

## Original Paper

# Entrepreneurs, Teams, and Bureaucracy in Post-WWII America

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### Abstract

*This article leans against specialization by cutting across three disciplines to analyze the entrepreneurial function in modern, U.S. capitalism. The author blends the basic ideas of Joseph A. Schumpeter (economics), Alfred D. Chandler (history), and Max Weber (sociology), with recent work done by Daniel Kahneman in behavioral economics. Two case studies are used to illustrate how these ideas interact in the study of innovation; one of the case studies focuses on a startup business and the other on a large, well-established, bureaucratic firm.*

### Keywords

*entrepreneurship, bureaucracy, industrial revolutions, opportunity*

### 1. Introduction

Specialization has contributed to the success of the developed economies, but it has also enacted a price. All too often, scholars today are isolated in their disciplinary and sub-disciplinary silos, reading only their major journals and remaining oblivious to closely related intellectual developments outside of their disciplinary boundaries. The following article addresses that problem and concludes that historians of modern America can develop new perspectives on capitalism and entrepreneurship, its driving force, by blending the ideas of Joseph Schumpeter, Alfred Chandler, and Max Weber with recent work in behavioral economics—in particular, the work of psychologist Daniel Kahneman. Schumpeter, Chandler, and Weber are, of course, very familiar to most historians, and especially those in economic and business history. Kahneman's Nobel-Prize winning explorations of behavioral economics are, however, less well-known and certainly less frequently employed in recent historical studies of modern capitalism. This is likely to change in the next few years, and this article attempts to accelerate that process insofar as studies of U.S. entrepreneurship in the second half of the twentieth century are concerned (Note 1). Along the way, the article also tries to establish a nuanced, middle ground between the stereotypes of stultifying bureaucracy and energizing entrepreneurship.

## 2. Schumpeter and Kahneman

Let's start with Schumpeter, the intellectual father of entrepreneurial studies in economic and business history in America and many other countries. He was the classic intellectual hedgehog, that is, a thinker who developed a central synthesis that he elaborated and refined over his lifetime but never changed in any decisive way (Note 2). Like Marx, his protagonist and model, Schumpeter provided us with a history-based, dynamic theory that explained the evolution of capitalism. Schumpeter's version was a growth-oriented system that was kept in permanent disequilibrium by the activities of its successful entrepreneurs (Note 3). The innovators who most interested Schumpeter were those who were most successful in developing businesses that reshaped production functions and thus drove the capitalist economy ahead in grand spurts of activity (Note 4). They created and moved markets. They were heroic business empire builders who, like Hegel's blind heroes, achieved general results while they sought self-interested, specific ends (Note 5). In his last major work, Schumpeter suggested that bureaucracy inside and outside the capitalist enterprise would eventually suppress the system's entrepreneurs.

What then can Kahneman add to this important model of capitalism? Kahneman's psychology—with its emphasis on fast (that is instinctive) and slow (that is calculating) thinking is particularly useful when we move down-scale to look at the middle and bottom of the entrepreneurial population at any one time. This brand of behavioral economics helps us understand why so many of those entrepreneurs failed, and why some tried again and again to build successful enterprises (Note 6). What they helped to launch were searches for viable opportunities, a general search process shaped in part by an entrepreneurial culture as well as economic incentives (Note 7). What Kahneman needs to take from Schumpeter is an emphasis on innovation's central role in the capitalist growth process (Note 8). So in this case there can be a true blending of ideas.

## 3. Chandler and Kahneman

Kahneman's approach to economic behavior can also add some important concepts to Alfred D. Chandler's synthesis of American business history in the nineteenth and twentieth centuries. Chandler, like Schumpeter, stressed the role of major firms and their leaders in shaping a second industrial revolution that brought the United States to the top of the heap in global industry and giant firms to the top of the heap in the American economy. Chandler—another hedgehog—stressed economies of scale and scope in bringing about these seemingly costless and largely errorless transitions (Note 9).

Kahneman's approach suggests that even the moguls were likely to have frequently overestimated their power and, like Chandler, largely ignored their mistakes. Some of their mistakes became apparent during the eras of Progressive and New Deal reform. Some were revealed in antitrust cases (Note 10). Others became apparent during the Great Depression of the 1930's and the three decades after WWII, when global competition began to wipe out entire American industries and take substantial market share from other U.S. enterprises in the 1960s and 1970s. As Kahneman notes, "the optimistic bias may

well be the most significant of the cognitive biases (Note 11).” Insofar as startups were significant during the post-WWII era, Kahneman makes us ponder the System 2 (slow thinking) capabilities they needed to succeed; they include: the ability to raise capital under conditions of uncertainty; to build an effective team; and to deal successfully with their business’s competitive and political environments. Insofar as large firms were innovative, Kahneman can benefit by accommodating Chandler’s great contribution: his emphasis upon the benefits of the massive organizational changes that took place when U.S. business leaders transformed centralized into decentralized and diversified industrial firms. Once again, there can be a creative sharing of ideas.

#### **4. Max Weber and Kahneman**

Now let’s add our third great hedgehog to the history. The sample I am using from Weber’s extensive work is the section of “The Theory of Social and Economic Organization” that deals with the three great structures of authority (Note 12). You will probably recall that Weber said bureaucracy “is superior to any other form [of authority] in precision, in stability, in the stringency of its discipline, and in its reliability.” Central to Weber’s theory was his conclusion that all of the modern, developed societies had moved relentlessly toward the bureaucratic structure of authority because it was the most rational and efficient way to organize large groups of people (Note 13). Weber’s focus was primarily on the public sector, but he was mindful that modern businesses were also bureaucracies.

The task of blending Weber’s sociology of “pure types” with behavioral economics and focusing the combination on entrepreneurship is challenging because Weber never seems to have worried about innovation and Kahneman only flirts briefly (pp. 417-418) with organizations and never specifically discusses bureaucracy. Despite this problem, I think we can link these two bodies of thought. Fortunately, Chandler and Schumpeter have provided us with intellectual bridges to Weber through their descriptions of private sector bureaucratization and its implications for the capitalist system. Schumpeter was intensely negative about both public and private bureaucratization; Chandler was intensely positive about what he referred to as “professional management”. He was largely dismissive of the public sector.

Left suspended between these two evaluations, we can start to figure out where we stand by asking how public and private bureaucracy impacted the fast thinking (System 1) aspects of entrepreneurship. Clearly—following analysts such as Robert Merton, James B. Taylor, and Alvin Gouldner—bureaucracy in all of its forms primarily impaired the entrepreneurial instinct. In both startups and large firms, the leaders needed to grapple with what Kahneman calls WYSIATI, the assumption that “What You See Is All There Is”. WYSIATI and the closely related “sin” of hubris clearly kept many American executives from anticipating the intense global competition of the 1970s and 1980s (Note 14). Where slow thinking (System 2) aspects like obtaining capital, engaging in marketing and sales, and handling accounting were involved, however, the histories of entrepreneurship and bureaucratic authority are a mixed bag of negative and positive outcomes (Note

15). Perhaps the best way to start sorting those out is to look at some specific examples of entrepreneurship in postwar America.

### **5. Results: System 1 and System 2 Thinking in Two Entrepreneurial Ventures**

For purposes of illustration (not proof) we can consider a specific example of successful innovation in the midst of the intense, destabilizing postwar competition. This case involves the classic startup firm with a clearly identified entrepreneur. The business in this instance is SNL, which should prompt you to reflect for a moment on the 1980s when the United States suffered through a Savings and Loan (hence S&L) crisis. The problem that entrepreneur Reid Nagle set out to solve, however, did not directly involve regulation, deregulation, or inflation—some of the problems used to explain the crisis. Nagle’s interest was in supplying accurate and timely information to those large firms that had economic ties to the S&Ls—a System 1, fast-thinking decision. He knew from experience that each of these organizations had to dig out and evaluate the information they needed from each S&L with which they were doing business. In effect, he was proposing to make business bureaucracies his market and make them more efficient by consolidating and selling information from the regulatory bureaucracy. Nagle built a small organization around the task of searching for, consolidating, and selling information that was available to anyone. Using his own capital and advice from his network, he paid to have a unique computer platform developed for the data. In the course of these System 2 activities, he had the advantage of an extensive personal network and his prior experience in this corner of finance.

Despite Nagle’s strengths, SNL had three major problems in its early years, all of which required substantial System 2 capabilities. Before the development of personal computers and the Internet, the work of gathering and processing information was extremely labor-intensive. Nagle, his wife, and staff had to dig out the information they needed in Washington, Xerox it, and then, back in their Hoboken headquarters, transfer it to their platform, process it, and print it out (Note 16). For a considerable length of time, Nagle was putting in the kind of 100-hour weeks we usually associate with two-job, recent immigrants and DC cab drivers. The second major problem was working capital. Like many a startup before and after SNL, Nagle ran out of money. He was forced to sell some of his time in consulting, and he “maxed” all of his credit cards before he managed to acquire the investment capital he needed without losing control of the firm. The third problem was competition. He was not guilty of WYSIATI. He knew he did not have patent protection for what SNL was doing and he knew a good bit about the other organizations selling the same or similar information. His competitors were, however, connected to other financial institutions that were likely to be competitive with the businesses Nagle had targeted as his likely customers. He saw where his competitors were vulnerable. That was his initial selling point and it proved to be effective. His bureaucratic competitors suffered a fit of WYSIATI and reacted too slowly. With his platform in place, he was then able gradually to expand, with very little additional cost, the information he could provide. As he did so, SNL competed by offering add-ons free and pushing additional competitors out of the market. Nagle’s variant on this

“Pac-Man strategy” was successful and would later be employed by a number of the high-tech giants of the digital era (Note 17). Happy to be an entrepreneur but less happy as a manager of a successful firm, he finally sold SNL to Standard & Poors for \$2.25 billion in 2015.

This successful outcome leaves us with two big questions to ponder: First, if this type of innovation was going on across a broad front in the digital era—and there is substantial evidence that it was—why do the improvements not show up in our figures for Total Factor Productivity? Second, if bureaucratization was generating opportunities like this for innovation, does it seem possible that America’s future will be with a workable form of democratic capitalism and a compromise between America’s bureaucratic and entrepreneurial organizations and cultures? That, for the short- and the middle-term appears more likely than a Kafka-like dystopia.

My second example of successful postwar entrepreneurship provides a sharp contrast with SNL. Here, we are looking at one of America’s large, science-based, bureaucratic firms of that era. During the early 1960s, Merck & Co., Inc., was a successful pharmaceutical business headquartered in New Jersey, with important operations in Pennsylvania and links to many other states and to other nations, primarily in the developed world (Note 18). While the business had a history of successful innovation (especially from 1933-1970), Merck’s CEO, Henry Gadsden was advised in the early 1970s to seek new leadership for his research division and make a radical change in the organization’s scientific tactics and strategy (Note 19). His initial decision to accept this advice had elements of System 1, instinctive thinking. Gadsden was not a scientist; he had come to leadership through sales and marketing. When he followed this advice and appointed Dr. Roy Vagelos as head of basic research in 1974, he was embracing substantial uncertainty and making himself the financier (à la Schumpeter) of an entrepreneurial venture in a bureaucratic setting (à la Chandler and Weber). The Merck bureaucracy (contra Weber and à la Robert Merton’s critique) quietly but forcefully resisted this transition to targeted, biochemical research.

The primary entrepreneur, Vagelos, had also embraced uncertainty (contra Schumpeter) because he had no prior knowledge of business. He had, however, substantial experience in science team building; he had extensive successful experiences in public (NIH) and non-profit (Washington University) bureaucracies; and he quickly built a team (System 2 à la Kahneman) to explore in cardiovascular treatments the kind of targeted research that was “on the tip” of biochemistry and enzymology (his primary professional networks) in the 1970s. The result of this effort was a break-through statin—a multi-billion-dollar drug—and his effort to transform the company’s research and development did not end with this initial innovation (Note 20).

An additional challenge came in the vaccine division, one of the firm’s most successful operations. Indeed, the problem emerged following an outstanding innovation, a new vaccine to prevent Hepatitis B infections. After more than ten years of research, Maurice Hilleman, the head of Virus and Cell Biology, developed an effective vaccine by using particles of the antigen taken from the blood of carriers infected with the virus. Many of those carriers, however, were also infected with HIV, and that

prompted Vagelos to look for a new way to produce the vaccine. Current developments in rDNA technology offered a solution, but Merck lacked the scientific and technological capabilities needed to move down that path (Note 21). After appointing a new head of the research effort and creating a three-headed alliance with a leading scientist and a biotech, Merck was able in 1986 to bring out *Recombivax HB*, the world's first rDNA vaccine (Note 22).

## 6. Discussion

As the SNL and Merck experiences, as well as other business histories from this era, suggest, the links between bureaucracy and innovation were more complex than any of our distinguished intellectual hedgehogs have indicated. While a bureaucratic culture might well impede innovation à la Schumpeter (and Merton), bureaucracies have continued to provide new opportunities for the individuals and firms selling them services (à la SNL). This allowed new firms like SNL to pursue their System 1 visions and test and improve their System 2 capabilities. Most of these efforts failed, as they always have in capitalist societies; WYSIATI has continued to foster discouraging mistakes. But the successes have and could in the future continue to foster disruptive innovations that keep the economy in disequilibrium (à la Schumpeter), on a positive growth path (Note 23).

Meanwhile, new sciences and new technologies have encouraged even well-established, bureaucratic organizations to change, to embrace higher levels of uncertainty and risk, and to encourage and sustain internal entrepreneurs (à la Merck and Chandler). If we scan across the entire U.S. postwar economy in the 1960s, 1970s, and 1980s, it will be apparent that this type of responsive, innovation-oriented private enterprise was the exception, not the rule, in many of America's leading industries. WYSIATI was the rule in automobiles, tires, and machine tools. Hence, the feeble U.S. business response when faced by intense overseas competition. This was also the case with the postwar public bureaucracies that provided more opportunities for others to innovate (à la SNL) than public innovations like the Internet (Note 24). Kahneman's behavioral economics helps us break open and analyze these activities, cultures, and organizations as we push forward with the history of American capitalism, its entrepreneurs, and entrepreneurial enterprises.

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### Notes

Note 1. I define the entrepreneur as an individual or group that combines capital, labor, natural resources and knowledge in a profit-seeking effort that involves some degree of novelty and, when successful contributes to the growth of the economy. Louis Galambos, “The Entrepreneurial Culture and the Mysteries of Economic Development,” *Essays in Economic & Business History*, 36 (2018), 290-01; and “Commercializing Science and Promoting Academic Innovation,” *Management & Organizational History*, 13, 2 (2018), 98-101. For other recent definitions see Daniel Wadhvani and Christina Lubinski, “Reinventing Entrepreneurial History,” *Business History Review*, 91, 4 (2017), 767-99. See also Hans Landström, “The Evolution of Entrepreneurship as a Scholarly Field,” *Foundations and Trends in Entrepreneurship*, 16, 2 (2020), 65-243. And Mark Casson, et al., eds., *The Oxford Handbook of Entrepreneurship* (Oxford: Oxford University Press, 2006).

Note 2. Isaiah Berlin, *The Hedgehog and the Fox: An Essay on Tolstoy's View of History* (London: Weidenfeld & Nicolson, 1953).

Note 3. On disequilibrium, also see Luigi Orsenigo, “Technological Regimes: Patterns of Innovative Activities and Industrial Dynamics,” *Cahiers d'économieetsociologierurales*, 37(1995), 23-67.

Note 4. For Schumpeter, you can start with his best and most famous studies: *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* (New York: Oxford University Press 1961 edition of a study first published in German in 1911). *Capitalism, Socialism, and Democracy* (New York: Harper & Brothers, 3<sup>rd</sup> edition, 1950). You can probably leave on the book shelf *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalistic Process*, I and II (New York: McGraw-Hill Book Company, 1939), and you can certainly ignore his least successful essays on *Imperialism & Social Classes* (Cleveland: Meridian Books, a 1955 edition of his 1919 and 1927 publications).

Note 5. Georg Wilhelm Friedrich Hegel, *Reason in History: A General Introduction to the Philosophy of History* (Indianapolis: Bobbs-Merrill, a 1953 edition of Hegel's 19<sup>th</sup> century lecture notes). My

thanks to the late Professor Leonard M. Marsak for guiding me through the Hegelian philosophy and its context.

Note 6. Throughout this paper, I use the behavioral economics developed in Daniel Kahneman, *Thinking, Fast and Slow* (New York: Farrar, Straus and Giroux, 2013 paperback edition). See also C. Jolls, C. R. Sunstein, & R. Thaler, “A Behavioral Approach to Law and Economics,” 1998, available at <http://digitalcommons.law.yale.edu/fss/papers/1765>; and R. H. Thaler & C. R. Sunstein, *Nudge: Improving Decisions about Health, Wealth, and Happiness* (New York: Penguin Books, 2009). Kahneman acknowledges his debt to Amos Tversky, *Thinking Fast and Slow*, 418-48.

Note 7. On opportunities—a concept less obvious than it first appears to be—see Andrew Popp & Robin Holt, “The Presence of Entrepreneurial Opportunity,” *Business History*, 55, 1 (2013), 9-28. See also J.S. McMullen, L. Plummer, and Z. Acs, “What is an Entrepreneurial Opportunity?” *Small Business Economics*, 28, 4 (2007), 273-83; and Yosem E. Companys & Jeffery S. McMullen, “Strategic Entrepreneurs at Work: The Nature, Discovery, and Exploitation of Entrepreneurial Opportunities,” *Small Business Economics*, 28, 4(2007), 301-22.

Note 8. While Kahneman includes entrepreneurs in chapter 24 on “The Engine of Capitalism,” he is far more ambivalent than Schumpeter about the impact they have on economic development. Their “risk taking,” he says “surely contributes to the economic dynamism of a capitalistic society, ...” but he is unsure whether the government should help them succeed and worries about “excess entry.” Mistakes might be “good for the economy but bad for their investors.” *Ibid.*, pp. 255-59. His position on entrepreneurship is thus consistent with his focus throughout on the cognitive biases that undercut the concept of the rational, economic individual at the heart of neoclassical economics.

Note 9. It is helpful to read Chandler’s major works in the order in which they were published. *Strategy and Structure: Chapters in the History of the Industrial Enterprise* (Cambridge, MIT Press, 1962). *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Harvard University Press, 1977). *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, Harvard University Press, 1990). For a recent, in-depth analysis of Chandler’s approach to innovation in his last few books see Ryan P. McDonough, Paul J. Miranti, and Michael P. Schoderbek, “Alfred D. Chandler’s integrated learning base: Towards the classification and measurement of corporate innovation” *Accounting History* 2019, 1-22. My reading of Chandler’s contributions (chapters 1-3) to A.D. Chandler, Jr., F. Amatori, & T. Hikino, eds., *Big Business and the Wealth of Nations* (Cambridge: Cambridge University Press, 1997), 3-101, suggests that the Chandler model was no longer as useful in analyzing the Third Industrial Revolution and global competition as it was in writing the history of America’s First and Second Industrial Revolutions. N.R. Lamoreaux, D. M. G. Raff, and P. Temin establish this point in “Beyond Markets and Hierarchies: Toward a New Synthesis of American Business History,” *American Historical Review*, 108, 2 (2003), 404-33.

Note 10. Peter A. Hall and David Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage* (Oxford: Oxford University Press, 2001), 1-244. John J. Wallis, “Federal,

State, and Local Government Finances—ensus of Governments,” in Susan B. Carter, et al., *Historical Statistics of the United States*, 5 (New York: Cambridge University Press, 2006), 10-12. Joseph Postell, *Bureaucracy in America: The Administrative State’s Challenge to Constitutional Government* (Columbia: University of Missouri Press, 2017), 127-206.

Note 11. Daniel Kahneman, *Thinking Fast and Slow*, 255.

Note 12. The two other structures were traditional and charismatic authority. Max Weber, *The Theory of Social and Economic Organization* (New York: The Free Press, 1947 edition). All three of my hedgehogs were at Harvard University at the same time. Schumpeter was teaching; Chandler was finishing his dissertation; and Weber, who died in 1920, was represented by Talcott Parsons, who was a co-translator and editor of *The Theory of Social and Economic Organization*. Weber’s analysis of bureaucracy exerted a strong influence on Parsons’ pattern variables. See, for instance, Talcott Parsons and Neil J. Smelser, eds., *Toward a General Theory of Action: Theoretical Foundations for the Social Sciences* (New York: Harper, 1962 edition of the 1951 publication); and *Economy and Society: A Study in the Integration of Economic and Social Theory* (New York: The Free Press, 1958).

Note 13. MAX WEBER, THE THEORY OF SOCIAL AND ECONOMIC ORGANIZATION, 337.

Note 14. WYSIATI fits very well with Clayton M. Christensen’s analysis of disruptive competition in *The Innovator’s Dilemma* (New York: HarperCollins edition, 2000).

Note 15. Robert K. Merton, *Social Structure* (New York: The Free Press edition, 1957), especially 197-206. Merton focused on the “bureaucrat’s trained incapacity,” “domineering attitude,” “inefficiency,” “conservatism and technicism,” 200-02. See also, James B. Taylor, “Bureaucratic Structure and Personality: The Merton Model Revisited,” in W. Boyd Littrell, Gideon Sjoberg, and Louis A. Zurcher, eds., *Bureaucracy as a Social Problem* (Greenwich: JAI Press, 1983), 151-71, which establishes a position close to the one advanced by this essay.

Note 16. This description is based in large part on an extensive oral history (conducted by Galambos and Scott Kasten) with Reid Nagle, who had many years before been a graduate student (economics) in my seminar at Johns Hopkins. On the savings and loan crisis see Alexander J. Field, “The Savings & Loan Insolvencies and the Costs of Financial Crisis,” *Research in Economic History*, 33 (2017), 65-113.

Note 17. Paul Henderson, ed., “Hoboken to Hong Kong: An Oral History of SNL Financial, 1987-2012” (Courtesy of the contributors: Tim Zawacki, Nathan Stovall, Sarah Barry, and Paul Henderson. With contributions by Nicole La Rocque, Holly Bonos, Amy Gleason, and Akash Sinha, June 2012).

Note 18. I have described the Merck experience and culture elsewhere. See, for instance, Roy Vagelos & Louis Galambos, *Medicine, Science, and Merck* (New York: Cambridge University Press, 2004) 37-57; Robert Hogan, Tomas Chamorro-Premuzic, & Louis Galambos, “Historical and Theoretical Explorations in the Theory and Practice of Entrepreneurship,” unpublished paper presented at the World Economic History Conference in Kyoto, Japan, 2015. See also Alfonso Gambardella, *Science*

*and Innovation: The US Pharmaceutical Industry during the 1980s* (New York: Cambridge University Press, 1995). In his last book, Chandler described research and development organizations like Merck's laboratories as an "integrated learning base," but he did not discuss the problems they periodically have when the science, technology or markets shift in a dramatic way. *Shaping the Industrial Century: The Remarkable Story of the Evolution of the Chemical and Pharmaceutical Industries* (Cambridge: Harvard University Press, 2005). For a more positive view of Chandler's concept of the "integrated learning base," see R.P. McDonough, P. J. Miranti, & M. P. Schoderbek, "Alfred D. Chandler's integrated learning base;" this article is important because it brings accounting innovations—a subject seldom discussed by historians—into the field of entrepreneurial studies.

Note 19. For several years, my colleagues and I conducted oral histories and interviews with executives, scientists, managers, and shop floor and office employees at Merck & Co., Inc. Jeffrey Sturchio, Jane Sewell, Patricia Watson, and numerous others were involved with these activities. Most of the records we compiled are still held in the Merck Archives. See Louis Galambos, with Jane Eliot Sewell, *Networks of Innovation: Vaccine Development at Merck, Sharp & Dohme, and Mulford, 1895-1995* (New York: Cambridge University Press, 1995), especially chapters 4-10.

Note 20. On the impact of statins see Rory Collins, et al., "Interpretation of the evidence for the efficacy and safety of statin therapy," *Lancet*, 388 (Nov. 19, 2016), 2532-61. Vagelos was a restless entrepreneur who pressed for innovations large and small as he steadily moved up the Merck hierarchy: head of basic research (1975), as president of Merck, Sharp and Dohme Research Laboratories (1976), Senior Vice-President of Merck (1982), Executive Vice-President (1984), and President and CEO (1985-1994). In addition to Roy Vagelos & Louis Galambos, *Medicine, Science, and Merck*, see Roy Vagelos, *Values & Visions: A Merck Century* (Rahway: Merck & Co., Inc., 1991).

Note 21. Dr. Hilleman, who officially retired in 1984, still remained active in vaccine research. Initially, however, he was not enthusiastic about the potential of molecular genetics in vaccinology. In the course of our research, we conducted three oral histories with the leading scientists and executives involved with the development of *Recombivax HB* and got three different versions of the history. Applying common sense, I reached a conclusion about this important transition, but it is a contested conclusion. Paul A. Offit, *Vaccinated: One Man's Quest to Defeat the World's Deadliest Diseases* (New York: Collins and Smithsonian Books, 2007), 138-40, reaches a different conclusion based primarily on Hilleman's recollections. See also Galambos, with Sewell, *Networks of Innovation*, 196-205; and Vagelos & Galambos, *Medicine, Science, and Merck*, 166-69, 243-46.

Note 22. The blood-based vaccine proved to be entirely free of HIV, as Hilleman and others claimed. Public health authorities employed various forms of the plasma-based vaccine extensively and effectively in Sub-Saharan Africa.

Note 23. Disequilibrium, like WYSIATI, meshes well with the idea of disruptive innovation. Clayton M. Christensen, *The Innovator's Dilemma*.

Note 24. For a contrasting interpretation of the role of U.S. public bureaucracies see Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs Private Sector Myths* (New York: Public Affairs edition, 2015).