 1997), 57.

challenge. Unlike authoritarian China, democratic Japan was a close ally of the United States, the United Kingdom, and Europe; furthermore, the country did not possess an offensive military as per its post-WWII constitution.¹³ Moreover, the FGCS did not include plans for the commercialization of any technologies—rather, it was Japan’s first and only national computing program to date that was *not* commercially focused. Its predecessor, the Promotion and Development of Technology for Next [Fourth] Generation Computers, or “VLSI Project,” catapulted Japan to the cutting edge of computer hardware, making it a world leader in advanced chip design and manufacture. However, as historian of Japanese technology Tessa Morris-Suzuki has observed, that project’s success merely “attracted lively interest overseas,” and even gave “a substantial boost to the international prestige” of Japan’s deft technology policies.¹⁴

This article solves this puzzle by first recounting Japan’s goals for and development of the FGCS project and then tracing some of the responses in the United States and elsewhere in the West. While Japan wanted to harness technology as a public good, the United States understood AI as an important tool of geopolitical power, critical to establishing and maintaining transnational control of globalizing markets. By elucidating the way notions of economic competitiveness and national security shaped computing R&D, the article reveals that AI, although often portrayed as the inexorable outcome of deterministic technological forces, is in fact the product of contingent choices made within the context of competing political agendas by a multiplicity of actors, from nation-states and government bureaucracies to corporations and individuals.

THE JAPANESE DREAM OF FIFTH GENERATION COMPUTING FOR THE PUBLIC GOOD

Japan rose from utter defeat in WWII to become a strong competitor to U.S. business interests within a mere three decades. By the mid-1970s, markets worldwide were overflowing with comparatively inexpensive, reliable Japanese cars and consumer electronics. The United States, by contrast, was suffering from oil crises, inflation, stagflation, and growing structural

13. See for example, Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 1986).

14. Tessa Morris-Suzuki, *The Technological Transformation of Japan: From the Seventeenth to the Twenty-First Century* (Cambridge: Cambridge University Press, 1994), 213.

unemployment.¹⁵ Americans watched the value of the dollar fall by 50 percent from 1971 to 1978 as Japan became arguably the most productive nation on Earth, assuming a formidable position as the world's second-largest economy. Articulated by influential sociologist Ezra Vogel, the image of "Japan as Number One" succinctly articulated a vision of this new possibility in the global economic order.¹⁶

Japan's Ministry of International Trade and Industry (MITI) received much of the credit for this seemingly miraculous rise from the ashes of nuclear devastation.¹⁷ MITI's deft steering of the Japanese economy encompassed the steel, automotive, and consumer electronics industries, as well as computing.¹⁸ After negotiating favorable patent-lease deals with American computing giant IBM in the 1950s, MITI sponsored collaborative, domestic computing R&D projects from the early 1960s onward.¹⁹ These projects focused on closing the technology gap with the West and commercializing products.²⁰ The strategy worked. Political economist Marie Anichordoguy's landmark study of Japanese computing found the nation's share of the domestic computer market rose from 6.9 percent in 1958 to 74 percent by 1982, making Japan "the only industrialized country in the free world where IBM [was] not the market leader."²¹

Thanks in part to MITI's success, the late 1970s comprised a pivotal moment in Japan's modernization. Recognizing that Japan had become a fully developed nation on par with the Western powers, Japanese policymakers and bureaucrats turned their attention to larger goals. As Morris-Suzuki put it, "Japan, having successfully transformed itself into an industrial

15. Roy Rothwell, "Towards the Fifth-Generation Innovation Process," *International Marketing Review* 11, no. 1 (1994): 9.

16. Ezra F. Vogel, *Japan as Number One: Lessons for America* (New York: Harper Colophon Books, 1979), 9, 225–56.

17. Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925–1975* (Stanford: Stanford University Press, 1982).

18. Morris-Suzuki, *The Technological Transformation of Japan*.

19. Marie Anichordoguy, *Computers Inc.: Japan's Challenge to IBM* (Cambridge: Harvard University Press, 1989).

20. Martin Fransman, *The Market and Beyond: Information Technology in Japan* (New York: Cambridge University Press, 1990); Martin Fransman, *Japan's Computer and Communications Industry: The Evolution of Industrial Giants and Global Competitiveness* (Oxford: Oxford University Press, 1995).

21. Anichordoguy, *Computers Inc.*, 166. For contrast, see Marie Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge: MIT Press, 2017), 225–27.

society, was now to become an ‘information society.’”²² But it would do so in a distinctly Japanese way.

In the West, the “information society” is an image equated with neoliberalism, and information technologies are regarded as aids to coordinating the global marketplace.²³ Entrance into the information society is achieved through neoliberal reforms designed to reallocate decision-making power from governments to markets, whose information-processing power is said to outstrip that of the state institutions that organized science under the Cold War regime.²⁴ Premised on the concept of knowledge as a fungible commodity—“intellectual property”—the neoliberal information society culminates in the commercialization of national science and technology R&D regimes.²⁵ By contrast, in Japan’s alternative modernity, the government took the lead in transitioning the nation into information society status; industry played only a supplementary role, guided by state actors.²⁶ Japan, now an economic power, was finally ready to do computing R&D free from market pressures.

Japan’s transformation into an information society thus deviated from the neoliberal trajectory pursued in Western nations. Japan evolved in a different direction, extending and refining the state-funded, military-led regime of science organization that America had imposed on most nations defeated in World War II.²⁷ Though MITI would replace the U.S. military in its coordinating role, Japan’s alternative modernity retained key aspects of America’s postwar regime of state-led R&D organization, such as the orienting ideologies of science as a public good and the “norms of science” articulated by sociologist Robert Merton.²⁸ Pacifist Japan would realize these ideals in ways the United States, with its relentless military-industrial war machine, never could. Accordingly, MITI planned projects

22. Morris-Suzuki, *The Technological Transformation of Japan*, 211.

23. David Harvey, *A Brief History of Neoliberalism* (New York: Oxford University Press, 2005), 32.

24. Philip Mirowski, *Never Let a Serious Crisis Go to Waste: How Neoliberalism Survived the Financial Meltdown* (London: Verso, 2014); Philip Mirowski and Edward M. Nik-Khah, *The Knowledge We Have Lost in Information: The History of Information in Modern Economics* (New York City: Oxford University Press, 2017).

25. Mirowski, *Science-Mart*, 31.

26. *Ibid.*, 134.

27. John Krieger, *American Hegemony and the Postwar Reconstruction of Science in Europe*, Transformations (Cambridge: MIT Press, 2006).

28. See Chapter 3, “Regimes of American Science Organization,” in Mirowski, *Science-Mart*; Merton, “The Normative Structure of Science [1942].”

for the 1980s with aspirational, even utopian goals, such as the Next Generation Basic Technology Project and the Technopolis initiative.²⁹ The most prominent of these projects, however, was the Fifth Generation Computer Systems project.

The late 1970s origins of the Fifth Generation provides a cultural contrast to its U.S. counterparts.³⁰ Whereas the origin stories of American computing are typically structured on a David versus Goliath narrative, with scrappy start-ups rising from humble beginnings (usually a garage) to battle corporate giants, Japan's Fifth Generation began in the mind of a mid-level MITI manager, Masataka Nakano, in 1978. As the cultural critic Jun'ichirō Uemae describes, the idea of a "fifth generation computer" occurred to Nakano, then only thirty, over a few heady afternoons discussing the next steps for the handful of sandal-clad programmers in their mid-twenties whom he oversaw in his capacity as a division chief for the fourth-generation VLSI Project.³¹ Riding high on that project's success, the team felt emboldened to turn their attention to the economic, social, and political challenges then facing Japanese computing.

They began with the limitations of contemporary computers. Since the 1940s, computing hardware had progressed through four generations, from vacuum tubes, to transistors, to integrated circuits, to by the late 1970s, very large-scale integrated circuits (VLSI). All these were based on the serial architecture named after the famous polymath, John von Neumann.³² Because von Neumann architecture limits the processor to a single operation at a time, FGCS project planners would later describe it as a "bottleneck" to achieving the processing power they desired for Fifth Generation computers.³³

However, Nakano and his team, familiar with the vicissitudes of hardware development, cast their rejection of this American computer architecture in geopolitical terms: it offered Japan freedom from the "yoke" of perpetual

29. See Chapter 8, "High-Tech Japan," in Morris-Suzuki, *The Technological Transformation of Japan*, 209–44.

30. Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).

31. Jun'ichirō Uemae, *Japanizu Dorimu: Michi No Mori e, Daigo Sedai Konpyūta* (Tōkyō: Kōdansha, 1985), 9–44. All translations my own.

32. Paul E. Ceruzzi, *A History of Modern Computing*, 2nd ed (Cambridge: MIT Press, 2003), 6.

33. JIPDEC, "Proceedings of the International Conference on Fifth Generation Computer Systems, October 19–22, 1981," (Japan Information Processing Development Center, 1981), 109.

competition with IBM, thus opening a new space for *Japanese* computing.³⁴ The U.S. company IBM dominated the international computer market not only in terms of total sales, but, as the global industry standard, through users' need for backward compatibility. Even competitors relied on the material forms of IBM's computing ecosystem, keeping them effectively yoked. Although Japanese computer manufacturers might make technically superior machines, businesses responded that "If they can't run the IBM software we've been using, we can't use them."³⁵ Nakano saw how this dynamic locked Japan into an endless cycle of imitation, closing off the path to Japanese innovation. He resolved to break the cycle with a fifth generation of computer hardware, telling his team, "This is why Japan has to be first to build a non-von Neumann machine. If we do, then we can race down an original path, outside of the world controlled by IBM."³⁶

To Nakano, it was not merely share in Japan's domestic computer market at stake, but the future of Japanese society. Importantly, he was not a programmer, nor did he have a technical background; he was therefore keenly aware of the social cost of the increasingly computerized Japanese office. Computers of the time were still mostly enormous machines that required specialized training; most government officials at MITI, including Nakano himself, did not understand how to use them. Nakano's wife Yuriko, a mathematician and programmer, explained to him that computers are typically "made by technically minded people for other technically minded people," leaving everyone else to struggle with their new and often incomprehensible language. Consequently, rather than streamlining Japanese bureaucracy, computers were adding to it.³⁷

It was not only Japan that felt the social impacts of computerization in the transition to post-industrial society; indeed, Western commentators had anticipated and observed these impacts since the late 1960s.³⁸ But Japan faced an added problem that did not affect the United States: computer language, where it was not numerical, was mostly English. Native, Japanese

34. Uemae, *Japanīzu Dorīmu*, 71.

35. *Ibid.*, 31.

36. *Ibid.*, 32–33.

37. *Ibid.*, 20–21, 24, 30.

38. Peter F. Drucker, *The Age of Discontinuity: Guidelines to Our Changing Society* (London: William Heinemann Ltd., 1969); Alvin Toffler, *Future Shock* (New York: Bantam Books, 1970); Daniel Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York: Basic Books, 1973).

language input systems did not yet exist at the time.³⁹ Japanese users had to learn a non-trivial amount of English in addition to the computer system itself—a considerable barrier for even the most technically proficient adepts. Hence the lack of uptake in the Japanese office.⁴⁰

Without intervention, these problems seemed likely to intensify over the next decade as the trend of office automation continued apace. Nakano's team proposed a Japanese language input system. More grandly, Nakano explained that he wanted to “make an unprecedented, new computer,” one that is “easy for anyone to use” because it “thinks like a human.”⁴¹ With such a machine, office workers would no longer need to learn programming, or English, or even to type on a keyboard. Instead, they could have a conversation with the machine, in Japanese—freeing them from another yoke.

Described by Uemae as the “Japanese Dream,” Nakano's bold, unconventional vision for the Fifth Generation computer gave three contours to the project: the computer would feature non-von Neumann, Fifth Generation hardware, it would address the social problems Japan was facing as it transitioned into an information society, and it would interact with non-specialist users like a human. The Fifth Generation computer thus offered a way forward for Japan to develop its own distinct-but-equal information society, rather than continue on as a 真似ざる (*manezaru*) or “copycat” of the West.⁴² Once articulated, the vision of the Fifth Generation computer impressed many upper-level bureaucrats at MITI and other agencies. Though few understood the technical details, and many were skeptical of the project's success, none of them wanted to be the one to kill this burgeoning Japanese Dream.⁴³

Nakano and his team eventually secured funds for a Committee for Study and Research on Fifth-Generation Computers composed of computer experts from both academe and industry and charged with elaborating the

39. Toshiba developed the first Japanese-language input system, the JW-10, in 1978 and shipped it in 1979. IPSJ, “Historical Computers in Japan—Japanese Word Processors: Toshiba JW-10,” Information Processing Society of Japan, <http://museum.ipsj.or.jp/en/computer/word/0049.html>, accessed January 31, 2019.

40. On a similar issue in the Chinese context, see Thomas S. Mullaney, *The Chinese Typewriter: A History* (Cambridge: MIT Press, 2017).

41. Uemae, *Japanīzu Dorīmu*, 25.

42. Jun'ichirō Uemae frequently used the term *manezaru* (literally “imitating monkey”), suggesting Japan's international reputation as an imitator—deserved or not—was a concern for MITI and the FGCS architects. *Ibid.*

43. *Ibid.*, 92–94.

vision of a fifth generation computer into a full project proposal within two years. (Nakano himself was rotated to a new post in another MITI division just as the planning committee formed in 1979. With two-year rotations a common workplace practice in Japan, the transfer was an “extraordinarily ordinary” one.⁴⁴ Consequently, his name is absent from the official FGCS literature.) Tōru Moto-oka, a well-respected University of Tokyo professor of electrical engineering, chaired the committee. Three subcommittees, on Basic Theory, Computer Architecture, and Social Impacts, were led by computer researchers Kazuhiro Fuchi, who would go on to become director of the project; Hideo Aiso, Fuchi’s former boss at Japan’s famed Electrotechnical Laboratory and a professor of electrical engineering at Keio University; and Hajime Karatsu, of Matsushita Communication Industrial Company Ltd., respectively.⁴⁵ The committee’s deliberations were extensive, with around one hundred representatives from science, industry, and government participating in as many meetings over the two-year period.

Rather than simply brainstorming new uses for an extant machine, or a faster machine for extant needs, Moto-oka explained that the committee sought to lay concrete plans for a computer the Japanese “society of the 1990s would require.”⁴⁶ For the committee, these needs included not only information processing, but more importantly the creation of a state-sponsored public good.

According to the committee’s first English-language report, the need to process information was crucial given the present-day “stream of international change and uncertainty.” Computers had already proven invaluable in the “appropriate processing and utilizing of information,” but in the next decade, the committee anticipated “the need for even more highly sophisticated technology in overcoming the many problems we will come to face.”⁴⁷ But the need to create computers that enhanced the public good was even more compelling. In the original Japanese-language version of the report, the committee cast a choice in geopolitical terms, as follows:

44. Ibid, 94–95.

45. The names of these committees have been translated variously in the English language literature.

46. Tōru Moto-oka and Masaru Kitsuregawa, *The Fifth Generation Computer: The Japanese Challenge* (Chichester: Wiley, 1985), 4.

47. JIPDEC, “Preliminary Report on Study and Research on Fifth-Generation Computers 1979–1980” (Japan Information Processing Development Center, Fall 1981).

For Japan . . . the decade leading up to 1990 is thought to be a historically pivotal period expanding its international contribution. Moreover, the UK and USA, perhaps because of their inability to bear the great burden of playing this role [as international leaders], have experienced a breakdown of industrial society that could be called, “UK sickness” (*eikoku byō*), or “USA-sickness,” (*beikoku byō*). At this time, we must also consider how Japan can avoid falling into their rut.⁴⁸

As this passage reveals, the committee’s vision for the Japanese society of the 1990s involved avoiding the mistakes of its modernized predecessors. Specifically, whereas the United States and the United Kingdom had responded to social ills through neoliberal reforms, entrusting their cure to the power of markets, Japan would avoid “falling into their rut” by steering the domestic computing industry toward the production of socially beneficial computers—machines that would more evenly distribute the potential benefits of computing to ordinary people than had the enormous mainframes of the age. In the Japanese information society of the 1990s, computing would be a state-sponsored public good, rather than intellectual property to be patented and licensed to a set of domestic firms, as MITI had been doing with its earlier computing programs, or spun off at public cost to private actors in what economist Mariana Mazzucato has called the “socialization of risk and privatization of rewards” process distinctive of Western neoliberal regimes.⁴⁹

This frame provides crucial context for understanding the unique role the Fifth Generation would allow Japan to play on the global stage over the next decades. Acknowledging that “Japan has come to be called an ‘economic power’ thanks to the remarkable growth of our various industries,” the committee announced that it was time to “stop playing ‘catch-up’ with the more advanced countries and to set goals of leadership and creativity in research and development. . . . By promoting this project, our country will play a world leading role in the field of computer technology development. Our efforts will not only foster creative technology for our own computer industry, but will also provide our country with bargaining power.”⁵⁰ This

48. Shakai kankyō jōken kenkyūbunkakai, “Dai Go Sedai No Denshi Keisanki Ni Kansuru Chōsa Kenkyū Hōkokushō” (Nihon jōhō shori kaihatsu kyōkai [JIPDEC], March 1980), 1. Author’s translation.

49. Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*, Revised Edition (New York: PublicAffairs, 2015).

50. JIPDEC, “Preliminary Report on Study and Research on Fifth-Generation Computers, 1979–1980,” 24.

“bargaining power” would be of a moral variety, derived through scientific R&D, rather than mere economic or military might. In Japan’s alternative modernity, becoming an “economic power” free of the need to play industrial “catch-up” came with a duty to fulfill, both to its people and to the international scientific community, through technology transfer during its post-WWII rise.⁵¹ Japanese leadership would therefore mean improvements in both technical performance *and* the R&D process itself.

Although scholars have argued that much twentieth-century Japanese innovation was marked more by improvement of existing Western technics than by innovation *per se*, the Fifth Generation broke with this mold.⁵² Rather than utilizing the imported American regime of state-led science and technology organization, Japan’s Fifth Generation improved upon the post-WWII notion of “basic science” itself.⁵³ Free from military influence, the Fifth Generation better enacted the scientific norms that Americans described but rarely lived up to in their scientific practice.⁵⁴ To this end, the committee refined those norms and adapted the project to Japan’s socioeconomic situation by framing the Fifth Generation computer as a public good to be utilized by ordinary people.

Thus the Fifth Generation computer, rather than neoliberal reform, was the key to the prosperous Japanese information society of the 1990s. Karatsu’s Social Impacts subcommittee identified specific socioeconomic problems facing Japan and outlined four ways the Fifth Generation computer should address them: First, noting that “serious social imbalances” had arisen as the largest companies had been the primary beneficiaries of computerization, the Fifth Generation computer would “increase productivity in low-productivity areas,” such as the service sector and small-scale manufacturing. Second, acknowledging Japan’s shrinking workforce, it would “meet international competition and contribute toward international cooperation” by augmenting, rather than replacing, Japan’s primary resource, skilled human labor. Third, recognizing Japan’s dependence on imported resources, it would “assist in saving energy and resources.” Fourth, it would help “cope with an aged society.”⁵⁵ Together,

51. *Ibid.*

52. Morris-Suzuki, *The Technological Transformation of Japan*.

53. Mario Daniels and John Krige, “Beyond the Reach of Regulation? ‘Basic’ and ‘Applied’ Research in the Early Cold War United States,” *Technology and Culture* 59, no. 2 (June 16, 2018): 226–50.

54. Merton, “The Normative Structure of Science [1942]”; Hess, *Science Studies*.

55. JIPDEC, “Preliminary Report on Study and Research on Fifth-Generation Computers 1979–1980,” 5.

these socioeconomic goals made the project a notable departure from previous technically focused, large-scale computing initiatives in both the West and Japan.⁵⁶

The four goals in turn shaped the project's technical ambitions. Karatsu argued the goals could be achieved by making the Fifth Generation computer usable by the general public, as "tool to give the ability of all citizens [sic] to join the social system more intimately." Moreover, it "will be effective to soften the social stress which comes from the modernization of environment [sic] where we live" by helping to alleviate the negative social impacts of rapid technological change.⁵⁷ That is, the Fifth Generation computer would aid lay people in coping with an increasingly complex, modern society—and it would do so by thinking like a human.

However, the Japanese Dream of the Fifth Generation was not an "AI" project. It would not produce 人口知能 (*jinkō chinō*) or "artificial intelligence" as the concept had been imported from the United States.⁵⁸ Rather, Fifth Generation computers would be 知識情報処理システム (*chishiki jōhō shori shisutemu*) or "knowledge information processing systems."⁵⁹ The "intelligence" of these systems manifested first in the user interface design. As Basic Theory subcommittee chair Fuchi noted, "today's technology is far from the ideal of being truly 'handy' for users."⁶⁰ People, he pointed out, communicate primarily through natural language conversations and secondarily through visual media. Echoing Nakano's concerns, the committee reasoned that if "information processing systems will be a central tool in all areas of social activity" by the 1990s, then the text-based interfaces of the time posed a significant barrier to wider use by those lacking technical training and

56. T. E. Bell, "The Teams and the Players: Japan, the United States, and Western Europe Provide Striking Contrasts in National Interests and Techniques: Strategies," *IEEE Spectrum* 20, no. 11 (November 1983): 45.

57. Hajime Karatsu, "What Is Required of the 5th Generation Computer—Social Needs and Its Impact," in *Fifth Generation Computer Systems: Proceedings of the International Conference on Fifth Generation Computer Systems, Tokyo, Japan, October 19–22, 1981* (Tokyo: North-Holland Publishing Company, 1982), 103.

58. "As Karatsu explained when interviewed on November 15, 1985, the term AI did not even come up in the early planning of the Fifth Generation project." J. Marshall Unger, *The Fifth Generation Fallacy: Why Japan Is Betting Its Future on Artificial Intelligence* (New York: Oxford University Press, 1987), 181.

59. JIPDEC, "Preliminary Report on Study and Research on Fifth-Generation Computers 1979–1980," 9.

60. JIPDEC, "Proceedings of the International Conference on Fifth Generation Computer Systems, October 19–22, 1981," 107.

computer expertise.⁶¹ Therefore, the new machines would need to have the “ability to process information conversationally using everyday language” and visual media, such as imagery and video, to teach its non-expert users, through natural language conversation, how they could put its “stored knowledge to practical use.”⁶² That is, rather than expecting linguists, doctors, or tradespeople to learn both English and new software in order to benefit from computer technology, the Fifth Generation computer would understand its users, learn their needs, and eventually teach them how best to utilize the system itself.⁶³ This vision of a computer that would augment, rather than simulate, the human intellect was a significant departure from contemporary Western AI.⁶⁴

TECHNICAL DEPARTURES, INDUSTRY REVOLT, AND FREEDOM FROM CORPORATE INFLUENCE

The planning committee conducted a broad survey of the computing field to gain an understanding of the state-of-the-art and move beyond it.⁶⁵ The survey indicated that “expert systems,” the second major AI paradigm, which was introduced primarily by the American Edward Feigenbaum at Stanford University, represented the cutting edge.

Feigenbaum was a student of Herbert Simon, one of the AI pioneers responsible for the initial boom of AI activity in the late 1950s and early 1960s, which attempted to simulate human cognition by building “machines who think.”⁶⁶ The failure to achieve this goal led to the collapse of AI funding in the early 1970s and inspired Feigenbaum to improve upon

61. Ibid, 3.

62. JIPDEC, “Preliminary Report on Study and Research on Fifth-Generation Computers 1979–1980,” 8.

63. Tōru Moto-oka, “Overview to the Fifth Generation Computer System Project,” in *Proceedings of the 10th Annual International Symposium on Computer Architecture* (New York: ACM, 1983), 417–22.

64. See Mortimer Taube, *Computers and Common Sense: The Myth of Thinking Machines* (New York: Columbia University Press, 1961); Hubert L. Dreyfus, *What Computers Can't Do: A Critique of Artificial Reason* (New York: Harper Collins Publishers, 1972).

65. In addition to reading the English-language literature, the planning committee sent representatives abroad to visit computer science labs in the United States and Europe, echoing Meiji-era modernization efforts undertaken a century prior. Uemac, *Japanizu Dorimu*.

66. Alan Newell and Herbert A. Simon, “GPS, A Program That Simulates Human Thought,” in *Computers and Thought*, ed. Edward A. Feigenbaum and Julian Feldman (New York: McGraw-Hill, Inc., 1963), 279–93; Pamela McCorduck, *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence* (San Francisco: W. H. Freeman, 1979).

Simon's approach. Feigenbaum's "expert systems" did so in two ways: by narrowing the scope of the domain to be modeled from human cognition writ large to the thinking processes of human experts, and by shifting focus from reasoning itself to experts' domain-specific knowledge. Expert systems were thus consistent with a fundamental tenet of neoliberalism—knowledge is a fungible commodity that retains its value after being abstracted from local contexts and formalized into computer code.⁶⁷ Building expert systems involved mining, extracting, and modeling human experts' knowledge of a given domain; most famously, chemistry and medicine.⁶⁸ Accordingly, allusions to extractive industries are rife within the expert systems literature, wherein the valuable commodity of knowledge must, in the words of Feigenbaum and AI chronicler Pamela McCorduck, "be mined out of [experts'] heads painstakingly, one jewel at a time."⁶⁹ Although expert systems were forever plagued by the "knowledge acquisition bottleneck"—a term describing the difficulty of this extraction process—the new approach rejuvenated AI in the 1970s and dominated Western AI during the 1980s.⁷⁰ Feigenbaum famously summarized the principle distinguishing expert systems from the first AI boom with the pithy slogan, "Knowledge is Power."⁷¹

Expert systems were designed for use mostly by businesses interested in eliminating the need for highly paid expert consultants.⁷² Thus, despite the late 1970s rise of neoliberal rhetoric elevating the individual over the collective, the American AI paradigm sought to aid corporate cost-cutting exercises then underway by placing employees into meritocratic competition with expert systems, facilitating their replacement by software. By contrast, the

67. Mirowski and Nik-Khah, *The Knowledge We Have Lost in Information*.

68. The first expert system, DENDRAL, was designed to infer chemical structures from spectrographic readouts. The second major system, MYCIN, performed medical diagnoses. Bruce G. Buchanan and Edward A. Feigenbaum, "DENDRAL and Meta-DENDRAL: Their Applications Dimension," *Artificial Intelligence* 11, no. 1–2 (1978): 5–24; Bruce G. Buchanan and Edward H. Shortliffe, eds., *Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project* (Reading, Mass.: Addison-Wesley, 1985).

69. Edward A. Feigenbaum and Pamela McCorduck, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World* (Reading, Mass.: Addison-Wesley, 1983): 77.

70. For critical views of knowledge acquisition, see Diana Forsythe, *Studying Those Who Study Us: An Anthropologist in the World of Artificial Intelligence* (Stanford: Stanford University Press, 2001); Lucy Suchman, "Feminist STS and the Sciences of the Artificial," in *The Handbook of Science and Technology Studies*, ed. Edward J. Hackett et al., 3rd ed. (Cambridge: MIT Press, 2007).

71. See, e.g., James Hendler and Edward A. Feigenbaum, "Knowledge Is Power: The Semantic Web Vision," in *Web Intelligence: Research and Development* (Springer, 2001), 18–29.

72. Author's interview with Edward Feigenbaum, January 25, 2019.

Fifth Generation focused on augmenting the abilities of laypeople. In what could be perceived as a challenge to Western expectations about Japan's collectivist culture, the planning committee saw ordinary people—rather than knowledge itself—as the primary source of economic value. In the Japanese information society of the 1990s, Fifth Generation computer systems would scaffold laypeople's tacit expertise into a cybernetic assemblage more capable than either human or machine alone—rather than replace them. Chairman Moto-oka summarized this augmentative aspect as a “Quantum Jump in Friendliness.”⁷³ Fuchi and colleagues conceded there were no guarantees of success, but nevertheless averred the project was their attempt to “bring about an age in which men can enjoy a richer, fuller life.”⁷⁴ The significance of this difference was not lost on some Western observers. As the editorial staff of *IEEE Spectrum* explained, the Fifth Generation's “prime aim is to make a machine that fits the needs of people instead of making people work by the rules of the machine.”⁷⁵

Responding to those who conflated the Fifth Generation with American AI, Fuchi later asserted that while similarities may exist, “our project is not an artificial intelligence project or an expert system project as wrongly understood by some people.” Rather, “we may call our project a software engineering project for a new age.”⁷⁶

The decision to accept non-textual user input further shaped the FGCS's technical design. The first four generations of computer hardware operated exclusively on numerical data. Any user interface other than a text-based command-line required many extra steps of processing to convert the input media, such as sounds or images, into binary code—an enormous task even for state-of-the-art VLSI computers. However, a computer capable of skipping the conversion process altogether by processing non-numeric data at the hardware level could achieve performance gains of several orders of

73. Tōru Moto-oka, “Japan: The Fifth Generation: A Quantum Jump in Friendliness,” *IEEE Spectrum* 20, no. 11 (November 1983): 46–47.

74. Norihisa Doi, Koichi Furukawa, and Kazuhiro Fuchi, “Fifth-Generation Computer Systems and Their Impact on Society,” *International Journal of Computer Applications in Technology* 2, no. 2 (1989): 123.

75. IEEE Spectrum Staff, “ICOT: Japan Mobilizes for the New Generation,” *IEEE Spectrum* 20, no. 11 (November 1983): 47–51.

76. Kazuhiro Fuchi, “Revisiting Original Philosophy of Fifth Generation Computer Systems Project,” in *Fifth Generation Computer Systems 1984: Proceedings of the International Conference on Fifth Generation Computer Systems 1984, Tokyo, Japan, November 6–9, 1984* (Tokyo: North-Holland, 1984), 3.

magnitude over traditional machines. The committee thus planned for Fifth Generation computers to operate directly on “Non-numeric data such as sentences, speeches, graphs, and images.”⁷⁷

Fuchi’s Basic Theory subcommittee argued that handling non-numeric data at the hardware level required the kernel—the core of the computer’s software operating system—to be written in a “logic programming” language, considered at the time to be the fifth generation of computer programming languages. The first major logic programming language, LISP, was originally invented for AI by American AI pioneer John McCarthy in 1958 while at the Massachusetts Institute of Technology. Based on formal logic, LISP was “designed to facilitate experiments . . . whereby a machine could be instructed to handle declarative as well as imperative sentences and could exhibit ‘common sense’ in carrying out its instructions.”⁷⁸ Logic programming thus provided a means of representing knowledge in computer language and formally specifying logical relations between those knowledge representations, allowing for reasoning processes such as deduction, inference, and recursion to be performed by machines. The importance of LISP to early AI cannot be overestimated; in 1983, DARPA’s Robert Kahn could claim “LISP is the machine language of AI research.”⁷⁹

Fuchi had been impressed by logic programming on his trips abroad and saw it as the “missing link” between knowledge information processing systems and non-von Neumann hardware.⁸⁰ After assessing the options, however, he chose PROLOG for the Fifth Generation kernel, an alternative to LISP co-developed by Robert Kowalski in Europe.⁸¹ The move would draw the ire of the American AI community, revealing nationalistic impulses beneath the supposedly logical exterior of computing. As one influential commentator put it, “Prolog is seen as somehow ‘un-American’—a European fad that has now been taken up by the Japanese. I have even heard it

77. Moto-oka, “Overview to the Fifth Generation Computer System Project,” 417.

78. John McCarthy, “Recursive Functions of Symbolic Expressions and Their Computation by Machine, Part I,” *Communications of the ACM* 3, no. 4 (April 1960): 184.

79. R. E. Kahn, “A New Generation in Computing: Microelectronics and Artificial Intelligence May Produce Advanced Computers That Are Both Fast and Smart,” *IEEE Spectrum* 20, no. 11 (November 1983): 38.

80. Kazuhiro Fuchi and Koichi Furukawa, “The Role of Logic Programming in the Fifth Generation Computer Project,” in *Proceedings of the Third International Conference on Logic Programming: Imperial College of Science and Technology, London, United Kingdom, July 14–18, 1986*, ed. Ehud Shapiro (Berlin: Springer, 1986), 1–24.

81. Robert Kowalski, “Predicate Logic as Programming Language,” *Information Processing* 74 (1974): 569–74; Robert A. Kowalski, “The Early Years of Logic Programming,” *Communications of the ACM* 31, no. 1 (January 1988): 38–43.

suggested that the only reason Japan has opted for Prolog, rather than Lisp, is that the Japanese do not wish to be seen to be copying American technology.”⁸² Feigenbaum interpreted the decision similarly.⁸³

Fuchi defended the move by arguing that PROLOG was technically superior and noting that Japan, as a newcomer to AI, had no obligation to adopt the legacy language LISP.⁸⁴ Still, the decision was not only a major technical departure from the Western tradition of AI, it amounted to a high-stakes gamble on a relatively unknown computer language, one that was unfamiliar to most academic computer scientists, not to mention professional programmers.⁸⁵ Yet Fuchi was able to convince the planning committee of the importance of logic programming and specifically of PROLOG for the Fifth Generation kernel language in part because he had replaced Nakano as the focal point around which the now much larger group of young programmers on the committee orbited. Only in his early forties at the time, Fuchi served as a bridge between them and the older Moto-oka, whose approval was necessary to adopt Fuchi’s radical plan.⁸⁶ Representatives from industry preferred an alternative proposed by Aiso, Fuchi’s old boss from the Electro-technical Laboratory—a staid but uninspiring extension of IBM-compatible hardware. Though Moto-oka was hesitant, he could see how the young programmers looked up to Fuchi and knew MITI wanted to demonstrate Japanese leadership in science and technology R&D with the project.⁸⁷ In a pivotal moment that decided the direction the FGCS would take, Moto-oka consented to Fuchi’s radical plan.

Once funding was secure from MITI, Moto-oka recommended Fuchi to lead the project. Under Fuchi’s direction, Nakano’s early vision cohered into a more concrete but still recognizable Japanese Dream of the Fifth Generation: computers that could reason about non-numerical data using PROLOG on non-von Neumann hardware.⁸⁸ Table 1 summarizes the essential

82. David H. D. Warren, “A View of the Fifth Generation and Its Impact,” *AI Magazine* 3, no. 4 (December 15, 1982): 38.

83. Nils Nilsson, Oral History of Edward Feigenbaum, June 20, 2007, 50, CHM Reference number: X3896.2007, Computer History Museum, Mountain View, Calif.

84. Kazuhiro Fuchi, “The Direction the FGCS Project Will Take,” *New Generation Computing* 1, no. 1 (1983): 7.

85. Scott Callon, *Divided Sun: MITI and the Breakdown of Japanese High-Tech Industrial Policy, 1975–1993* (Stanford: Stanford University Press, 1995), 69.

86. Uemae, *Japanizu Dorimu*, 110–12.

87. Callon, *Divided Sun*, 70–72.

88. Uemae, *Japanizu Dorimu*, 112–16.

TABLE 1. Technical Differences between Japan's Fifth Generation and American AI

Nation	Hardware	Software	Goal
USA	VLSI (4th gen., serial)	LISP	Artificial Intelligence (AI)
Japan	Non-von Neumann (5th gen., parallel)	PROLOG	Knowledge Information Processing Systems (KIPS)

technical differences between the Japanese plan and American AI systems of the time.

A large-scale endeavor, FGCS was planned to run in three stages from 1982 to 1992. MITI's ambitions were reflected in the budget it promised—an unprecedented 100 billion yen (approximately \$500 million at the time) over the decade.⁸⁹ Not only was this the largest budget for any of MITI's computing projects, the FGCS was the first such project to run for a full decade.⁹⁰ Moreover, MITI had initially stipulated that the funds were to be matched by eight collaborators in the computing industry: Fujitsu, Hitachi, Matsushita, Mitsubishi, NEC, Oki, Sharp, and Toshiba, for a total budget of nearly \$1 billion. This was a substantial sum for AI R&D anywhere in the world at the time.⁹¹

But the plans for the new computer system proved too radical for the Japanese computing industry; the eight participating firms were unwilling to gamble on major innovations. When industry participants learned Fuchi's plan had been approved and Fifth Generation computers would not be IBM-compatible, the firms attempted to back out of the project entirely.⁹² Their participation was essential, however, because the domestic university system then lacked robust computer science programs and could not provide researchers in the numbers required. MITI applied pressure by threatening

89. Hiroyuki Odagiri, Yoshiaki Nakamura, and Minoru Shibuya, "Research Consortia as a Vehicle for Basic Research: The Case of a Fifth Generation Computer Project in Japan," *Research Policy* 26, no. 2 (May 1997): 191–207.

90. Uemac, *Japanizu Dorimu*, 178.

91. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World*, 106.

92. Yoshiaki Nakamura and Minoru Shibuya, "Japan's Technology Policy—a Case Study of the R&D of the Fifth Generation Computer Systems," *International Journal of Technology Management* 12, no. 5/6 (1996): 509–34.

exclusion from future government funding opportunities if the firms did not cooperate, and eventually industry relented.⁹³ Though never agreeing to match funds, FGCS industry collaborators conceded to sending researchers on a rotating basis to the project's Tokyo headquarters, the newly established Institute for New Generation Computer Technology (ICOT).

Fuchi, who left behind a successful career and secure retirement package at the Electrotechnical Laboratory to become the director of ICOT, welcomed industry's reduced role. It gave him a freer hand to build a unique culture at ICOT, which he envisioned as an autonomous research institution. He communicated his intention to limit MITI's direct control of the project, albeit obliquely, by agreeing to accept the position of director only on two conditions, both quite radical within the context of Japanese business culture: First, he would be allowed to choose any computer manufacturer to provide terminals during the initial design phase of the project—even American machines.⁹⁴ Second, researchers sent to ICOT were to be under thirty-five years old—to maintain what he perceived as the youthful energy and freedom of thought that had propelled the project from its first days in Nakano's office.

Autonomy from the immediate concerns of the computer industry not only freed the FGCS research agenda from the constraints of profit-seeking, it allowed ICOT to commit itself to the scientific norms of openness and disinterestedness. Fuchi signaled this commitment by regularly and painstakingly emphasizing that the project had “no commercial objectives.”⁹⁵ The lack of corporate influence was, of course, unusual for a massive computing project, Japanese or otherwise. MITI, for example, was running several other major computing projects concurrently with the FGCS, all of which required participating firms to commercialize their results.⁹⁶ But the flagship FGCS project was to demonstrate Japan's new leadership role in science and technology. Therefore, MITI took steps to distinguish the FGCS from earlier “catching-up” projects by limiting incentives for competition and profiteering between participating firms. First, ICOT was given control of

93. For conflicting accounts of this decision, see Uemae, *Japanizu Dorimu*; Callon, *Divided Sun*, 55–84.

94. Fuchi selected American Digital Equipment Corporation's (DEC) 2060 systems, known for their ability to run PROLOG, as the initial batch of ICOT terminals. Uemae, *Japanizu Dorimu*, 226–28.

95. Fuchi, “The Direction the FGCS Project Will Take”; K. Fuchi, S. Sato, and E. Miller, “Japanese Approaches to High-Technology R&D,” *Computer* 17, no. 3 (March 1984): 14.

96. Unger, *The Fifth Generation Fallacy*, 183–84.

FGCS funding, granting it considerable autonomy since neither MITI nor industry partners could pull purse strings to steer the project. Second, the bulk of research would be conducted at the ICOT facilities, where researchers from various corporate firms and universities would collaborate openly in a shared workspace. Third, results were to be shared among all participating firms, as well as in scientific articles and conference presentations domestically and abroad.⁹⁷

At ICOT, the hub of Japan's alternative modernity, Fifth Generation computing was to be pursued in an open, disinterested manner—a stark contrast to the epicenter of commercialized science and technology R&D then forming across the Pacific in Silicon Valley. Indeed, the ideal of R&D as a public good had already been displaced in the United States. As critics of America's war in Vietnam had pointed out in the late 1960s and 1970s, pervasive military funding and influence gave lie to the supposed disinterestedness of the scientific establishment.⁹⁸ By 1980, that establishment was transitioning to a new, neoliberal, privatized regime of science organization, in which corporations outsourced their research through profitable relations with the government and universities.⁹⁹ Eschewing both these extremes—the hypocrisy of militarized disinterestedness on the one hand and the commercialization of knowledge production on the other—the FGCS and ICOT embodied a distinctly Japanese adaptation of the vision of science and technology R&D as a public good. Oriented around social problems and the needs of ordinary people, the FGCS offers a glimpse of an alternative modernity in which R&D was conducted free from the enabling constraints of the military-industrial complex.

Where the FGCS compromised on its commitment to universalism by focusing on the particular needs of the Japanese nation, it compensated by opening the project to foreign participation. ICOT was to become a global research hub for computing research, and international collaboration would become a central pillar of the FGCS. Nakano had originally assumed Japan would work alone on a national Fifth Generation project. But Moto-oka and

97. Nakamura and Shibuya, "Japan's Technology Policy"; Odagiri, Nakamura, and Shibuya, "Research Consortia as a Vehicle for Basic Research."

98. Kelly Moore, *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945–1975* (Princeton: Princeton University Press, 2008); Colin Garvey and Daniel S. Chard, "Disrupting the AAA\$, " in *Science for the People: Documents from America's Movement of Radical Scientists*, ed. Sigrid Schmalzer, Daniel S. Chard, and Alyssa Botelho (Amherst: University of Massachusetts Press, 2018), 36–61.

99. Mirowski, *Science-Mart*, 119.

Fuchi, both of whom had lived through WWII, demonstrated their commitment to universalism by arguing international collaboration would be essential on a project of such size, scope, and ambition.¹⁰⁰ Because “Our project is an effort to create a new age for modern man,” explained Fuchi, it “must not be exclusive or closed to outsiders.”¹⁰¹ Foreign researchers would be invited to participate, and results published in English as well as Japanese, including at conferences abroad, wherever possible.

Furthermore, this approach helped frame the project as a modernization effort fully worthy of a mature, developed nation: Japan, having achieved near economic parity with the United States—thanks in part to technology transfer from the West—would now give back to the international scientific community with the FGCS. As Fuchi saw it, international collaboration on computing in this mode was “the key to a new world.”¹⁰² This “new world” epitomized Japan’s alternative modernity: a new space, one differing from the Western information society not only in terms of vision and values, but spatially and materially in the very hardware and software from which it was to be constructed.

FROM JAPANESE DREAM TO JAPANESE THREAT: REACTIONS TO THE FGCS IN THE UNITED STATES, EUROPE, AND THE SOVIET UNION

Westerners quickly perceived the Fifth Generation Computer Systems project as a threat to Western economic and computing hegemony. This perception began at the 1981 launch of the project at the International Conference on Fifth Generation Computer Systems in Tokyo, which ran from October 19 through October 22. MITI’s earlier “catching-up” projects had been initiated with little if any English-language fanfare. By contrast, the FGCS was announced with what seemed to be, from the perspective of Westerners who had until then mostly ignored Japan’s computing activities, “as much publicity as the Japanese could muster.”¹⁰³ Invitations to the conference were sent, unsolicited, to computer science departments around the world. The ambitious and somewhat vague description of the Japanese project piqued the interest of the international computing community and

100. Moto-oka and Kitsuregawa, *The Fifth Generation Computer*.

101. Fuchi, “Revisiting Original Philosophy of Fifth Generation Computer Systems Project,” 7.

102. *Ibid.*, 7.

103. Brian Oakley and Kenneth Owen, *Alvey: Britain’s Strategic Computing Initiative* (Cambridge: MIT Press, 1989), 215.

inspired around eighty researchers from fourteen countries to attend. Around three hundred people came, including invited speaker Edward Feigenbaum. Nakano, the original Fifth Generation visionary, was away in New York for a business trip.¹⁰⁴

The form of the meeting was typical of any other computing conference. Moto-oka's opening keynote summarized the planning committee's report and outlined the project's ambitious plans.¹⁰⁵ He stated Japan's intention to be a full partner in the international scientific community and called for future cooperation with scientists and technologists abroad. Fuchi, Aiso, and Karatsu detailed their respective subcommittees' findings. Several junior FGCS researchers presented more technical memoranda. The invited lecturers mostly praised the project. Importantly, Feigenbaum concluded his talk by calling for international cooperation.¹⁰⁶ Finally, a summary panel and discussion closed out the conference.¹⁰⁷

Yet in the wide range of subjective responses the meeting provoked, it was nothing like an ordinary computing conference. The MITI bureaucrats in attendance, attempting to gauge the foreign reaction, faced a nearly impossible task.¹⁰⁸ First, there was the question of what was actually communicated. Nontrivial linguistic barriers between the Japanese hosts and their guests compounded the difficulty of communicating the Fifth Generation vision. Although senior FGCS researchers such as Fuchi could speak English, the reverse was not true.¹⁰⁹ Second, with more than two decades of experience in AI, many Western attendees offered advice to the fledgling program,

104. Uemae, *Japanizu Dorimu*, 119–45, 204.

105. JIPDEC, *1981 Nen: Dai 5 Sedai Conpyūta Kokusai Kaigi Kaigi Roku (Proceedings of the 1981 International Conference on Fifth Generation Computers)* (Nihon jōhō shori kaihatsu kyōkai [JIPDEC], 1982).

106. Edward A. Feigenbaum, "Innovation and Symbol Manipulation in Fifth Generation Computer Systems," in *Fifth Generation Computer Systems: Proceedings of the International Conference on Fifth Generation Computer Systems, Tokyo, Japan, October 19–22, 1981* (Tokyo: North-Holland, 1981), 226.

107. Tōru Moto-oka and Nihon Jōhō Shori Kaihatsu Kyōkai, eds., *Fifth Generation Computer Systems: Proceedings of the International Conference on Fifth Generation Computer Systems, Tokyo, Japan, October 19–22, 1981* (Amsterdam; New York: North-Holland Publishing Company, 1982).

108. Nakamura and Shibuya, "Japan's Technology Policy," 531.

109. Karen Fitzgerald and Paul Wallich, "Next-Generation Race Bogs Down," *IEEE Spectrum* 24, no. 6 (June 1987): 30. In the Japanese edition of the conference proceedings all four social goals of the project are in English, as are most technical diagrams. JIPDEC, *1981 Nen: Dai 5 Sedai Conpyūta Kokusai Kaigi Kaigi Roku (Proceedings of the 1981 International Conference on Fifth Generation Computers)*.

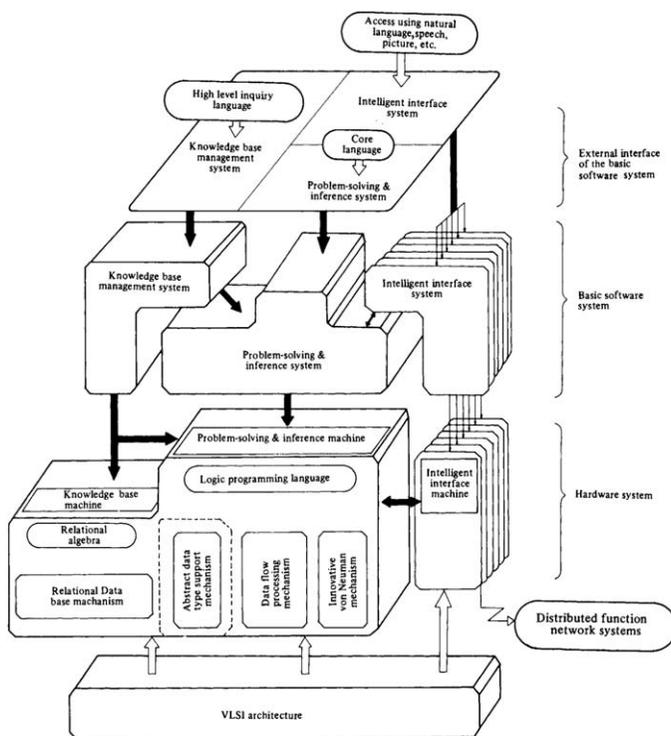


FIGURE 1. Basic configuration image of the fifth generation computer systems. *Source: Moto-oka, Tōru, and JIPDEC, eds. Fifth Generation Computer Systems: Proceedings of the International Conference on Fifth Generation Computer Systems, Tokyo, Japan, October 19–22, 1981* (New York, N.Y.: North-Holland Pub. Co., 1982).

but their paternalistic attitude and rhetorical portrayal of Japan as a “child” left the FGCS team cold.¹¹⁰ Third, the complex FGCS plan itself, with its litany of social goals interspersed alongside technical requirements for the society of the 1990s, perplexed many foreign attendees.¹¹¹ Despite the conference materials being presented and later published in English, many attendees found the materials, as one put it, “rather obscure.”¹¹²

110. See, e.g., Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World*, 24–29. For Japanese reclaiming of the “child” metaphor, see Uemae, *Japanizū Dorimū*, 206–13.

111. Ehud Y. Shapiro, “The Fifth Generation Project—a Trip Report,” *Communications of the ACM* 26, no. 9 (September 1983): 638–39.

112. Warren, “A View of the Fifth Generation and Its Impact,” 35.

For example, a conceptual diagram outlining the project (fig. 1), appeared throughout much of the FGCS literature for many years. In its complexity, the diagram not only evokes the difficulty faced by Western attendees in deciphering the project, but also encapsulates the Fifth Generation as a symbol of an alternative, Japanese modernity. Echoing a centuries-old trope common to Western accounts of visiting Japan, it suggests how the tables of cultural sophistication had turned.¹¹³ Dozens arrived from the Occident to find Japan doing something high-tech, something advanced—something, perhaps, too complicated, too different for the world’s leading computer scientists to understand as an integrated social and technical endeavor.

As if the FGCS were some cross-cultural, technologized Rorschach test, foreign attendees saw different things in the program, and their responses said more about themselves than their hosts. On the U.S. side, IBM, having been all but shut out of the domestic Japanese computer market (although in possession of a majority market share globally) was uninterested.¹¹⁴ By contrast, the British delegation saw a project worthy of emulation. The British had already been in discussions with the Japanese as to the possibility of collaboration on a large-scale national computing project prior to the conference, but afterward they were convinced that “the fifth-generation effort signaled a major, and expensive, thrust in informatics.” They returned with a new proposal for their superiors: Instead of collaboration, “there was an urgent need for the U.K. to form its own fifth-generation computing strategy.”¹¹⁵ The Department of Industry quickly organized a committee, led by the noted weapons scientist John Alvey, which proposed an R&D program “based heavily on the committee’s understanding of the Japanese approach, adapted to British circumstances”—such as the neoliberal government of Prime Minister Margaret Thatcher.¹¹⁶

After receiving what one reporter for *Science* called “a decidedly cold initial reaction from Thatcher,” England’s Conservative government “bent its free-market economic principles” and launched the Alvey Programme, a collabo-

113. Michael Cooper, ed., *They Came to Japan: An Anthology of European Reports on Japan, 1543–1640* (Ann Arbor: University of Michigan, 1995).

114. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 177–78.

115. Oakley and Owen, *Alvey*, 19.

116. Brian Oakley, “Great Britain,” *IEEE Spectrum* 20, no. 11 (November 1983): 70.

rative government-industry computing initiative, in April 1983.¹¹⁷ Funded at \$525 million over five years, “Alvey,” as it came to be called, was the first national response to Japan’s Fifth Generation.¹¹⁸ As Alvey director Brian Oakley reflected, “This is the first time in our history that we shall be embarking on a collaborative research project on anything like this scale.”¹¹⁹ Yet it was not a “national project” like Japan’s: Alvey broke with the post-WWII, state-led regime of science and technology R&D and adopted a neoliberal approach that *New Scientist* characterized as “Government money for firms.”¹²⁰

The United States soon followed. With anxieties about Japanese economic domination already high, a narrative stabilized: Japan’s FGCS was a direct challenge to American power and a threat to Western technological dominance. One of the first articulations came from David H. Brandin, then president of the Association of Computing Machinery (ACM), the world’s largest computing society. He warned that the FGCS “has generated considerable interest and excitement and clearly threatens the West’s technical supremacy in computer technology.” Although the threat from Japan, if there was one, was economic and certainly not military, the illustration that accompanied Brandin’s article—a sword-wielding, computerized samurai—provided a stunning visual template for his interpretation of the project as a threat to both economic and national security. Decades after the military conflagration that ended in nuclear terror from the skies, the global war had shifted to a new economic battlefield. And here was pacifist Japan, holding a sword over the head of any (Western) nation that dared stand in its path to “technical supremacy in computer technology.” Even if it should fail to meet its goals, Brandin argued, the Japanese project demanded an equivalent response: “I believe the West must make comparable investments in research and facilities.”¹²¹

Yet it was Feigenbaum who was most influential in reframing the FGCS as a threat and shaping the American response. He was not only an authority on AI, but also on Japanese computing in particular, having multiple ties to

117. David Dickson, “Britain Rises to Japan’s Computer Challenge,” *Science* 220, no. 4599 (1983): 799–800.

118. Jeffrey Hsu and Joseph Kusnan, *The Fifth Generation: The Future of Computer Technology*, 1st ed (Blue Ridge Summit, Penn.: TAB Books, 1989), 27.

119. Oakley and Owen, *Alvey*, 301.

120. P. Marsh, “The Race for the Thinking Machine,” *New Scientist* 95 (July 8, 1982): 87.

121. David H. Brandin, “ACM President’s Letter: The Challenge of the Fifth Generation,” *Communications of the ACM* 25, no. 8 (August 1982): 509, 510.

the country and the Fifth Generation.¹²² But after calling for international cooperation in his invited lecture at the 1981 FGCS conference, he began traveling around the United States giving seminars to computer scientists and government officials, raising the alarm about Japan's Fifth Generation.¹²³

Why? Feigenbaum, who had dedicated himself to reinvigorating the field of AI, was operating in a new, neoliberal space. AI, which had relied almost exclusively on military funds for decades, could no longer expect financial support from government agencies.¹²⁴ As Feigenbaum later recalled, he recognized that securing funds meant appealing to a “much broader community of influence outside of Washington,” including the “New York audience” and a “broadly-spread industrial audience.” Luckily, all those audiences were “quite interested, at the time, in Japan’s surge into the arena of business and technology.”¹²⁵ The launch of the FGCS thus provided Feigenbaum with the opportunity he needed to attract enough funding to revive AI in the United States. Recognizing that these audiences no longer believed in either the promise of AI or in funding science and technology R&D as a public good, he instead capitalized on the threat that Japan—rather than the United States—would be the one to realize AI’s promise.¹²⁶

Feigenbaum made his case in *The Fifth Generation: Japan’s Computer Challenge to the World* (1983), coauthored with Pamela McCorduck. Written for popular audiences, the book argues that the Japanese FGCS project posed a significant, credible threat to the United States. Feigenbaum and McCorduck began the book with a frank admission of its partisan nature, writing that they were “decidely not disinterested observers,” but were “writing this book because we are worried” about the Japanese threat. America, they said, must rise and meet the challenge because failure to respond would mean consigning “our nation to the role of the first great postindustrial agrarian society.”¹²⁷

122. Nilsson, Oral History of Edward Feigenbaum, 50.

123. For example, Edward Feigenbaum, “The Fifth Generation: What Is It? What Will It Mean to Corporate Competitiveness? The Diebold Multi-Sponsor Continuing Programs, Sixty-First Plenary Meeting, Grenelefe Resort, Grenelefe, Florida, October 17–19, 1983,” The Edward A. Feigenbaum Papers—Spotlight at Stanford, accessed May 10, 2018, <https://exhibits.stanford.edu/feigenbaum/catalog/gv953fv5007>.

124. Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge: MIT Press, 1996), 260–73.

125. Nilsson, Oral History of Edward Feigenbaum, 49–50.

126. Colin Garvey, “Broken Promises and Empty Threats: The Evolution of AI in the USA, 1956–1996,” *Technology’s Stories*, March 12, 2018, <http://www.technologystories.org/ai-evolution/>.

127. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 3.

In order to cast the Japanese FGCS project as a threat, the book made a three-part argument: First, it claimed that expert systems were transforming computers from “calculating machines” that relied on data, to “reasoning machines” that relied on knowledge. This change, the authors explained, was pushing the global economy toward a “New Wealth of Nations,” in which the most powerful nations will no longer be those that commanded material resources, but those that could exploit knowledge. Second, Japan, as a nation of few natural resources, had no choice but “to dominate the traditional forms of the computer industry” and “establish a ‘knowledge industry’ in which knowledge itself will be a salable commodity like food and oil.”¹²⁸ Building on Vogel’s argument that Japan embodied a post-industrial “knowledge economy,” Feigenbaum and McCorduck pointed to Japan’s recent economic success as proof the nation was already on its way to global dominance.¹²⁹ Third, they concluded the FGCS was nothing other than Japan’s attempt to take the global lead in the “knowledge industry” and “thereby become the dominant industrial power in the world.”¹³⁰ Reframed thus, the FGCS ironically became the ultimate neoliberal project. According to Feigenbaum and McCorduck, Japan threatened to undermine American dominance and disrupt the economic order by defeating other nations in the game of globalized capitalism with its Fifth Generation computers.

McCorduck remembers the book as being “quite restrained” and having “celebrated the Japanese vision.”¹³¹ But her recollection is contradicted by reviewers’ descriptions of its “audacious claims.” Indeed, after invoking the pitiful fate of America and the rest of the world under Japanese domination, the book concluded with an “unambiguous plea.”¹³² Feigenbaum and McCorduck called on their fellow citizens to commit their nation to compete against Japan in AI. “We believe that Americans should mount a large-scale

128. *Ibid.*, 2.

129. Drucker, *The Age of Discontinuity*; Bell, *The Coming of Post-Industrial Society*; Vogel, *Japan as Number One*; Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 20–23.

130. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 2.

131. Pamela McCorduck, *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence*, 25th anniversary update (Natick, Mass: A.K. Peters, 2004), 437.

132. Neil C. Rowe, “Review of ‘The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World’ by Edward A. Feigenbaum and Pamela McCorduck. Addison-Wesley 1983.,” *SIGMOD Rec.* 14, no. 1 (September 1983): 64–65; Saul Amarel, “Review of ‘The Fifth Generation,’” *AI Magazine* 4, no. 3 (September 15, 1983): 94.

concentrated project of our own; that not only is it in the national interest to do so, but it is essential to the national defense.”¹³³

Published at the height of America’s Japanophobia, the book, with its call for “an all-out mobilization of base nationalistic impulses” as one reviewer put it, proved highly successful and widely influential.¹³⁴ As Feigenbaum later recalled, the book “really caught people’s attention”—including the communities of influence he sought to reach.¹³⁵ It was even a best-seller in Japan.¹³⁶ Of course, the book had its critics.¹³⁷ But it succeeded in redefining the FGCS as a serious threat by playing off of American economic insecurity, reinterpreting the significance of computing and AI through the neoliberal lens of the “knowledge industry,” and wrapping the entire package in the Cold War rhetoric of national technology programs, national security, and international competition—a language that both policymakers and the broader public could understand.

Animated in part by the widespread alarm Feigenbaum and McCorduck generated, the United States launched two major national computing projects within the year. According to Feigenbaum and McCorduck, the FGCS symbolized the Japanese threat in the same way the launch of *Sputnik* symbolized the Soviet threat decades earlier—and it demanded the same kind of response. America, they wrote, “needs a national plan of action, a kind of space shuttle program for the knowledge systems of the future.”¹³⁸ Despite the invocation of *Sputnik*, however, the AI programs that America responded with bore little resemblance to the moon landing, space shuttle, and other state-led national programs of America’s Cold War regime.¹³⁹ Instead, they

133. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 216.

134. On 1980s American Japanophobia, see Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015); Howard Ullman, “Machine Dreams,” *The New Republic*, July 17, 1989, 12.

135. Nilsson, Oral History of Edward Feigenbaum, 51.

136. Uemae, *Japanīzu Dorīmu*.

137. For a critical response see Unger, *The Fifth Generation Fallacy*, 6. For guarded praise, see Toshiaki Yasuda, “Review: The Fifth Generation—Artificial Intelligence and Japan’s Computer Challenge to the World,” *Journal of Japanese Trade & Industry* 1 (1984).

138. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan’s Computer Challenge to the World*, 3.

139. For an historical view of the differences between projects under the old Cold War regime and under neoliberal corporate capitalism, see Thomas Haigh, “Hey Google, What’s a Moonshot?: How Silicon Valley Mocks Apollo,” *Communications of the ACM* 62, no. 1 (December 19, 2018): 24–30.

were pioneering neoliberal efforts, exemplars of the burgeoning commercialized regime of science and technology R&D.

The Microelectronics and Computer Technology Corporation (MCC), a for-profit industrial consortium of thirteen corporations, was founded in September 1983. Such consortia had been illegal before the neoliberal reforms undertaken during Reagan's first term in office.¹⁴⁰ Initially funded at \$250 million over four years and led by former CIA deputy director Admiral Bobby Inman, MCC was considered by the American computing community to be a direct counter to the Japanese project because it was a rare example of rival Western corporations cooperating with one another, not unlike MITI's arrangements across the Pacific at ICOT.¹⁴¹ Though MCC was heralded widely for the cooperative spirit in which it was initially undertaken, the purported resemblance to the Japanese project was superficial; at the fundamental level of scientific ethos, they were nothing alike. Whereas researchers from different companies worked side-by-side on shared projects at ICOT, spatially enacting the FGCS's commitment to openness, the for-profit MCC reflected the neoliberal regime of science organization. The *IEEE Spectrum* reported that it "shrouded much of its research in secrecy to protect shareholder advantage" almost immediately after launch, resulting in forced "isolation between projects" that undermined the potential benefits of cooperation between firms.¹⁴² Though they overlapped temporally, the FGCS and MCC existed within and operated according to the values of two alternative modernities clashing across the Pacific.

The other major U.S. response was the Strategic Computing Initiative (SCI), a decade-long, \$1 billion applications-oriented project to create autonomous weapons and AI systems for each branch of the military.¹⁴³ The program was finally set in motion after the U.S. Congress called Feigenbaum to testify about the Japanese threat in June 1983. Appearing alongside DARPA director Robert Cooper, Feigenbaum put his arguments into the mouths of the Japanese themselves. The Japanese "have a slogan" for the coming economic changes that computers and AI will bring about, he

140. Mirowski, *Science-Mart*.

141. M.A. Fischetti, "The United States," *IEEE Spectrum* 20, no. 11 (November 1983): 51-69; Mark A. Fischetti, "A Review of Progress at MCC: Although Its Current Objectives Do Not Include 'Beating Japan,' This U.S. Organization Is Positioned to Help Industry Do So," *IEEE Spectrum* 23, no. 3 (March 1986): 76-82.

142. Fitzgerald and Wallich, "Next-Generation Race Bogs Down," 32.

143. Edwards, *The Closed World*, 294.

explained; “they call it the *knowledge industry*. The Japanese view knowledge as the *new wealth of nations*, similar to oil, natural resources, and agriculture.” MITI, he said, “has set a goal for Japan to be number one in the world computer industry in the late 1990s and beyond,” and the FGCS was their plan to achieve it.¹⁴⁴

Setting the stakes in stark, deterministic terms, Feigenbaum warned Congress that the era of “reasoning machines is inevitable. It is the ‘manifest destiny’ of computing.” Whether or not he intended to suggest the locus of computing was headed West across the Pacific to Japan, Feigenbaum’s message was clear: Japan was threatening to undermine American exceptionalism with advanced AI, and something had to be done. He proposed three options: First, engage in “some kind of orchestrated national response,” as he had advocated in his book. Second, create an “ICOT-like center”—not modeled on the old regime of open, disinterested R&D for the public good, but as an expression of America’s will to power in a neoliberal modernity ruled by competition in all domains—a “manifestation of the national will to maintain our number one position in the computing world.” Or third, do nothing and invite disaster.¹⁴⁵

Feigenbaum did not list cooperation with the Japanese as one of the options, an omission that Congressman Buddy Mackay probed. Reasoning that if “Japan is an ally in their democratic society and our futures are sort of irretrievably bound up militarily” then “we ought to be encouraging cooperation,” Mackay asked Feigenbaum to explain himself. Feigenbaum replied by drawing on his significant experience with the Japanese FGCS project to conclude that “It just doesn’t sound like they are inviting international cooperation.”¹⁴⁶

Whatever it sounded like, DARPA’s own stratagem called for competition, not cooperation. DARPA had been trying without success to launch a massive, AI-focused computing project for several years before Feigenbaum’s testimony. Historians Alex Roland and Philip Shiman note in their account of the SCI that while Feigenbaum had been derided as “chicken little” in the computing community, Congress, on the other hand, “embraced Feigenbaum’s sense of alarm.”¹⁴⁷ By portraying Japan’s Fifth Generation as

144. Edward A. Feigenbaum, “Testimony to the US House of Representatives, Committee on Science & Technology,” June 29, 1983, 110, 111. My emphasis.

145. *Ibid.*, 116, 117, 120.

146. *Ibid.*, 136.

147. Alex Roland and Philip Shiman, *Strategic Computing: DARPA and the Quest for Machine Intelligence, 1983–1993* (Cambridge: MIT Press, 2002), 91–92.

a credible threat and advocating for a large-scale national response, Feigenbaum's expert testimony provided the justification DARPA needed for the SCI.¹⁴⁸

Yet two of the main architects of the SCI privately doubted Feigenbaum's threat assessment: Robert Cooper, the DARPA director, and Robert Kahn, the director of DARPA's Information Processing Techniques Office (IPTO), the division most closely involved with AI. Having attended the 1981 FGCS conference themselves, they returned with a different impression: the Japanese were still trailing the United States in computing and headed down a dead-end with the FGCS, which posed no threat. This analysis did not stop them, however, from exploiting the opportunity Feigenbaum's alarmism presented. In later interviews, Cooper confessed to trundling out the Japanese "as the arch-enemies" and using Feigenbaum's threat narrative "unabashedly" in private conversations with congresspeople and senators.¹⁴⁹ The scare tactic worked.¹⁵⁰ The SCI passed Congress and was signed by President Ronald Reagan in December 1983.

The willingness of the SCI's architects to enroll government officials to their cause—by Machiavellian means if necessary—reflected the new, privatized, neoliberal model at work. Economic historian Philip Mirowski has argued that despite an exoteric aversion to government intervention in markets, the esoteric core of neoliberalism holds that free markets do not arise organically but must be created by historical actors; therefore government intervention is necessary to leverage the state's resources and authority in service of the market.¹⁵¹ Thus while governments had created the digital infrastructure necessary to transform the entire globe into a field of potential military action during the Cold War, neoliberalism, using the rhetoric of globalization, leveraged government funds to further transform the world into a field of action for markets.¹⁵²

By the early 1980s, markets had become the primary battlefield for international competition, and neoliberal logics would determine how Western computer scientists, government officials, and business executives would evaluate the success and failure of the FGCS and its Western counter-projects. Historian Paul Edwards describes how the SCI plan thus "made much of

148. Nilsson, Oral History of Edward Feigenbaum, 51.

149. Roland and Shiman, *Strategic Computing*, 93.

150. McCorduck, *Machines Who Think* (2004), 437.

151. Mirowski, *Science-Mart*; Mirowski, *Never Let a Serious Crisis Go to Waste*.

152. Collins, *A Telephone for the World*.

potential commercial spin-offs,” and its “unity of commercial and military goals stemmed from the Reagan-era view of the two spheres as elements of a larger geostrategic system” in which competition—military and market-based—linked everything together in a “closed world.”¹⁵³

Further responses followed from Europe.¹⁵⁴ The most prominent of these was the European Strategic Programme on Research in Information Technology (ESPRIT). Hailed for its cooperative ethos, ESPRIT connected private firms, government agencies, and academic research labs in contractual arrangements organized by the European Economic Community (EEC), the predecessor to the European Union.¹⁵⁵ With a budget of nearly \$2 billion over five years, ESPRIT also funded smaller AI-related computing programs launched by several EEC members around the same time.¹⁵⁶ Because ESPRIT supposedly demonstrated the need for supra-national organizations (here, the EEC) to coordinate various states’ funding for science and technology R&D on behalf of a globalized market, ESPRIT was an early demonstration of transnational neoliberal governance.¹⁵⁷

Commenting on the series of computing programs rapidly being launched around the world, many journalists adopted a familiar Cold War trope, describing a global “race for AI.”¹⁵⁸ The competition had intensified to the degree that Alvey director Brian Oakley remarked, “It’s like some sort of warfare. . . . It’s strange that we should compete in this nationalistic way.”¹⁵⁹ In fact, it was *economic* warfare; state-funded, market-driven competition between military allies—clearly different from the nuclear arms race that drove science and technology R&D under the old Cold War regime. Accordingly, the Soviets were merely peripheral actors in this drama. Feigenbaum and

153. Edwards, *The Closed World*, 298.

154. For projects in France, West Germany, and Europe more broadly, see Shōhei Kurita, *90-Nendai No Konpyūta Wōzu: Chiteki Jōhō Shori e No Biggu Torendo (Computer Wars of the 1990s: Big Trends in Intelligent Information Processing)* (Tōkyō: Nikkan Kōgyō Shinbunsha, 1988), 24–25.

155. H. Nasko, “European Common Market,” *IEEE Spectrum* 20, no. 11 (November 1983): 71–72.

156. Hsu and Kusnan, *The Fifth Generation*, 25.

157. Wayne Sandholtz, “ESPRIT and the Politics of International Collective Action,” *Journal of Common Market Studies* 30, no. 1 (March 1992): 1–21.

158. Marsh, “The Race for the Thinking Machine”; Schrage, “‘5th Generation’ Spurs a Global Computer Race”; Fitzgerald and Wallich, “Next-Generation Race Bogs Down”; Data Processing, “Fifth Generation: The Race Is On,” Manuscript, November 1983, Folder 10, Box 37, SC0340, Accession 2005–101, Department of Special Collections and University Archives, Stanford University Libraries.

159. Schrage, “‘5th Generation’ Spurs a Global Computer Race.”

McCorduck's book dismissed them in less than two pages as doing "pretty boring stuff."¹⁶⁰ Western actors hardly noticed when the USSR, the last of the major powers to enter the race, launched what was by their own standards a major response to Japan's Fifth Generation.¹⁶¹ The five-year Soviet plan coordinated computing projects across nations such as Bulgaria, Czechoslovakia, East Germany, Hungary, and the Soviet Union and was funded at a comparatively modest level of \$100 million for 1984 to 1989.¹⁶² Evidently, the neoliberal regime had penetrated beyond the Iron Curtain; *Datamation* magazine described how the Eastern Bloc governments justified the projects as "necessary for their economic and military survival."¹⁶³

EPILOGUE: CHANGING THE RULES OF THE GAME

Here we return to the historically resonant situation with which this article began: the present-day Global AI Arms Race. Today, the economic, technological, and cultural competition is primarily between the United States and another Asian superpower—China—with participation from nations and corporations around the world. Some similarities are uncanny. China—increasingly seen as a potential Number One—promotes its AI plan, developed by bureaucrats at its Ministry of Science and Technology, as a means to provide public goods to its citizens.¹⁶⁴ AI experts in the West raise the alarm about the threat of an AI-dominant China, and business leaders take notice, fearful of losing the race.¹⁶⁵ As governments around the world respond by funding AI, the United States issues top-down directives funding military-led industry-university collaborations.¹⁶⁶ Even SCI architect Robert Kahn's

160. Feigenbaum and McCorduck, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World*, 172.

161. P. Walton and P. Tate, "Soviets Aim for 5th Gen," *Datamation*, July 1, 1984.

162. Hsu and Kusnan, *The Fifth Generation: The Future of Computer Technology*, 32.

163. Walton and Tate, "Soviets Aim for 5th Gen."

164. Graham Webster et al., "China's Plan to 'Lead' in AI: Purpose, Prospects, and Problems," *New America*, August 1, 2017, <https://www.newamerica.org/cybersecurity-initiative/blog/chinas-plan-lead-ai-purpose-prospects-and-problems/>.

165. Jeremy Kahn, "Deep Learning 'Godfather' Bengio Worries About China's Use of AI," *Bloomberg.com*, February 2, 2019, <https://www.bloomberg.com/news/articles/2019-02-02/deep-learning-godfather-bengio-worries-about-china-s-use-of-ai>; Heather Long, "In Davos, US Executives Warn That China Is Winning the AI Race," *Stars and Stripes*, January 23, 2019, <https://www.stripes.com/news/europe/in-davos-us-executives-warn-that-china-is-winning-the-ai-race-1.565648>.

166. Tim Dutton, Brent Barron, and Gaga Boskovic, "Building an AI World: Report on National and Regional AI Strategies," Toronto, Ont.: CIFAR, 2018; DARPA, "DARPA Announces \$2 Billion Campaign to Develop Next Wave of AI Technologies," accessed November 14, 2018,

pronouncement that the “nation that dominates [AI] will possess the keys to world leadership in the twenty-first century” is echoed by Russian President Vladimir Putin’s remark that “Whoever leads in AI will rule the world.”¹⁶⁷

Yet today’s iteration comes with important differences from the story of the FGCS in the 1980s. Whereas democratic Japan sought to lead through large-scale scientific practice for the public good, authoritarian China uses AI as an instrument of social control and repression.¹⁶⁸ Whereas the Fifth Generation was free of military influence and corporate profit-seeking, the U.S. AI industry, led by some of the most profitable companies in modern history, remains thoroughly intertwined with the military.¹⁶⁹ In this light, the FGCS remains comparatively unique.

As of this writing, it remains to be seen how the current race for AI will unfold. But how did the first AI race, the Global AI Arms Race of the 1980s, play out? Japan’s Fifth Generation Computer Systems project officially launched in 1982 and ran in three stages until 1993, when it received a two-year extension.¹⁷⁰ As planned, the initial stage (1982–1985) focused on R&D for basic technologies, the intermediate stage (1985–1989) on subsystem development, and the final stage (1989–1993) on total prototype systems.¹⁷¹ Under

<https://www.darpa.mil/news-events/2018-09-07>; Donald J. Trump, “Executive Order on Maintaining American Leadership in Artificial Intelligence,” The White House, February 11, 2019, <https://www.whitehouse.gov/presidential-actions/executive-order-maintaining-american-leadership-artificial-intelligence/>.

167. R.E. Kahn, “A New Generation in Computing,” 36; “Whoever Leads in AI Will Rule the World: Putin to Russian Children on Knowledge Day,” *RT International*, September 1, 2017, <https://www.rt.com/news/401731-ai-rule-world-putin/>.

168. Josh Chin, Clément Bürge, and Giulia Marchi, “Twelve Days in Xinjiang: How China’s Surveillance State Overwhelms Daily Life,” *Wall Street Journal*, December 20, 2017, <https://www.wsj.com/articles/twelve-days-in-xinjiang-how-chinas-surveillance-state-overwhelms-daily-life-1513700355>; Christina Larson, “China’s Massive Investment in Artificial Intelligence Has an Insidious Downside,” *Science | AAAS*, February 7, 2018, <http://www.sciencemag.org/news/2018/02/china-s-massive-investment-artificial-intelligence-has-insidious-downside>.

169. Cade Metz, “Pentagon Wants Silicon Valley’s Help on A.I.,” *The New York Times*, March 15, 2018, <https://www.nytimes.com/2018/03/15/technology/military-artificial-intelligence.html>; Lee Fang, “Google Is Quietly Providing AI Technology for Drone Strike Targeting Project,” *The Intercept*, March 6, 2018, <https://theintercept.com/2018/03/06/google-is-quietly-providing-ai-technology-for-drone-strike-targeting-project/>; Scott Shane and Daisuke Wakabayashi, “The Business of War: Google Employees Protest Work for the Pentagon,” *The New York Times*, April 4, 2018., <https://www.nytimes.com/2018/04/04/technology/google-letter-ceo-pentagon-project.html>.

170. The “FGCS Follow-on Project” ran until 1995. Shunichi Uchida et al., “Outline of the FGCS Follow-on Project,” *New Generation Computing* 11, no. 2 (June 1993): 217–22.

171. Kazumasa Yokota, “Fifth Generation Systems,” *Encyclopedia of Electrical & Electronics Engineering* 7 (January 7, 1999): 423–35.

Fuchi's direction, the FGCS conducted R&D openly in a communal environment of scientific inquiry. Researchers found the open setting to be highly conducive to interdisciplinary collaboration, something they longed for after returning to their companies.¹⁷² International collaboration was central to the project. Hundreds came from overseas to visit ICOT each year, including Feigenbaum.

By the project's end, the original Japanese dream of producing non-von Neumann computer hardware running software written in logic programming languages (first PROLOG, then a series of refinements) had been achieved.¹⁷³ Working prototype "knowledge information processing systems" running a variety of software applications were demonstrated at the final FGCS conference in 1993.¹⁷⁴ Finally, the commitment to international cooperation and disinterestedness culminated in the open-access publication of the project's entire archive of software and scientific results on the young Internet.¹⁷⁵

When the project concluded, it was certainly a new world. But not the world Fuchi, Nakano, or anyone who believed in the Japanese Dream of a Fifth Generation computer had envisioned. The Cold War had ended in the fall of the Soviet Union, leading to American consolidation of geopolitical power and the so-called "end of history" in the triumph of liberal democracy and "free markets."¹⁷⁶ That the 1980s had been dominated by state-led national economies was overlooked as neoliberalism became the new common sense.¹⁷⁷ Neoliberal ideology prevailed worldwide—in both legislation and the information technology networks repurposed from their Cold War military origins to digitally connect local markets into a globalized economy.¹⁷⁸ The commercialized regime of science and technology R&D

172. Kunio Murakami et al., "Reunion of Former ICOT Researchers (The Latter Part)," *ICOT Journal* 11 (March 1986): 8–20. The project produced three English-language journals: *ICOT Journal*, *New Generation Computing*, and *Future Generation Computing*.

173. Ehud Shapiro and David H. D. Warren, "Epilogue," *Commun ACM* 36, no. 3 (March 1993): 101.

174. R.P. van de Riet, "Guest Editorial: Fifth Generation Computer Systems: Success or Failure?," *Future Generation Computer Systems* 9, no. 2 (July 1993): 79–81; "An Overview and Appraisal of the Fifth Generation Computer System Project," *Future Generation Computer Systems* 9, no. 2 (July 1993): 83–103.

175. Kazuhiro Fuchi, "The Fifth Generation Computer Project: What I Think about It after Eleven Years," コンピュータソフトウェア (*Konpyūta Sofutouea*), Japan Society for Software Science and Technology (JSSST), 25, no. 3 (July 25, 2008): 66–68.

176. Francis Fukuyama, "The End of History?," *The National Interest*, no. 16 (1989): 3–18.

177. Harvey, *A Brief History of Neoliberalism*, 88.

178. Collins, *A Telephone for the World*.

was ascendant—except in Japan, whose state-led miracle-cum-bubble economy had collapsed.¹⁷⁹

In the information society of the 1990s, Fuchi and his team of researchers at ICOT had to endure the indignity of being told that the Fifth Generation was a failure.¹⁸⁰ Ehud Shapiro and David Warren, two researchers who worked on the FGCS, suggested the project simply failed to live up to the hype: the West perceived Japan as “promising to make the dream of artificial intelligence (AI) come true,” claims that were “further amplified by scientists around the world, who capitalized on the fear of Japanese technological supremacy in order to scare their own governments into funding research.”¹⁸¹ Indeed, Feigenbaum and McCorduck’s argument had circulated globally, procuring public money for AI and computing wherever it went. But once funding was secure, the threat narrative was no longer necessary; computing experts discarded it within a few years.¹⁸²

Nevertheless, after Feigenbaum and others had reframed the FGCS as the ultimate neoliberal computing project, the image stuck. And when Japanese computers failed to dominate the global economy by the 1990s, many in the West regarded the Fifth Generation as a failure. Fuchi, noting how “an exaggerated image of the project was engendered” early and “seems to persist even now,” complained of a Catch-22: “we [initially] had to face criticism, based on that false image, that it was a reckless project trying to tackle impossible goals. Now we see criticism, from inside and outside the country, that the project has failed because it has been unable to realize those grand goals.”¹⁸³

This outcome was ironic because, as physicist and Kobe University Emeritus Professor Matsuda Takuya notes, while the FGCS was called a “big failure” abroad, many Western nations attempted similar projects, and “all of them failed too.”¹⁸⁴ What AI chronicler Daniel Crevier called the

179. Saori N. Katada and Gene Park, “Fiscal Survival and Financial Revival: Possible Futures for the Japanese Economy,” in *Japan: The Precarious Future*, ed. Frank Baldwin and Anne Allison (New York: New York University Press, 2015).

180. Ehud Shapiro and David H. D. Warren, “Personal Perspectives,” *Communications of the ACM* 36, no. 3 (March 1993): 48.

181. Shapiro and Warren, “Epilogue,” 100.

182. See, e.g., David H Brandin and Michael A Harrison, *The Technology War: A Case for Competitiveness* (New York: Wiley, 1987), 162.

183. Kazuhiro Fuchi et al., “Launching the New Era,” *Communications of the ACM* 36, no. 3 (March 1993): 49.

184. Takuya Matsuda, *Jinrui o koeru ēai wa nihon kara amareru* (Tokyo: Kōsaidōshuppan, 2016), 38–39. Author’s translation.

“Rollercoaster of the 1980s” resulted in near-total collapse by the end of the decade.¹⁸⁵ Dozens of expert systems companies and AI-focused hardware manufacturers failed *en masse* as hype turned to disillusionment.¹⁸⁶ In 1993, as the FGCS concluded with a final international conference and professional evaluations of the project by international teams of computing experts, the SCI “did not quite end; it simply disappeared,” having simply “vanished” from the DARPA budget.¹⁸⁷ Moreover, IBM “announced the biggest loss in corporate history,” plunging the company into a “deep crisis” from which it did not emerge for many years.¹⁸⁸

Yet while the SCI, MCC, Alvey, and ESPRIT are typically remembered as partial successes, Japan’s FGCS is regarded as an outright failure, even a tragedy.¹⁸⁹ Crevier’s evaluation, for example, is typical: whereas the SCI merely “disappointed its military sponsors,” he claims “the Japanese fell far short of their objectives.”¹⁹⁰ Subsequent AI histories continue to repeat this evaluation.¹⁹¹

To be sure, Japan’s Fifth Generation did not lead to the domination of the global economy, nor did it produce any commercial technologies.¹⁹² The fact that economic payoff was never the goal, and that MITI considered the project a success on its own merits, did not matter.¹⁹³ The rules of the game had changed: At the close of the 1980s, state-led Japanese computing programs still offered a compelling, alternative model to the West.¹⁹⁴ But by the mid-1990s, with the Japanese economy stalled out, “the very same system of science management that had been praised for its postwar economic success was then equally indicted as an explanation of its stagnation,” and Japan

185. Daneil Crevier, *AI: The Tumultuous History of the Search for Artificial Intelligence* (New York: Basic Books, 1993), 210–12.

186. Andrew Pollack, “Setbacks for Artificial Intelligence,” *The New York Times*, March 4, 1988, sec. Business Day, <https://www.nytimes.com/1988/03/04/business/setbacks-for-artificial-intelligence.html>.

187. Roland and Shiman, *Strategic Computing*, 285.

188. Fransman, *Japan’s Computer and Communications Industry*, 167.

189. Callon, *Divided Sun*, 129.

190. Crevier, *AI*, 197.

191. Pamela McCorduck, *Machines Who Think* (2004), 441; Nils Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and Accomplishments* (Springer, 2010), 351.

192. Edward Feigenbaum and Howard Shrobe, “The Japanese National Fifth Generation Project: Introduction, Survey, and Evaluation,” *Future Generation Computer Systems* 9, no. 2 (July 1993): 116.

193. Nakamura and Shibuya, “Japan’s Technology Policy,” 509.

194. See, e.g. Anchordoguy, *Computers Inc.*, 185–86.

undertook rapid and far-reaching neoliberal reforms.¹⁹⁵ In a variation on a familiar pattern, Japan improved and refined the imported American regime of privatized science and technology R&D, adapting it to the Japanese context with verve.

The supposed failure of the Fifth Generation tainted the reputation of AI in Japan for more than a decade. Leading contemporary University of Tokyo AI researcher Yutaka Matsuo has observed that from 1997 to 2002, AI was so taboo that to even use the Japanese word for it (*jinkō chinō*) drew condemnation.¹⁹⁶ Nevertheless, the Japanese Dream of the Fifth Generation—an alternative modernity in which science and technology R&D are conducted according to refined norms—lived on in his generation. Praising the FGCS for bringing “excellent, talented people together in AI research” and “inviting famous researchers from overseas,” Matsuo imagines how the Japanese computing industry might have progressed differently: “I know there is no ‘What if?’ in history, but my dream is to imagine that if the Web had appeared 15 years earlier, Japan would be sitting where Silicon Valley is right now.”¹⁹⁷

This trans-Pacific juxtaposition allows two final lessons to be drawn from the FGCS. As the technology industry, academics, and governments grapple with the problem of how to do ethically and socially responsible AI, the FGCS stands out as an exemplar. Deliberative, open, and oriented around the needs of ordinary people, it was the first (and last?) large-scale national AI program conducted on the model of science and technology R&D as a public good. It is proof that AI can be pursued at a high level by leading technologists free from the hypocrisies of military funding and the constraints of corporate profiteering. As one alternative to neoliberal modernity, Japan’s Fifth Generation demonstrates that others are yet possible.

At the same time, the FGCS stands as a warning about the danger of hubris. At the height of Japan’s economic preeminence, the well-positioned, well-intentioned architects of the Fifth Generation thought they could anticipate what the Japanese society of the 1990s would look like—and even what technologies would be needed to fix its future problems. Despite the considerable advantages provided by billions of yen, some of the world’s brightest technical minds, and an innovative workplace in a global hub city

195. Mirowski, *Science-Mart*, 134–35.

196. Matsuo, *Jinkō Chinō Wa Ningen o Koeru Ka*, 3–4. Author’s translation.

197. *Ibid.*, 107–9.

on the Pacific Rim, they—like most technocrats throughout history—were more or less wrong. None of them foresaw that the mid-1990s would bring a “personal computing” revolution in the form of von Neumann architecture-based desktop computers, or that the most enduring symbol of the Japanese Information Society would not be the Fifth Generation, but the Nintendo, made by an arcade game manufacturer founded in the late nineteenth century.¹⁹⁸ ■

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198. Ceruzzi, *A History of Modern Computing*; Morris-Suzuki, *The Technological Transformation of Japan*, 221.