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Information-intensive innovation: the changing role of the private firm in the research ecosystem through the study of biosensed data

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Abstract

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In a world instrumented with smart sensors and digital platforms, some of our most intimate and information-rich data are being collected and curated by private companies. The opportunities and risks derived from potential knowledge carried within these data streams are undeniable, and the clustering of data within the private sector is challenging traditional data infrastructures and sites of research. The role of private industry in research and development (R&D) has traditionally been limited—especially for earlier stage research—given the high risk, long time horizons, and uncertain returns on investment. However, the information economy has changed the way Silicon Valley and other technology firms operate their business models, which has vast implications for how they respectively innovate. Information drives competitive advantage, and builds upon the emergence of technical infrastructure for collecting, storing, and analyzing data at scale.

Basic research and fundamental inquiry are becoming important innovation priorities for private firms as they tailor algorithms and customize services, and these changes have vast implications for individual privacy and research ethics. This information-intensive innovation does not simply introduce a new source of inquiry, but a shift in the possibilities and boundaries that enable market edge.

This shift challenges prior models of innovation and reconsiders the role of the private firm within the research ecosystem—specifically in regards to Vannevar Bush's Linear Model of Innovation and Donald Stokes' Quadrant Model of Scientific Research. This change builds upon prior Silicon Valley innovation models outlined by AnnaLee Saxenian and Henry Chesbrough, but features additional key changes within industry R&D that are fundamentally reshaping the role of the firm within the broader

ecosystem. No longer can industry be cast as a place only equipped to grapple exclusively with narrowly applied or developmental research and fully separated or agnostic from users, customers, and citizens. Within this information and data abundant moment, the research and innovation ecosystem is at an inflection point that could alter decades of embedded beliefs and assumptions on who should conduct research and ask fundamental questions, not to mention who should govern and grant access to research data.

This dissertation studies how the rise of data science infrastructure is changing the role of the private firm in the R&D ecosystem. This research works to understand how and under what conditions private sector firms are synthesizing user data (e.g., those picked up by sensors) internally and/or shared externally for research purposes. This dissertation specifically looks at applications of biosensed data for the purposes of social, behavioral, health, or public health research applications. Qualitative and mixed methods are used to research, document, and examine practices within the lens of existing research and innovation theoretical models. Historical frameworks are used to ground and place contemporary practices within broader context.

This research presents three illustrative cases on firms that exemplify different aspects of strategies to adapt to the competitive pressures of information-intensive innovation. The firms include the Lioness smart vibrator, Kinsa smart thermometer, and Basis smart watch. This research establishes findings about how firms are working within the data and R&D landscape, and how new pressures are influencing emerging practices and strategies. Findings outline the changing definitional boundaries of research within the private firm, and evolving practices relating to knowledge sharing and research activities within the firms. This analysis also points to two key emerging challenges firms are coping with, including how to grapple with research ethics and the rise of secrecy practices that may impede collaboration and research strategies implicit with information-intensive innovation.

Research is occurring at many levels within firms, breaking free of any traditional laboratory structure. Collaborations and data sharing with academics for mutually beneficial research partnerships are taking new, largely unstructured forms to meet rising demand and interest. There is fresh demand for new kinds of collaboration models derived from data sharing needs, and exploration into ways of leveraging research practices and incorporating academic research curiosity across firms.

This dissertation concludes by summarizing the importance of reconsidering the role of the firm within the broader R&D ecosystem and broader policy considerations. Programs to help structure and incentivize private/academic research collaborations should be considered, and private firms should consider their internal protocols and strategies in light of this changing landscape.

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Chapter 1

Introduction

In a world instrumented with smart sensors and digital platforms,[1] some of our most intimate and information-rich data are being collected and curated by private companies. Wearable sensors monitor our vital signs and physiological idiosyncrasies at second intervals. Smart in-home devices track our behaviors and daily rhythms in the hopes of making our lives more efficient and frictionless. Smart phones are ubiquitous parts of daily living, mediating our communications, meticulously charting our GPS location throughout the day, all while wrangling our other smart devices onto one centralized control panel. Individuals may choose to augment their lives with these devices to outfit our curiosities (and vulnerabilities) with data intended to help us inform our existence with algorithmically-assisted decision making. Even individuals who choose to opt-out or cannot otherwise afford these often expensive data augmentations are subject to the record-keeping surveillance from remote sensing technologies in public, or within contexts like school, work, or healthcare.[2] The reach of these sensors and information flows are often inexorable to the average person, but the opportunities and risks derived from potential knowledge carried within these data streams are undeniable.

The clustering of data within the private sector is challenging traditional data infrastructures and sites of research. The information economy has changed the way Silicon Valley and other technology firms operate their business models, which has vast implications for how they respectively innovate. Information drives competitive advantage, and builds upon the emergence of technical infrastructure for collecting, storing, and analyzing data at scale. Basic research and fundamental inquiry are becoming important innovation priorities for private firms as they tailor algorithms and customize services, and these changes have vast implications to individual privacy and research ethics. This information-intensive innovation does not simply introduce a new source of inquiry, but a shift in the possibilities and boundaries that enable market edge.

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[1] A smart device is generally taken to mean a device that is capable of communication and/or computation.

See for example, Silverio-Fernández, Manuel. "What Is a Smart Device? - a Conceptualisation within the Paradigm of the Internet of Things." *Visualization in Engineering* 6, no. 3 (2018). https://doi.org/7-018-0063-8. https://link.springer.com/article/10.1186/s40327-018-0063-8.

[2] See for example: Sedenberg, Elaine, Richmond Wong, and John Chuang. "A Window into the Soul: Biosensing in Public." In *Surveillance, Privacy and Public Space*: Routledge, 2018. https://arxiv.org/pdf/1702.04235.pdf

This shift challenges prior models of innovation and reconsiders the role of the private firm within the research ecosystem—specifically in regards to Vannevar Bush's Linear Model of Innovation and Donald Stokes' Quadrant Model of Scientific Research. This change builds upon prior Silicon Valley innovation models outlined by AnnaLee Saxenian and Henry Chesbrough, but features additional key changes within industry R&D that are fundamentally reshaping the role of the firm within the broader ecosystem. These changes are altering the placement of private industry within research activities, and implicating areas of research that extend far beyond the purview of traditional Silicon Valley software and hardware development. No longer can industry be cast as a place only equipped to grapple exclusively with narrowly applied or developmental research and fully separated or agnostic from users, customers, and citizens. Within this information and data abundant moment, the research and innovation ecosystem is at an inflection point that could alter decades of embedded beliefs and assumptions on who should conduct research and ask fundamental questions, not to mention who should govern and grant access to research data.

This dissertation studies how the rise of data science infrastructure is changing the role of the private firm in the R&D ecosystem. This research works to understand how and under what conditions private sector firms are synthesizing user data (e.g., those picked up by sensors) internally and/or shared externally for research purposes. To narrow the scope of this work, this dissertation specifically looks at applications of biosensed data for the purposes of social, behavioral, health, or public health research applications.[3] Qualitative and mixed methods are used to research, document, and examine practices within the lens of existing research and innovation theoretical models. Historical frameworks are used to ground and place contemporary practices within broader context.

Chapter 2 explores the changing role of the private firm within the R&D ecosystem, by outlining the foundational theoretical models, emerging challenges to these models, and introduces the concept of "information-intensive innovation." This chapter also defines key terms and concepts. Chapter 3 explains the scoping and approach of this project, and presents a documentation of the methodology used. The following Chapter 4 presents historical context on the role of industrial or private sector R&D, so that contemporary practices and tensions may be understood and grounded within their historical foundations. This enables the analysis to establish how practices and strategies within firms have changed and evolved over time. Chapter 5 presents three illustrative cases on firms that exemplify different aspects of strategies to adapt to the competitive

[3] Biosensed data means the physiological, kinesthetic data that can be used to infer health, wellness, or emotional/mental states of an individual or group of people. See for example, Sedenberg, Wong, and Chuang. "A Window into the Soul: Biosensing in Public."

pressures of information-intensive innovation. The firms include the Lioness smart vibrator, Kinsa smart thermometer, and Basis smart watch.

Finally, Chapter 6 presents findings about how firms are working within the data and R&D landscape, and how new pressures are influencing emerging practices and strategies. This chapter outlines the changing definitional boundaries of research within the private firm, and evolving practices relating to knowledge sharing and research activities within the firms. This analysis also points to two key emerging challenges firms are coping with, including how to grapple with research ethics and the rise of secrecy practices that may impede collaboration and research strategies implicit with information-intensive innovation. The ways in which these activities are considered research and thus part of the larger research and knowledge sharing ecosystem are in flux, and pressuring the traditional models of research and innovation in new, profound ways. Research is occurring at many levels within firms, breaking free of any traditional laboratory structure. Collaborations and data sharing with academics for mutually beneficial research partnerships are taking new, largely unstructured forms to meet rising demand and interest. There is fresh demand for new kinds of collaboration models derived from data sharing needs, and exploration into ways of leveraging research practices and incorporating academic research curiosity across firms.

Finally, this dissertation concludes in Chapter 7 by summarizing the importance of reconsidering the role of the firm within the broader R&D ecosystem and broader policy considerations. Programs to help structure and incentivize private/academic research collaborations should be considered, and private firms should consider their internal protocols and strategies in light of this changing landscape.

Moving into the future

In 1993 at a small conference at Harvard Business School, a group of research managers and innovation scholars began debating the future of private sector R&D.[4] One of the foundational papers stated that there is “a broad restructuring of the US national R&D system that involves change in the funding and functions of industry, universities, and government agencies.”[5] Just as in the 1990s, experts saw a shift in how private firms were investing and conducting research, this contemporary moment of palatial data and private platforms represents a shift: a

[4] These papers were then published in “Engines of Innovation.”

Rosenbloom, Richard S., and William J. Spencer. Engines of Innovation : U.S. Industrial Research at the End of an Era. Boston, Mass.: Harvard Business School Press, 1996.

[5] Mowery, David C., and David J. Teece. "Strategic Alliances and Industrial Research." Chap. 3 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p.111. Boston, Mass.: Harvard Business School Press, 1996.

shift in the power dynamics of who holds (or shares) the goldmines of data and how these companies invest in their innovation pursuits. As scholars and practitioners struggled to make sense of the changes that were happening as the computer and electronics industries accelerated, so too must now be a moment to reckon with the new underlying motives, challenges, opportunities, and consequences of the digital data age.

The product of this dissertation research is intended for three key audiences: 1) Federal, state, and non-governmental policymakers to assist with the allocation and strategy of R&D programs and dollars to help design a more robust system of public/private partnerships appropriate for 21st century data realities; 2) Private sector R&D managers, researchers, and/or startup founders to help them design their internal processes and external partnerships in a way that drives responsible innovation outcomes. 3) A final audience—academics in research ethics, internet/information/organizational studies, open data, information law and policy, and science and technology policy—are of course heavily cited and leaned upon to create this body of work. This research is intended to make reciprocal contributions to this amorphous field, in pursuit of making actionable findings and recommendations for the first two stakeholder groups.

Chapter 2

Changing role of the private firm in the R&D ecosystem: Foundational Theoretical Models, Emerging Challenges, and Key Concepts

Introduction

This chapter establishes a conceptual and theoretical groundwork for this dissertation study, and presents the emerging practices and trends within technology firms that challenge this foundation. The documentation and analysis of these emerging practices and trends form the basis for this empirical study. Beginning by presenting the accepted models of R&D and innovation, this section highlights the origins and consequential limitations of these theories—particularly in regard to the role of the private firm.

This chapter builds primarily on Vannevar Bush's Linear Innovation Model and Donald Stokes' Quadrant Model of Scientific Research (also known as Pasteur's Quadrant). Then, in narrowing the focus from the broader theories of research and innovation, this chapter considers in Section II how these theories were modified (and qualified) to fit the unique qualities and emerging insights from Silicon Valley technology firms in the 1980s through early 2000s. This section presents academic literature that documents and theorizes key changes that occurred within the private technology innovation ecosystem, and how it influenced—but did not completely overturn—the theoretical models of the larger R&D ecosystem. In particular, this section focuses on the regional innovation models presented in AnnaLee Saxenian's work, alongside the paradigm shift and rebuttal of linear innovation within Henry Chesbrough's model of Open Innovation. The shifts and departures from Bush and Stokes' models identified by Saxenian and Chesbrough's work provide the foundation for understanding new developments and the changing role of the private firm in the R&D ecosystem.

The next section (III) then establishes the key aspects and driving forces of change within Silicon Valley and contemporary tech firms' approach to research and development via a focus and emphasis on information-intensive innovation for competitive advantage. This section establishes the important forces and changes within the last decade (2010-present) which drive the development of this emerging model of innovation—elements which form the basis and findings for this empirical research. These changes within the context of existing research and innovation models highlight a subtle evolution that has shifted the relationship of the firm to the R&D ecosystem from late stage consumer to data generator, data controller, data consumer, and knowledge contributor.

These changes rely and build upon innovation structures and practices identified by Saxenian and Chesbrough decades prior, that together created a Silicon Valley model of innovation. The changing innovation models in Silicon Valley documented by Saxenian and Chesbrough (collectively referred to here as the Silicon Valley models)[6] altered the process of research and innovation within the private sector that were specific to the region and industry, but did not fundamentally challenge the role of the private sector within the overall research ecosystem. In contrast, this empirical research found changes within industry R&D that are fundamentally reshaping the broader ecosystem—altering the placement and role of private industry—and implicating areas of research that extend far beyond the purview of traditional Silicon Valley software and hardware development.

Industry has been empowered to collect and generate troves of data that are uniquely valuable to fundamental research questions (as opposed to exclusively later stage applied inquiry) in that they generate a new window into the social, behavioral, and health aspects of our human existence and society. Yet these data repositories cannot be matched in scale and scope within a university lab. The private firm is changing in its centrality and importance as an access and data gatekeeper for the next wave of scientific questions, allowing corporations to shape which research questions will be asked and how they will be answered.

These shifts are challenging governments' traditional role as a primary source and repository of administrative data important to social science research (among other disciplines) by offering private sector alternatives for researchers (as well as governments) at faster speeds, increasing granularity, offering new opportunities for insights and points of collection, and at previously unmet sizes and scope. In addition to access to data, industry now controls massive infrastructures for behavioral experimentation which allow researchers provided

[6] The collective Silicon Valley model is being introduced here to reflect the broader contributions of scholars (in particular, Saxenian) who documented early shifts in innovation patterns, that largely contributed later (~2006) to the construction of the Open Innovation Paradigm.

access to test theories at lightning speed, often in parallel, and on extremely large populations.

This new opportunity for what this research refers to as an “information-intensive innovation” has fueled an industry driven on algorithmic developments that toys with our fundamental nature as social human beings. The profits of many of these firms turns on the use of algorithms and design to respond to and shape human behavior, thus the demand the ability to leverage fundamental research in entirely new ways through internal practices, outside partnerships, and data sharing. These changes have occurred both within traditional academic contexts as well as by forming new internal modalities that account for changing concepts of research within the private firm. In addition to challenging prior theories of research and innovation, these shifts present new challenges to individual privacy, research ethics, and are generating new questions about the management of these issues through corporate governance and risk management practices. This shift toward information-intensive innovation and the affordances this allows have fundamentally changed the role of the private firm within the research ecosystem in a way that demands new policy considerations and strategy adjustments.

This chapter concludes by discussing the accepted definitions of key concepts —specifically focusing on research, innovation, and the relationship between knowledge and public goods. This section then considers how these concepts relate to each other, and how the terms will be used throughout this dissertation work to provide a foundation in which to explore these shifts within empirical evidence.

Section I: Theoretical Models of R&D and Innovation

Theories and accepted models of R&D and innovation are important for policy decisions at organizational, national, and international scales. These theories move beyond mere conceptualizations and mental models of how ideas and inquiry coalesce into tangible technological progress. In the past these theories have served as the basis for forming agencies—and an entire extramural research funding system—from scratch. They have also justified federal investment and continuous budgets by arguing the importance and value of early stage research. These research and innovation models have influenced policies that fund, incentivize, and protect research activities around the world. University programs and private firm investments have been designed with tacit acceptance of the premises widely argued within these theories. These models and theories seek to optimize the market both for economic output and social gain through the generation of knowledge and social benefits derived from developments in technology and science.

This section introduces some of the most widely known theories, and in particular focuses on Vannevar Bush's linear model of innovation from 1945. This model not only brought the concept of "basic research" into the canon, but influenced post-war US science policy leading to an entire funding and belief system that endures today. Though there are many critiques and tweaks to the model, key assumptions (as illustrated at the end of this chapter in definitional concepts of research) are so deeply intertwined in beliefs about the process of research and innovation that they elude scrutiny. Updates to the model such as Donald Stokes' "Pasteur's Quadrant" provide important caveats that have also influenced policymaking, but each of these models relegate the role of the private firm to a later and applied stage—carving out room only for narrow caveats such as the Bell Labs model where basic research is isolated and known to be the exception but not the rule. This dissertation study and discussion focuses in particular on these theories in relation to to the private firm.

Bush's Linear Model and Stokes' Pasteur's Quadrant are intended to sweep broadly across all areas of science advancement and technological advancement—from medical research to electrical hardware. Later models focus on Silicon Valley's technology development strategies and specialized innovation models within and in between firms—becoming a key subset and rebuff of these broader theories of innovation.

Linear Innovation Model

Prior to WWII, there were tensions between "pure research" and applied industrial research, but philosophical and pragmatic differences were not encapsulated in theory to explain the larger innovation ecosystem. This is possibly in part because there were no centralized institutions or accepted models for pursuing research systematically across organizations and throughout the larger national system. A full discussion of this time and debates around "pure" research and industrial applications of research are explored in Chapter 4, which describes how historically research conducted within the boundaries of the private firm were seen as less virtuous than those conducted within the early university.

At the end of the war and at the request of President Roosevelt, science advisor and director of the Office of Scientific Research and Development (OSRD) Vannevar Bush[7] prepared a memo: "Science the Endless Frontier."

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[7] Vannevar Bush was an electrical engineer and the first acting science advisor to President Roosevelt. Bush ostensibly set up WWII research infrastructure (including the national laboratory infrastructure), and paved the way for the government funding of basic research and post-war federal science agencies.

Within this memo, Bush constructs the first widely held theory of R&D in the "linear model of innovation" where he creates the term "basic research" from the concept of what had previously been called "fundamental" or "pure" research. He posits that innovation within research occurs sequentially in a linear fashion, progressing from basic to applied and what would later be appended as "development."[8] As with any theory—but in this case, particularly with the linear model of innovation—the politics and context of the post-war time played a vital role in the development and strategy embedded within. These forces and context are documented in detail in Chapter 4.

The linear model posits that research occurs in distinct and sequential stages: basic and applied, with development and final processes/products as the eventual final steps. Basic research, Bush proclaims, is "performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws."[9] According to Bush, it is in the realm of "applied research" to completely answer the questions and problem at hand, whereas the basic research scientist may not care at all about the applications of their work.

Bush goes further by stating that "basic research is the pacemaker of technological progress" and that all industrial progress will slow and grow increasingly weak without investment in basic research—investment that can only be obtained through government programs since it is wholly without practical application. Instead of calling for the government to provide basic research activity through the infrastructure of government national labs set up during WWII, Bush calls for universities and research centers to be the sites of research given the intellectual freedom afforded by these institutions and the ability to create a pipeline of scientists who can feed government and industry talent demands and idea pipelines.

> "Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science."[10]

The logic follows: without basic research, applied and developmental will whither away. This is the central core argument of the linear innovation model.

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[8] It is important to note the memo itself contains the phrasing "research and development" though Bush spent the memo distinguishing the sequential and differential natures of basic and applied research. This linear model later was understood to imply that development, and even production and operations would follow in a linear fashion after the first two key phases.

[9] Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

[10] Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

The model further argues that universities are the only place where basic research can thrive, and that without government investment basic research will fail to flourish.

The role of industry within the linear innovation model is clearly articulated. By its very nature, industry is constrained by its own desire to apply research to applied problems, which relegates it as a later consumer of basic research findings and generator of only applied goals.

> "Industry is generally inhibited by preconceived goals, by its own clearly defined standards, and by the constant pressure of commercial necessity. Satisfactory progress in basic science seldom occurs under conditions prevailing in the normal industrial laboratory. There are some notable exceptions, it is true, but even in such cases it is rarely possible to match the universities in respect to the freedom which is so important to scientific discovery."[11]

At its essence, the linear model was a blueprint for governments and policymakers on how to support an R&D ecosystem. Bush's memo and the linear model for innovation was an important strategic vision to capture the R&D government investment and innovative spirit committed during the war for peacetime efforts that aimed to benefited society. However, this classification and sequential model, which cast industry—an otherwise important employer and participant in wartime efforts (as described within Chapter 4)—as a late stage consumer and participant which has had lasting effects that constrain our collective thinking about industry's potential and appropriate place in the research ecosystem.

Critiques of the linear model

In the book "Cycles of Invention and Discovery," Narayanamurti and Odumosu question the linear innovation model implicit with this three stage categorization. In part of questioning this canonical model, the authors bring attention to the "false dichotomy" often pontificated on by scholars, businesspeople, economists, and policymakers to distinguish the highly lauded basic or pure research from other stages.[12] Narayanamurti and Odumosu argue that not only is the pursuit of R&D messy and likely to mix stages and fall out of order (e.g., applied to final product, or developmental leading to basic research line of inquiry)[13] but it is a tussle that has no clear resolution given the

[11] Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

[12] Venkatesh Narayanamurti and Toluwalogo Odumosu. *Cycles of Invention and Discovery: Rethinking the Endless Frontier*. (Cambridge, Massachusetts: Harvard University Press, 2016), 2.

[13] For example, Narayanamurti & Odumosu cite the example of James Watt's invention of the steam engine before the study of the laws of thermodynamics, of which the functioning of the steam engine is entirely dependent. The creation of this technology led in part to the fundamental science research that

complicated, messy, and sometimes fraught process of innovation. They argue the exact classification of activities have no bearing on the potential impact of eventual discoveries or innovations.

Within "Science, the Endless Frontier,"[14] Bush was deliberate about distinguishing "basic" and "applied" research, which as Narayanamurti and Odumosu put it: "enshrining the idea of a fundamental divide in research between "basic" and "applied"—and setting the parameters of the debate around federal funding of science and technology through the rest of the 20th century and into the present."[15] The authors state that after the report was published, there was an increase in the terms' use in the Congressional Record indicating its adoption within policymaking circles.[16]

It is important to note that in the decades following "Science the Endless Frontier" many academics and policymakers have tweaked the model, but largely followed the linear model. For instance, within the Organization for Economic Cooperation and Development's (OECD) report on scientific and technological activities, there were successive tweaks throughout the 60s and early 70s in what is known as the OECD's Franscati Manual (named for the Italian town, Franscati, where the modification was developed in conference) where scholars began to reconsider basic research that was oriented toward a particular goal. This "oriented research" still fell within the broad linear structure, but simply accounted for basic research that was applied toward scientific, economic, or social interests.[17] The divide between basic and applied research, and the respective roles of the university verses the private firm in conducting these modes of inquiry remained largely unquestioned or reconsidered.

Pasteur's Quadrant

In the late 1990s, Donald Stokes reconsidered the linear model (and successive modifications like the Franscati Manual) by questioning the strict casting of scientific motivation and purpose, using prior scientific advancements

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followed. Venkatesh Narayanamurti and Toluwalogo Odumosu. *Cycles of Invention and Discovery: Rethinking the Endless Frontier*. (Cambridge, Massachusetts: Harvard University Press, 2016), 27.

[14] Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

[15] Venkatesh Narayanamurti and Toluwalogo Odumosu. *Cycles of Invention and Discovery: Rethinking the Endless Frontier*. (Cambridge, Massachusetts: Harvard University Press, 2016), 3.

Also note that this was the report that popularized the terms basic and applied according to the authors.

[16] Venkatesh Narayanamurti and Toluwalogo Odumosu. *Cycles of Invention and Discovery: Rethinking the Endless Frontier*. (Cambridge, Massachusetts: Harvard University Press, 2016), 33.

[17] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 64-66.

and his firsthand knowledge managing university research programs to create a new approach to a theoretical framework. Stokes summarized, what was in his view, the two key aphorisms from Bush's work:[18]

1) Basic Research is performed without thought of practical ends

2) Basic Research is the pacemaker of technological progress

Stokes critiques that the first aphorism asserts a belief that the creativity necessary within basic research "is lost if it is constrained by premature thought of practical use."[19] The second aphorism contains the belief that only with basic research will innovations in products and processes be possible, and that those who invest in the virtues of basic research will be able to capture the value in successive stages. From Stokes' perspective the linear model—though laudable in its dynamism and staying power—casts aside alternative processes that had achieved past technological advances by creating the illusion of an orderly and prescriptive process.

Drawing in particular from the 19th century French scientist Louis Pasteur's career, Stokes presents evidence that fundamental and basic science research can be achieved through the use of applied questioning. Pasteur's early advancements in understanding crystallography, fermentation, and pasteurization were all tied to applied questions, yet absolutely fundamental to many science disciplines. His work was often tied to industry needs and ends,[20] and yet this tension did not contaminate his scientific intellectual pursuits or contributions.[21]

Stokes' Quadrant Model of Scientific Research (more commonly referred to by the title of his book as Pasteur's Quadrant, which also denotes the key difference between Stokes' framework and the linear model) establishes a 2:2 grid, where the X axis includes research inspired by consideration of use, and the Y axis research inspired by a quest for fundamental understanding.[22]

Within Stokes' Pasteur's Quadrant, the theoretical framework explicitly allows for industrial inspiration and application of fundamental research aims. Though there are cases Stokes presents of collaboration in pursuit of these aims, the framework still mostly casts industry as a consumer and largely absent participant—a stakeholder that provides the application questions for fodder and motivation for some research aims only.[23] Stokes' model allows for the location of fundamental researchers within industry, citing that the goals of the

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[18] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 3.

[19] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 3.

[20] As noted in the historical chapter, this tie to industry is not unique during this time. (See Chapter 4)

[21] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 8.

[22] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 73.

[23] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation*.)Washington, D.C.: Brookings Institution Press, 1997), 15.

organizational setting (and usually the segregation of particular labs and teams) matter more than the employer of the scientist.[24] However, the model does not account for the role of industry beyond occasional employer, research question inspiration, or eventual practical application of knowledge. It was, in any case, an important theoretical critique of the linear model's sequential and strict purposeless pursuits of basic research.

Stokes considered this theoretical model in the late 1990s an important reconsideration of how research was funded, and opportunity to reexamine beliefs about how technological progress could be harnessed for economic and social gains. By widening the thinking to a more dynamic model that explicitly allowed for exceptions, and policy programs that operated wholly outside of the linear mode, Stokes saw an opportunity to more adeptly capture the potential of contemporary advancement. It is within this same spirit that this dissertation continues to reexamine the theoretical frameworks in light of contemporary practices, and reconsider the relegation of industry into narrowly applied and consumptive roles.

Section II: Silicon Valley Specific Models of Innovations

The Linear Model of Innovation and Quadrant Model of Innovation were intended to apply across research disciplines and industries, creating theoretical models of research and innovation that could guide organizational and national strategy. However, beginning in the 1980s with Silicon Valley, unique innovation models began emerging within and in-between firms specific to both the region and larger tech industry. The development of computer hardware and semiconductors, though rooted in fundamental physics and chemistry, began their own innovation patterns that fueled not only a region, but an entire industry and global competition. These changes throughout the 1980s, 90s, and early 2000s were remarkable in that they reshaped how technology firms pursued research[25]—forming new collaborative models and relationship to others outside of the firm. These changes were captured in the work of AnnaLee Saxenian, most specifically within *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. These changes challenged the broader innovation and organizational theories to form a series of key insights, and new conceptions of

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[24] Donald E. Stokes. *Pasteur's Quadrant : Basic Science and Technological Innovation.*)Washington, D.C.: Brookings Institution Press, 1997), 81.

[25] Specifically focusing here on high-tech firms, not biotechnology, pharmaceutical, and agriculture style firms, for instance.

innovation processes like the paradigm shift later noted by Henry Chesbrough called "Open Innovation." By understanding the caveats specific to early Silicon Valley technology firms in their pursuit of rapid innovation and technological development, the contemporary and dynamic changes of current Silicon Valley technology firms can be better understood in their growing influence over existing models. Together, Saxenian and Chesbrough's contributions will be loosely referred to as the Silicon Valley model, which has great influence over the emerging, revised model presented within this dissertation.

Silicon Valley as a region of specialized entrepreneurship became a key vanguard in developments that later echoed internationally through many different technology firms. Instead of the highly integrated firms that dominated mid-20th century firms, Silicon Valley entrepreneurial spirit called for decentralized and highly specialized services (e.g., legal expertise, contractors, suppliers, etc.) that existed outside of the firm and within the region.[26] The networks of these boutique services and rapid small firm innovation broke down the previous barriers of large vertical and integrated firms, and developed a strong network of collective infrastructure and services catered to the highly specialized needs of the technological innovation.[27]

Within this space, R&D models also became more decentralized and cooperative. Many firms dissolved their formal R&D departments (with notable exceptions like Xerox PARC), and relied instead on outside expertise from (particularly local) universities.[28] Some firms like IBM espoused management styles that declared "everyone was an innovator" and therefore no one set of employees needed a special research designation.[29] Further, the open and decentralized networks afforded rapid information and knowledge sharing between firms, which further challenged more structured research organizations and linear captures of applied research knowledge.

Additionally, international competition pressures to push semiconductor innovation—alongside the prohibitively high cost of machinery and materials—pushed for cooperative research organizations that further brought research out of the university and corporate laboratories and into shared models of collaboration.[30] A full and detailed analysis and discussion of particular research structures within technology firms, and between them in cooperative models is

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[26] Saxenian, AnnaLee. Regional Advantage : Culture and Competition in Silicon Valley and Route 128. Cambridge, Mass.: Harvard University Press, 1994. (Page 133)

[27] See for example: Saxenian, AnnaLee. "The Origins and Dynamics of Production Networks in Silicon Valley." Research Policy 20 (1991): 423-37.

[28] Saxenian, AnnaLee. Regional Advantage : Culture and Competition in Silicon Valley and Route 128. Cambridge, Mass.: Harvard University Press, 1994. (Page 41; 138-139)

[29] Armstrong, John. "Reinventing Research at IBM." Chap. 5 I*n Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, p151-54. (Boston, Mass.: Harvard Business School Press, 1996), 152.

[30] See, for example: Mowrey "Collaborative R&D: How Effective Is it?" 1998
ES to grab other cites from history section

found within Chapter 4.

These changes began to strain the existing linear model, and required more system complexity than offered by Pasteur's Quadrant in order to make effective national policy and organizational strategy. Chesbrough in 2003 introduced the concept of "open innovation" to begin encompassing the important key elements and shifts documented by scholars like Saxenian, Mowrey, Teece, Sturgeon, and Chandler (and others) within Silicon Valley and technology firms. Without these scholars, Chesbrough's concept could not have been established.

Chesbrough defines open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."[31]

Chesbrough's open innovation paradigm shift builds upon the more dynamic model posed by Stokes in 1997, but adds specificity that arises from the study of Silicon Valley entrepreneurial firms. It asserts that R&D is an open system, rather than the increasingly closed and funneled nature embedded within the linear innovation model. Within the old model, basic research knowledge is translated into applied knowledge and developmental applications, the system becomes increasingly closed off and stove-piped into a single firm.[32] Open source tools and methodologies prevalent in Silicon Valley and the technology industry strategy have increasingly opened the system and ushered in new intellectual property regimes.[33] Open innovation is, in the words of Chesbrough, the "antithesis of the traditional vertical integration model where internal research and development activities lead to internally developed products that are then distributed by the firm."[34] Instead of the closed laboratories like Bell, open innovation espouses models that include spin off venture companies. This was a system that functioned to serve the drive to build out the computing and communications hardware and software for the industry and market.

The Open Innovation model sets an important precedence for the development of updated models, which account for innovation that occurs outside of the locus of the firm, with porous knowledge flows and innovation capture.[35] The model also breaks from what Chesbrough calls the "man of genius"

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[31] Henry William Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation." In *Open Innovation : Researching a New Paradigm*, eds. by Henry William Chesbrough, Wim Vanhaverbeke and Joel West (Oxford: Oxford University Press, 2006), 2.

[32] Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation," 1-3.

[33] There is a more nuanced discussion by Chesbrough and others in Open Innovation about how open source tools increase value creation but not value capture within firms.

[34] Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation," 1.

[35] Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation," 8.

model within the closed innovation paradigm,[36] where firms invested in "brilliant" individuals and segmented research groups that had little business focus or designated path to market—thus relying on the theory behind the linear model of innovation that basic research would in time fuel economic gains for the investors. The open model of innovation additionally promotes the rapid spillover of knowledge from the firm, rather than the property capture of insight and knowledge from R&D activities.

These key insights into firm and regional behaviors were important to understand the contemporary information technology industry, but at the time largely did not challenge the returning impact to the entire R&D ecosystem. The new emerging model of information-intensive innovation, though focused within the next iteration of these technology firms, builds upon these key changes within Silicon Valley that have continued to place pressure on the generalized models of innovation from Section I. These collective forces call for a reconsideration of the role of the private firm within the R&D ecosystem and new frameworks that account for these fluctuations and tensions. Within the edited volume *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, the Forward states that the phenomena of innovation is "too complex, dynamic, and adaptive to fit into a single conception for any extended period of time."[37] This dissertation builds upon these Silicon Valley models to account for key phenomena reshaping and now fundamentally altering research and innovation paradigms, thus building a new conception appropriate for contemporary practices.

Section III: Emerging model of information-intensive innovation

This section focuses on three key changes: the clustering of data within the private sector, challenges to traditional data infrastructures and sites of research, and emergence of basic research as an important innovation priority for private firms. These changes have implications to individual privacy, research ethics, and are generating new questions about the management of these issues through corporate governance and risk management practices.

Silicon Valley and the larger tech industry has undergone additional transformations, as companies moved from hardware and software to digital platforms and services. Social media companies, search engines, smart devices,[38]

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[36] Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation," 8.

[37] Chesbrough, "Open Innovation: A New Paradigm for Understanding Industrial Innovation," viii.

[38] The business model for smart devices varies, some are device purchase only whereas others also require a monthly service fee.

and service platforms operate primarily under freemium models—collecting data to optimize their algorithms and services. Even more traditional online retailers use digital platforms to collect vast amounts of information about users. The information economy sells data about users, places advertisements, and charges for premium access to the platform or services—doing so in a context that thrives on categorization, individual tailoring, and subtle nudges. The information economy has changed the way Silicon Valley (as well as other technology) firms operate their business models, which has vast implications for how they respectively innovate. Information drives competitive advantage, and builds upon the emergence of technical infrastructure for collecting, storing, and analyzing data at scale. This infrastructure was enabled by advancements stemming from earlier Silicon Valley innovation models, but has opened up a new information-intensive innovation opportunities (and risks) that have flowed into virtually every corner of society that generates data—data most often captured by privately operated devices and platforms.

The information economy is placing additional pressure on traditional data stewards like government institutions—entities who collected and curated data via surveys, records, and reports and had a civic obligation to make these data accessible for the public interest. The traditional sites of research, data collection, information access, and researcher employment are in deep transition and contested by stakeholders. Suddenly not only are the traditional role of actors in the research ecosystem in question, but research questions essential to driving information-intensive innovation have bled from almost strictly applied to more basic in nature. Even though some large firms like IBM, Microsoft, and Google have kept some forms of traditional industry laboratories that emphasize process and outputs consistent with academia, the research boundaries are contested and porous within many information-intensive firms given the demands of this developing sector.

The transition of these data-rich portfolios to private entities introduces vital questions about obligations, mechanisms, and incentives to share, and consequences of use. These changes coincide with developments and limitations within academia as well, meaning these private sector changes are not happening in independent parallel. Rather, both changes have deep implications for the future of academic research. These data holdings are not easily replicable by traditional institutions and researchers, either in scale or blocked through proprietary devices and platforms. Academic researchers—medical, social, behavioral—rarely have large budgets to buy data or the time to negotiate and broker access to private data holdings.

Information-intensive innovation does not simply introduce a new source of inquiry, but a shift in the possibilities and boundaries that enable market edge. These private data holdings offer intimate personal and community portraits that present deeper opportunities to explore fundamental questions relating to our social and behavioral natures, not to mention health and wellness states, rather than limit itself to customer transactional data. No longer can industry be cast as a place only equipped to grapple exclusively with narrowly applied or developmental research and fully separated or agnostic from users, customers, and citizens. Through sensors and platforms the private sector has embedded themselves into nooks and crannies of our society. Within this information and data abundant moment, the research and innovation ecosystem is at an inflection point that could alter decades of embedded beliefs and assumptions on who should conduct research and ask fundamental questions, not to mention who should govern and grant access to research data.

The ways in which these activities are considered research and thus part of the larger research and knowledge sharing ecosystem are in flux, and pressuring the traditional models of research and innovation in new, profound ways. Research is occurring at many levels within firms, breaking free of any traditional laboratory structure. Collaborations and data sharing with academics for mutually beneficial research partnerships are taking new unstructured forms to meet rising demand and interest. There is fresh demand for new kinds of collaboration models derived from data sharing needs, and exploration into ways of leveraging research practices and incorporating academic research curiosity across firms. Startups, though resource poor, are resourceful in leveraging outside expertise and experimenting with ways to develop their products and public image. Large firms have many resources and high profile instances of sharing data or running studies, but often with public pushback and limited extensibility.

However, some developments specific to the new information economy are developing strategies that run directly oppose to the open innovation model of past firms. Secrecy practices to protect trade secrets and information practices—alongside proliferation of pervasive contracts like non-disclosure agreements and employee surveillance technologies—are rising hindrances to open innovation practices. Tensions between generating public benefits and positive images often oppose and complicate efforts to monetize information platforms. Many large and dominant firms are acquiring new innovators rather than spinning off new startups—locking up ideas and motivations to openly collaborate in walled gardens rich with resources but poor in knowledge transparency.

These shifts present new challenges to individual privacy, research ethics, and are generating new questions about the management of these issues through corporate governance and risk management practices. Even though many studies can be designed to be passively observational (rather than experimental that often involves user manipulation) and aimed at groups of people rather than individuals, research poses risks for private entities. The process for research ethics within industry is largely unregulated,[39] and research/data sharing

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[39] With the exception of pharmaceutical, medical, and medical device studies which are regulated by the FDA.

partnerships open companies up to public relations and legal risks, not to mention resource and administrative burdens. Even though these data may be used and studied within the private sector, sharing or partnering externally—even if conducted carefully to generate social benefit—is sometimes too risky to pursue. To add further complications, many PhD trained researchers are being employed within the private sector to analyze these data but in research-ambiguous positions.[40]

This dissertation seeks to document and understand these phenomena and developments, and better understand the essential ways these changes are challenging existing models of research and innovation and placing the private firm in a new position within the research ecosystem. This shift toward information-intensive innovation and the affordances this allows have fundamentally changed the role of the private firm within the research ecosystem in a way that demands new policy considerations and strategy adjustments. By understanding the ways in which research and innovation models and the role of the firm within them should be reconsidered, policy programs, funding, and firm strategy may be reevaluated for effectiveness and efficiency.

Section IV: Key Concepts

"*Research, like poetry, cannot be defined in a manner that is universally acceptable*"[41]

One of the challenges of studying a classification concept as broad and pervasive as "research" is that there is no singular or definitive definition of what constitutes a proper research activity—particularly in the context of the private sector. The boundaries of this activity are fuzzy—stemming from the mixture of disciplines, practices, methodologies, and contexts implicit with this direction of inquiry. As previously stated in Section I, Bush's linear model introduced "basic" research (a departure from fundamental or pure terminology) into the lexicon, and established the entire linear conceptualization of which research definitions are structured. Stokes added dimension to this definitional debate derived from theory by questioning the limitations Bush offered in purpose of the activity. Additional Silicon Valley innovation models often do not offer crisp debates about what qualified as a research activity, tending to focus more in inputs and outputs to the technology development system.

The debate over where particular activities, especially in the private sector,

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[40] See for instance: Check Hayden, Erika. "Tech Titans Lure Life-Sciences Elite." Nature 526 (2015).

[41] Furnas, CC. ed. 1948 Research in Industry: It's Organization and management. New York: D. Van Nostrand Company.

fit on this spectrum—or qualify as R&D[42] at all—have been contested throughout the 20th century through today. These definitional concepts seek to specifically include those that relate to the boundaries offered within the context of private industry and the development of software and algorithms, given the focus of this dissertation study. Understanding the definitionally broad scope, as well as the ambiguity of these widely accepted definitions is a key concept for the rest of this dissertation. As will be explored in later chapters, one often repeated belief was that private sector activities did not classify as "research," both because of the place where it was occurring (industry) and the applied nature of the activity. Though these boundaries and ambiguities are examined later, it is important to establish what is defined as research, R&D, innovation, and public goods since they are key definitional premises of this body of research.

Research and R&D

R&D, or research in general, is typically broken down into three general stages—the linear assumption embedded in this definitional structure is explicated above:

1) Basic research
2) Applied research
3) Developmental research

The purpose embedded within an activity relating to research is often used to define the activity, but as explored below the place or location of research is also used as a definitional guide. This is often based upon the assumption that particular places, such as industry, imply particular purpose and motivated ends.

The names of each of these stages may be slightly different depending on the source of the categorization, but usually most of the debate centers around basic/ applied research, and development is lumped as more amorphous final catchall for later stage research. For instance, the OECD called the third stage "experimental development" but still generally captures the final stage where new knowledge is tweaked and applied to new or existing products/processes.[43]

The OECD defines R&D as "creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge." The OECD includes a list of five core criteria necessary for an activity to qualify as R&D, including that it must be: novel, creative, uncertain, systematic, transferable and/or reproducible.

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[42] "Development" though often forgotten or cast as separate from research activities is an important part of late stage research, as per definitions below.

[43] OECD. Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development (2015). http://www.oecd.org/sti/inno/Frascati-Manual.htm.

Definitions of R&D also translate differently depending on who is conducting the work. These nuances are reflected in documentation provided by the National Science Foundation (NSF) that provides (or curates others') definitions of research and development activities, which offers unique definitions for: A) International activities; B) Business/Private Sector; C) Federal or state governments; D) Academic or non-profit organizations.[44]

The definition of business enterprise R&D, as stated in the federal Business R&D and Innovation Survey (BRDIS) is as follows:

> "Research and development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge and to devise new applications of available knowledge. This includes a) activities aimed at acquiring new knowledge or understanding without specific immediate commercial applications or uses (basic research); b) activities aimed at solving a specific problem or meeting a specific commercial objective (applied research); and c) systematic work, drawing on research and practical experience and resulting in additional knowledge, which is directed to producing new products or processes or to improving existing products or processes (development)."

This definition goes on to state that R&D does not include market research or "seasonal or periodic design changes to existing products" which could be interpreted to exclude UX research to improve functionality, but leaves open to interpretation studies that seek to understand the behavior of users that could lead to new features or new products[45]/services.

This definition does specify R&D activity in software to include within the classification of R&D:
"-Software development or improvement activities that expand scientific or technological knowledge
-Construction of new theories and algorithms in the field of computer science"

However, this statement is followed by exclusions that state software development that does not depend on a scientific or technological advance, such as the addition of new functionality to existing application programs, does not qualify as research under this definition. Even in this precise context of algorithm and platform development there are shades of gray depending on one's interpretation of what qualifies as a "scientific or technological advance[46]."

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[44] National Science Foundation. Definitions of Research and Development: An Annotated Compilation of Official Sources. (2018). https://www.nsf.gov/statistics/randdef/rd-definitions.pdf.

[45] Especially as some large user platforms define many different features as "products."

[46] In the case of biosensing, the connection between instrumentation, biosignals, and user experiences probes science questions.

There are other notable federal definitions of business R&D, such as the Financial Accounting Standards Board (FASB; focusing more on definitions as they related to financial accounting) and the US Code of Federal Regulations (focusing on the terms as they relate to R&D for tax filing purposes). The BRDIS is the most specific, particularly with regard to algorithms.

Additionally, a common source for the definition of research is found in what is known as the Common Rule regulatory text (45 CFR 46), which mandates guidelines on the protection of human subjects in research. This definition ties research to the end goal of the activity, which is described as "designed to develop or contribute to generalizable knowledge" which is subsequently not defined[47].

Evolution of industry specific definitions of R&D

Economist Richard R Nelson defined industrial R&D in relation to the place, laboratories, where it is carried out but linked a wide spectrum of activities relating to product innovation and development to R&D: "Research laboratories may be created and maintained by firms for many purposes, including development and application of quality control and other testing techniques, elimination of manufacturing troubles, and improvement of manufacturing methods, improvement of existing products and development of new uses for them, development of new products and processes, and scientific research to acquire knowledge enabling more effective work to be done to achieve the above purposes."[48]

Similarly and many years prior in 1985, Leonard Reich wrote that industrial research occurs in "industrial laboratories set apart from production facilities, staffed by people trained in science and advanced engineering who work toward deeper understandings of corporate-related science and technology, and who are organized and administered to keep them somewhat insulated from the immediate demands yet responsive to long-term company needs."[49]

As explored in the previous section, these definitions hinge primarily on

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[47] "Subpart a—Basic Hhs Policy for Protection of Human Research Subjects." In 5 U.S.C. 301; 42 U.S.C. 289(a); 42 U.S.C. 300v-1(b), 2017. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=83cd09e1c0f5c6937cd9d7513160fc3f&pitd=20180719&n=pt45.1.46&r=PART&ty=HTML#se45.1.46_1102.

"Revised Common Rule Regulatory Text." In 45 CFR 46, 2018. https://www.hhs.gov/ohrp/regulations-and-policy/regulations/revised-common-rule-regulatory-text/index.html.

"Revised Common Rule Regulatory Text." In 45 CFR 46, 2018. https://www.hhs.gov/ohrp/regulations-and-policy/regulations/revised-common-rule-regulatory-text/index.html.

[48] Nelson, Richard R. "The Economics of Invention: A Survey of the Literature." The Journal of Business, no. 32 (1959): 119.

[49] Leonard S. Reich. *The Making of American Industrial Research : Science and Business at Ge and Bell, 1876-1926*. Studies in Economic History and Policy. (Cambridge Cambridgeshire ; New York: Cambridge University Press, 1985), 3.

assumptions that activities driven by purposes generally fall along a sequential progression implicit in the linear model of innovation.

Innovation

Other key terms like "innovation" come up a lot in this research and also have broad meanings, though likely with less political or organizational consequences. For the purposes of this work, "innovation" is taken to mean a new product, method, or idea. Narayanamurti and Odumosu sum up the relation between discovery and invention in relation to research and development quite succinctly: "Discovery is the creation of new knowledge and facts about the world, and Invention is the accumulation and creation of knowledge that results in a new tool, device, or process that accomplishes a particular or specific purpose. We understand innovation to encompass discovery, invention, research, and development, extending these into the products, processes, and ideas that result in significant improvements in the world."[50]

Put simply: research and development can be seen as an input, whereas innovation is the output.[51]

The concept and model of "open innovation" as introduced by Hendry Chesbrough will be defined in the context of its theory below.

Knowledge and the Public Good

In addition to understanding the definitions of research and innovation, it is important to understand these concepts in connection to data, knowledge generation, and contributions to the public good.

For the purposes of this dissertation, data are considered to be base observations, signals, sensor readings, statistics, or various other measurements that could either be quantitative or qualitative in nature. Data are assumed to have varying degrees of accuracy and precision. This concept is extensively discussed in the edited volume "'Raw Data' is an Oxymoron," and also considers the inability to have truly naked or raw data due to larger socio-technical influence and bias.[52] Information, another fuzzy concept even among proper "information scholars," is considered loosely within this dissertation to be meaning or useful facts derived collectively from data and as a resolution from

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[50] Venkatesh Narayanamurti and Toluwalogo Odumosu. *Cycles of Invention and Discovery: Rethinking the Endless Frontier*. (Cambridge, Massachusetts: Harvard University Press, 2016), 11.

[51] Credit for this succinct conceptualization belongs to Anno Saxenian.

[52] Gitelman, Lisa. *"Raw Data" Is an Oxymoron*. Infrastructures Series. Cambridge, Massachusetts ; London, England: The MIT Press, 2013.

uncertainty. A more in depth discussion of the concepts of information may be found in the writings of philosophers, communication, information, and STS scholars.[53] Knowledge for the purposes of this work is taken to mean lessons, general truths, new information applied to problems, and validation (or repudiation) for existing theories.[54] Knowledge generation was an important output and purpose for the definitions of research and development supplied above.

Within economics, public goods are defined as something that is non-excludable and non-rivalrous, meaning that an individual cannot be excluded from consumption or use, and that the use or consumption by one individual cannot decrease its availability to others. Canonical examples of a public good include public health, national security, knowledge, etc.[55] Similarly, a common good is rivalrous (meaning consumption by one person decreases availability) but it is non-excludable, like natural resources. A club good or scarce good is the opposite of a common good where it is excludable but non-rivalrous, and are often considered to be things that require payment or membership to use. Private goods as the opposite to public goods are both excludable and rivalrous, and often refer to property. Social goods, though often lumped with the concept of a public good or common good, is most often used to loosely describe an action or product that widely benefits a large group of people or society, and does not necessarily imply its relation to being excludable or rivalrous. In many cases where social good is described as the common good, it refers to the philosophical "greater good" rather than the economic concept. Social goods often relate to corporate social responsibility which conveys a responsibility of a private company to use their business model to promote a greater wellbeing of employees, citizens, or societies.

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[53] See, for example:

Israel, David, and John Perry. "What Is Information?". In Information, Language and Cognition, edited by Philip P. Hanson: University of British Columbia Press, 1990.

Dretske, Fred I. Knowledge & the Flow of Information. 1st MIT Press ed. Cambridge, Mass.: MIT Press, 1981.

Shannon, C.E. "A Mathematical Theory of Communication." Bell Systems Technical Journal July & October (Reprinted in ACM SIGMOBILE) 5, no. 1 (1948 (2001)): 3-55.

These citations are from the course syllabus Info 218 taught by Paul Duguid and Geoff Nunberg in 2015.

[54] The concepts here could be the subject of entire dissertations and should be considered definitive, but guiding frameworks for their use within this research.

[55] There are of course ways to control and limit the flows of public good implementation, thus making them club goods or private goods. The challenges around controlling knowledge flows are discussed within this dissertation.

Stiglitz, J. "Knowledge as a Global Public Good." In Global Public Goods: International Cooperation in the 21st Century, edited by I. Kaul, I. Grunberg and M.A. Stern. New York: The United Nations Development Programme, 1999.

Research, and specifically the knowledge derived from research activities, is often thought of as a public good. When research creates new knowledge, this knowledge in theory cannot be contained in a way that excludes others from the benefits or rivalrous in a way that use by one person decreases availability by another. There are however legal and policy mechanisms that can turn the knowledge generated by research activities into a club good, where one can be excluded by form of payment for the tangible device that came out of this new knowledge (e.g., a medical device) and knowledge can be prevented from open consumption through access barriers or by being treated as an entirely private good if the information underlying the knowledge is kept private. The intellectual property system in the US created what has been referred to as the “grand bargain” where in exchange for offering patent protection for new knowledge (e.g., invention, device, application), inventors must publicly disclose their invention through the publishing of patent applications.[56] Even when an individual or firm does not have a right to the invention and thus cannot make money off of knowledge contained within a patent, the idea and technology is able to be scrutinized and studied in public or academic discourse. Trade secrets and other mechanisms control the knowledge flows in ways that damage the public good externalities of research and consequential knowledge generation, and this is explored in depth in this dissertation study.

This section established accepted definitions of research and development, innovation, and how research can be seen as the input to the system and innovation as a form of output. Additionally, this section presents some important concepts embedded in the use of the word data, as well as how data fuels research. Knowledge generation—which was utilized within the definitions of R&D—is an important goal and output of research activities, and contributes to the generation of public goods. Public good utility, as well as data donation and “data for good” programs will be referenced later in this dissertation, so having a basic understanding of how research, knowledge flows, and public goods are broadly defined and relate to each other will grow increasingly important throughout the rest of this dissertation’s chapters.

[56] Williams, Heidi L. "How Do Patents Affect Research Investments." HHS Public Access (2017). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5664960/pdf/nihms844246.pdf.

Chapter 3

Research Approach, Methodology, and Researcher Positionality

> "The social scientist is supposed to be able to help the public to understand any social problem (especially ideological ones) and the policy analyst to come up with clear recommendations on any issue, including the future of mankind or, at least, of American civilization."[57]

> "Interviewing gives us access to the observations of others. Through interviewing we can learn about places we have not been and could not go and about settings in which we have not lived."[58]

Introduction

The aim of this research is to use social science methods to gather data about practices that may inform policymaking and discussions around the future of R&D and private sector data sharing in the United States.[59] Data gathered throughout the course of this work are meant to examine activities and motivations (particularly those unavailable or otherwise invisible to the public), document these cases as a foundation for future work, contextualize current practices. In doing so this work aims to propose adjustments to existing research and innovation theory, specifically relating to how firms utilize user data internally and share externally for research purposes in the social, behavioral, health, and public health fields. By understanding the emerging themes including

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[57] Orlans, Harold. "Developments in Government Policies toward Science and Technology." Chap. 9 In *Public Science Policy and Administration*, (edited by Albert H. Rosenthal. Albuquerque, NM: University of New Mexico Press, 1973), 252.

[58] Weiss, Robert Stuart. *Learning from Strangers:The Art and Method of Qualitative Interview Studies* (New York
Toronto: Free Press ; Maxwell Macmillan Canada; Maxwell Macmillan International, 1994), 1.

[59] Given the international reach of multinational corporations and the interconnected nature of the 21st century, the implications of these findings likely have a wider reach but the policy implications and firm focus are on the United States.

motivations, barriers, and forces (internal and external), this work seeks to provide insight into how these actors and stakeholders may impact the national research and data sharing ecosystem, and how policies at the corporate, state, and national level may influence and shape future outcomes.

This chapter first describes the primary research questions and details a purpose statement of this particular dissertation study. Next, this chapter situates this dissertation work within the qualitative methodological tradition, and provides a detailed rationale that led to the selection of this particular approach and the philosophical approach that underpins this strategy. Following this research approach, this chapter provides a detailed view of the study scoping, data collection and sources, and analysis process. This chapter then discusses ethical frameworks around handling interviews and interviewees, including how side conversations and background information are included (or not) in this dissertation work. Referencing back to the methodological tradition, this chapter also contains a positionality statement that reflects on the researcher (me) as an instrument and how my implicit participation and view in this research space shaped and influenced the data collected and presented within this dissertation. Finally this chapter describes the trustworthiness of the findings, credibility, and dependability. The methodology described here provides a description of all aspects relating to the study design, data collection, analysis, and a discussion of the limitations and tradeoffs of this research.

Research Questions and Purpose Statement

The primary purpose of this dissertation is to develop a grounded theory of how the rise of data science infrastructure is changing the role of the private firm in the R&D ecosystem, thus challenging existing research and innovation models. In order to construct a grounded theory, this work seeks to understand how (and under what conditions and forces) private firms make decisions and construct processes to use or designate user-generated data for research purposes relating to social, behavioral, health, and public health. These activities may be for internal use, or may be shared externally with outside parties for these research purposes. Based on these findings and understanding of stakeholder actions, broader implications to the national research and data sharing ecosystem may be better understood and recommendations to help shape this system will be proposed. In order to develop this grounded theory, there are two central research questions:

1) How and under what conditions are private sector firms synthesizing user data internally and/or sharing data externally for research activities relating to social, behavioral, health, and public health?

2) How may the collective actions of these firms impact the national research and data sharing ecosystem, and what policy recommendations may be considered to shape these outcomes?

These two primary research questions are supplemented by the following sub-questions,[60] that although they could be considered implicit to the above questions, signal a particular attention to specific details:

A) What research activities (relating to social, behavioral, health, and public health) are being conducted within private firms on user-generated data, and how do practitioners decide what is considered a research activity? How does that distinction impact (if at all) the treatment of ethics, knowledge sharing, and allocation of resources?

B) What conditions (including access arrangements, incentives, barriers) enable or preclude private sector data sharing, information exchanges, or partnerships for research activities relating to social, behavioral, health, and public health? This includes academic researchers university and medical researchers, as well as government actors like public health researchers.

C) What policy interventions (if any) based on these findings shape research activities and their outcomes? This includes considerations relating to knowledge sharing/documentation, research ethics, long-term investments, public good programs, and partnerships.

What emerged in the course of pursuing these research questions was that this work and theory of practice was ultimately addressing a larger, more fundamental yet comprehensive question: How is the rise of data science infrastructure changing the role of the private firm in the R&D ecosystem?

Identifying this core question, and understanding its significance in contemporary policy and friction against past innovation models would not have been possible without first pursing the original questions of inquiry. This is exactly why grounded theory approaches are designed the way described below.

Research Approach: Philosophical groundings, methodological traditions, and analysis approach

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[60] The presentation of central research question and sub-questions follows the guidelines in Creswell. Creswell, John W. *Qualitative Inquiry and Research Design : Choosing among Five Approaches* (3rd ed. Los Angeles: SAGE Publications, 2013), 141

Selecting a philosophical tradition

This dissertation work falls under mixed method research, with an interpretive framework based on pragmatism with some key elements of social constructivism as uncovered during the research process and incorporated as allowed by the pragmatist approach.[61] The "philosophical assumptions"[62] or "knowledge claims"[63] imbue researchers with particular assumptions about how knowledge will be learned or uncovered during data collection.[64] These research paradigms, worldviews, or philosophical groundings influence the chosen research design and methods used because they implicitly (or sometimes explicitly) make claims about the nature of reality with regard to knowledge shared from different perspectives (ontology), how researchers discern knowledge from participants (epistemology), and the values embedded in discerning this knowledge (axiology), and the process for collecting and understanding this knowledge (methodology).[65]

Pragmatism (as opposed to postpositivism, social constructivism, transformative frameworks, critical theory, etc.) focuses research on the outcomes and consequences of inquiry rather than antecedent conditions (postpositivism)[66] or necessarily the experiences of individuals or groups (social

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[61] See, for example:

Creswell, John W., and Vicki L. Plano Clark. *Designing and Conducting Mixed Methods Research*. 2nd ed. Los Angeles: SAGE Publications, 2011.

Plano Clark, Vicki L., and John W. Creswell. *The Mixed Methods Reader*. Thousand Oaks, Calif.: Sage Publications, 2008.

Creswell, John W. *Qualitative Inquiry & Research Design : Choosing among Five Approaches*. 2nd ed. Thousand Oaks: Sage Publications, 2007.

[62] Creswell, John W. *Qualitative Inquiry and Research Design:Choosing among Five Approaches*, 16.

[63] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End* (2nd ed. Thousand Oaks, Calif.: SAGE Publications, 2012), 28.

[64] Note that Creswell and Bloomberg differ in some of their categorization of philosophical assumptions and differ in how to classify critical theory, for instance. Since this is not an approach used in this work, the discussion here should be sufficient for this dissertation work.

[65] Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 20.

[66] Postpositivism, often called the "scientific method," approaches research questions with he belief that a set of laws and theories govern all actions/matter in the world, and thus these theories/laws can be tested and verified using hypotheses and often experiments. The term postpositivism is used instead of positivism because contemporary postpositivists do not constrain themselves to strict cause and effect, but instead recognize that all cause/effect is tied to a probability that it may or may not occur. (Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 24.) This approach can be seen as reductionistic, particularly when applied to some social or organizational phenomena by some researchers, while others see it as a rigorous way to collect multiple levels of data collection and analysis.

constructivism).[67] Social constructivism (also known as interpretivism) challenges the assumption embedded in postpositivism that all phenomena can be broken down into testable parts, and treats reality as a construct of social, cultural, and historical influences. This approach is value-bound rather than value-free,[68] and assumes that individuals are influenced by their own personal experiences—making multiple meanings or truths possible. In social constructivism, the process under which the researcher interacts with is taken into account through their "position" to the subjects. Researchers seek to make sense of, or interpret, the meaning others hold about the world in this approach, and generate a theory or pattern of meaning to these processes and perspectives.[69]

Critical theory[70]—which is often used within the interdisciplinary and cross disciplinary fields contributing to internet studies broadly—may also be referred to as advocacy, transformative frameworks, or participatory frameworks, and encompasses approaches that address marginalized or disenfranchised groups including feminist studies or queer theory. Pragmatism, on the other hand, is not committed to any one philosophical approach but approaches knowledge acquisition as a product of its context and conditions. Pragmatism is from the work of Peirce, James, Mead, and Dewey,[71] and concerns itself primarily with the practical application and workable solutions to address a research problem.[72]

Pragmatism gives researchers the freedom to choose methods, techniques, and procedures for research that best fit the purposes and needs of the project, and allows the inquiry to naturally be open to social, historical, and political contexts. Within a pragmatic philosophic grounding, researchers allow for truth to be what it is at that point in time for subjects, and allow for the world to exist

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[67] Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 22-35.

[68] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 28.

[69] Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 25.

[70] Critical theorists approach their work with the belief that research is intertwined with politics and advocating action to address inequalities or injustices, and often involve approaches like participatory acton research. Creswell (Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 27) separates the philosophical approaches of transformative frameworks, postmodern perspectives, feminist theories, critical theory/critical race theory, queer theory, and disability theories but for this discussion these have been lumped together following Bloomberg. Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 28.

[71] These scholars were repeatedly cited in the methodological literature, and a brief overview of their contributions may be found here.

"Pragmatism." Stanford Encyclopedia of Philosophy, 2008, 2018, https://plato.stanford.edu/entries/pragmatism/.

See, for instance, citations in Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 29.

[72] Patton, Michael Quinn. *Qualitative Evaluation and Research Methods*. 2nd ed. Newbury Park, Calif.: Sage Publications, 1990.

outside of an absolute unity of a single truth.[73] Researchers using pragmatism as a worldview do not see the world in absolute unity, and thus look toward many approaches and data sources to produce results. A mixed methods approach that employs many ways to creatively study and understand a research problem from any available angle is best suited for research grounded in pragmatism (e.g., mixed qualitative approaches, or qualitative and quantitative studies).

From the onset, this dissertation was rooted in a pragmatist worldview and philosophical approach. Pragmatism gave this dissertation research a problem-centered, real world practice oriented approach, which from the beginning allowed for the research to accept the limitations of this line of inquiry and stay focused on policy-relevant findings. In talking to employees, I anticipated their answers (or ability to answer) would be heavily influenced by their corporate environments and culture, position within the company, length of time within the company, and any other numerous factors. These factors often of limited transparency to me as the researcher, and would be impossible to control for systematically across companies—pragmatism allows this research to acknowledge the presence of these complications and influences, account for them where possible, and allow for the uncertainty they may present while generating findings. Artifacts online represent narratives constructed by the firms which explicitly contain biased and curated content, and additional experts polled throughout the study may have their stances on issues shaped by current events especially since this dissertation examines contemporary phenomena. However, these concessions were necessary in order to gain access and address the research questions at the heart of this dissertation study. These constraining factors need to be acknowledged and taken into account by both me as the researcher, the audience of this study, and, where possible, incorporated into the findings.

Throughout the course of this dissertation, it became apparent my positionality as a white female researcher at UC Berkeley living in the San Francisco Bay Area (referred to in this dissertation as "the Bay Area") was influencing my access and likely some of my responses from individuals. By living in the Bay Area and thus embedding myself in this particular cultural and historical moment, I not only was becoming a part of this story but my particular experiences, professional status, affiliations, and my appearance were all influencing my interactions with research subjects and companies. Because of this and my grounded theory approach (explained in the next subsection) that allowed me to pose research questions and inductively generate meaning from my data collected in the field, this dissertation lends itself to a pragmatic worldview. I also borrow heavily from the social constructivism/interpretivism given my sensitivity to how my own experiences living within the Bay Area

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[73] Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 28.

culture and experiences conducting this research were shaping my access and findings. Reflections on my positionality as a researcher may be found later within this chapter.

Building off of this understanding of philosophical approach and the embedded assumptions made within this choice, several qualitative methods were selected to create a mixed methods[74] approach to this dissertation research.[75] Qualitative research is immersed in real world settings, and considers context when setting a research design and generating findings from data. The findings derived from qualitative research are emergent and evolving, and often move between induction and deduction. As expected from a qualitative research study, this dissertation includes the voices of participants/subjects, a reflection of the reflexivity of the researcher, a detailed and complex description of the problem and an interpretation of the context by the researcher, and a final contribution to the literature or a call for change.[76] Where possible, this dissertation used economic data or survey data from separate studies to complement the qualitative work.

Approach to inquiry and implications for analysis

Based on the philosophical groundings of the research, approach to the inquiry or qualitative research tradition or genre needs to be selected—this[77] dissertation based its approach off of grounded theory.[78] Grounded theory enables a researcher to move beyond mere descriptive techniques by making it possible to generate a theory of process or action based on the views and practices of participants (interviewees).[79] This theory is developed by—or

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[74] Mixed methods research has emerged as a central part of interdisciplinary projects, and in the past few decades has received increasing discussion in diverse academic communities, and has given rise to a group of conceptual and research design models. Mixed methods research allows the researcher to gather more comprehensive evidence for the problem at hand than quantitative or qualitative research alone.

Creswell, John W. *Research Design : Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed. Thousand Oaks, Calif.: Sage Publications, 2009), 203. Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 15.

[75] Strategies of inquiry are most often associated with quantitative research, whereas qualitative work has associated traditions or genres that specify the focus and form of the work which is how this dissertation was approached. Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 30.

[76] Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 44.

[77] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 30.

Creswell, John W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 69.

[78] Grounded theory approaches include narrative research, phenomenological research, ethnographic research, case studies, hermeneutics, or action research. In this dissertation, case studies are specifically used as an analytical tool, in addition to semistructured interviews.

[79] Strauss, A., and J. Corbin. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, CA: Sage Publications, Inc., 1998.

grounded in—data collected through mostly qualitative methods that describe the actions, social processes, and interactions of subjects or firms in a way that brings forward key themes.[80] This approach creates a theory that might explain the practices of participants (and in this dissertation's case, firms as well as their employees), and/or set up a framework for additional research on the topic area.[81] Grounded theory has two primary characteristics: 1) constant comparative method that involves the ongoing analysis of data generating emerging categories; 2) theoretical sampling that focuses on different groups to maximize the possible similarities and differences of subjects.[82] As best stated in the literature: "For the purposes of this paper, grounded theory is defined as a theory generated from data systematically obtained and analyzed through the constant comparative method."[83]

Based on data collected, grounded theory allows the researcher to create a theoretical framework that articulates the causes, conditions, and consequences of processes being studied.[84] This identification of causes, conditions, and consequences is done in part through the qualitative coding of interviews, notes, and other artifacts. In this dissertation research, qualitative coding of interviews and artifacts taken together with research notes and experiences were used to construct a framework of practices and external forces (or at times, internal forces within the firms) that shaped this research and information sharing system. The analysis identified unique cases of incentive structures that were used to explore broader themes and lessons, key drivers of actions, decisions influencers, new paradigms, and resulting models of private sector R&D practices and data sharing relating to social, behavioral, health, and public health realms. These findings were able to challenge existing theories and models of private sector research and innovation, and present key elements that have constructed a new emerging model of practices.

Analysis Strategy

As per this approach to inquiry, coding was done iteratively. The theory is meant to evolve during data analysis and through the "continuous interplay

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[80] Strauss and Corbin. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.*

[81] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

[82] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

[83] Conrad, Clifton F. "A Grounded Theory of Academic Charge." Sociology of Education 51, no. 2 (1978): 101-12

[84] Alternatively, grounded theory may enable a researcher to amend existing theory on the subject if one already exists.

Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

between analysis and data collection."[85] This process is meant to allow the researcher to continually ask new questions as they arise, and make adjustments accordingly to the data collection and theory development—especially since knowledge gleaned from subjects is assumed to be linked closely with place and time.[86] First after every interview, thorough memoing of key themes and reflections on commonalities or differences with existing interviews.[87] Once a large portion of interviews—the primary source of data—were collected, a read through was done to generate open codes for themes identified as large types of information categories. Following this open coding process, axial coding was used to identify the codes that represent core phenomena.[88] Causal conditions, strategies (responses to core phenomena), contextual and intervening conditions (elements of the context that influence strategies), and consequences are all key theoretical elements generated by the axial coding step.[89] The final stage of coding—selective coding—was completed after forming a hypotheses about how coded categories interrelate and thus formed the final articulated theory.

Limitations of Grounded Theory Approach

When using grounded theory, a researcher does not enter the field with testable hypotheses. Ideally, grounded theory researchers enter the field with little to no idea what they will find, and remain open to all possibilities. It is in practice difficult for researchers using grounded theory "to suspend theoretical ideas so that the analytic substantive theory can emerge."[90] Given the motivations underlying the topic of this research, the formation of my research questions, and the very limited time I had with interviewees (~20-90 minutes), I used my existing experience/knowledge and pre-interviews to inform "hunches" which thereby informed my interview guide and participant selection.

It is also difficult to fully assess when coded categories are fully saturated and when the theory has been sufficiently developed to reflect the full comprehensive picture of reality.[91] It is also a risk that theory will not be fully developed by the end of the study, but in the case of this dissertation and

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[85] Strauss and Corbin. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 273.

[86] Strauss and Corbin. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 276.

[87] This memoing also captured additional details or thoughts from the interview.

[88] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

[89] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

[90] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

[91] Bloomberg, Linda Dale, and Marie Volpe. *Completing Your Qualitative Dissertation : A Road Map from Beginning to End*, 33.

research in general, this dissertation project is part of a longer research agenda that should (and is intended) to continue over time. This work will provide theory to continue to revise in the future, and to assume any social and organizational phenomena can be reduced to a simple theory that will stand over time is simply ridiculous and out of touch with reality. This dissertation is merely a starting point for a lifetime of inquiry.

Evidenced-based Policymaking

Calls for informed policymaking—legislation and programs created or altered on the basis of research and data rather than political maneuvering or public perception—are hardly new. Yet, these calls have seen a renaissance in recent years as calls to place more academic research in the pipeline set to directly inform the policymaking process, in forms such as anticipatory governance and more contemporary or reflective stances like in evidenced-based policymaking.[92] Donald T. Campbell, a renown social psychologist and scholar in new methodologies, wrote about what he termed the “experimenting society” in 1969 that called for social policy programs to experiment with possible solutions. He stated that for these experimental programs[93] to be able to reflect on their success, limitations, or failures, a more robust set of evaluation criteria should be available to make these determinations.[94] Ray Pawson, in his book-length discourse on what “evidenced-based policymaking” is and is not, is careful to outline that political positioning of research, data portals (or other tools that simply bring together raw materials), polling of public opinion, or partnerships with government organizations do not qualify.[95] Pew Charitable Trust describes evidenced-based policymaking as policy that “uses the best available research and information on program results to guide decisions at all stages of the policy process in each branch of government. It identifies what works, highlights gaps where evidence of program effectiveness is lacking, enables policymakers to use

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[92] Guston, David H. "Understanding ‘Anticipatory Governance’." Social Studies of Science 44, no. 2 (2014): 218-42.

[93] Previously, I worked on a team that conducted a lifetime evaluation of the EPSCoR Program (Experimental Program to Stimulate Competitive Research) [Yes the word program after EPSCoR is repetitive, but the program is now almost exclusively known for the acronym and not the title]. EPSCoR was founded in the late 1970s, and at the time I think there was some uncertainty about the origins of the word “experimental” in the title. It is possible this title choice originated from Campbells’ work at the time, especially since the program was trying a new method of distributing scientific research funds across states. Zuckerman, Brian L. , Rachel A. Parker, Thomas W. Jones, Brian Q. Rieksts, Ian D. Simon, Gilbert J. Watson III, Elaine M. Sedenberg, et al. Evaluation of the National Science Foundation’s Experimental Program to Stimulate Competitive Research (Epscor): Final Report. IDA Science and Technology Policy Institute (Washington DC: 2014). https://www.ida.org/~/media/Corporate/Files/Publications/STPIPubs/2015/P-5221.ashx.

[94] Campbell, D.T. "Reforms as Experiments." *American Psychologist* 24, no. 4 (1969): 409.

[95] Pawson, Ray. *Evidence-Based Policy: A Realist Perspective* (Sage Publishing, 2006), 4-6.

evidence in budget and policy decisions…."[96]

This dissertation work, strictly speaking, falls more in line with a broader goal to inform policymaking by providing empirical evidence from the field on how private firms are conducting R&D, the barriers or opportunities to partnerships, motivations and arrangements underlying private sector data applications for public good activities, knowledge sharing from private sector data, and the impact these activities may have on the broader research ecosystem. Even though this work is not executed to inform a particular policy or set of policies, the products of this research are intended to broadly reflect on available policy mechanisms (e.g., public/private partnership funding programs via agencies like SBA or DoD), the need of new programs to address misaligned incentives or market failures, and/or provide a framework for similar lines of inquiry. This work is therefore intended to be a foundational building block for future work in evidence-based policymaking, though the goal to inform policymaking is quite clear. This goal is reinforced by the decision to use grounded theory, which was cited as a useful method to study diverse and complicated phenomena including policy.[97]

Research policy, Science policy, S&T policy, tech policy: Just all of the policy

This research falls within the realm of "science and technology policy" or "S&T policy" relevant research. Technology policy, or tech policy is more often associated with high-tech or internet policy, whereas science policy is more historic and has roots in the law and policy worlds primarily following WWII (but, traces of this can be seen in relation to research in the historical context found in Chapter 4). Science policy can either be oriented as "science for policy" where data or scientific research is used to inform policymaking, or "policy for science" in that policy can dictate research agendas, special programs, and regulations on innovation processes and technology itself. The latter can also be viewed as "research policy," and as Kleinman states: "The notion of science policy is fairly broad. It may include the establishment of research priorities for government-supported research, as well as the regulation of the potentially negative effects of technological development…. I focus on the former, which I term research policy, because I believe that how and what research priorities are set has a dramatic impact on the contours of a society and indeed, says a good

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[96] Evidence-Based Policymaking: A Guide for Effective Government. The PEW Charitable Trust MacArthur Foundation (2014). http://www.pewtrusts.org/~/media/assets/2014/11/-evidencebasedpolicymakingaguideforeffectivegovernment.pdf. 2.

"Evidence-Based Policymaking Collaborative." Brookings, nd, accessed August, 2018, https://www.brookings.edu/evidence-based-policymaking-collaborative/.

[97] Strauss and Corbin. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 275.

deal about the society's broader views and priorities."[98] In some ways, this dissertation itself is science policy in that it is hoped to inform policymaking, but it studies in some ways how policy for science has influenced industrial R&D.

Scope, sample selection, sources, and data collection

Scope, research setting, and context

The scope of this dissertation included companies (firms) who collect or curate biosensed data from users as part of their business model through the functioning of their product or service.[99] Biosensed data includes physiological, kinesthetic, biological samples, and emotion/behavior data about individuals. Biosensed data was chosen because it is particularly rich in inferential and scientific potential, and enables research regarding health, wellness, social lives, and behaviors of users—in addition to larger studies implicating groups of people or public health interests. These activities may be conducted through internal activities, partnerships, or exchanges (either through data or devices, usually in this case prototypes) with outside entities.

This dissertation primarily focused on sensor-based companies and smart Internet of Things (IoT) devices. However, as seen with inferences made through search data with regard to the health status of users,[100] a variety of data may be relevant given unknown links between digitally mediated interactions and other personal states. Almost all of these data may be considered to be passively collected from the user using sensors or activity logs, but some data flows may be augmented with additional context or information from the user. Companies included were or intended to be consumer facing, but in a few cases companies were business to business (B2B) applications. In these limited cases, the business was based off of data collected directly from recruited study subjects from the general population, or from users of the business using the application. Biosensing is one of many possible lenses to examine this phenomena, and though it lends some specificity to the analysis and discussion many of the broader themes can be extracted for non-biosensing companies.

This dissertation focused primarily on North American companies (US and Canada), but several companies are either large multinational firms or have a strong presence in another country due to the home of the founders. All companies interviewed have at least some presence within the US, and either had

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[98] Kleinman, Daniel Lee. *Politics on the Endless Frontier : Postwar Research Policy in the United States* (Durham: Duke University Press, 1995), 5.

[99] Sedenberg, Wong, and Chuang. "A Window into the Soul: Biosensing in Public."

[100] Gigerenzer, Gerd. "Can Search Engine Data Predict Pancreatic Cancer?". The BMJ 358:j3159 (2017). https://www.bmj.com/content/358/bmj.j3159.

an "office" (or more likely in the case of startups, a WeWork address)[101] in Silicon Valley/Bay Area, or another technology prominent region of the US like Boston, New York, or Austin. Some regional diversity was sought within the US in order to help diversify geographic influences, but each company either had clients in the US or intended to after launch.

There are two geographic firms used throughout this dissertation that may be confusing due to shifting boundaries over time. Originally, Silicon Valley was the part of the San Francisco Bay Area (Bay Area) that had the rich technology activity. Silicon Valley properly means the peninsula south of San Francisco to what is known as "South Bay" around San Jose.[102] Today, the technology activity is pervasive to almost all of the Bay Area, and in particular traditional Silicon Valley as well as San Francisco and East Bay (in Berkeley and Oakland). Historically when discussing activities, Silicon Valley will be used as the most accurate description but, when applying or comparing to today, it will more likely be described as the Bay Area or Silicon Valley (understanding the now porous boundaries) to maintain logical consistency.

Often in studies of industry, Standard Industrial Classification (SIC) codes or the newer North American Industry Classification System (NAICS) codes are used to help provide standard definitions and boundaries around an industry of interest. In the context of this study however, they do not provide much guidance. For instance, most companies that collect and process user data are under the business type "Information," and have a primary NAICS Code as "518210 - Data Processing, Hosting, and Related Services." Yet some sensing technologies, like Fitbit Inc. are classified under business type "Retail Trade" and have a primary NAICS Code as "443142 - Electronics Stores." Additionally, many startups' self-identified NAICS code are not published, and hard to ascertain from the outside —or most importantly, invisible when using the code to find and identify potential interview targets. There is additional complexity with apps and platforms associated with the sharing economy, which means platforms like Airbnb may be listed under codes relating to travel accommodations,[103] rooming/boarding, real estate, or data processing. From a researcher's perspective, even with occasionally fuzzy industry definitions, there are notable exchanges within a particular set of information companies. For instance, many of these companies collect, curate, and analyze user data in order to provide a service or information-enriched product. These companies exchange employees with the same skillset, exchange methods and techniques, often attend the same set of conferences, and receive funding from similar tech sources and VCs.

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[101] WeWork is the popular cowering space found in many large cities, especially in the United States

[102] See for example: Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. Cambridge, Mass.: Harvard University Press, 1994.

[103] Airbnb is obviously not a sensing company (at least at the moment) but is used here to illustrate some of the conflicting and complicated codes used for digital platform and services in this space.

The unit of analysis for most of this dissertation study was the company (firm) to understand the organization and the people fueling it. Semi-structured interviews were the primary source of qualitative data which naturally relied on participation from current or former employees. The employees of course bring their own perspectives, biases, and limited experience to the table, but that is expected and part of the process. When possible, multiple people were interviewed and public artifacts (e.g., legal documents, public statements, websites, product descriptions) were used to make these data more robust.

When speaking to individuals put forth by their firms for an interview request it is difficult to try and instill gender and ethnic diversity into my interviewee pool. For the first several months I realized I had—with one exception—only spoken with white males. By the end of the study, I had achieved more diversity. Though I did not ask or thereby record the race of my participants,[104] I did personally feel it was important to strive for some diversity on my interview subjects in order to get a fair and accurate reflection on corporate practices.

Firm Selection and Purposive Sampling

To begin the scoping of this work I conducted several preliminary interviews to talk openly with professional contacts at startups and large firms about their experiences in R&D and their reflections on current practices. These interviews were used to shape the overall dissertation study, and inform the first interview guide.

Purposive sampling[105] was used to to select firms for recruitment.[106] Purposive sampling is based on selecting firms that are particularly information rich for the research questions. Using Bailey's edition's sampling procedures,[107] three different types of sampling procedures were used:[108] 1) Intensity (selecting cases that manifest the phenomena intensely but not extremely and are "information rich"; 2) Extreme or deviant cases ("selecting cases that have unusual manifestations of the phenomena of interest"); and finally 3) Criterion (Cases selected based on a particular criterion of interest). Procedures 1 and 2

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[104] In an ideal world researchers would have all possible data from their subjects. Since this was not central to my research questions, and I had very limited time with each interviewee these were not questions I asked. However, these reflections were made in my own internal research notes, but of course limited by my own interpretation and not verified by interviewee's identities.

[105] Bailey, Carol A. *A Guide to Qualitative Field Research*. Third Edition. ed. Los Angeles: SAGE Publications, 2018.

Patton. *Qualitative Evaluation and Research Methods*.

[106] There are several different types of purposive sampling frameworks that have been amended based on Patton's (1990) original work

[107] Bailey. *A Guide to Qualitative Field Research*. 120.

[108] As per Bailey, "different sampling procedures can be combined." Bailey. *A Guide to Qualitative Field Research*. 119.

were sequential at first, and eventually simultaneous. At first cases that were in the information sharing space either through press or internal but otherwise public knowledge of experts were selected. Firms that fell into this category were those that had some information sharing or internal research, but it may not be a well developed program or a one off example. Eventually cases were identified through public announcements or searching of lists (see recruitment methods below) that were highly sought because they exemplified an unusual case of contributing to research or research-related activities through data sharing or internal practice, a policy of no sharing at all, or an unusual encounter with regulation or acquisition that made the firm's experience exceptional. This method allowed recruitment to go broad and then more narrow, while still allowing for continued recruitment of information-rich firms that participated in research/information sharing without being an extreme or otherwise exemplary case. Procedure 3 was used in the final stretch of analysis to round out findings in the initial analysis and check for robustness and was done using a framework described below looking for companies who included "research activities" in their privacy policy, as identified through lists of most innovative companies.

In addition to these cases, experts were interviewed on particular topics, and were selected based on the criterion that they had deep knowledge or unique experience with a detail or practice. These supplemental interviews added depth to particular topics relevant to my firms of interest, even if they could not openly speak about their current or past firms. These interviews were sought in order to bring detailed insight to light for analysis.

The Numbers and saturation

For most companies, only one or two individuals were interviewed assuming their jobs were central to the activities of interest or their experience relevant to the discussion. In many startups, other individuals would be asked to participate in parts of the interview or looped in later during follow up. For a few early cases, every team member was contacted and the majority interviewed about their role and perspectives on the team. After about two people, information quickly became redundant or not helpful for this particular study—particularly the farther their role was to R&D or partnership management. Many small firms are resource constrained so talking to each team member would likely have not benefited the research and would have unduly burdened the firm. For cases in large firms, it is often hard to get more than one contact to agree to participate. (See Appendix for a detailed documentation and description of these practices)

As noted above, deciding when saturation has been reached is a challenge when using grounded theory. For qualitative research, there is no magic or correct number signaling enough interviews have been done — particularly considering the diversity of possible experiences and examples in the world. This dissertation project is meant to begin building the framework of a lifelong research agenda. Once the three procedures of sampling were complete and I felt there was enough data to form a theory, interviews were paused.

This research design is not meant to be representative, but rather to collect data that allows for a rich description and understanding of common and exceptional cases of private sector data being used internally for research or shared externally for public benefit.

Recruitment

A variety of recruitment methods were used after a company had been identified as part of the sampling framework—usually after reading about their work in a press release, hearing a presentation, talking with employees at events, finding them while scanning websites of companies (e.g., TechCrunch or incubators). In some cases, a personal interaction led to the interview invite and I gave participants my contact information. In other cases, I emailed a publicly available general contact on the company website introducing myself and my research, asking for an interview. In several cases, a personal introduction through a colleague or professional acquaintance was made after the interviewee consented to be approached.

Many emails to companies or attempts to follow up with individuals who agreed to be contacted were met with no response, or a very tardy response (up to 6 months). This issue is discussed and reflected on further in another section (Appendix B), and became an unexpected and important aspect of this research.

Data collection methods & interview process

The primary source of data was obtained using semi-structured interview methodology. The consent and ethical process is described separately below.

If possible, interviews were conducted in person at their place of work or a public location like a coffee shop. The interview was recorded on two separate recording devices for redundancy and transcribed later using a service.[109] If the interview needed to take place digitally, Skype was used and ECamm was used to record the session.[110] Interviews typically lasted 30-90 minutes, with the average or typical interview lasting just under 60 minutes. Follow up on the progress of companies and their projects/initiatives of interest would occur with permission of the interviewee, and for any attribution/quotes additional follow up was done after the analysis/write up to confirm both the accuracy of content as well as the

[109] This saved one 1.5 hour long interview when the primary microphone inextricably stopped recording 10 minutes in.

[110] This was before Skype released an embedded recording feature in September 2018.

continued consent of the interviewee.

In the beginning, there was one interview guide developed based on preliminary interviews and content analysis. However over time, it became clear there were distinct types of interviews that required their own guide:
-Firm with identification (and maybe identification of interviewee)
-Non-identified firm and non-identified interviewee (i.e., the "Why people won't talk to me" interview)
-Expert interview for key details, unique experience, or perspective on activities of interest

Before each interview, as much information as possible was gathered about the firm's activities via publicly available information so that the interview could be structured to make best use of the interviewee's time. The method of semi-structured interviewing was informed by Weiss (1994), Bailey and influenced by other key methodology texts including Holstein and Gubrium (1995) and Morgan (1997).[111]

During the interview, I took notes to reinforce key statements, concepts, or quotes said during the interview. These notes provided a basis for some initial open qualitative coding, and memoing about observations such as the workplace environment, body language of the interviewee, people around us, etc.

This dissertation was initially constructed to include a survey of more individuals about their views and to solicit information about their firms. However, previous work studying organizations demonstrated that: 1) It is hard to reach the right individuals within organizations since there is no unifying job title, consortia, professional organization, etc.; 2) Without the ability to establish trust with the respondent (as is the case in semi-structured interviews), it is difficult to get an honest and detailed response—let alone any response; 3) Many people who are in the "right" position within the firm do not think they are knowledgable about the topic of interest and self-disqualify. This was the case in cybersecurity, as well as demonstrated during interviews when interviewees would state they "didn't know how much help they could be but they would try anyway" and their experiences were exactly what our study was looking for.[112]

There were 23 completed full interviews, and an additional 9 background interviews.

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[111] Weiss, Robert Stuart. Learning from Strangers : The Art and Method of Qualitative Interview Studies. New York; Maxwell Macmillan International, 1994.

Bailey. *A Guide to Qualitative Field Research*. 119.

Holstein, James A., and Jaber F. Gubrium. T*he Active Interview*. Qualitative Research Methods. Thousand Oaks: SAGE Publications, 1995.

Morgan, David L. *Focus Groups as Qualitative Research*. Qualitative Research Methods Series. 2nd ed. Thousand Oaks, Calif.: Sage Publications, 1997.

[112] For more information, see Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In *Rewired: Cybersecurity Governance*, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

Analysis

Part of the analysis strategy may be found above as it relates to the grounded theory approach. Qualitative coding was used to identify core phenomena and then the causal conditions, strategies, and contextual elements that contribute or stem from these key insights. These codes were done iteratively on interviews and content in order to allow key themes to emerge, and then revisited as findings were fully developed. The final stage of coding—selective coding—was completed after forming a hypotheses about how coded categories interrelate and thus forms the final articulated theory.[113]

Archival process

Since many of the links to company content (e.g., press releases, privacy policies, etc.) are hosted on private websites, they could disappear without a record in the future. Material used in this dissertation will not only be on file with the author, but will also be backed up to the Internet Archive so that anyone reading or conducting similar research could have open access to the same material. The process used after consulting with the Internet Archive's WayBack Machine staff was to use "Archive-it.org" for URLs, or to establish a permanent URL using "perma.cc." This practice should be more widely adopted as responsible citation management for material that lives outside of classic academic periodicals, including primary sources referenced in internet studies work.

Ethics

As someone who studies research ethics, I found it particularly important and vital to my professional reputation to hold myself to the highest standard possible. Here I detail two processes for how I approached my interactions with interview subjects. This is all conducted in addition to review and approval of procedures by the UC Berkeley IRB.

Formal interviews - Ethical Process

Each interviewee was presented with two traditional informed consent forms (one to sign and one to keep) along side what I called "Plain English Informed Consent" which I created to plainly state the most salient features embedded in the form for research participants (e.g., data collection, storage, and attribution). If the interview was in person, I provided them the paper versions

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[113] Bernard, H. Russell, and Gery Wayne Ryan. *Analyzing Qualitative Data : Systematic Approaches*. Los Angeles Calif.: SAGE, 2010.

and asked them to sign it after verbally going over key points and allowing them time to read it and ask questions. If the interview was over Skype or the phone, I sent these documents ahead of them, and then asked for verbal consent after we went over key details and questions.

In rare occasions, what I thought was a background informational interview would turn into an opportunity formal one. There I asked the participants if they were comfortable with being a part of my research and recited the key facts of the informed consent form to them for verbal consent. If any attributions were made in these cases, I followed up via email to confirm they were comfortable with the quotes or general attribution to make sure the research process had been made clear to them.

In many cases, I asked to use the company name but to generalize their position within the company (e.g., data scientist or product manager). In some cases, particularly with startups, individuals asked that their company and name/title be used explicitly to avoid confusion with competitors and to promote the company. This often happened because interviewees were high enough in the company they felt comfortable giving permission for full attribution. In some cases, interviewees were uncomfortable with their company or name/position be used or recorded at all. These interviews have made up what will be discussed later as "why people won't talk to me" phenomena. In these cases, I took very seriously the concerns of interviewees and followed their requests. One interviewee wanted to make sure that their name was nowhere in my records, and that the transcript of the conversation was done by hand instead of using a transcription service. In other cases, interviewees simply asked that they or their companies not be identified in my dissertation. Attribution took great care, and I worked with interviewees who occasionally wanted to read transcripts or quotes before determining if they wanted to be identified. I felt this was an important part of not only my role as an ethical research and prevent any harm on their part, but I also felt these extra steps helped me establish trust with my interviewees—a process that was undoubtedly important to the research and data collection within this dissertation.

Each interview began with a statement that I did not want to know any sensitive material about them or their past/present companies. I made it explicitly clear to all interviewees that not only could they refuse any questions or end the interview at any time, but they could contact me later and ask to be removed or deleted from the study. I explained though I could not forcibly "forget" anything they told me, I would do my best to remove them from any unpublished work or adjust their level of attribution.

For any particularly negative findings, I decided that I would remove attribution ahead of time and only focus on key factors of the firm and generally describe possible antecedent conditions that would be relevant for discussion. I did not feel it necessary to use my dissertation as a shaming platform, when the same lessons could be learned from anonymous sources.

In some cases, I offered companies write ups for their blogs based on my research or insights from my general research tailored for their company in exchange for their time. To date, no company has taken me up on this offer, but I felt this was a gesture that did not compromise my subjectivity but yet offered an exchange for time. If companies felt uncomfortable, I allowed the ability to review selected quotes from the interview for accuracy but was careful to never allow for the review of my findings or entire discussion. In some cases, I also circled back to companies and employees to make sure I had the story correct, and offer a chance for them to offer any updates since the last time we spoke. I felt this move only strengthened the quality of my research and gave them a fair opportunity to ensure my facts and interpretation was correct, without compromising my integrity or intellectual freedom as a researcher.

Informal background interviews - Ethical Process

As part of the process of validating my results, I often discussed my research and findings with colleagues and friends familiar with the area to solicit their opinions and perspectives. I feel this is similar to how many people discuss their work and obtain outside feedback. I would also often find someone through professional connections or complete happenstance who would provide details and commentary relevant to my dissertation work but were not themselves a formal subject—a part of living and breathing the Bay Area for five years as discussed in positionally reflection. For these informal interactions, I tried to always make it clear who I was (a researcher studying the topic at UC Berkeley) and felt it was a violation of my ethics to ever “pump” someone for information, even if it was not considered a formal and quotable interview. I felt this sort of prying would be unethical and betray the trust of those individuals willing to discuss their views of my dissertation topic, and I also felt offhand comments said while individuals were drinking at social events would be unethical to record—even though I of course cannot forget things volunteered or said to me, I did find it appropriate to make any notes of these conversations/comments. For the other open conversations with sober individuals talking openly about my area of research, I made notes after the conversations in my dissertation journal, memoing to myself the comments/anecdotes/suggested readings or references/ and my reflections about them. These reflections or comments would be made without attribution to individuals or companies since it was outside of the framework of my informed consent.

Research Reflection Memo — My positionally to (mostly)

Silicon Valley/Bay Area firms[114]

In beginning this dissertation research, I had naively assumed that in studying organizations and their associated practices, policies, and cultures that my positionality to these firms and their employees would not be remarkable. Based on my professional experiences conducting qualitative policy research in Washington, DC and working alongside collaborators here at Berkeley, I felt I had a good feel for what conducting my own qualitative dissertation work would be like. What I discounted was the effect of conducting field research on my own, with entirely new contacts forged myself.

I think these differences can be attributed to three things, that sometimes worked in my favor with regards to access or developing trust-based relationships, or hampered my credibility, stature, or ability to conduct interviews. 1) My physical appearance and identity as a blonde female junior scholar; 2) My position at UC Berkeley in the Bay Area; 3) the Bay Area/Silicon Valley/Northern Californian general culture.

Overall, my experiences were mostly positive and I feel deeply indebted to the women and men who took the time out of their busy schedule to chat with me. The majority of interviewees were kind, helpful, and professional. But I have realized over the course how several particular interactions shaped my approach within my interviews, and likely influenced some of my perceptions of my fieldwork and culture of the tech scene.

One of my first interviews when I was still establishing my scope and getting comfortable with my interview guide was with a male subject at a large firm who chatted with me at a conference reception. He said he worked in research for the firm, and he would be happy to chat with me. When I tried to schedule a time, he requested I come to his office in downtown San Francisco on a Saturday, which I was happy to do. Except when I showed up, the office was completely empty. We proceeded with the interview when it became very clear he did not actually work in any research part of the organization, and really had no clue what I was trying to chat about despite his original claims. I politely wrapped up the interview and thanked him for his time, and left without incident. However, he proceeded to begin texting me after I left (I give all my interviewees my cell phone number in case they need to contact me to reschedule, etc.) asking me out on a date. I professionally and politely declined, but this was met with further protestations telling me that as a PhD student I should get out and have some fun, and that he would really like to see me. I remained firm, and finally stopped responding. This was one of my first solo interactions and interviews conducted after my qualifying exam. But this initial interview ushered in a series

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[114] The content and style of this section was inspired by Derry, Min, "Writing Strategies: What's Your Positionality?," WEINGARTENLEARNINGRESOURCES ed., 2017, https://weingartenlrc.wordpress.com/2017/01/09/research-writing-whats-your-positionality/.

of circumstances were often I wasn't sure how one-on-one interactions were motivated—especially when it came to background off the record interviews.

It is impossible to know why certain people or firms were or were not willing to participate in my research or respond to my emails. In some cases, I think I was able to get access because of my position at UC Berkeley—a school and program with name recognition, proximity and access to exclusive events, and with a large alumni base seeded in the tech industry. In some cases, I suspect I got access because I was a young woman—in other cases I think I was denied access based on these same features and embedded (and often gender oriented) assumptions made about my qualitative and policy-oriented research. Maybe neither of these is true—I am only left with my suspicions based on my reflections compared to my colleagues' shared experiences. Compared to my colleagues, I got less access inside firms on a professional level, but more access to "social" events like parties or invitations to hang out over drinks.

Ideally in qualitative interviews, the interview plays the role of a minimally informed yet curious participant. This allows interviewees to fully establish their points without introducing bias, yet this is hard to do when interviewing experts and highly educated employees who prefer to speak to a peer rather than explain the basics. I found over the course of my interviews that I led my questions more than I would have liked from a methodological standpoint. I began doing so because I realized it was essential I demonstrated my expertise and qualifications to be having these discussions in the first place—again, a possibly gendered bias. It is hard in semi-structured interview to prompt the interviewee to give a detailed explanation of what might otherwise be obvious to anyone with subject matter expertise, but requires explicit descriptions to either confirm or document the instance*. Part of this is the challenge of essentially having ten minutes to introduce myself, my work, go over ethics and consent, and then establish some baseline trust with my interviewee. This is an impossible task, yet I was a standard I strove to hit in all of my interviews—also establishing the deep subject matter expertise while asking basic questions about practices was a skill I have not yet finessed. I now attempt to explain this challenge plainly in the beginning, but even when I do it often comes off in the conversation as if I am not simply playing a naive but curious participant.

The best example I had of this was in one interview where the interviewee had somehow accepted my request, but was late, changed the medium of our interview moments before (a challenge for recording set up), and attempted to explain from the first moment (incorrectly) why my dissertation was already a studied topic. When he stated he couldn't share any details of his firm's internal practices because of intellectual property issues, I switched the interview into the "why you can't talk to me" category. Upon inquiring about these limitations, I received a patronizing lecture about cupcakes, and how if I were a cupcake salesmen I would not give away how many cupcakes I was baking that day or the flavors that was offered. What I could not retort back, despite my deepest urgings, is that the analogy was in fact broken: the number of cupcakes and flavors of the day refer to business analytics, and the secret recipe for the cupcakes (trade secret algorithm), test kitchen preparations underway to create entirely new flavors (internal R&D), or partnerships with specialized chefs to bring in unique culinary talent in order to meld or develop a new type of cupcake based dessert (R&D partnerships) would be more appropriate. I have a difficult time imagining this interviewee going on about cupcakes to a male interviewer.

Particularly given the onslaught of sexist issues within the technology industry, I feel as a researcher I doubled-down on establishing my extensive knowledge—the continual reemphasis on my own knowledge became painfully apparent during qualitative analysis of transcripts where I see myself performing this assertion repeatedly. This is not an intention I had in the beginning of my interviews, and something that within my desire to be as scientific and controlled as possible I wish could have better standardized. This in many ways was an impossible standard given my knowledge that the human researcher is an instrument of the study as discussed in prior sections of this chapter. The vast majority of my interviewees were fair and professional, but with so much on the line (as there is in a dissertation research project) the instinct to establish my credibility and not lose a research participant—one that probably took hours to find, recruit, and schedule with—due to assumptions made about me led to more performativity than my ideal standard of an inert and minimized interviewer as an instrument.

While conducting the majority of this research, I lived in the Bay Area which meant I lived and breathed the tech industry even on my personal time. Meeting up with friends almost invariably involved some facet of the tech industry—either through meeting people, talking about current events, installing the latest app designed to make the aging city infrastructure less frustrating, or confronting the social inequalities made apparent by the stark juxtaposition of the homeless at the literal feet of pristine and contemporary tech headquarters in downtown San Francisco. Despite all aspirations to be as objective, fair, and neutral, I too have been a part of the culture or forced to reckon with its fallout in my personal life. While I still approached my work as objectively as possible, it would be remiss not to acknowledge my own participant (and sometimes forced participant-observer) role as a resident in Oakland from 2013 to 2018.

2018 Silicon Valley is a land full of leakers, journalist-led exposés, and a largely critical public. This is a theme discussed later in negotiating access to subjects and companies. I felt at times my research was treated as if I was an investigative journalist—and while investigative journalists are an important role of this tech landscape,[115] the goals of research and investigative journalism are

[115] See, for example, Carreyrou, John. *Bad Blood : Secrets and Lies in a Silicon Valley Startup*. New York: Alfred A. Knopf, 2018.

vastly different. My role is to study and understand. My professional ethical obligation is to protect my research subjects from harm. A journalist's goal is to find and tell a story for the public. This mixed perception and common treatment no doubt impacted my ability do my research.

A reflection on the reticence and secrecy practices impacting this research is found in the Appendix.

As previously stated, I approach my research from a place of pragmatism: my goal is to document practices and provide an explanation in order to inform evidenced-based policymaking. I have colleagues who approach their work from an advocacy and critical theory perspectives, which makes their approach much different than mine. I am willing to work with companies and accept their claims as their public positions and work to find solutions given constraints of the private sector—different scholarly orientations have different approaches to working with companies' positions and constraints and this diversity I believe is needed within the field.

Trustworthiness: Credibility and Dependability

Credibility/Validity: As per the research design, it was expected that answers from employees, founders, or individuals who are otherwise participants in the system may contain biased perspectives. This was built into the structure of this study and anticipated as part of the narrative. Where possible, multiple people were interviewed and statements were corroborated with others' perspectives and public documents where necessary. The number of interviews was also increased in order to incorporate more cases and experiences into this theory.

As a researcher, it is acknowledged (particularly in my positionally statement) that I bring bias into this qualitative work which bears on my understanding, approach, and access to firms' perspectives. However, every attempt to minimize this was made by keeping dissertation notes through memoing of interviews and thoughts related to the dissertation, using recordings (and transcripts) instead of relying on my memory of interview, and multiple corroborating sources including other interviews, public documents, national statistics, etc. were used to confirm or dispute findings. Additionally, dissertation findings were discussed with outside experts for their input and feedback, as well as some of the subjects themselves to confirm the accuracy of the cases as they are portrayed here.

Dependability/Reliability: This chapter has described in detail every aspect thought to be important in retracing the data collection and analysis. All public records, where possible, are made available via the archival process and interview data is on record with the researcher.

Transferability: The research design did its best to work with what was accessible and set research questions that could reasonably be answered using the methods available.

Conclusion

This chapter describes the research design and methodology used to answer the selected research questions. This section also sought to establish why choices were made both in the design and methodology, and present what other options were so that future work could build off of this work in novel ways or expand the work established here.

Chapter 4

Traditional Role of the Private Sector in Research: Historical Context of American Industrial R&D, Academic Partnerships, and Traces of Data Sharing Instances

> *"Firms that pioneered industrial R&D in the United States did so because they were threatened by competition, because they were engaged in a process of rationalizing their organizations (often in response to antitrust threats and actions), and because they saw benefits to internalizing R&D rather than relying on the market. Yet in internalizing these functions, the R&D pioneers and firms that emulated them were never completely free to do what they wanted vis-a-vis scientists and research-oriented engineers. Corporations were highly dependent on educational institutions and an elite cadre of university professors for their supply of researchers."*[116]

> *"Today the research laboratory is widely recognized as an indispensable part of the country's industrial equipment. From it comes the knowledge that leads not only to improved methods and materials but also to entirely new processes and products and occasionally new industries."*[117]

> *"Chemically based electronics functions had slipped through the cracks in university research. Because it fit neither the chemical engineering nor electrical engineering departments of universities, for a decade basic research*

[116] David A. Hounshell, "The Evolution of Industrial Research in the United States." Chap. 1 *In Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, 56. Boston, Mass.: Harvard Business School Press, 1996.

[117] Howard R. Bartlett, "The Development of Industrial Research in the United States." *Journal of the Patent Office Society* 23 (1941), 475.

in semiconductors was the province of the semiconductor industry.”[118]

“In an industry in which survival hinges on conducting research, Intel Corporation is distinct among semiconductor manufacturers in that it has no formal research organization and yet it invests steadily in R&D.”[119]

Introduction

Without historical contextualization, the present can be seen as entirely new phenomena ripe for novel policy recommendations and constructed solutions. Take your pick of aphorisms on the subject of history and they almost always underscore the importance of reflecting upon repetitive nature of our actions. George Santayana said “those who cannot remember the past are condemned to repeat it,” or in the case of innovation patterns, perhaps we are of equal risk of falling into the same quagmires as we are of failing to repeat the successful footsteps of the past that led to innovations that revolutionized modern society.

In Silicon Valley and the broader tech world, “history” can often be traced back through the recent lifetimes of key inventors and actors in the computer revolution—dating back merely six or seven decades—whereas broader innovation processes and information exchanges have a much longer evolutionary arch. Washington DC is notorious for short-lived institutional memory—often forgetting policy programs that happened a decade or administration before—resulting in sometimes nearsighted policy recommendations affected heavily by recency bias. Discussions surrounding private sector R&D are almost all dominated by lamentations about the golden days of Bell Labs and replete with calls to revive a lost era of industry-led and funded innovation[120]—speaking as if it is the best or only example of successful

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[118] Gordon E. Moore, "Some Personal Perspectives on Research in the Semiconductor Industry,” Chap. 7 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, eds by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 167.

[119] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry,” 165.

[120] See, for example:

Levine, Steve. "What Obama Could Learn from Bell Labs." The FP Group (Washington DC), March 15, 2012. https://foreignpolicy.com/2012/03/15/what-obama-could-learn-from-bell-labs/.

Slywotzky, Adrian. "Where Have You Gone, Bell Labs?" Bloomberg Businessweek (New York, NY), August 27, 2009. https://www.bloomberg.com/news/articles/2009-08-27/where-have-you-gone-bell-labs.

Gertner, Jon. "Like Building Refrigerators: Bell Labs and the End of Game-Changing Innovation." Time, March 27, 2012. http://business.time.com/2012/03/27/like-building-refrigerators-bell-labs-and-the-end-of-game-changing-innovation/.

private sector research. The research done at Bell Laboratories has reached almost mythical level in the way it is idolized and held up as a gold standard for private research—and certainly there is plenty to admire—but these praises often lack resolution of what structure, policy, and economic alignment led to that particular instance and culture of innovation. This circular referencing to Bell Labs casts aside a more robust and complete picture of private sector R&D practice, and unnecessarily pigeon holes the conversation and consideration of possible modern remedies and approaches into one segment of industry and time.

This chapter seeks to establish a baseline of historical background on private sector R&D—predominately in the United States but drawing from international examples or contrast when necessary—as well as documenting the evolving structure and culture around university research partnerships that foreground the collaborations and data exchanges taking place today. This is done to clarify the traditional role of the private sector in research based on historical evidence and prior scholarship. In addition to a historical discussion of corporate research and research partnerships, this work weaves in the history of early marketing and policy research (done on behalf of industry), as well as early forms of consumer data brokering since data exchanges play a key role in many present day research activities. Market research and research on users also have many commonalities including the need to study behavior, impulses, and desires, and also often relied on expert consultants or academics to conduct the work. This chapter introduces examples from primary sources at the start of the computer industry that illustrate how changing economic pressures influenced private sector R&D strategy. These changes were further aided by the new semiconductor and personal computing industries that challenged research models of established industries by changing the cost of equipment, introducing new competition models, new social and regional contexts, and most importantly new collaboration regimes. Only when presented in its totality can the evolution of private sector research be fully understood in a way helpful to parse out modern practices and their implications on the wider research ecosystem.

This section asserts that there are four key timeframes in terms of distinct

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Center for American Progress. "Foster Partnerships between Universities and Industry to Address New Challenges." Washington DC, April 11, 2008. https://www.americanprogress.org/issues/general/news/2008/04/11/4244/foster-partnerships-between-universities-and-industry-to-address-new-challenges/.

Carafano, James Jay. "Next President Shouldn't Be a Mad Scientist." Washington DC: The Heritage Foundation, June 28, 2016. https://www.heritage.org/government-regulation/commentary/next-president-shouldnt-be-mad-scientist.

Hochheiser, Sheldon. "Your Engineering Heritage: Bell Labs and the Transistor." IEEE InSight (Piscataway, NJ), 2009. https://insight.ieeeusa.org/articles/your-engineering-heritage-bell-labs-and-the-transistor/.

trends in industrial R&D leading up to modern practices in the last 10 years: 1) Early industrial era (late 1800s and early 1900s); 2) Wartime and Interwar R&D activity (WWI and WWII); 3) Post-war innovation and growth; and 4) Personal computer and semiconductor industries. The 3rd and 4th time periods focus more exclusively on high-tech and the budding computer industries—whereas earlier sections focus on any documented industry R&D—though relevant examples from other industries, such as biotech, are cited as relevant. This chapter will discuss each of these timeframes in terms of key players, notable practices, incentive structures, cultures around scientific innovation, and political economies before concluding with some brief remarks which will foreground the proceeding dissertation study. An analysis of the ways in which modern practices aligns and diverges will occur throughout this dissertation. This chapter serves to establish a historical baseline for each eventual analysis, though a brief discussion will conclude the section. The material from this chapter comes from a mix of literature from science and innovation historians, primary documents and historical literature. This work builds upon the 1996 work "The Evolution of Industrial Research in the United States" by David A. Hounshell[121] which is a part of the edited volume "Engines of Innovation."[122] Hounshell's work was an important and distinctive piece of scholarship off of which this work supplements with additional sources and a broader attention to academic partnerships, data exchanges, early market research, and later "high-tech" R&D efforts. This chapter frames these elements to contemporary phenomena by pulling out the key themes that are particularly salient now, over two decades later. (The appropriate citations with page numbers to Hounshell are placed throughout.)

Early industrial pre-war research era (late 1800s and early 1900s)

The early 19th century US economy was fueled by small and independent business owners including farmers, carpenters, trades people, and merchants. Howard Bartlett in 1941 stated "The nineteenth century was nearly over before the industrial research laboratory became an important factor in the economic life of the United States."[123] Hounshell traces the first roots of industrial research to somewhere in between 1875—when the Pennsylvania Railroad hired a PhD in

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[121] David A. Hounshell's work is some of the most well researched, thorough, and well-organized manuscripts I've seen in a long time. He sets a model this author strives to immolate.

[122] Hounshell, David A. "The Evolution of Industrial Research in the United States." Chap. 1 *In Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, 56. Boston, Mass.: Harvard Business School Press, 1996.

[123] Bartlett, "The Development of Industrial Research in the United States," 475.

chemistry, Charles B. Dudley,[124] to integrate science into their railroad practice by setting up a chemical laboratory especially for them—to 1900 when General Electric established a laboratory with the intent that knowledge generated would fuel the company's core technologies and insulate them from competition on the market.[125] These events, which arguably marked a departure in how industry organized and pursued innovation, coincided with larger changes in academic research and the professionalization of science.

In the early 1800s, new technological contributions to industry were isolated and individualized coming from independent inventors (e.g., George Westinghouse in railroads and Thomas A. Edison in the telegraph industry) who would sell their patents to big business industries like the railroads and telegraph companies as sort of one-off accidental discovery and casual business partnership.

Small external research organizations began growing at the close of the 19th century with the intention of supplying R&D capabilities to companies too small to support their own internal R&D capabilities. As Mowery and Rosenberg point out, these firms not only existed to outsource R&D capabilities to small firms, but also were used to supplement larger firms' routine research through contract work.[126] These early research consulting firms provided a bridge between external researchers and internal company needs.

Outside of the invention of products and manufacturing machinery that made processes faster and cheaper to produce consumer goods, business innovations came in the late 19th century as early efficiency experts who made industrial processes run faster and more cheaply. Functioning as business consultants, part of this job was to collect information and return recommendations to business owners.[127] Early "information research" at this time had roots in market surveys to customers, special advice on technology, and early management consulting but was primarily focused on improving factory-level efficiencies.[128] Firms like Lord

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[124] One of the most interesting contributions of bringing academic ingenuity into early industry was Dudley's invention of an analytical chemistry test for the purity of lard oil. At that time, signal lamps on the railroad were lit by lard oil but the lamps were frequently growing dim or extinguishing completely when lard oil purchased from outside producers was used—which put railroad passengers in danger of crashes. Dudley figured how to test oil to see if it was a mixture of lard oil and grape seed oil (the mixture that was being sold as pure lard oil) and once this test was announced there were no more issues obtaining pure lard oil on the market. Howard, "The Development of Industrial Research in the United States," 493-494.

[125] Hounshell, "The Evolution of Industrial Research in the United States," 13; 17.

[126] David C. Mowery and Nathan Rosenberg. "New Developments in U.S. Technology Policy: Implications for Competitiveness and International Trade Policy." *Business and Public Policy* (1989), 79-82.

Mowery, David C. "Industrial Research and Firm Size, Survival, and Growth in American Manufacturing, 1921–1946: An Assessment." *The Journal of Economic History* 43, no. 4 (1983).

Hounshell, "The Evolution of Industrial Research in the United States," 17.

[127] James W. Cortada, *All the Facts : A History of Information in the United States since 1870*, (New York, NY: Oxford University Press, 2016), 110.

[128] Cortada, *All the Facts : A History of Information in the United States since 1870*, 110.

& Thomas collected information from retailers and consumers, and then sold them to advertisers and their customers to inform pricing and product introductions. Lord & Thomas, along with their contemporaries, referred to their products as “commercial research.”[129]

Independent firms that melded academic and business initiatives arose to meet the data needs of industries in the early 1900s. Organizations like the Harvard University Bureau of Business Research and the National Retail Dry Goods Association used academic methods for business ends by collecting, curating, and selling reports about retail operations. Interestingly, Arthur C. Nielsen—known for his radio and television viewer ratings—started his firm “A. C. Nielsen Company” in 1923 as a retail research center producing performance surveys on industrial equipment and businesses. The firm drifted from industrial research to consumer research by testing advertising and marketing strategies, price changes, and product packaging—eventually establishing audience measuring systems that are still widely known and used.[130] In 1962, Neilsen was described as having “a raging curiosity, a desire to find out the facts behind appearances, and an engineer’s conviction that the facts were measurable. In the belief that he could get at the facts, organize them, and sell them to those who could use them, he founded the A. C. Nielsen Company.“[131] Nielsen made a science of measuring markets, and publishing the results as part of a business model.[132]

These examples provide the closest early historical example of industry research data and information exchanges flowing in and out of the boundaries of the private firm. Though these examples relate more closely to modern consulting and market research practices, it represents an important moment where information exchanges with outside research parties offered market advantages for private companies.

Research organizations now known as “think tanks” have military origins, but arose out of joint commercial and academic interests.[133] Early 20th century think

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[129] Cortada, *All the Facts : A History of Information in the United States since 1870*, 89.

[130] Carter, Bill. "A.C. Nielsen Jr., Who Built Ratings Firm, Dies at 92." New York Times (New York City, NY), October 4, 2011. https://www.nytimes.com/2011/10/05/business/media/ac-nielsen-jr-who-transformed-research-firm-dies-at-92.html.

James Playsted Wood. "Leaders in Marketing: Arthur C. Nielsen." *Journal of Marketing* 26, no. 3 (1962): 77.

[131] Wood, “Leaders in Marketing: Arthur C. Nielsen,” *77*.

[132] It should be noted that Nielsen data is made available to researchers via the Kilts Center for Marketing at The University of Chicago Booth School of Business. This is an important and early example of contemporary private sector data sharing for research from a company with such long roots in private research and data collection.

[133] “Think tanks” get their name from early concepts in military contexts were academics, military professionals, and others could freely toss out ideas and discussion within a contained “room”)

tanks were often funded by specific industries in order to extend their public relations and lobbying interests, yet attempted to maintain a neutral appearance.[134] Academics at these institutes conducted research and published findings relating to public policy issues that often supported the point of view of funding industries.[135] Economic research firms like the National Bureau of Economic Research (NBER), Institute for Government Research (IGR), and Brookings Institute all received partial or complete funding from large companies who also populated their boards with executives from their respective industries.[136] The origins of corporate-funded and guided research illustrate early use of social and economic research to inform political and policy aims, but also shed light on the use of seemingly-independent research institutes to advance corporate agendas. These early think tanks also show an early partnership between academics and corporations.

The beginning outgrowth of small contract firms that provided outside R&D expertise, early industry graduate fellowships, market research, and policy analysis begins to paint a picture of how the modern day instantiations of these firms plays a role in the broader industry research ecosystem. At the turn of the century these outside firms developed to respond to the complex research needs of private industry in different sectors and seeded organizational tradition that continued into later decades.

Internalizing Formal R&D

The German industry innovation system provided a stark contrast to the ad-hoc, happenstance organization within US industry, owing much of the difference to the general superiority of the German research-based graduate education system (the US research education system was only its foundational stages around 1900). Hounshell describes industrial sponsorship as a key element of the German university research system, and that German firms in the chemical and electrical industries “believed that the interests of their firms and those of professors were mutual.”[137] This system was based heavily off of these industry-academic research partnerships (as well as government-sponsored initiatives) through the formation of special research institutes that represented these mutual research interests. Firms including Siemens, Vader, BASF, and Hoechst held dominate research positions compared to the non-existent private

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Carafano, James. "The Origins of American Think Tanks." The Daily Signal, October 23, 2015. https://www.dailysignal.com/2015/10/23/the-origins-of-american-think-tanks/.

[134] Cortada, *All the Facts : A History of Information in the United States since 1870*, 112.

[135] According to Cortada, early think tanks used social science methods to address issues relevant to businesses in the hopes that these methods could inform better policymaking, thus making these firms early practitioners in “evidenced-based policymaking” but for arguably industry biased ends.)

[136] Cortada, *All the Facts : A History of Information in the United States since 1870*, 113.

[137] Hounshell, "The Evolution of Industrial Research in the United States,” 20.

infrastructure in the US leading up to 1900, and overall was the most advanced system of academic collaboration and research activity until World War I.

By contrast, it took nearly 20 years after the turn of the century for US firms themselves to successfully begin piloting internal research programs—let alone lead charge for academic/industry partnerships. Several laboratories began springing up around 1900 at firms including General Chemical, Dow, Standard Oil of Indiana, Goodyear, and American Cyanamid though there is debate among historical scholars exactly what counted as a research laboratory. Hounshell did not count what he calls “analytical and control laboratories” unlike other scholars like Mowery who did,[138] but this time represents when US firms began developing their own internal protocols and management structures for innovating in-house and moving away from the ad-hoc relationships with independent inventors.[139] Bartlett attributes the eventual rise of corporate laboratories as a result of improved US education, but it should be noted that much of the PhD-level talent in the US were educated in Europe up until just before WWI.[140]

It is common to see a blurring of mid-20th century R&D successes painted over the struggles of early firms around the turn of the century in statements like: “US firms were among the pioneers in the development of in-house industrial research laboratories in the late nineteenth and early twentieth centuries.”[141] Understanding that US firms were not always R&D pioneers, in part due to the influences and consequences of these organizational choices, lack of structured partnerships, and weaknesses in domestic research education is important when reconsidering the implications of research within this dissertation.

Hounshell states that “the founding of formal R&D programs by these manufacturers stemmed in part from competitive threats to their business or core technologies.”[142] He cites the creation of the General Electric Research Laboratory (GERL) in 1900 which was created in order to keep up with outside competition that could have rendered the company’s business obsolete since Edison’s foundational patents were set to expire. The lab was led by a prominent MIT researcher Willis R. Whitney—who was conflicted about taking the role in industry and embodied the challenge of the new role of R&D director that required as much business savvy as it does technical expertise. Whitney reportedly kept the lab focused on efforts that were of business importance by selling the problems to research staff on the basis of their intrinsic scientific

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[138] See for instance: David C. Mowery, "The Emergence and Growth of Industrial Research in America Manufacturing, 1899-1946." (PhD Dissertation Stanford University, 1981), 104.

[139] Hounshell, "The Evolution of Industrial Research in the United States,” Footnote 16.

[140] Howard, "The Development of Industrial Research in the United States,” 475.

[141] Mowery, David C., and David J. Teece. "Strategic Alliances and Industrial Research." Chap. 3 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 111.

[142] Hounshell, "The Evolution of Industrial Research in the United States,” 21.

merit.[143] Suddenly, industry could no longer depend on the market of independent inventors to fuel their own competitive advantage.

Similarly, American Telephone & Telegraph (AT&T) was pushed to pursue formalized R&D activities by major Bell patents expiring, and the increase in the number of independent telephone companies, and competitive technological threat from developments in radio (making the hefty financial investment in wires obsolete).[144] These early foundations led to the formation of the now infamous "Bell Laboratories" in 1925.

Antitrust attitudes in the early 20th century—following the passage of the Sherman Antitrust Act in 1890—also began to play a large part in the sudden imperative for firms to diversify internally and gain market dominance through the "merit of invention." For instance, DuPont had become the primary supplier of explosives to the US military, but after acquiring about 2/3 of the American explosive industry, policymakers and the US military expressed uneasiness. DuPont had upped their investment in the early 1900s by establishing the General Experimental Laboratory and the Eastern Laboratory that worked on chemical R&D and improving manufacturing.[145] This high research investment paid off for DuPont because after they were found guilty violating the Sherman Antitrust Act in 1912, the US military intervened because they "recognized that DuPont had devoted considerable sums to innovation in smokeless powder" and left that portion of DuPont intact—a move that positioned them in a powerful business position just prior to the outbreak of WWI.[146]

Similarly, Kodak Eastman founded their laboratory in 1912 out of fear of antitrust action and competition.[147] Reportedly, George Eastman had been on a trip to Europe in 1911 or 1912 and while sitting next to a head of Bayer who casually dropped the number (several hundred) of chemists with doctorates employed within their research laboratory and then asked how many were employed by Kodak. This was of course embarrassing to Eastman, since Kodak only employed a few chemists and had no formal research laboratory.[148] Coincidentally, Louis Brandeis (who was not yet a Supreme Court Justice) gave an address to the City Club in Rochester that said large firms "wouldn't do any research because they were self-satisfied with their positions and didn't need any

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[143] George, Wise. *Willis R. Whitney, General Electric and the Origins of U.S. Industrial Research*, (Columbia University Press, 1985), 91.

[144] Hounshell, "The Evolution of Industrial Research in the United States," 23.

[145] David A. Hounshell and John K. Smith. Science and *Corporate Strategy : Du Pont R&D, 1902-1980. Studies in Economic History and Policy*. Cambridge Cambridgeshire ; New York: Cambridge University Press, 1988.

[146] Hounshell, "The Evolution of Industrial Research in the United States," 25.

[147] Hounshell, "The Evolution of Industrial Research in the United States," 25.

[148] Unfortunately there does not appear to be a digitized or accessible source to this reference from Hounshell, "The Evolution of Industrial Research in the United States." Hounshell cites Jeffrey L. Sturchio and his paper "Experimenting with Research: Kenneth Megs, Eastman Kodak, and the Challenges of Diversification" which was presented at the October 1985 R&D Pioneers Conference.

technical advice."[149] These two events led to Eastman establishing the Kodak Laboratory later that year. Hounshell points out that it's impossible to tell if Eastman established the lab in order to keep up appearances with other large businesses at the time or for the investment and commitment to internal discovery.

David Mowrey, in his dissertation at Stanford, argued that most of the R&D before WWII was focused on chemistry and chemical technology, but as evidenced above, this paints a very limited and inaccurate depiction of the diversity of activity that fed what would later become a network of industrial research labs and organizations.[150] This time was important where large firms began recognizing research not only as an important actual asset, but a strategic public one as well to earn prestige for this internal investment. In the early part of the 20th century in the absence of much of the modern university R&D funding, these formalized laboratories were an important employer of PhD-level researchers (though many were coming from Europe) and led to regional demands that put pressure on educational institutions to develop more rigorous research education. Further, this internalization of R&D was an important defense against anti-trust regulatory action in the early part of the century. By investing in R&D and developing innovations in house rather than poaching smaller to midsize businesses, industry was seen more favorably and benevolent to the general public—not to mention the regulators. It is important to understand how the organizational structure and external political and policy pressures were important in shaping a private research ecosystem, which has implications today. During this early time, industry usually was a later consumer and commercializer of research, but the ways in which industry helped to breed ideas in the absence of robust academic research (not to mention the ways external data and independent researcher firms were consulted) have important implications for modern practices.

Wartime (WWI + WWII) and Inter-wartime R&D Activity

Breakout of War

At the time of WWI, many academics—who still received little funding from the federal government—saw the first war as a way to promote research and advance a scientific agenda in the US in order to help in the war effort. The

[149] Quote from Sturchio, 1985 via Hounshell, "The Evolution of Industrial Research in the United States," 25.

[150] David C. Mowery, "The Emergence and Growth of Industrial Research in America Manufacturing, 1899-1946." (PhD Dissertation Stanford University, 1981), 104.

National Academy of Science (NAS)—the first of the academies; the National Academy of Engineering and Institute of Medicine followed later—was chartered in 1863 by President Lincoln to engage scholars with the policymaking process and was one of the first science policy organizations to bridge the technical and policy gap.[151] The NAS voted in 1916 to help match scientific experts with the federal government by forming the National Research Council (NRC) as the functioning research arm. This move was made by prominent scientists who thought the NAS was too slow to take action and wanted to make a stronger impression on the Wilson Administration that scientists could be essential contributors to the war effort. These scientists recruited GE's research director Willis Whitney to help make their case to establish the advanced university and ecosystem of research institutes that were found in Germany and set the country up technologically for international conflict. Hounshell describes this venture as "pure opportunism"[152] but these discussions were one of the earliest proposals for the government to permanently and continuously fund American science research.[153] It is particularly of note that Whitney, a private sector researcher, was one of the two primary promoters of this proposal. It should be noted that this policy strategy inherently supported ideas that were later encapsulated in the linear model of innovation. Interestingly, the research directors at the pioneering R&D firms—Willis Whitney (GE), Charles Reese (DuPont), Kenneth Mees (Kodak), JJ Carty (AT&T) and Frank Jewett (AT&T)—became prominent advisors for the government and American military, as well as other industry leaders on how research could be used to generate technological advances.[154]

At the end of WWI, these R&D directors created the Directors of Industrial Research (DIR) as a forum to meet and discuss everything from "starting salaries for scientists with doctoral degrees, publication policies, and coordination of research a diversified firm."[155] Members also hosted 1-2 daylong tours of their respective research facilities, which gave other outsiders an opportunity to see how the facilities were set up but also to give members without R&D backing from management the ability to go back and give specifics on why their firms should invest.[156]

Interwar Period

The success of research during the interwar years was described by John

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[151] Homer A. Neal, Tobin L. Smith, and Jennifer B. McCormick. *Beyond Sputnik : U.S. Science Policy in the Twenty-First Century*, (Ann Arbor: University of Michigan Press, 2008), 44.

[152] Hounshell, "The Evolution of Industrial Research in the United States," 31.

[153] Wise also notes that these individuals "put the job of promoting science first with nearby fatal consequences for the defense technology effort." Wise. *Willis R. Whitney, General Electric and the Origins of U.S. Industrial Research*, 186-87.

[154] Hounshell, "The Evolution of Industrial Research in the United States," 32.

[155] Hounshell, "The Evolution of Industrial Research in the United States," 33-34.

[156] Hounshell and Smith, *Science and Corporate Strategy : Du Pont R&D, 1902-1980. Studies in Economic History and Policy*, 315-316.

Kenly Smith Jr as based on “two ingredients: the use of science to understand and improve technology, and the possession of organizational capabilities to develop and commercialize new products.”[157]

Several of the laboratories that would go on to dominate the post-war years were founded after WWI but before the breakout of WWII—namely, Bell Labs (even though AT&T did have formalized research activities prior to Bell Labs) and RCA Laboratories. But in addition to these new dominate players, this time was rich with industry research leadership, early policy proposals for the federal support of fundamental research, and expanding presence of private sector R&D practice.

Many of the key industry research leaders who had led conversations during WWI continued their advocacy to gain continual federal support for research. By the 1920s, several prominent researchers (who founded CalTech) and the National Research Council created a plan that was taken up and led by Herbert Hoover (then Secretary of Commerce) to raise $20 million from industry to set up a research endowment to fund basic science research at universities.[158] This effort failed to raise enough industry financial backing and was abandoned by 1932, but was an important policy strategy as an alternative to government funding of research that would later feed into industry under the assumptions of the linear innovation model.

In thinking critically about corporate strategy, scholars have noted that many times companies did what Wise calls “leapfrogging” by acquiring core technology outside of the firm and then using the corporate internal research capabilities to surpass competition.[159] This can be seen in cases of DuPont and cellophane, GE refrigerators, and Kodak color film. But by the 1930s, industry leaders at DuPont and AT&T began incorporating more academic-style research into their research units because science was seen as the rate limiting factor in innovation—since companies were free to capture innovations stemming from good ideas happening outside of the company.[160] These strategies support the model of linear innovation posed by Bush within the next decade.

Bell Telephone Laboratories (Bell Labs) was founded in 1925 to support the research and development capacities for American Telephone and Telegraph (AT&T). This move formalized earlier R&D efforts that arose in an effort to shape the patent portfolio of AT&T in the 1910s. Bell Labs is among the most well-known privately funded basic and applied research lab—responsible for an array of groundbreaking technologies including the transistor, laser, UNIX operating system and 6 Nobel prizes.[161] At the peak of Bell Labs’ production, the

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[157] John Kenly Smith, "The Scientific Tradition in American Industrial Research." *Technology and Culture* 31, no. 1 (1990): 126-127. http://www.jstor.org/stable/3105763.

[158] Hounshell, "The Evolution of Industrial Research in the United States,” 35.

[159] John Kenly Smith, "The Scientific Tradition in American Industrial Research,” 127.

[160] Smith, "The Scientific Tradition in American Industrial Research.,” 127

[161] Neal and McCormick. *Beyond Sputnik : U.S. Science Policy in the Twenty-First Century*,135.

organization had over 15,000 employees that included approximately 1200 PhDs.[162]

University partnerships and colocation

The large corporate labs of this time were often built with an easy proximity to university talent—not unlike labs like DuPont and pharmaceutical companies earlier in the century. Except this time instead of taking advantage of local university talent (e.g., state schools in the region because the industry was already established in the area), this new wave of corporate research groups explicitly sought out colocation with elite private universities, and especially those who were willing to embrace engineering as a new field.[163]

State schools, on the other hand, continued a trend to use their research talent to help local industries—particularly during the war effort. For example, the University of Akron supplied skilled personnel to the local rubber industry and consequently became a leader in rubber research and innovation during the war.[164] The colocation for talent and access to collaborations, and the consequential divide that results from these geographic choices or accidents remains a theme in contemporary partnerships.

World War II

By WWII, research and the potential for industry to contribute to public knowledge was well regarded. In 1941, Bartlett stated: "Today the research laboratory is widely recognized as an indispensable part of the country's industrial equipment. From it comes the knowledge that leads not only to improved methods and materials but also to entirely new processes and products and occasionally new industries."[165]

According to John Kenly Smith Jr, the burst of wartime innovation was a result of cooperative R&D between governments, industry, and universities and by bringing resources together—in particular government (mostly military) funding of basic R&D thus removing the risk involved with financially committing to these activities.[166] However this shared role in funding and intellectual leadership would be reshaped at the close of the war.

Some of the large corporate labs played very central and vital roles during

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[162] Jon Gertner. *The Idea Factory : Bell Labs and the Great Age of American Innovation*. New York: Penguin Press, 2012.

[163] Yale and Harvard were resistant to adopting engineering as a new discipline for their students to specialize in.

[164] Nathan Rosenberg and Richard R. Nelson. "The Roles of Universities in the Advance of Industrial Technology." In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, ed by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 89.

[165] Bartlett, "The Development of Industrial Research in the United States," 475

[166] John Kenly Smith, "The Scientific Tradition in American Industrial Research." *Technology and Culture* 31, no. 1 (1990): 121-31. http://www.jstor.org/stable/3105763.

the war. Bell Laboratories shut down most of its planned operations to dedicate their research staff to joint DoD projects, and many of their famous researchers, such as Claude Shannon, held security clearances. Projects were run in a military like manner, and information was primarily controlled using national security classification systems. According to Gertner (author of *The Idea Factory*) the research department within Bell labs had halted research activities and devoted about 75% of the lab's work to wartime electronics development.[167] Gertner also notes that Jewett, the Bell Labs President, spent the majority of his time in Washington DC strategizing with public leaders on how to use US scientists for the war effort.[168] Much of the work from this time was shrouded in secrecy.[169] The military/defense partnerships Bell and other major labs had leading into and during the second world war lasted well into the 20th century, and undoubtedly had a great influence on how these labs organized and thought about research.

World War II in the United States was an important time to solidify the importance of researchers in not only contributing to national security, but in the potential for science and engineering to benefit social and economic challenges. It is out of scope to cover the numerous scientific leaps and developments that occurred during WWII, at least in part from involvement from the private sector, but this is detailed in many other works. The effect this time had on companies and cultures of research is described in detail in the rest of this chapter.

RCA [170] (Radio Corporation of America) was a major electronics company created at the end of WWI, but whose formal laboratory would come about in the WWII era. At the close of the first world war, the radio industry was highly fragmented. GE was seeking to recoup over $1 million in development costs incurred during the war, but when the Marconi Company (a UK firm) tried to buy 24 alternators and exclusive rights from GE for $3 million President Wilson stepped in to block the sale and prevent these assets from going to a foreign country.[171] As a result of this block and new policies regulating how much a foreign firm could own in an American radio station, GE was ordered to buy American Marconi for $9.5 million and from that established a new company: RCA, which took on leadership from both GE and American Marconi.[172] Prior to the laboratory being built, RCA's research and development divisions were split between the RCA Radiotron Division in Harrison, New Jersey and the RCA Victor Division in Camden, New Jersey. One history book referred these two facilities as both old and full of red tape.[173] When the company began to contract for more

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[167] Gertner, *The Idea Factory : Bell Labs and the Great Age of American Innovation*, 59.
[168] Gertner, *The Idea Factory : Bell Labs and the Great Age of American Innovation*, 59.
[169] Gertner, *The Idea Factory : Bell Labs and the Great Age of American Innovation*, 65.
[170] RCA stands for Radio Corporation of America but is better known by its acronym
[171] Sturgeon, "How Silicon Valley Came to Be," 26-27.
[172] Sturgeon, "How Silicon Valley Came to Be," 26-27.
[173] Alexander B. Magoun, *David Sarnoff Research Center : RCA Labs to Sarnoff Corporation* (Images of America. Charleston, S.C.: Arcadia, 2003), 9.

R&D as well as production for the US armed forces in 1940-1941, a management decision was made to free up factory production space by consolidating R&D into one location, with an added bonus that such consolidation would make securing facilities against espionage much easier.[174] Making the process for new innovations more straightforward appeared to be a bonus. RCA Laboratories (later renamed the David Sarnoff Research Center) was founded in 1941 just prior to the US involvement in WWII in Princeton because of its proximity to the company's Rockefeller Center headquarters and a major university[175]. When the war broke out, the laboratory conducted unplanned defense focused research until the end of the war and even produced apple sauce as part of the war effort out of the orchards adjacent to the lab—which was built on farmland[176]. The lab is known for its advances in film, television displays, and basic research in physics that also resulted in a Nobel Prize. RCA, with its wartime roots, is often cited alongside Bell Labs as a notable model of corporate research laboratories in the mid-20th century.

The war and interwar periods were an important point for industrial research since internal research laboratories had grown and formalized substantially, and there was a growing consensus among industry leaders that changes had to be made to invest in the educational pipeline of researchers. Most industry research had become completely internal through robust private infrastructure, with partnerships beginning to move toward public-private wartime collaborations. Despite the growing tussles over the sites and contexts of "pure" research, there was undeniable utility to the R&D efforts coming from private industry by the close of the second world war. These partnerships and applications heavily influenced post-war policy decision making and conceptualization of the linear order of innovation, which has shaped the modern research ecosystem and public perception to present.

Post-War Innovation Policy and Growth

Arguably, the most defining moment for US R&D came in the post-war period with large ramifications not just for academic research but for industrial R&D—in how it was typecast, organized, networked, and built into mental models of private sector R&D. The publication of several post-war books lauding the role of

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[174] Magoun, *David Sarnoff Research Center : RCA Labs to Sarnoff Corporation, 9.*

[175] Magoun, *David Sarnoff Research Center : RCA Labs to Sarnoff Corporation, 9.*

[176] Magoun, *David Sarnoff Research Center : RCA Labs to Sarnoff Corporation, 8.*
Notably in 1942 after the crop of jarred apple sauce, one RCA executive said of their laboratory products "establishing high standards of quality which we hope may be attained in future products in other fields."

the scientist—and most notably Vannevar Bush's "Science, the Endless Frontier"—set in motion both policy infrastructure as well as the formalized conceptualization of the linear model of innovation that exist and define the R&D landscape today.[177] (A detailed discussion can be found in Chapter 2) This was a critical moment in the shaping of corporate R&D identity, that has lasting ramifications on how firms evolved and perceived their in house innovation, not to mention how innovation cycles were conceptualized globally.

There are entire books written about the politics of post war science policy, often focusing in particular on the impact of "Science, the Endless Frontier." These works include: Kleinman's "Politics on the Endless Frontier,"[178] Narayanamurti and Odumosu's "Cycles of Invention and Discovery: Rethinking the Endless Frontier,"[179] among many other works. This section intends to pull out the salient background, politics that shaped the national perception and functioning of industrial R&D, and explore the limitations of these pervasive narratives on mental models of industry R&D. Admittedly, entire dissertations could be written on this subtopic alone. Understanding key influences and how they shaped the perception and execution of industrial research and the entire R&D landscape in the US are briefly discussed here.

Key moments at the closing of the war

Science had in the eyes of many won the war, and brought with it many different technological innovations like antibiotics, digital computing, and new materials that made their way directly into the home and workplace, while the bomb captured the imaginations—or likely rather fear and awe—of the general public. Sadly, wars also prompt improvements to emergency medicine, home health, and often public health. Though versions of homemade tampons were used in many cultures prior to WWI, it was not until the Kimberly-Clark company produced "tampons" in such large quantities in 1914 that they became commercially available as Kotex,[180] and then widely popularized during WWII as women took on more active jobs and additional companies like Tampax.[181] The war also saw great leaps in the prevention and treatment of public health

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[177] Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

[178] Kleinman, Daniel Lee. *Politics on the Endless Frontier : Postwar Research Policy in the United States*. Durham: Duke University Press, 1995.

[179] Venkatesh Narayanamurti, and Toluwalogo Odumosu. *Cycles of Invention and Discovery : Rethinking the Endless Frontier*. Cambridge, Massachusetts: Harvard University Press, 2016.

[180] Eschner, Kat. "The Surprising Origins of Kotex Pads." Smithsonian Magazine, August 11, 2017. https://www.smithsonianmag.com/innovation/surprising-origins-kotex-pads-180964466/.

[181] Fetters, Ashley. "The Tampon: A History." The Atlantic, June 1, 2015. https://www.theatlantic.com/health/archive/2015/06/history-of-the-tampon/394334/.

concerns like malaria.[182]

The credit was taken home by an educated elite in white coats rather than the engineers and industrialists, in part because of the focus by popular press and books like Scientists Against Time published in 1946.[183] Not to mention calculated actions by leaders. Hounshell aptly puts it: "Seldom have the lessons of war been more fundamentally misunderstood. Seldom have such misunderstandings been more important, for they governed the course of national policy and the direction of the US industrial R&D until the 1960s. What everyone, including those who should have known better overlooked was that none of these new technologies and products could have emerged without the enormous engineering and manufacturing know-how and capabilities of the nation's corporations."[184] This narrative by Bush focused on basic science as the determining factor of key wartime developments, completely ignoring the the massive infusion of military and government spending on these activities to make these advancements possible—regardless of their classification.[185]

Toward the end of WWII, then President Franklin Roosevelt expressed an interest in continuing the expansive science and technology apparatus that had been established between the military, federal government, private industry, and academics—only devoting this energy toward improving the health and standard of living of society instead of weapons of war. In a letter[186] to his personal scientific advisor[187] and the Director of the Office of Scientific Research and Development (OSRD)[188], Roosevelt requested recommendations for how to reallocate and organize peacetime efforts. A more cynical view is that the report was requested in order to politically confront Senator Henry Kilgore who was pushing (and would continue to push) for an egalitarian distribution of contracts and science grants throughout the US (as opposed to basing the system off of merit).[189] The response, in the form of a report titled "Science, the Endless Frontier" was published several months after Roosevelt's death in July 1945, but the ideas contained were both continued by the Truman administration and entrenched in discourse surrounding American R&D.

"Science the Endless Frontier" was put together not only by Bush, but a team he had assembled of like-minded individuals who shared a vision of a pure

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[182] See, for instance: Masterson, Karen. The Malaria Project : The U.S. Government's Secret Mission to Find a Miracle Cure. New York, New York: New American Library, 2014.

[183] Baxter, James Phinney. *Scientists against Time*. Boston,: Little, Brown and company, 1946. Hounshell, "The Evolution of Industrial Research in the United States," 41.

[184] Hounshell, "The Evolution of Industrial Research in the United States," 41.

[185] Smith, "The Scientific Tradition in American Industrial Research.," 128.

[186] Bush, Science the Endless Frontier, 1945.

[187] Vannevar Bush is often considered to be the first unofficial Presidential Science advisor in part because of his close relationship to Roosevelt.

[188] This office more or less eventually became The Office of Science and Technology Policy (OSTP)

[189] Hounshell, "The Evolution of Industrial Research in the United States," 42.

science ideology.[190] The report repeatedly casts non-academic researchers into the shadows by: 1) creating a theory that innovation is linear requiring fundamental science before any other advancement is possible[191] and 2) creating the illusion that non-academic researchers were not central to many of the advancements made during the war. For instance, the report states "With some notable exceptions, most research in industry and Government involves application of existing scientific knowledge to practical problems. It is only colleges, universities, and a few research institutes that devote most of their research efforts to expanding the frontiers of knowledge."[192]

The invocation of the American west in the title of Endless Frontier is a trope that has been used repeatedly throughout science (e.g., space as the "final frontier" in the 1960s). In the case of Bush, it was deliberately used to inspire and call to action both citizens and policymakers alike.

Politically, the push to establish reliable funding from the federal government was calculated and picked up on the stalled efforts of research advocates and leaders from the interwar period. However, this push by Bush and the committee had to make it clear that industry was not enough to sustain R&D or fund research in academia. Of corporate research the report states: "Industry is generally inhibited by preconceived goals, by its own clearly defined standards, and by the constant pressure of commercial necessity. Satisfactory progress in basic science seldom occurs under conditions prevailing in the normal industrial laboratory. There are some notable exceptions, it is true, but even in such cases it is rarely possible to match the universities in respect for the freedom which is so important to scientific inquiry." This statement neglects to mention not only the role industry played in technological advances in the early 20th century, but in orchestrating academics and independent inventors through funding and partnerships. This statement also casts aside the important role industry scientists had in collaborative war efforts. The report does make key arguments that it is government's role to ensure the sustainability of research education, but completely neglects to mention the negative aspects of academia: individual egos driven by fame and career advancement above science, limited funding for truly uninhibited thinking, time constraints, university politics etc. However this report can, and is by many scholars cited within this section seen as a political calculation to take advantage of a moment in history in order to set up a federal

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[190] This is discussed throughout Daniel J. Kevles' work. For instance: Kevles, Daniel J. Principles and Politics in Federal R&D Policy, 1945-1990: An Appreciation of the Bush Report. National Science Foundation (1990). http://onlinebooks.library.upenn.edu/webbin/book/lookupname?key=Kevles%2c%20Daniel%20J%2e%20Principles%20and%20politics%20in%20federal%20R%26amp%3bD%20policy%2c%201945-1990%3a%20an%20appreciation%20of%20the%20Bush%20report.

[191] Narayanamurti, and Odumosu. *Cycles of Invention and Discovery : Rethinking the Endless Frontier*, 23.

[192] Bush, Science the Endless Frontier, 1945, 8.

infrastructure for federal R&D funding and education pipeline.

Two other key political choices in the report had impacts on the narrative around US R&D. First, despite Bush's training as an engineer, he carefully ensured the entire report emphasized the role of "scientists" instead of "engineers." For instance, in the report it states "For more than 5 years many of our scientists have been fighting the war in laboratories, in the factories and shops, and at the front. We have been directing the energies of our scientists to the development of weapons and materials and methods, on a large number of narrow projects initiated and controlled by the Office of Scientific Research and Development and other government agencies. Like troops, the scientists have been mobilized, and thrown into action to serve their country in a time of emergency." This storytelling scrubs the work of engineers funded by OSRD, directly implied even by discussing "factories and shops" where it is engineers, not scientists, who do most of the work. This erasure of engineers, or rather the intentional relabeling, is attributed by Narayanamurti, and Odumosu as a strategy to counter the American military's "antipathy toward engineering salesmanship and British snobbery toward engineering" in general[193]. The strategic consequences of this narrative was that it propagated the notion that applied work done by engineers, often in industry, was not "research" or was less valuable. This monitor favoritism enforced the linear model of innovation implicitly, and as Narayanamurti, and Odumosu put it, "In some regard, the rationale of the linear model that places emphasis on science over engineering builds on some long-standing ideas in western culture (and other cultures as well) that favor the "head"—or intellect—over that of the "hand"—including in this case technical expertise."[194]

Second in political calculations, Bush recast "pure science" as "basic research" in part because of the urging of Bell Labs President Frank Jewett's comments that this language implied that other types of research, specifically industry research, was "impure."[195] This switch to "basic" also reinforced a linear model notion that research occurs in three consecutive stages. Interestingly, Hounshell notes that with the exception of the assertion that basic research should only be done in academic environments, US industrialists largely embraced the tenets of the Bush model and Science, the Endless Frontier.[196]

In part to Bush's calculated strategy and advocacy, this moment of politics defined the R&D system that continues today, and has a great impact on how industry research is viewed with a modern lens. Instead of explicitly highlighting the many ways intellectual cooperation and infrastructure was shared between

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[193] Narayanamurti, and Odumosu. *Cycles of Invention and Discovery : Rethinking the Endless Frontier*, 17.

[194] Narayanamurti, and Odumosu. *Cycles of Invention and Discovery : Rethinking the Endless Frontier*, 25.

[195] Kleinman, *Politics on the Endless Frontier : Postwar Research Policy in the United States*, 45.

[196] Hounshell, "The Evolution of Industrial Research in the United States," 43.

government scientists, academics, and industry researchers, the story was told as a singular hero narrative. It was a strategic choice to fight for basic science government agencies and continual federal investment in fundamental research, but obscured key elements and lessons that can be learned from even today when thinking about potential roles for private industry in the advancement of social goods through technologies.

Post-war industrial laboratory development (Post war lab development and boom; space race and remilitarization of R&D)

The story about basic science was not just heard by policymakers and scientists themselves, but also industry leaders who wanted to use the post-war economy to ensure their firms were successful in their innovation investment strategies. A bit ironic because many private firms had been so central to the successful efforts coming out of the war and yet in some cases seemingly neglected the key elements that made these partnerships so important, such as cooperative research and federal funding.

International Business Machines' (IBM) President and Founder Thomas J. Watson Sr. established what is now known as IBM Research in 1945—just prior to Bush's report touting the virtues of basic science—and described their labs as "The First Corporate Pure Science Research Lab[197]." The foundation of IBM Research was heavily tied to Columbia University—the first laboratory space was in a former fraternity house—however the deep ties to a particular university are not unique. RCA Laboratories had close associations with researchers at Princeton University, while Bell Laboratories had many universities. Both RCA Labs and Bell Labs had deep ties with US defense and national security efforts and were located on the east coast, which undoubtedly influenced their internal culture and practices.

During this post war time, Bell Labs also expanded and repositioned their "human factors research" from the late 1940s to include social psychology, group psychology, and generally what was grouped together as "behavioral research" and "applied behavioral research."[198] This is particularly notable because it was a rare documented example of private industry investing in research that applied directly the social, behavioral, health, and public health states of their users (or customers). Hanson's paper reflects primarily on the motivations and organizational structure of these research pursuits, but their mere existence stands out among any other industry research lab, and foregrounds later research in user experience from a much more academic and fundamental approach.

Kenly Smith described the post-war 1950s industry development

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[197] "Research, IBM." nd, 2019, http://www.research.ibm.com/history/.

[198] Hanson, B. L. "A Brief History of Applied Behvioral Science at Bell Laboratories." The Bell System Technical Journal 62, no. 6 (1983): 1571-90.

succinctly, detailing the shifts in culture to move laboratories toward an academic research style. “The new research orthodoxy raised the status of the research laboratory and gave it an unprecedented autonomy. Corporate management believed that, if innovation was the product of science, then the process was best left to the scientists.”[199]

The antitrust narrative was still present in the post war period through the 1970s. As Kenly Smith summed up, “Making this concept even more attractive to corporate management was the late New Deal antitrust attack on big business that continued into the 1950s and made corporate acquisitions or cooperative activities highly suspect. Companies had to rely on internally generated technology, but the Bush concept reassured executives that in-house science would generate an adequate supply of inventions.”[200] According to Hounshell companies like DuPont had begun preparing for the post-war era before the US had even entered military conflict in WWII by expanding their antitrust divisions.[201] This move was in part motivated by the anti-big business motives of the Roosevelt administration, and the antitrust actions that had been levied against them.[202] Firms like DuPont had been saved by their R&D departments developing lines like nylon, and internal memos note that they read Bush’s report very carefully—buying into the linear innovation cycle and call to invest in more basic science. This is ironic considering that Bush’s report assumes this type of research isn’t happening in industry, but in the case of DuPont specifically this type of forecasting was almost a dare to double down on internal investments. It set up that the US would be investing heavily in basic science, and they would have to invest even more internally to keep their leadership. Other firms similarly invested in expanding their internal R&D or shifting to more fundamental research in the post war period for a variety of reasons, but likely due to the narrative poised by the report and as an effort to stave off antitrust. These firms included Kodak, GE, General Motors, RCA, Merck & Co and AT&T.[203] With the way research ecosystem has evolved, it’s almost unimaginable firms would take this investment as a challenge instead of a free ride.

Part of the singular focus of firms during this time to invest internally is that all innovation that happened outside of their own corporate spheres could be viewed as inaccessible due to the antitrust climate. Mowrey and Teece categorize this as the “golden years” of corporate research since firms focused their

[199] Smith, "The Scientific Tradition in American Industrial Research.,” 128.

[200] Kenly Smith, "The Scientific Tradition in American Industrial Research,” 128.

[201] Hounshell, "The Evolution of Industrial Research in the United States,” 44.

[202] Hounshell and Smith, *Science and Corporate Strategy : Du Pont R&D, 1902-1980. Studies in Economic History and Policy*.

[203] Hounshell, "The Evolution of Industrial Research in the United States,” 46.

innovation seeking (and thus investments) inward.[204]

Losing faith: Decline of Industrial R&D in the 1960s

After about ten years of large post-war R&D investments, firms grew weary. "Chief executives, who once accepted R&D on faith, are no longer willing to keep hands off and let the technological tail go on wagging the corporate dog. Many are beginning to look for ways to measure results, which they rightly suspect are not always what they should be."[205]

Kenly Smith Jr. states that many organizational experts were deployed to justify why scientists required such special treatment. "This literature was aimed at a new generation of research directors who, unlike their predecessors, defined their jobs more narrowly by insisting that the laboratories were responsible only for research, not innovation. They had grown up in a research culture and saw their job as sustaining a tradition, not as supporting corporate goals. Not surprisingly, their labs became increasingly isolated through the 1950s. The physical manifestation of this was laboratories built in suburban country-club settings far from the plant and corporate headquarters."[206] The way researchers were isolated and the entire research divisions were organized (or disorganized from other corporate efforts) played a large role. Additionally, other scholars like John Jewkes, a historian in the 1950s, concluded with his colleagues that many innovations came from outside of the laboratory.[207] The original many of the leading firms (e.g., AT&T) separated their research labs physically and not just organizationally is that they were required or requested to do so by federal funders of classified projects.[208] This infrastructure design choice was permeated in many corporate labs following the war because it was conflated with the special needs and role of the researchers, but instead propagated an ivory tower that set many of these R&D branches to fail.

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[204] David C. Mowery, and David J. Teece. "Strategic Alliances and Industrial Research." Chap. 3 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 113.

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This direct quote was found in: Norman D. Fast. *The Rise and Fall of Corporate New Venture Divisions. Research for Business Decisions.* (Ann Arbor, Mich.: UMI Research Press, 1978), 14. The quote is cited from:

Ansoff, H. Igor, and John M. Steward. "Strategies for a Technology Based Business." Harvard Business Review November/December (1967): 71-83.

[206] Kenly Smith, "The Scientific Tradition in American Industrial Research," 129.

[207] See, for instance: Jewkes, John. *The Sources of Invention.* London,
New York,: Macmillan;
St. Martin's Press, 1958.

Kenly Smith, "The Scientific Tradition in American Industrial Research," 122.

[208] Mowery and Teece, "Strategic Alliances and Industrial Research," 113.

According to Hounshell a variety of wavering social views (e.g., growing suspicion of government and technology) also contributed to the continued decline of federal R&D investment in the private sector during the Vietnam War.[209] This coincided with a decline in the internal investment in research from firms that had previously been heavy investors in uninhibited fundamental research. Hounshell cites waning faith in the linear model Bush proposed, since many firms had invested large amounts of money in programs that reaped little financial reward for companies over two decades.[210] Firms included DuPont, Kodak, and IBM. Critical to these points, Hounshell points out the inflation in the 1960s and 70s meant that R&D budgets which were held flat through the decade were actually decreasing when calculated in constant dollars.[211] The impact of budgets and overall changes to firm executive management style will be echoed later as an important factor in how firms invested in R&D. Unlike during the Great Depression, economic shocks during the early 1970s resulted in less faith in R&D investments.

In President Nixon's address to Congress on March 16, 1972[212], in what would later be called "the Presidential Message on Science and Technology" called for a cooperative endeavor in order to harness the power of science to improve national progress. He stated: "Finally, we must appreciate that the progress we seek requires a new partnership in science and technology—one which brings together the Federal Government, private enterprise, State and local governments, and our universities and research centers in a coordinated, cooperative effort to serve national interest. Each member of that partnership must play the role it can play best; each must respect and reinforce the unique capacities of the other members. Only if this happens, only if our new partnership thrives, can we be sure that our scientific and technological resources will be used as effectively as possible in meeting our priority national needs."[213] What is fascinating about this address, is that Nixon famously had a strained relationship with his science advisor, Dr. Edward D. David, and that this statement—considering the actual history of WWII 27 years prior—is unremarkable and entirely unoriginal. But the fact that the popular narrative that erased industry's vital role in WWII technological and scientific advancement made the call for cooperation appear as a novel solution in a time of otherwise decaying R&D support.

Part of the reason the investment had not paid off was "in part because the scientists were unwilling to undertake the mundane task of development and

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[209] Hounshell, "The Evolution of Industrial Research in the United States," 50.

[210] Hounshell, "The Evolution of Industrial Research in the United States," 50.

[211] Hounshell, "The Evolution of Industrial Research in the United States," 51.

[212] For reference, the break in at the Watergate building was on June 17, 1972.

[213] Albert H. Rosenthal, "Approaches to Public Science Policy and Administration." Chap. 9 In *Public Science Policy and Administration*, edited by Albert H. Rosenthal, (Albuquerque, NM: University of New Mexico Press, 1973), 5.

commercialization. To remedy this situation, in the 1960s and 1970s companies emphasized development and commercialization of new products, forcing reluctant scientists into new molds."[214] Once again, the total separation of R&D facilities from corporate goals and strategy was an unsuccessful approach that assumed the pragmatic matters of technology transfer could be solved by sheer intellectual ingenuity alone. Even in cases where that may have been the case, lack of successful business models (as was the case with Xerox, below) to help capture and exploit the technologies meant firms could not reap the rewards of their investments—thus disincentivizing R&D investment overall.

As part of an organizational response to these commercialization failures, many companies in the 1970s began corporate "New Venture Divisions" which were found in large firms as an effort to address the gap between the ivory tower R&D divisions and the business strategy of the company. Norman Fast describes New Venture Divisions in his study of this emergent management approach to innovation.[215] He states: "A New Venture Division (or NVD) is an organizational unit whose primary functions are 1) the investigation of potential new business opportunities, 2) the development of business plans for new ventures, and 3) the management of the early commercialization of these ventures." Though his study tracks the rise of these organizational units throughout the 1960s and 1970s, by the conclusion of the study half of his cases had been disbanded, and he states that these were short-lived solutions. However, these NVDs served as a popular trend of the time to manage innovation and corporate diversification. Fast states that the 1960s saw a high number of acquisitions because of high price earnings rations and a general popularization of the "conglomerate concept," but that this fell in the 1970s due to tighter available credit, declining price to earnings ratios, increasingly stringent accounting rules, and a tougher anti-trust climate.[216] Understanding how firms adapted organizationally to manage innovation activities in response to more global economic and policy climates gives clues to how firms could and maybe even should respond in contemporary day.

Many different industries reported pressures on internal R&D, and different approaches to try and remedy the stagnation. Alcoa (aluminum) reported their R&D organization began to struggle, and "the signals were vague at first but became clearer by the late 1970s, when a series of new corporate faces began showing up to 'fix' the labs."[217] In part this was attributed to the fact the company had exhausted their initial foundations of scientific knowledge, and that the

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[214] Kenly Smith, "The Scientific Tradition in American Industrial Research," 129.

[215] Norman D. Fast. *The Rise and Fall of Corporate New Venture Divisions. Research for Business Decisions*. (Ann Arbor, Mich.: UMI Research Press, 1978), 1.

[216] Norman D. Fast. *The Rise and Fall of Corporate New Venture Divisions. Research for Business Decisions*. (Ann Arbor, Mich.: UMI Research Press, 1978), 13-14.

[217] Peter R. Bridenbaugh, "The Future of Industrial R&D, or, Postcards from the Edge of the Abyss." Chap. 6 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 158.

development efforts could only carry them so far.

During this post-war time as federal research investment mechanisms were designed from scratch to seed basic and fundamental research within academia, private industry reallocated their wartime efforts back into formalized research laboratories intended to mimic academic settings. Threats of antitrust continued to be a motivation for industry to invest in R&D, but there was also wide acceptance internal research was the best method for innovation. This emphasis on internal and highly academic labs by industry began to disintegrate in the 60s and 70s as bureaucratic barriers to labs began to fade and the realization of the challenges commercializing various stages of research sunk into business leadership. This time period established several models for how many industries —including the rising high tech industry—would come to think of gold standard, Bell Labs-like research operations and more porous internal research organizations.

Rise of Personal Computer and Semiconductor Industries, alongside new research models

Focusing specifically on "high tech" computer and semiconductor industries' research strategies, the 60s and 70s post-war laboratory boom and bust fostered a unique collection of models which modified and built off of the linear innovation schemas that dominated the post-war conceptualization of the role of the private firm in research. The demands for new models of cooperative innovation and collapse of formal laboratories in many firms builds the foundation for contemporary practices in tech, and was a unique phenomenon for the tech industry. This section explores the implementation of Silicon Valley R&D theoretical models introduced in Chapter 2, including examples such as Xerox PARC where a formal lab was created, and emerging consortia and joint ventures to foster cooperative research in the face of global competitiveness. This final section also examines firms like Intel that did not create a research division, and how research was incorporated and leveraged into the business strategy.

Bush, in addition to his policymaking, was a cofounder of one of the central companies on Boston's "Route 128" which was a high tech regional cluster. One of his students, Fredrick Turman—the co-inventor of the transistor—returned to Stanford after the war. Turman built upon Bush's convictions about the importance of academic-industry,[218] and went after key DoD grants in the late 1950s and early 1960s which in part continued to spur growth in the budding

[218] G. Pascal Zachary, *Endless Frontier : Vannevar Bush, Engineer of the American Century*. 1st MIT Press ed. Cambridge, MA: MIT Press, 1999, 4.

Silicon Valley.[219] With the assistance of notable individuals, such as Turman, the Bay Area became an alternative to the traditional east coast technology hubs—particularly around Route 128 in Boston, but also in other areas clustered in upstate New York and New Jersey. The first computer industry instances are often traced back to the 1939 William Hewlett and David Packard collaboration. The establishment of Shockley Semiconductor—using technology stemming from Bell Labs—in 1956 is another key historical moment in the history of Silicon Valley. Interestingly, the moniker "Silicon Valley" originated in 1971 from Dan Hoefler who was a reporter at Electronic News after he wrote a three part series about the region's history.[220]

Xerox PARC as the formalized Silicon Valley research lab

Notably, some high tech firms did still establish R&D arms during this otherwise decline of corporate laboratory popularity. As with any trend, there are exceptions. Xerox's first formalized research roots took shape in the early 1960s,[221] and is a company whose business strategy is the topic of many accounts and analyses—including Fumbling the Future—which[222] are deeply intertwined with their relationship to R&D and innovation strategy over time. Much like Bell/AT&T, only the parts most relevant are described here but entire dissertations could be written about these companies alone. Xerox of course is synonymous with copying, often serving as an eponym for the act of using the technology they deployed. Xerox began pursuing a central research laboratory under the direction of board member John Bardeen, and in 1962 recruited several senior research managers from General Electric's Schenectady Research Center—continuing a long tradition of poaching other industry research managers to jumpstart an R&D division (according to Myers).[223] The Webster Research Center (WRC) was dedicated in 1964 in upstate New York, and grew rapidly in reputation and size between the years 1968 and 1986.[224] To continue the tradition set by WRC, additional research centers were established in Palo Alto (1970), Canada (1974), and eventually laboratories were installed in Rank Xerox in Europe and research

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[219] For a more complete picture of the origins of Silicon Valley, reference works such as the beginning chapters in Kenney, Martin. Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region. Stanford, Calif.: Stanford University Press, 2000.

[220] Martin Kenney, "Introduction." Chap. 1 In *Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region*, ed by Martin Kenney, (Stanford, Calif.: Stanford University Press, 2000), 3-4.

[221] Mark B. Myers, "Research and Change Management in Xerox." Chap. 4 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, (Boston, Mass.: Harvard Business School Press, 1996), 135.

[222] Smith, Douglas K., and Robert C. Alexander. Fumbling the Future : How Xerox Invented, Then Ignored, the First Personal Computer. 1st ed. New York: W. Morrow, 1988.

[223] Myers, "Research and Change Management in Xerox," 135.

[224] Myers, "Research and Change Management in Xerox," 135.

began at Fuji-Xerox in Japan[225] (both of the latter moves representing initial international joint ventures that foreshadow trends about to come). Myers, who was senior vice president of research and technology, was involved with these strategic decisions, comparing the Xerox strategy with contemporaries of Xerox's time—like GE, AT&T, IBM, and DuPont—who each took a centralized and consolidated approach to research.[226] Xerox, on the other hand, exploited their geographic distribution and their associated cultures and missions by focusing each center on a particular core competency. Rochester (WRC) focused on imaging sciences, chemistry was consolidated in Canada, and Palo Alto [known as Xerox PARC (Palo Alto Research Center Incorporated)] on digital systems.[227]

Myers attributes the continual increase in research investments during 1976 and 1986, when the company was otherwise facing financial struggles, to the positive relationship between the head of research and Xerox's chairman.[228] Myers quotes an expert who detailed the corporate philosophy, and how it influenced the aspirations to hire "the best, most creative researchers you can find," providing the most supportive environment with advanced instrumentation possible, and working the business needs into the program via budget selection.[229] Much like Bell, Xerox strove to create an intellectual environment that was in touch with (and a part of) the academic research communities. Xerox PARC had close ties to nearby universities including UC Berkeley and Stanford, and also broke the regional pattern of east coast laboratories. Some cite this regional jump as responsible for the free-thinking creative style of the organization, and its lack of ties to national security and military applications.

This approach, particularly as it related to PARC, gave the company high visibility and respect from academics and the public alike. The inventions originating at PARC are considered ubiquitous technology including the laser printer, ethernet, modern personal computer, graphical user interface (GUI), object-oriented programming, etc. However, it became clear by the 1980s that the investments, though they earned this admiration and notoriety, were not making an economic impact on the company. Reputation is not enough to keep a business afloat.

Xerox's ability to capture technology into their business model struggled. In order to try and keep up with Japanese competition and offer desktop laser printers (as opposed to low-end copiers), Xerox faced a dilemma to where—to put it in Myers' words—"research" favored entirely new iconographic approach that

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[225] Myers, "Research and Change Management in Xerox," 135.
"About Fuji Xerox, Company Profile, History." 2018, 2019, https://www.fujixerox.com/eng/company/profile/history/corporate.html.
[226] Myers, "Research and Change Management in Xerox," 135.
[227] Myers, "Research and Change Management in Xerox," 135.
[228] Myers, "Research and Change Management in Xerox," 136.
[229] Myers, "Research and Change Management in Xerox," 135.

migrated away from already taxed manufacturing competencies, whereas "development" favored using traditional xerography.[230] The senior management favored the research approach, and the project was designated as "skunk works[231]" internally and given special secret status. However, given what is now to be known issues with Xerox's ability to deliver new products into the business model and move quickly to be among the first in the market, the entire operation failed. What is fascinating about this is that the failure came in the ability to properly move on new technology and integrate it into the business model of the rest of the company, not on the ability to innovate itself[232]. Which suggests in the case of Xerox PARC, where many of the technologies relevant to this dissertation were developed, it was a business model failure—or at least an integration failure—not a failure on the design of the R&D department. As Myer's stated: "Xerox's proprietary, vertically integrated business model missed the open system, horizontal business structuring that ultimately characterized the advance of the distributed computing paradigm in the office workplace."[233]

Relaxation of antitrust, beginning of cooperative research and technology development

Entering into the 1980s, global competitiveness became a driving force behind organizational and investment decisions by US firms and policymakers. Compared to the more inward domestic focus of the post-war decades, the late 1970s and early 1980s began a shift to where US firms no longer had a lead over war-devastated economies across the world. Europe had not only rebuilt and revitalized the academic prowess and corporate strength of the pre-war years, but countries like Japan introduced massive competition on the US market. These economic forces in part led to a relaxation of the anti-trust polices as a way of making cooperative arrangements and collaborative R&D models possible for tech firms. Prior to the passage of any federal legislation, early semiconductor pioneers banded together to form the Semiconductor Industry Association (SIA) in 1977 to present a united front and state of the industry to both international competitors and the US Federal Government as a way of courting and demanding national assistance.[234] This assistance was in part achieved by the passage of the National Cooperative Research Act of 1984 (P.L. 98-462), which established a research consortia to assist with technology competitiveness by forming

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[230] Myers, "Research and Change Management in Xerox," 139.

[231] A detailed description and history of Skunk Works may be found in Appendix C.

[232] See for example, Chesbrough and Rosenbloom, Industrial and Corporate Change, Vol 11, No 3, p529-555

[233] Myers, "Research and Change Management in Xerox," 140.

[234] Moore, Gordon E. "Some Personal Perspectives on Research in the Semiconductor Industry." Chap. 7 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, ed. by Richard S. Rosenbloom and William J. Spencer, p165-74 (Boston, Mass.: Harvard Business School Press, 1996), 172.

SEMATECH (a portmanteau derived from "Semiconductor Manufacturing Technology") and the Microelectronic and Computer Technology Corporation (MCC). Eventually, the National Cooperative Research Act was replaced in 1993 by the National Cooperative Research and Production Act (NCRPA[235]; P.L. 103-42) which further reduced the potential antitrust liabilities of joint ventures productions as well as standard setting organizations. Within the world of semiconductors, there were also the presence of advisory councils created to help innovators and firms work with policymakers to create policies that promoted American technological competitiveness. Congress established the National Advisory Committee on Semiconductors (NACS) in 1988 to help create national policies and strategy by connecting industry leaders and hosting workshops to coordinate with various public agencies, but most of NACS activities were concluded by 1991.[236] This, however, set an important example of how even short termed advisory councils can serve as a bridge between industry actors and government, in the interest of national innovation style strategy.

Additionally during this time, technology transfer policies were put into place to help encourage the translation of fundamental research from national labs or academia to the private sector as a way to spur the economy and increase American competitiveness. The Stevenson-Wydler Technology Innovation Act 1980 (PL 96-480) sought to encourage the transfer of federally-owned or developed technologies (usually from federal laboratories) by making transfer activities a requirement and budgetary obligation. Additional legislation bolstered these "tech transfer" priority efforts including the Federal Technology Transfer Act of 1986 (PL 99-502) which specifically focused on the transfer of federal agency technology to the commercial private sector, and the National Competitiveness Technology Transfer Act of 1989 (PL 101-189[237]) which made technology transfer of federal R&D agencies a mission and priority. Not only did these laws seek to establish tech transfer of federal investment to the private sector as a priority, but it enabled programs and made clear the ability to transfer technology that was not central to national security.

This shift in national and private sector R&D strategy was spurred not only by the need to outcompete foreign companies, but because the cost of equipment and facility upkeep had drastically increased. This equipment was not readily available in infrastructure like federal laboratories to private companies (as is sometimes the case with fundamental research either by federal employees or through joint projects with academics in areas like experimental physics).

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[235] https://www.justice.gov/atr/national-cooperative-research-and-production-act-1993
Note that this law later had extended provisions under the Standards Development Organization Advancement Act of 2004 (PL 108-237)

[236] Moore, Gordon E. "Some Personal Perspectives on Research in the Semiconductor Industry." Chap. 7 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, ed. by Richard S. Rosenbloom and William J. Spencer, p165-74 (Boston, Mass.: Harvard Business School Press, 1996), 173.

[237] https://www.energy.gov/sites/prod/files/2014/02/f8/OAS-M-14-02.pdf

Splitting the cost of the facilities through joint ventures—explicitly allowed through laws previously described—also reduced the risk to any one firm. It was also impossible for universities to afford all of the necessary equipment required to conduct their own supporting and relevant research to industry to keep up with the state of the art in semiconductor technology. Because of these challenges and as part of the more cooperative approaches found between industry and academia like SEMATECH, other methods of connecting industry and academics were created. For instance, the Semiconductor Research Corporation (SRC) was founded as a non-profit in 1982 and has since spawned many joint research initiatives (as well as graduate fellowships) with partner universities.

Though this section focuses primarily on the budding computer industry, this was a trend—like those previously—felt more broadly across all industries in the United States. In 1988, The Conference Board held an "R&D/Technology Management Conference" where they convened R&D Directors and other related management to talk about the challenges facing companies from agriculture, cosmetics, and technology companies. In the forward, the president of the association stated: "R&D and technology are key ingredients in sustaining and enhancing a company's competitiveness. So it is essential that these functions be managed with that end in view. Yet doing so often entails a great deal of collaboration and cooperation, not just internally, but with outside organizations, like academic institutions, government laboratories, and other companies—including, sometimes, competitors."[238] The explicit call out to maintain "competitiveness" and to view R&D as a cooperative venture gestures explicitly to the research strategy of the 80s and 90s. The conference organizers stated a desire to better understand how to fully capture the benefits of external collaboration without compromising company assets—something that is clearly a perennial struggle in the globalized age—and identify this skill as just as important as knowing how to manage internal R&D.

Kenly Smith Jr. also noted that a large portion of semiconductor research was done by entrepreneurial firms who had been able to break free of large and bureaucratic R&D firms—the behemoths of its time—but the new firms were all dependent on the defense sector for funding, and Bell Labs for underlying technology and personnel.[239]

Mowrey and Teece categorized the different consortia models in three forms: 1) international strategic alliances; 2) pre-commercial research consortia; 3) university-industry research collaborations. The development strategies around alliances tended to be product specific, whereas consortia were more broad in approach and expansive.[240]

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[238] Townly, Preston. "From the President." In Managing R&D and Technology: Competition and Collaboration, edited by Evelyn Samore and James K. Brown, v: The Conference Board, 1988.

[239] Kenly Smith, "The Scientific Tradition in American Industrial Research," 130.

[240] Mowery and Teece, "Strategic Alliances and Industrial Research," 115.

International strategic alliances played an important role as new commercial technologies were being developed without standards, such as the Beta-VHS competition in videocassette recorder technology, where VCR architecture required getting buy in from not only Japanese but international firms.[241] These partnerships were also vital in navigating new trade market rules and market practices, but these alliances challenged firms' tested domestic innovation capacities. According to Mowrey and Teece, these partnerships tried different models of circulating research and engineering staff abroad to help capture (tacit and codified) knowledge, but it was hard to fully communicate these lessons and facilitate knowledge transfer back to headquarters since some of it required strong duplicate infrastructure at home to replicate or riff off of learned knowledge.[242] Additionally, figuring out how to match contributions equally was a challenge. For instance, some partners would be contributing country specific expertise but gaining technological know-how in exchange.[243] These international and cooperative arrangements put additional pressure on R&D management to adapt to an innovation process that was still yet to be perfected under more contained and traditional in-house laboratory models.

As for pre-commercial research consortia, many in the US received sponsoring through legislation (cited above) and government programs, so they were explicitly restricted from accepting international partners. Firms forming a joint venture needed to register with the Department of Justice under the 1984 National Cooperative Research Act, and there were over 450 registered by 1994.[244]

MCC was established in the mid-1980s as a response to Japanese cooperative programs VLSI (from the 1970s) and the Fifth Generation Computing project in the 1980s because computer companies agreed the long-term research agenda could only be tackled to match the Japanese in a collective way. However, as Mowrey and Teece point out, MCC and others like the Electric Power Research Institute illustrate that these efforts lose long-range vision and began to focus more on generic technology that is of immediate interest to members.[245] This suggests a failure of these collective efforts to commit and calculate risks and benefits of delayed research gratification. MCC was horizontally organized, where often direct competitors came together for a common mission, unlike SEMATECH (as well as the National Center for Manufacturing) which was vertically integrated in a way that evolved to improve

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[241] Mowery and Teece, "Strategic Alliances and Industrial Research," 116.

Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

[242] Mowery and Teece, "Strategic Alliances and Industrial Research," 117.

[243] Mowery and Teece, "Strategic Alliances and Industrial Research," 117.

[244] Mowery and Teece, "Strategic Alliances and Industrial Research," 119.

[245] Mowery and Teece, "Strategic Alliances and Industrial Research," 119.

the relationships between users and suppliers of equipment. MCC also had special research staff, which made integrating new knowledge back into member firms more challenging and less likely to capture the externalities that can still benefit firms.[246] Rigid bureaucracy made bending rules or working around constraints time consuming at MCC—which also meant the efforts intended to insulate competitors eroded the effectiveness of all members.[247] SEMATECH on the other hand, was comprised of assignees from each member firm and more flexible—an arrangement made easier by the evolution toward vertically integrated firms—and ultimately led to a more effective model when compared to MCC.[248]

Mowrey and Teece make a point that the Japanese consortia that promoted these US reactions by firms and the federal government were not oriented toward fundamental research, but rather focused on technological dissemination among members and developmental activities.[249] The Fifth Generation Computing Project that did have a long-range research agenda was seen largely as a failure in 1996 by Mowrey and Teece in the citation above. SEMATECH illustrated that given how hard it was to gain consensus from consortia members about specific products or processes to focus on, when the benefits of such models would only felt long-term by members and not in the immediate time relevant to profits and competitive advantage.[250]

University-Industry research collaborations as the third model addressed by Mowrey and Teece are described as one off collaborations, that are often used as filters for hiring future research personnel (both in regards to vetting as well as an opportunity to transfer new skills into firms).[251] This model is not as fully fleshed out as the other two, probably based on the fact that collaborations around the 1980s and 1990s between the private sector and academics were so narrowly constructed in order to be beneficial to both parties. In the information age, however, these partnerships can be much more varied since studies that reveal value in underlying user data may deviate from the intended business model yet represent new market opportunities or feed other corporate value like "data for good initiatives." (See Chapter 2)

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[246] Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

[247] Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

[248] Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

[249] Mowery and Teece, "Strategic Alliances and Industrial Research," 119.

[250] Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

[251] Mowery and Teece, "Strategic Alliances and Industrial Research."

Popularization of Joint Ventures

Internal models of established in-house R&D departments were also developed to reflect the changing pressures of internationalization and changes to how technology was bought and sold. John Armstrong, longtime employee and lastly the Director of Research and Vice President of Science and Technology, reflected that "joint programs came about as a response to the competitive conditions of the 1980s" and that throughout the 1990s companies could no longer rely on technologies themselves as a source of comparative advantage.[252] Armstrong reflected that IBM developed programs that partnered internal researchers with developers and engineers from areas outside of their own (e.g., semiconductors, scalable supercomputers, database technology) in order to adapt to the changes in technology patterns occurring outside the company. They also began more partnerships with their researchers and customers (i.e., governments or businesses) to help improve the IBM product through collaborations. The company began offering to do the development in their own labs for customers at one third or less of the projected costs of the project if done on its own.[253] This move mimicked some of the early research consulting firms that used their R&D infrastructure to offer outsourced research to small firms. Additionally, this also represented a small progression in what was considered "research" by companies, in that these services focused on product code testing and design that fit solely within the category of "product development."

The Semiconductor Industry Association (SIA) established the Semiconductor Research Corporation (SRC) in the early 1980s to collect money from member firms to fund research that was important to industry. This was part of the broader movement toward collective action taken by firms to compete internationally and design new strategies to do so. Harkening back to unsuccessful interwar efforts to pool industry funds and jumpstart research that was not federally funded, this collective action to invest in market research continued until technology advanced enough to bring down the costs for firms to continue smaller scale and individualized innovation.

Emerging Implementation of Silicon Valley R&D Models

Chapter 2 establishes the changes in innovation theory outlined by Saxenian and Chesbrough that are specific to Silicon Valley tech industry. These changes were driven in part due to specific technological demands as well as cultural and

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[252] Armstrong, John. "Reinventing Research at IBM." Chap. 5 I*n Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, p151-54. (Boston, Mass.: Harvard Business School Press, 1996), 152.

[253] Armstrong, John. "Reinventing Research at IBM." Chap. 5 I*n Engines of Innovation : U.S. Industrial Research at the End of an Era*, edited by Richard S. Rosenbloom and William J. Spencer, p151-54. (Boston, Mass.: Harvard Business School Press, 1996), 153.

organizational changes. Silicon Valley made its name on the rapid flow of knowledge between firms thanks to the rich networks of practice and practical wisdom—not to mention shared goals and personal context. This became embedded in the innovation and research approach of the region. Saxenian documents the collaboration among even business competitors: "Information exchanges continued on the job. Competitors consulted one another on technical matters with a frequency unheard of in other areas of the country."[254] Saxenian then quotes an interviewee as saying, "this is a culture in which people talk to their competitors. If I had a problem in a certain area, I felt no hesitation to call another CEO and ask about the problem—even if I didn't know him. It was overwhelmingly likely that he'd answer (my question)."[255] These fluid information exchanges point to a shifting culture with high specialization and lessening competitive advantage of a fully integrated vertical firm. The pressures to cooperate externally, and find new ways to bring in the latest R&D in order to maintain competitive advantage formed the key components leading to the Silicon Valley model of innovation.

The entire semiconductor industry was set in motion by the invention of the germanium transistor at Bell Labs (and thus private industry investment) in 1947 by John Bardeen and Walter Brattain under William Shockley's direction. Shockley founded his own laboratory business in 1955 after leaving Bell Labs, and used the silicon transistor that had been placed within the public domain after a DOJ consent decree with Bell Labs.[256] From Shockley Semiconductor, a group began collaborating with engineers from Fairchild Camera and Instrument and eventually formed Fairchild Semiconductor Corporation. Moore counters popular opinion that Fairchild's development of the planer structure in the silicon transistor was influenced by Department of Defense R&D, claiming that the space program of the 1960s only had a negligible impact via the space programs. Which at most, according to Moore, only hurried the development by providing a large market volume for the final product.

Moore discusses the "Silicon Valley effect" where Fairchild produced more ideas and innovation spurs than the company could keep up with, leading to a plethora of spinoffs that did nothing to dampen the market space or wealth of technological opportunity. R&D in the case of semiconductors had to come from the private sector and government since university labs (and the disciplines at large) had not kept up. "Chemically based electronics functions had slipped through the cracks in university research. Because it fit neither the chemical

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[254] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 33.

[255] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 33.

[256] Moore, Gordon E. "Some Personal Perspectives on Research in the Semiconductor Industry." Chap. 7 In *Engines of Innovation : U.S. Industrial Research at the End of an Era*, ed. by Richard S. Rosenbloom and William J. Spencer, p165-74 (Boston, Mass.: Harvard Business School Press, 1996), 166.

engineering nor electrical engineering departments of universities, for a decade basic research in semiconductors was the province of the semiconductor industry."[257]

Intel,[258] and perhaps semiconductors on the whole, represented a departure in how R&D was pursued by firms. In 1996, Gordon E. Moore—former director of R&D at Fairchild Semiconductor and researcher behind Moore's Law (and author referenced above)—spoke about Intel Corporations' R&D approach. Founded in 1968 after Moore and Robert Noyce left Fairchild (previously they had been at Shockley Semiconductor), the company reflected the rapid turnover of new firms within this small area of technology.[259] Moore began his talk with a reflection: "In an industry in which survival hinges on conducting research, Intel Corporation is distinct among semiconductor manufacturers in that it has no formal research organization and yet it invests steadily in R&D."[260]

When Intel was established, the founders Moore and Noyce wanted to "forestall problems with technology transfer by establishing Intel without a separate R&D laboratory," by performing development activities embedded within manufacturing—admitting that the move likely cost manufacturing and efficiency in the R&D process.[261] Noyce established a principle of "minimum information" where instead of systematically studying to uncover an answer, one guesses the answer and goes all the way. If the problem isn't solved, then another solution is tried. This reflects a very different approach than any systematic research or development study. As Moore put it: "Thus, rather than mount research efforts aimed at truly understanding problems and producing publishable technological solutions, Intel tries to get by with as little information as possible. To date, this approach has proved an effective means of moving technology along fairly rapidly."[262]

Not pursuing in house R&D does not mean Intel did not need it to stay competitive. Moore states in 1996 that they looked to Bell Laboratories for the materials and fundamental science behind semiconductor devices, RCA Princeton Labs for consumer-oriented product ideas, materials and metallurgy research from General Electric—thus citing that the biggest in-house labs were providing them with the cutting edge research they needed essentially for free.[263] Later Moore states that Intel began looking toward Fairchild and Texas Instruments as R&D leaders within semiconductors specifically.

As a later strategy, Moore stated that Intel looked to universities for more of

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[257] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 167.

[258] Intel is another portamanetau for "Integrated Electronics"

[259] Online, PBS. "Another Giant Is Born: The Founding of Intel." Arlington, VA, 1999. http://www.pbs.org/transistor/background1/events/intelfounded.html.

[260] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 165.

[261] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 168.

[262] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 168.

[263] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 170.

the basic research—probably because by the mid-1990s many of the in-house R&D laboratories had been massively downsized. It was possible to begin mining universities for research because disciplines had caught up to the needs of industry—specifically the semiconductor industry—which was not only a result of federal investment but association investment through the SIA as well.

Though Intel undoubtedly contributed to the pooled efforts via the SIA for university research, it otherwise piggybacked on the investment into common/ public goods of knowledge production from larger firms. Moore plainly states it as "the large, central research laboratories of the premier semiconductor firms probably have contributed more to the common good than to their corporations. Bell Labs, for example, did contribute much to AT&T, but its greater contribution seems to have been to the economy as a whole. Fairchild's large research organization, particularly in its later years, probably contributed more to the many spin-off companies that exploited the ideas that surfaced within it than it did to its parent company."[264] He goes on to discuss the failure of Xerox Corporation to take financial advantage of the "tremendous contributions to the community at large" coming out of Xerox PARC.[265]

Spinoffs here were enabled by the intellectual property regime of semiconductors, that allowed for cross-licensing of inventions and also made it so that the IP was not easily protected. Moore also calls out how difficult it is for large companies to exploit new ideas, and observes of the Silicon Valley ecosystem "running with the ideas that big companies can only lope along with has come to be the acknowledged role of the spin-off, or start-up."[266] He adds: "It is often said that start-ups are better at creating new things. They are not; they are better at exploiting them. Successful start-ups almost always begin with an idea that has ripened in the research organization of a large company. Lose the large companies or research organizations of large companies, and start-ups disappear."

There was also a perception of the computer industry in 1988 that it was the young, and presumably smaller and more agile companies who were able to "challenge and even bedevil older, larger, and better-known rivals" with their new technology, and it was speculated this trend would continue beyond just the personal computer industry to biotechnology and other industries.[267] Goodman, the Executive Vice President of R&D at Calgene Inc.—a startup in the biotechnology field in Davis, California adjacent to the Bay Area—spoke of the increasing research partnerships between large firms and small startups, which could either cripple the younger partners by fostering an over dependence on the

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[264] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 171.

[265] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 171.

[266] Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," 171.

[267] Robert M. Goodman, "Rewriting David and Goliath: A Small Company's Experience in Collaborative R&D." In *Managing R&D and Technology: Competition and Collaboration*, eds. Evelyn Samore and James K. Brown, (The Conference Board, 1988), 39.

resources of the large firm, or create a mutually beneficial relationship between the two. "To exploit these opportunities, we have sought and developed several kinds of relationships with major corporations in the various markets to which our technology applies. This strategy has provided Calgene with extensive experience in R&D collaborations."[268] The small firm bringing agility and innovation, whereas the large firm provides resources and market share (for instance).

This sets up a first time where there was a need for partnerships between small and large firms at least in the same competitive space, even if they were not direct competitors. This perhaps is because there were more market opportunities where firms complemented each other rather than posing direct competition as siloed and vertically integrated firms.

IBM and other Early Secret Keepers

Not all research and innovation was conducted under porous and open innovation structures and models. IBM was infamous for its firm secrecy at the dawn of the computer industry, building its first PC in under a year at their Boca Raton facility in 1981.[269] The buildings in Boca Raton were built to be low profile and unmarked, even though over 20 were located in the general region in 1983.[270] "The company doesn't need to draw attention to itself (it doesn't even have a boldface listing in the local telephone book); everyone knows IBM is here."[271] The secrecy went beyond modesty. Access within the company was controlled by badges at every corridor—the opposite of the modern open office space. When asked how security was maintained, Howard Davidson (plant general manager) responded: "Our employees know that success of the company, and thus their jobs, depend on security. Apparently, they want to keep their jobs."[272]

IBM was an early adopter of the employee NDA. An article from 1993 attributed the changes in innovation cycles and employee information access due to personal computers. "The widespread use of interconnected personal computers, along with the recent drive to flatten out corporate hierarchies, means that many companies have widened the internal access to detailed information about their unique manufacturing processes or business strategies.

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[268] Goodman, "Rewriting David and Goliath: A Small Company's Experience in Collaborative R&D," 39.

[269] Nisen, Max. "17 of the Most Mysterious Corporate Labs Coolest Skunk Works." Business Insider (2013). https://www.businessinsider.com/coolest-skunk-works-2013-2#xerox-parc-15

[270] Kidder, Tracy. "The Talk of Boca." PC Magazine, November 1983, 164.

[271] Kidder, Tracy. "The Talk of Boca." PC Magazine, November 1983, 164.

[272] Kidder, Tracy. "The Talk of Boca." PC Magazine, November 1983, 168.

As well, in highly technical fields such as biotechnology, advances often come in small incremental steps, rather than huge leaps. As a result, even one employee's scrap of knowledge can be worth millions of dollars in a highly competitive industry."[273] Given the rising stakes, an attorney for IBM is interviewed and describes how each employee now signs a "so called nondisclosure agreement" to spell out what information employees can share outside the company, during employment and afterwards.[274] However, lawyers interviewed noted that it was hard to enforce what "employees know in their heads" and prevent that transfer to other firms in the future.

There are also other examples of secret projects, like the 1980 unveiling of Sony Corporation's automated at home office software. "Hush-hush communications among a small, select circle of Sony Corp. executives in Tokyo and New York over the past couple years regularly contained references to Snoopy, Lucy, and Charlie Brovim. On Dec. 17, Sony caught the office-equipment market flat-footed and unveiled its "Peanuts project"—a major move into the so-called automated office."[275] Even though Apple may have the most recent legacy of corporate secrecy (described in the proceeding section), IBM was known for its practices long before and other companies made use of surprise unveilings and discrete development missions.

Vestiges of Formalized Corporate Laboratories and Modern Instances

The closure of corporate labs and R&D divisions around the same time in the late 1980s and 1990s is in part attributed by the authors of "Beyond Sputnik" to a "realization by corporations that the reductions or closure of their research centers would likely result in an immediate improvement in the company's bottom line (since the operating costs for advanced research would vanish" and that the downsides would only appear much later—likely after the CEOs departure.[276] Given the decreasing tenure times of corporate CEOs over time, long-term R&D investments have become harder cases for expenditures.

When RCA was purchased in the 1980s by General Electric, most research operations were closed down with the exception of a portion transitioned to the

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[273] Wickens, Barbara. "Keeping Secrets." Maclean's 106, no. 35 (1993).
[274] Wickens, Barbara. "Keeping Secrets." Maclean's 106, no. 35 (1993).
[275] "Apple's Morning After: Lots of Competition." Business Week December 29, 1980 (1980): 47-48.

[276] Neal, Smith, and McCormick. *Beyond Sputnik : U.S. Science Policy in the Twenty-First Century*, 135.

Sarnoff Corporation (created during the acquisition by GE as a tax write off.)[277] The Sarnoff Corporation was later donated to SRI International.

Bell Labs was fractured and mostly spun off in the mid-1990s to Lucent Technologies (later Alcatel-Lucent), and it was purchased by Nokia in 2015. Nokia Bell Labs continues to conduct research, but at a much smaller and more focused scale.

Intel Research Labs was formed in 2000 to promote "proactive computing" where users would interact with surrounding things and have a fully digital life. In 2001 Intel Research moved toward a more open collaborative model with surrounding universities that employed very liberal research agreements that did not retain IP ownership. This model was designed around the concept that research and technology developed in the labs was not central to Intel's core business areas. There are still many labs across the world, and under different CEO leadership, Intel Research has taken on different research and collaboration models.[278]

Microsoft Research was also formed around 1991, and still hosts some of the most prominent researchers bridging the industry/academia divide. However, there are not many public accounts about the organization, political forces, and other key elements to help reflect upon the limited instances of formalized research laboratories.

PARC Incorporated was formed by Xerox in 2002 and works on a much smaller scale compared to what it was. The de-emphasis of these once formalized and organizationally insulated research divisions and labs opens up the line of inquiry explored in this dissertation.

Apple: Secrecy made Sexy and Departure from elements of the "Silicon Valley Innovation Model"

Apple built an entire reputation around the company's notorious secrecy and paranoia around new inventions. This was an important note in how companies approached research that was not simply confined to a discrete set of teams or siloed, skunkworks style lab. These practices expanded upon those previously discussed with IBM.

Apple was far from the first Silicon Valley tech firm to invoke practices of secrecy—Skunk Works and other forms of innovation seclusion explored above—but Apple took legal contracts, employee surveillance, and soloed cultures to a new level of sophistication. Even though much of the technology underlying their hardware would be patented (thus protected while guaranteeing "blueprints"

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[277] "Sarnoff Corporation, Wikipedia." 2019, https://en.wikipedia.org/wiki/Sarnoff_Corporation. Please note, alternatives to Wikipedia were sought but there is a dearth of literature—primary or secondary—on recent corporate laboratories.

[278] This knowledge is from one of my anonymous interviewees.

would eventually become public), the company thrived off of the pageantry of model releases and mystical design. This pomp and circumstance fueled early market edge by fostering a reputation for the behind the scenes attention to detail touted by the firm's illusionary Steve Jobs.

In 2006, one article described the transition from being one of the most open companies in the mid-1990s to one of the most closed, even compared to its peers.[279] "Apple's singular focus on secrecy is unusual, even among high-tech companies that closely guard their product plans."[280] Apple's product strategy was a departure from other large computer manufacturers, who reportedly would go to great lengths in order to make their product lines known in order to fit into corporate IT strategies and procurement plans which are set well in advance.

> "Microsoft has never been known for its modesty either and can certainly be irksome. But it will bend over backward to get you product information, particularly about future plans. So much so, it's considered the world leader in FUD -- the fear, uncertainty and doubt it inspires throughout the industry as it details what's on its drawing boards is more than enough to make IT managers hesitate before moving to another vendor's technology...Apple, in contrast, has mastered the art of FAPP -- forget Apple for product planning. The company's "loose lips sink ships" attitude works well for its consumer market, where pre-announcing a cool new gadget can kill the sales of your suddenly has-been widget."[281]

This switch in strategy was in part to market directly to consumers, and the secrecy became part of the branding. The level of transparency described here in 2004 about Microsoft is now the exception rather than the rule. Companies may release vague plans about a product, e.g., smart watch or home assistant, either close to the product launch to build press or as a move announced by an acquisition.

The surprise element and aura had long been a tool of Steve Jobs. In 1998 Jobs took a handful of sales reps and a bowling ball bag to a meeting at a local university to convince them to invest, and after going on a long rant about how screwed Apple was as a company ordered the sales reps out of the room (signifying privilege in audience) and pulled the new iMac out of the bowling ball bag and announced with fanfare how they were going to save the company.[282]

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[279] Wingfield, Nick. "Core Value: At Apple, Secrecy Complicates Life but Maintains Buzz; Maker of Mac and Ipod Keeps Customers, Workers in Dark; Watermark on the Memo; Frustration for Business Buyers." Wall Street Journal (New York, NY), 2006, Eastern.

[280] Wingfield, Nick. "Core Value: At Apple, Secrecy Complicates Life but Maintains Buzz; Maker of Mac and Ipod Keeps Customers, Workers in Dark; Watermark on the Memo; Frustration for Business Buyers." Wall Street Journal (New York, NY), 2006, Eastern.

[281] Hall, Mark. "Secrecy Eating at Apple." (2004). https://www.computerworld.com/article/2565666/secrecy-eating-at-apple.html.

[282] Kaihla, Paul, and Paul Sloan. "The Secrecy of Success." Business 2.0 6, no. 3 (2005): 78-78.

A June 2009 New York Times article titled “Apple’s Obsession with Secrecy Grows Stronger” described the company’s practices as follows:

> “Secrecy at Apple is not just the prevailing communications strategy; it is baked into the corporate culture. Employees working on top-secret projects must pass through a maze of security doors, swiping their badges again and again and finally entering a numeric code to reach their offices, according to one former employee who worked in such areas.
>
> Work spaces are typically monitored by security cameras, this employee said. Some Apple workers in the most critical product-testing rooms must cover up devices with black cloaks when they are working on them, and turn on a red warning light when devices are unmasked so that everyone knows to be extra-careful, he said.”[283]

Apple made secrecy practices alluring within the industry, and built the accompanying aura of mystery to seem like a vital component not just in its public communications, but as a strategy for rapid disruptive innovation. Don Melton described in 2013 how his team went to great lengths to keep the Safari project secret while it was developed, accessing the open web from the Apple campus, and described how the team “operated the project like some CIA black op — loyalty oaths and all.”[284] These secrecy practices were not just preventative but also punitive; focusing on spreading false information to identify sources of leaks to the press.[285]

Apple was aggressive with its own employees: suing suspected leakers and reportedly compartmentalizing teams (à la IBM Boca Raton interiors) so that even managers were unsure what others worked on.[286] Apple hired a former parole officer, Robin Zonic[287], to work on physical and information security. Zonic reportedly tells new employees “if you leak, we will find you, we will fire you, we will sue you, and we will prosecute you.”[288] The internalized focus on general employees—not just those working on sensitive topics—ushered in (or was part of a shift) of a shift in many tech corporate cultures. This shift ushered

[283] Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." The New York Times, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

[284] "Keeping Safari a Secret." 2013, https://donmelton.com/2013/01/03/keeping-safari-a-secret/.

[285] Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." *The New York Times*, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

[286] Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." *The New York Times*, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

[287] Zonic worked at Apple from 1990 to 2008 according to her LinkedIn, and according to news sources was tasked with sealing leaks in 1997 when Jobs returned to the company.

[288] Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." *The New York Times*, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

in a reputation for punitive consequences rather than mission-focused and necessary secrecy.

Though the culture of wanting to keep activities secret was known among employees, as reported by tech companies such as IBM in the 1980s, the threatening nature of Apple, and the popularization of these techniques among other firms over time, suggests a more recent and widespread cultural shift. Regardless of the influence Apple's culture played on the actions of other firms, there has been a large response among tech firms to chase leakers to the press. This fear of leaking information to the press bleeds over into academic discourse and any general conversations between firms.[289]

Conclusions

This chapter provides important historical contextualization of industry of the role of the private sector in the research ecosystem. It details R&D practices which are foundational to arguments within this dissertation and referenced throughout. This historical documentation, bringing together unique primary sources as well as the scholarship from historians establishes a foundation so that this analysis can be conducted grounded in facts rather than historical perceptions.

An essential overarching element in this chapter is where research activities were located in proximity to private firms. In early examples, research was completely externalized and individualized with independent inventors, and partnerships with academia were limited in the United States unlike countries like Germany with a more advanced research-based graduate education and programs to foster these partnerships. There were limited early cases of information sharing between firms and external researchers—usually for market research or for organizational efficiencies. These information exchanges were an important predecessor for understanding information exchanges in a modern context. Research was only brought in-house in limited and exceptional circumstances, but later paved the way for American firms to recognize the importance and strengths of having in-house talent, partly because of expiring patents driving the need for new competitive innovation and the need to stave off antitrust regulation in the early 1900s. The world wars and interwar period raised the stature of private sector research significantly, and began conversations about a government funded pipeline to help educate researchers who could later be employed by universities. The wartime also popularized the importance of internal research, and established a post-war time period where private industry

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[289] This is especially due to some of the activist-style research orientation among some critical theory scholars, who also often write tech opeds in the press as well as conducting research.

invested heavily in internal R&D and academic style laboratories. However, as struggles to commercialize technology developed within industry and create seamless and flexible business plans that could follow the whimseys of invention, many laboratories were shut down and research was moved outside of the firm to external partners once again. The high tech, computer, and semiconductor industries brought new shifts in how firms developed and used their innovations. Firms spun ideas off into separate companies instead of attempting one overarching business model, and research was often no longer insulated within firms into formalized research divisions but democratized across all areas of the firm. Cooperative research and joint ventures also became an important trend as equipment necessary to innovate became too large for an individual firm, and university research struggled to keep up with new disciplinary norms demanded by the emerging technology. These later models broke down the organized and formalized internalized research of earlier decades, and instead ushered in hybrid models where firms looked to new models (e.g., cooperative research and consortia) to fill research gaps, and also the slow collapse of any internalized research. This lack of internalized research placed tech firms back into the position of looking to academia or to other externalized units for research, and partnerships began to supplant internal activities—a trend echoed today.

The following chapters begin to document and examine contemporary R&D trends in private industry, including the forces that pull research-related activities inside a firm, outside of the firm, or where they help broker industry/academic partnerships. With the exception of early industry R&D where some information was exchanged between firms and outside researchers or analysts (the term consultant was not used yet), there were few instances where data alone was shared between industry practitioners and academics. As discussed in the introductory Chapter 2, data has emerged as a new vital currency for research, and presents new challenges (e.g., privacy and ethics) in facilitating and organizing these arrangements. By understanding practices of early private firms, different models for internal research and external partnerships, and the unique pressures and strategies embraced by high tech firms, the rest of this dissertation work can be grounded in historical context to explore the implication of returning ideas, and new paradigms.

Chapter 5

Illustrative Cases from Exemplary Firms: Vibrators, Thermometers, and Smart Watches Research and Data Sharing Strategies

Several companies interviewed employed unique data collection, sharing, and innovation strategies as it related to social, behavioral, health, and public health research. They each illustrate how the relation of the private firm to fundamental research inquiry is evolving and challenging existing models and theories of practice. The key pivot illustrated is twofold: First, these firms generate biosensed data by users in real-time and in the real world, which has previously been prohibitively expensive for researchers, ethically complicated, and near impossible to replicate at scale. This infrastructure and access enables previously unobtainable fundamental research questions within academia and medical research.[290] Second, these firms require knowledge feedback from independent research and through partnerships in order to improve and validate their algorithms, which flourish best when built upon findings rooted in science rather than correlation. These cases were selected because they exemplify particular elements and themes from this dissertation, and were accessible to provide an in-depth story that make this dissertation's concepts and findings more clear. These illustrative cases provide unique research contributions and their stories may not be understood simply by viewing publicly available material online.

The firms selected for these illustrative cases include: Lioness, Kinsa, and

[290] These particular cases (as well as other firms interviewed) focus predominately on observational studies and A/B testing style comparative analysis rather than more manipulative experimental techniques. Experimental manipulation of users carries a higher ethical weight and risk of public backlash, and was not discussed by interviewees. Experimental study was also not the best methodology to study the fundamental and basic research questions craved by firms and researchers, just ask researchers did not need to experimentally manipulate government survey data to find great research utility.

Basis Sciences. The Lioness smart vibrator illustrates how data, uniquely held by the private sector with regard to users' intimate lives, can be used to address a dearth of federally-funded women's sexuality research. Data sharing and inquiry are in part motivated by the desire of users to enrich basic scientific understanding, in a way that circles back to inform the firm on their own product and algorithm design. Lioness' voluntary data from users is both a fertile repository for novel research inquiry, as well as an important long-term pivot for the company—not only empowering their users by supporting this knowledge generation but by filling a literature gap blocking advancements toward a better vibrator with features and algorithms rooted in science.

Kinsa smart thermometers stands out among health sensors connected to phone apps. This firm created an information infrastructure and data surveillance[291] program designed for public health officials, researchers, and policymakers to generate new insights—insights that could in turn feed back into algorithmic development and better serve Kinsa users, as well as the public good. Unlike other Silicon Valley innovation models in Chapter 2 that are usually unidirectional with knowledge flows feeding into the firm, Kinsa represents a firm that has mutually beneficial and porous potential from the data infrastructure built into their smart device and platform.

Basis Science (also known as Basis Labs or by their product name: Basis Peak) was an early entrant to the smart watch wearables in 2010, and stood out on the market because of the quality of the product and the designed portability of the data. Even with a strong internal research and algorithms team, the firm was pushed to pursue external research partnerships in order to leverage external research infrastructure, outsource knowledge sharing publications, and obtain external "truth data" to validate internal algorithms. The strategy of Basis demonstrates how information-intensive firms continue in the model of Saxenian and Chesbrough in outsourcing expertise, but differentiate themselves in that these emerging strategies are lack consistent structure and rely more heavily on researchers than other specialized private firms and services. This reliance on researchers and their infrastructure illustrates the importance of fundamental research inquiry to information-intensive firms.

Interviewees for these companies agreed to have their firm referred to by name, and these cases were developed through the cooperation of employees and updated over time or pieced together using publicly available material. The purpose of these illustrative cases is to provide a more in-depth view of how a firm makes decisions, structures data collection, sharing, and internal inquiry in order to better understand the emerging practices within information-intensive innovation. In addition, these cases provide key insights into the motivations, limitations, barriers to desired activities, and workarounds created by the firms

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[291] "Surveillance" in this case refers to public health surveillance (the systematic collection of data) which is almost always distinct from "surveillance state" discussions.

and their partners.

The phrase "illustrative cases[292]" was selected in order to distinguish them from more formal comparative case study methodology,[293] which involves a detailed analysis of a particular aspect of a historical episode in order to develop (or test) explanations of this event that may then be generalized to other events. These cases are told from the viewpoint of willing participants—and therefore limited by their recall of events and processes—or available materials. Responses are filtered through the desired presentation of contemporary firms and occurred at different times (and many are ongoing). The limitations of participants and bias of companies is addressed fully within the methods section. Unlike government offices or programs, the activities of these companies are not subject to public records requirements or releases of any kind—let alone systematic archiving efforts. Without qualitative interviews and material preserved on the web, many of these cases and programs would never be brought into the academic or public discourse.

Understanding the culture and context of each of these cases—and the motivations underpinning decision making and strategy with regard to data sharing and research uses of user data—illustrates how biosensed user data is changing the relationship of the firm to fundamental research via partnerships and internal inquiry.

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[292] Vignettes, though not a formal and recognized methodology within other disciplines, implies that the details and instances described are brief yet evocative accounts or episodes of events. Vignettes from interviews are utilized where appropriate in following sections, but these illustrative cases are more substantive than fleeting or brief portraits of an encounter and more focused around the motivations, limitations, and decision making of unique firms. Vignettes from this research, and from interviews, are presented conceptually throughout this dissertation, while these illustrative firm cases stand alone.

[293] Alexander L. George and Andrew Bennett. *Case Studies and Theory Development in the Social Sciences*. BCSIA Studies in International Security. (Cambridge, Mass.: MIT Press, 2005), 5.

I feel it coming: Lioness and the desire to share data for underfunded, understudied women's sexuality research

"...Like a Fitbit for your cooch." Gizmodo via the Lioness Website

Data collected from a smart vibrator—specifically, a vibrator to stimulate and measure sexual arousal and climax in women—seemed like an unlikely candidate firm for studying research data sharing activities. However, this firm became the most provocative example of how incentive structures around sharing user-generated data were evolving within the context of information-intensive innovation. These new competitive and innovative forces are placing pressure on firms to seek knowledge from fundamental research and reconsider the risks and costs associated with sharing user-generated data.

Lioness, the data collecting and biosensing vibrator company, exemplifies a firm with unique imperatives to share data, and support external research partnerships to inform their own internal product development. Women's sexuality[294] research, and specifically sexuality research that connects physiological experience—especially experiences validated by data—to sexual satisfaction, is chronically underfunded by governments and grant-making entities. The inequality in funding and attention to women and hormone-specific health research has been a longstanding challenge, which made the even more politically sensitive funding of women's sexuality research an impenetrable issue.[295] Recognizing the gap in available research on women's sexual experiences, Lioness became a surprise guardian of data that would enable entirely new studies examining the link between physiological experiences and satisfaction. Encouraged by their user base, this illustrative case explores the challenges of a small startup to empower their users by supporting data sharing for research purposes. This case illustrates how unique and sensitive data held by

[294] "Women" is intended to include all women-identifying individuals.
[295] This is discussed and cited in detail in the following sections.

the private sector could enable entirely new research streams, and stands defiantly against an industry often dominated by pornographers (who may not always value or place monetary value on women's personal satisfaction) and gender-biased technology. Even without an assured "happy ending" to solving the women's sexuality research gap, this data sharing case illustrates important realignments in incentives and obligations to participate in basic research partnerships and pursuits. Lioness shows how information held by a private sector entity can empower both users and reinvigorate research streams through data access, and walks through the barriers experienced by a small firm taking on managing these research relationships and data sharing initiatives.

Lioness: A pride of women's data and a dearth of global research investment

Lioness was founded in 2013 in Berkeley, California with a stated goal of "destigmatizing women's sexual health through information and conversation"[296] with their smart vibrator product and platform.[297]

One of the founders, Liz Klinger, describes their motivations to start a smart vibrator company on the company website FAQ and blog.

> "A lot has changed since the 1980s, but research on female sexuality hasn't advanced much since then. It's not for a lack of interest—global taboos, personal discomfort, and lack of funding have held us back, and it doesn't look like things are going to get much better on their own.
>
> What happens in research doesn't exist in a bubble. We know that sexual pleasure is more than sex and is an essential part of everyone's lives. However, the lack of information available affects all of us - in our self-confidence, relationships, health, and even our ability to talk about sex and sexuality.
>
> That's why the kind of work that we're doing at Lioness is especially important right now. We've created a platform for self-experimentation to help women learn about their own, unique bodies, and to learn more about female sexuality as a whole. There's so much more to learn and we've barely gotten started."[298]

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[296] "Organization Overview." 2019, 2019, https://www.crunchbase.com/organization/lioness#section-overview.

[297] Data about the company are from the website and Crunchbase Pro (Updated Feb 2019)

[298] "Frequently Asked Questions." 2019, accessed January 2019, https://lioness.io/pages/frequently-asked-questions.

The Lioness Vibrator was outfitted with force sensors (to measure vaginal and pelvic floor muscle contractions), an accelerometer and gyroscope (to measure and track movement in space, similar to a smartphone), and a temperature sensor (to assist in triggering data collection and tracking core body temperature). The device connects to a smartphone app via a Bluetooth connection, only when explicitly synched by the user. The device provides users with a visualization of their session, history of all logged sessions for comparison over time, and uses the app as a diary to reflect on a variety of open factors, feelings, and influences that may have impacted the session. These patterns and sessions over time, with analytics provided by Lioness, help the user to reflect and explore their orgasms.

Exploring orgasms and finding resources for help is not always easy. As CTO James Wang put it, "a lot of women have that experience and they've been rebuffed by medical practitioners, like gynecologists where the older ones will go, 'This isn't my area. You shouldn't talk to me about this. I'm good at helping you deal with infections and babies but that's pretty much it.'"

Women's medical research has lagged for decades and is well documented.[299] The difference arises from several different factors:

1) Many diseases or medical conditions related to female anatomy and hormones like ovarian/endometrial cancer do not receive much research funding. Breast cancer[300] has received more publicity due to its high prevalence and attention from advocacy groups, as well as research foundations like the Susan G. Komen Foundation.[301]

2) There are known gender and hormone biases in many medical studies, because male rodents or hormonally male presenting humans are tested first to decrease confounding variables hormonal cycles.[302]

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[299] See for instance this 2010 report from the National Academies: Committee on Women's Health Research. Women's Health Research: Progress, Pitfalls, and Promise. National Academies Press (2010). https://www.nap.edu/read/12908/chapter/2.

Though this case focuses on the challenges of women and women-identifying individuals, gender non-conforming and fluid individuals experience a profound lack of research support for their health decisions that should and needs to be addressed by the wider research community. Additionally, there is much needed health research support for gender transitioning individuals.

[300] It is important to note and emphasize that breast cancer does occur in men, just at lower rates than women.

[301] "About/Budget/Data/Research Funding." 2019, accessed March 2019, https://www.cancer.gov/about-nci/budget/fact-book/data/research-funding.

"Hematology-Oncology/Gynecologic Cancer." 2019, accessed March 2019, https://www.healio.com/hematology-oncology/gynecologic-cancer/news/online/%7b3a17f7e9-435c-4f11-9e44-211c4a44537d%7d/gynecologic-cancer-research-disproportionally-underfunded.

[302] Within the rodent model, the fact hormone cycles complicate studies is debated, and interestingly often male rodents are thrown out of studies because they fight with each other—an issue exasperated by testosterone.

3) The gender and hormone component of well-studied diseases or injuries such as heart disease, diabetes, and brain injury are not well researched.[303]

4) Gender and hormone-specific side effects to treatment are not well understood.[304]

5) Pregnant[305] women are not included in medical research for obvious ethical

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Prendergast, B. J., K. G. Onishi, and I. Zucker. "Female Mice Liberated for Inclusion in Neuroscience and Biomedical Research." [In eng]. Neurosci Biobehav Rev 40 (Mar 2014): 1-5. https://doi.org/10.1016/j.neubiorev.2014.01.001. https://www.ncbi.nlm.nih.gov/pubmed/24456941.

Bichell, Rae Ellen. "A Fix for Gender-Bias in Animal Research Could Help Humans." NPR - All Things Considered, 2016. https://www.npr.org/sections/health-shots/2016/02/10/464697905/a-fix-for-gender-bias-in-animal-research-could-help-humans.

Male mice cannot be used as proxies for female mice.

Sorge, R. E., J. C. Mapplebeck, S. Rosen, S. Beggs, S. Taves, J. K. Alexander, L. J. Martin, et al. "Different Immune Cells Mediate Mechanical Pain Hypersensitivity in Male and Female Mice." [In eng]. Nat Neurosci 18, no. 8 (Aug 2015): 1081-3. https://doi.org/10.1038/nn.4053. https://www.ncbi.nlm.nih.gov/pubmed/26120961.

Ritz, S. A., D. M. Antle, J. Côté, K. Deroy, N. Fraleigh, K. Messing, L. Parent, et al. "First Steps for Integrating Sex and Gender Considerations into Basic Experimental Biomedical Research." [In eng]. FASEB J 28, no. 1 (Jan 2014): 4-13. https://doi.org/10.1096/fj.13-233395. https://www.ncbi.nlm.nih.gov/pubmed/24056086.

[303] Hamilton, Jon. "Female Athletes Are Closing the Gender Gap When It Comes to Concussions." NPR - Health News, 2017. https://www.npr.org/sections/health-shots/2017/07/24/538294331/female-athletes-are-closing-the-gender-gap-when-it-comes-to-concussions.

Villapol, S., D. J. Loane, and M. P. Burns. "Sexual Dimorphism in the Inflammatory Response to Traumatic Brain Injury." [In eng]. Glia 65, no. 9 (09 2017): 1423-38. https://doi.org/10.1002/glia.23171. https://www.ncbi.nlm.nih.gov/pubmed/28608978.

Rabin, Roni Caryn. "Major Study of Drinking Will Be Shut Down." The New York Times (New York City, NY), 2018. https://www.nytimes.com/2018/06/15/health/alcohol-nih-drinking.html?login=smartlock&auth=login-smartlock.

Homer, Brady. "Studying Female Physiology a Priority in the New Era of Exercise Science." Medium.com, 2018. https://medium.com/@bradyholmer/studying-female-physiology-a-priority-in-the-new-era-of-exercise-science-e01aaf0b8d06.

[304] Rademaker, M. "Do Women Have More Adverse Drug Reactions?" [In eng]. Am J Clin Dermatol 2, no. 6 (2001): 349-51. https://doi.org/10.2165/00128071-200102060-00001. https://www.ncbi.nlm.nih.gov/pubmed/11770389.

Franconi, Flavia, Sandra Brunelleschi, Luca Steardo, and Vincenzo Cuomo. "Gender Differences in Drug Responses." Pharmacological Research 55, no. 2 (2007): 81-95. https://www.sciencedirect.com/science/article/abs/pii/S1043661806002040.

Heinrich, Janet. "Drug Safety: Most Drugs Withdrawn in Recent Years Had Greater Health Risks for Women." United States General Accounting Office (GAO.gov), 2001. https://www.gao.gov/new.items/d01286r.pdf.

[305] Kodjak, Alison. "Research Gaps Leave Doctors Guessing About Treatments for Pregnant Women." NPR Health News (NPR - All Things Considered), 2018. https://www.npr.org/sections/health-shots/2018/12/10/673897043/research-gaps-leave-doctors-guessing-about-treatments-for-pregnant-women.

and safety issues. However, as a result of not collecting any data about prescription drug use during pregnancy, women are often forced to make life changing decisions about whether or not to continue medication for their own well-being and health without the support of any studies or doctor advice.

6) Reproductive studies such as in-vitro fertilization (IVF) have been politicized and de facto banned at various points, for instance during the Reagan Administration. In the 1980s, publicly funded research on IVF was halted because of lack of funding appropriations and because the Ethics Advisory Board, which was required to evaluate and approve or deny all proposed experiments that raised questions about medical ethics, was disbanded.[306] Without the board in place, no proposed research or experiments could be evaluated for over a decade. This policy move, pushed by the anti-abortion lobby, influenced other aspects of women's health research outside of reproductive technology as well, including the role the reproductive system had on female and hormone-driven cancers.[307] As a result, most of the reproductive technology research was carried out by the private sector given the monetary potential of these technologies, but foreshadows themes in this case about the role of the private sector in picking up the slack for federally funded research in the US.

Some of these issues have been addressed through private sector initiatives (e.g., IVF technology which was largely funded by the private sector). Others were addressed through policy directives that targeted the inclusion of women and minorities in medical research studies,[308] in animal studies,[309] as well as new approaches to studying the risks and impacts of drugs during pregnancy and

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Aubrey, Allison. "Xanax or Zoloft for Moms-to-Be: A New Study Assesses Safety." NPR (NPR - Morning Edition), 2017. https://www.npr.org/sections/health-shots/2017/09/18/551020800/xanax-or-zoloft-for-moms-to-be-a-new-study-assesses-safety.

McElhatton, P. R. "The Effects of Benzodiazepine Use During Pregnancy and Lactation." [In eng]. Reprod Toxicol 8, no. 6 (1994 Nov-Dec 1994): 461-75. https://www.ncbi.nlm.nih.gov/pubmed/7881198.

Sachdeva, P., B. G. Patel, and B. K. Patel. "Drug Use in Pregnancy; a Point to Ponder!" [In eng]. Indian J Pharm Sci 71, no. 1 (Jan 2009): 1-7. https://doi.org/10.4103/0250-474X.51941. https://www.ncbi.nlm.nih.gov/pubmed/20177448.

[306] Hilts, Philip J. "Abortion Debate Clouds Research on Fetal Tissue." The New York Times (NYC, NY), 1989. https://www.nytimes.com/1989/10/16/us/abortion-debate-clouds-research-on-fetal-tissue.html.

H.A. Shenkin, *Medical Ethics: Evolution, Rights and the Physician*. Springer, 1991, 320.

[307] Wymelenberg, Suzanne, and Institute of Medicine (U.S.). Science and Babies : Private Decisions, Public Dilemmas. Washington, DC: National Academy Press, 1990.

[308] Health, National Institute of. Nih Policy and Guidelines on the Inclusion of Women and Minorities as Subjects in Clinical Research. US Department of Health & Human Services (2017). https://grants.nih.gov/grants/funding/women_min/guidelines.htm.

[309] Clayton, Janine A., and Francis S. Collins. "Policy: Nih to Balance Sex in Cell and Animal Studies." Nature International Weekly Journal of Science 509, no. 7500 (2014). https://www.nature.com/news/policy-nih-to-balance-sex-in-cell-and-animal-studies-1.15195#/b1.

providing more guidance to patients and healthcare providers.[310]

There are also less measurable and hard to address challenges in women's healthcare, such as studies that show women are less likely to be believed when they report pain to a doctor (particularly women of color). Women also are often not believed when they report symptoms,[311] or are given blanket dismissals such as patronizing as "you are probably just stressed" and not given any tools or resources to investigate further. There are also documented cases within medical contexts such as "the husband stitch"[312] after delivery where women are, most often to the detriment of their own pleasure (even going so far as to cause pain),

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[310] "Pregnancy and Lactation Labeling (Drugs) Final Rule." US Food and Drug Administration, 2014, accessed January, 2019, https://www.fda.gov/drugs/labeling/pregnancy-and-lactation-labeling-drugs-final-rule.

Food and Drug Administration. "Content and Format of Labeling for Human Prescription Drug and Biological Products; Requirements for Pregnancy and Lactation Labeling." Federal Register, 79 FR 72063 (2014). https://www.federalregister.gov/documents/2014/12/04/2014-28241/content-and-format-of-labeling-for-human-prescription-drug-and-biological-products-requirements-for#citation-6-p72075.

Dinatale, Miriam. Presentation: Two Years In: Lessons Learned with the Pregnancy and Lactation Labeling-Rule approaches to Human Data. (2017). https://www.fda.gov/media/111774/download.

[311] Kiesel, Laura, "Women and Pain: Disparities in Experience and Treatment," Harvard Health Publishing ed. Harvard Health Blog, 2017, https://www.health.harvard.edu/blog/women-and-pain-disparities-in-experience-and-treatment-2017100912562.

UPI. "Researcher Says Women Less Likely to Get Painkillers." UPI - United Press International, 1989. https://www.upi.com/Archives/1989/03/11/Researcher-says-women-less-likely-to-get-painkillers/2047605595600/.

Fassler, Joe. "How Doctors Take Women's Pain Less Seriously." The Atlantic, 2015. https://www.theatlantic.com/health/archive/2015/10/emergency-room-wait-times-sexism/410515/.

Nabel, E. G. "Coronary Heart Disease in Women--an Ounce of Prevention." [In eng]. N Engl J Med 343, no. 8 (Aug 2000): 572-4. https://doi.org/10.1056/NEJM200008243430809. https://www.ncbi.nlm.nih.gov/pubmed/10954767.

Fetters, Ashley. "The Doctor Doesn't Listen to Her. But the Media Is Starting To." The Atlantic, 2018. https://www.theatlantic.com/family/archive/2018/08/womens-health-care-gaslighting/567149/.

For instance, famous cases like Gilda Radner who reported symptoms of ovarian cancer for 10 months before she was believed and then it had progressed so far she died a short time later. More recently, Serena Williams revealed her struggle to receive a CT scan and heparin drip to treat blood clots she knew she was at risk for after recognizing symptoms in her own body and knowing her own health history. It should be further underscored that Serena Williams is one of the top athletes in the world, and as a professional athlete knows her body even more than the average person.

Wilder, Gene. "From the People Archives: Gene Wilder's Tearful Goodbye to Wife Gilda Radner." People, 1991/2016. https://people.com/movies/gene-wilders-tearful-goodbye-to-wife-gilda-radner/.

Haskell, Rob. "Serena Williams on Motherhood, Marriage, and Making Her Comeback." Vogue, 2018. https://www.vogue.com/article/serena-williams-vogue-cover-interview-february-2018.

[312] Murphy, Carrie. "The Husband Stitch Isn't Just a Horrifying Childbirth Myth." In Healthline, 2018. https://www.healthline.com/health-news/husband-stitch-is-not-just-myth#1.

sewn up in such a way that is thought to benefit their male partner(s). The horrifying list of bias and inequality in women's medicine that persists even today is a topic that deserves its own dissertation. It should be noted predictably there are critics of these claims, even when there is evidence to the contrary. For instance, a 1994 Atlantic article—written by a male doctor—to respond to calls from then President Clinton to increase breast cancer research, claimed medical gender bias does not exist when most of his citations date back to the 70s and 80s. The article also misses the nuances of gender bias in research and medical contexts as discussed above, and illustrates how at critical times when the system was being reevaluated, voices worked actively to deny their validity, without data.

For the purposes of this case, it is important to simply understand the dramatic extent to which bias infiltrates both care and wellness for women. With all of these challenges to achieve parity within the medical R&D space, advocating for studies understanding women's sexual experiences remain low on the list. Reportedly, nobody has ever died from the lack of an orgasm.[313] Though discovered by accident, drugs to treat erectile dysfunction in men have been massively profitable for the pharmaceutical industry.[314] Yet, the physiological variance and changes over time isn't even documented for the female anatomy. John Bancroft, former director of the Kinsey Institute is quoted in a 2004 paper (shortly after Viagra reported record profits) saying: "The recent history of the study of female sexual dysfunction is a classic example of starting with some preconceived, and non-evidence based diagnostic categorization for women's sexual dysfunctions, based on the male model, and then requiring further research to be based on that structure. Increasingly it is becoming evident that women's sexual problems are not usefully conceptualized in that way."[315]

Part of this disparity could be attributed to the lack of—or inability to collect—such data. Smart vibrators like Lioness open up entirely new opportunities for personal introspection and broader, collective study. Doctors traditionally view sexual dysfunction as a purely anatomical problem that can only be addressed through tools and diagnostics available to modern medicine so far.

Further, collecting intimate data—quite literally, sexually intimate data—is a challenge in most contexts. IRBs within universities may not be equipped to fully weigh the ethics and privacy/security needs of this type of data collection, and

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[313] Kadar, Andrew G. "The Sex-Bias Myth in Medicine." The Atlantic Monthly Digital Edition 274. (1994): 66-70. https://www.theatlantic.com/past/docs/issues/96jun/cancer/kadar.htm.

Editorial note: it is also odd that this is still a top Google hit for generic terms in 2019.

[314] Quartz Staff. "Big Little Blue Pill: After 20 Years, Viagra Has Impacted So Much More Than Just Sex." Quartz, 2018. https://qz.com/quartzy/1238783/its-the-20th-anniversary-of-viagra-heres-how-its-changed-the-world/.

[315] Mayor, S. "Pfizer Will Not Apply for a Licence for Sildenafil for Women." BMJ 328, no. 7439 (Mar 6 2004): 542. https://doi.org/10.1136/bmj.328.7439.542. https://www.ncbi.nlm.nih.gov/pubmed/15001492.

most doctors who conduct medical research are not equipped to do this type of study due to ethical or perception issues. Additionally, women who may fear the authority of a doctor or researcher may avoid participation in such studies. Women's sexuality certainly does not make sense within the context of a federal government laboratory. Studies conducted within these academic contexts also might be a much smaller "n" group than a collective group of users who choose to donate their data in a large pool. Considering the constraints of traditional contexts for research and its underlying data collection, it makes sense that a private company who sells a product designed to collect these intimate data will become the arbiter for the next wave of data-informed sexuality studies.

(Limited) history of research in sexuality

The lack of study around sexuality—and specifically women's sexuality—has been consistent throughout research history. Alfred Kinsey pivoted his career as a biologist (specifically, in entomology) toward a lifelong career studying human sexuality when he discovered the lack of scientific literature on sex after teaching a course at Indiana University (IU) on "Marriage and Family."[316] He then began collecting information from his students about their sexual histories, which eventually caused the IU president to demand he choose between his job at the university and studying sexuality in 1947.[317] He chose the latter, and founded the Institute of Sex Research as a way of creating a separate entity that could be insulated from the politics of government and universities.[318] This need for institutional separation foreshadows the unique role the private sector could play in sexuality data collection and use 70 years later. The institute created a path for other groundbreaking work like Masters and Johnson studies that illuminated new findings about sexual orientation, and the physiology and experience of men and women during orgasm. The institute that was designed to be insulated from political influence, renamed The Kinsey Institute, has been under recent influence to evolve their original mission in sex research into intimacy and wellness research[319]. Part of this shift was due to not only shrinking funding, but explicit political pressure from groups that were set up to directly counter the work of the institute, including the 2014 "Stop the Kinsey Institute." The institute was set up as an independent nonprofit organization so it was mostly insulated from external political pressure, but the institute merged with IU in late 2016 which challenged its previous immunity and forced it into less politically controversial research topics. The reasons behind this merger remain unclear.[320]

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[316] Hallie Lieberman, "Desexing the Kinsey Institute." The New York Review of Books (2018). https://www.nybooks.com/daily/2018/03/20/desexing-the-kinsey-institute/.

[317] Lieberman, "Desexing the Kinsey Institute."

[318] Allen, Judith A. The Kinsey Institute : The First Seventy Years. Bloomington, Indiana: Indiana University Press, 2017.

[319] Lieberman, "Desexing the Kinsey Institute."

[320] Lieberman, "Desexing the Kinsey Institute."

James wrote in an October 2017 blogpost that: “Lioness is dedicated to providing our customers and community with services and insights that are backed up by real science. The problem is, there’s just not a lot of research and data out there. We’ve found that research in the field of female sexuality has been pretty neglected. There are a lot of great researchers out there, but between societal taboos around the topic and scarce funding, it’s been hard to push forward.”

Without public support or even institutional support, research and technology development in sexuality has been left to the pornographers—who often do not prioritize women’s individualized experiences.

Free Love...Data

Lioness, as part of their stated mission, is dedicated toward advancing the data-driven science behind female sexuality and orgasms. In a blog from October 2017 James wrote: “Here at Lioness, we are committed to destigmatizing and demystifying female sexuality. For us, that means fostering conversation, spreading knowledge, and yes, selling vibrators that help you explore your body. But we’re also focusing on one area where you might not expect a vibrator company to contribute: scientific research.”[321]

According to James, this motivation to advance the state of research came both from the need internally to find academic/medical research for product and algorithm design, as well as to improve the overall quality and state of the foundational literature.

> “It's like this observational data is basically doing what was left off by research in the 1980s. That was sort of the heyday in terms of the confluence of lots of federal funding before it sort of sharply dropped off at all sectors basically. Lots of federal funding, but also the technology was at a point where you could more easily collect a lot of this data. It was after Masters and Johnson originally did their stuff, so there was better instrumentation as well and understanding of how to collect data. That was the golden age, but even with that in terms of pelvic floor patterns, if you do a literature review there's definitely the right way of doing it in terms of not having ... because for example, the other ways of doing it, like blood flow and heart rate more or less are derivatives of that. Super noisy. All sorts of things will cause heart rate and blood flow to go up so it's not really a good indicator. This seems to be a great indicator—of what I am aware of—there is an N of like 22, in terms of the overall research literature.”

[321] Lioness, "Orgasm Patterns Using the Lioness Vibrator," Lioness, 2017, https://blog.lioness.io/orgasm-patterns-using-the-lioness-f9b55b7834de.

There is another important dimension that furthered the dedication to this data-driven scientific mission. Early users often voiced their enthusiasm to use these data for knowledge and scientific advancement. James reflected:

> "The attitudes towards this [data sharing] are interesting because there has been so little information around it [orgasms and women's sexuality]. It's been so stigmatized, people are actually quite happy to take away some of that stigma and work with researchers to do that. We actually had people and some of the in person get togethers where it's like, 'Hey come visit our office and come meet us,' actually bring up to us directly. 'Hey your privacy stuff is great and all, can I share more data if I'd like in terms of for research and stuff because I don't care and I'd like to have better research in this area.'"

This push to use their data for a greater good signifies an important role Lioness as a company has taken on, in part, because of the needs and wants of their users—not to mention the company mission.

Finding the love (orgasm data) research connections

A side benefit of a small research community is that researchers reached out to Lioness before the opt-in research program was ever created. However, the shortage of researchers in this area still impacts potential outlets for these data.

> "We've gotten introduced in various channels. I think being part of Berkeley Research community and academia being such a small space, it sort of bounces around. Perhaps less so because the massive bouncing is less in this particular area just because there is so little sex research left in the US in general. UCLA recently closed their well-regarded program. Cornell is on their way to trying to shut off the lights as quickly as possible for their program. Canada is the promised land in terms of sex research and a lot of folks have moved up there."

There is interest both on the research side and on Lioness' side on creating data sharing mechanisms, but even when the incentives align there are challenges with facilitating the data exchanges in a responsible yet effective way.

Data Stewardship and Approaches

Lioness minimizes data collection by design. Demographic data is limited during sign up, and names of users are hashed so that if the database of users was ever somehow compromised, it would be very difficult to even obtain a list of users and their volunteered names. Also in order to limit any potential vulnerabilities to data, Lioness does not have an API because although it would give users access to their own raw data, it would also open up the possibility users could opt in to connecting third parties who could then take all of their data. Even though the monetary value is low, as is the potential to use in other harmful ways such as revenge porn—it's only the data, no photos or audio—the company still is mindful of protecting their users. Lioness is also mindful of potential celebrity clients who would be at an increased risk of exposure.

> "You can't lose what you don't have. Just in terms of it, we basically try to do it by levels where it's like try to minimize the attack surface. It's going to get broken or whatever into. If it is going to get broken into make it as low value as possible for this level if they decide to steal this. Make it as low value as possible for this level if they decide to steal this. We would like no one to actually steal our entire database or anything, but if they do we'd like it to be as useless as possible in terms of identifying the individual user."

However in this unique case, the need to create another option for users to volunteer their data for these greater good purposes—which require more demographic and background data to be useful—emerges. This incentive puts Lioness in the role of advocating both for their user by brokering these data sharing connections, but also guarding these data exchanges to protect user privacy and prevent harm. In this unique case, the need for more underlying research aligns with the company's interests as well. Not only is Lioness interested in empowering their users and sexual experiences, but the firm would like more research to help them improve their product line and algorithms.

Lioness' business model is not primarily oriented around selling data, marketing to individuals, or otherwise profiting off of the experiences of their users. In thinking about future opportunities to use data for observational studies for pharmaceuticals and biotechnology relating to sexual experiences, James reflected: "The goal of it ultimately is to have better safer products faster, and more effective products that go out to market. Also, with a lot of companies, it's usually marketing data, so the end buyer actually wants to know who the hell this is. In terms of the pharmaceuticals and the biotech companies, they really don't care [about identifying individuals]. They would like to know the demographics in order to actually do their studies and all these different things. They want the aggregate data because they couldn't care less who the individuals are because it has no monetary value to them. For marketing companies, obviously the monetary value, regardless of how much they say, "Oh we anonymize it, blah, blah, blah," the value is the individual."

Knowledge Sharing

Lioness regularly posts blogs about their product, shares articles and press around vibrators/orgasms/trends as they relate to Lioness, and includes findings and information backed up from user generated data. This is one way in which the team at Lioness shares the data-backed findings with their users and the general population. The Lioness team, and specifically James, is very clear about the limitations of the internal study findings. Yet the company is able to use the blog medium as a way of disseminating new information to users and general public, thus setting up further discussions, collaborations, and knowledge sharing. Instead of keeping preliminary findings behind closed doors, this approach both acknowledges the limitations of this type of work while openly circulating the state of the art on orgasm science.

James[322] tempers the findings in one blog with: “To be clear, this isn’t itself a scientific paper with a rigorously controlled methodology, sampling, and error bar estimation—but this is preliminary data we’ve found really interesting and will evolve over time.” He later reflected on this statement in an interview.

> “The reason why I made this statement in that particular blog post is because I've worked with researchers, I know what research is or isn't. In terms of this, if we tried to push it as research, well, one it's not. Like not in the formal sense in terms of academic research. Also, we'd probably get, rightly so, flack in terms of that. "Oh you didn't control this study. This is just random observations." Which is what it is because the difference between commercial research and academic research is basically we're trying to figure out what works and tends to be something that's correlated with other things that ... well, what tends to be correlated is fine with us, where if it largely works, in terms of the root cause why? Which is a lot of the aim of science and academic research.”

The emerging theme that the role of academic research on user data is to help generate the “whys” and “hows” was shared across many interviewees, and is discussed in Chapter 6.

For the case of Lioness, James went on to clarify that this pragmatic reality was not driven by a lack of interest or desire for answers to these questions internally, but that digging deeper would require accurate demographic information which conflicts with the privacy stance of the company. “The privacy that we try to give the users in terms of not having perfect demographics and everything, makes it a lot harder to do the controlled research that you would ideally do in an academic setting.”

In terms of the drivers of the research or investigation direction, it often comes from the team or James himself, but occasionally the users through

[322] Lioness, "Orgasm Patterns Using the Lioness Vibrator," Lioness, 2017, https://blog.lioness.io/orgasm-patterns-using-the-lioness-f9b55b7834de.

product feedback surveys or customer feedback. James reflected that it's often the team that comes up with the easier questions, and the users who pose the harder challenges since they are likely topics close to their personal experiences and priorities. For instance, users have asked for an orgasm predictor which is something that would take a much longer time to roll out and test—something the company is working on but knows will take time to properly develop and manage expectations in the highly personal and sensitive world of orgasm experiences.

> "Turns out, you can easily measure these pelvic floor movements with the Lioness Vibrator in the comfort of your own home (no need for bulky lab equipment!). We're actually starting to replicate some of the research, but we're also seeing different things from our data— patterns that appear to fall outside of the boundaries of previous research." (Blog October 2017)

In the case of Lioness, research findings (including informal and small scale research) are openly disseminated on forums, like the blog, to facilitate conversation. The next steps for research investigations are driven by team questions, but also feedback from users who usually ask tougher questions based on their own personal experiences.

Enthusiastic Consent By Design

With the incentives to use private data uniquely aligned with voiced user perspectives on wanting to share data, Lioness took it upon themselves to design a special opt-in mechanism to recruit users for research.

The Lioness Privacy Policy (dated May 1, 2017; accessed November 27, 2017) contains the following statement about research uses of data:

"Aggregate Data (Non-identifying Data): Lioness may share or sell aggregate data that does not identify you, with partners and the public in a variety of ways, such as by providing research or reports about health and sexuality. When we provide this information, we perform appropriate procedures so that the data does not identify you and we contractually prohibit recipients of the data from re-attributing it back to you."

Yet even with this statement which would have allowed sharing, Lioness wanted to have explicit consent to opt into research. By opting in, it also would allow Lioness to collect important demographic and medical information that would make these data more important for researchers. "Our philosophy on it is if you can't stand the scrutiny of daylight it might not be a good thing to do. The benefit for us is that our incentives align with our users pretty well." At the time of the interview, these mechanisms were still under design and consideration.

Prevailing Bias in Tech

There is important context to acknowledge about the challenges of women-centric startups face. Though it is not explicitly tied to information-intensive innovation emerging strategies, it is influencing which firms and players are a part of this budding ecosystem—Lioness is an important outlier in this regard. The research rat lab or doctor's office are not the only places where bias infiltrates science and tech. There are known disparities in funding female founders, and funding tech products for women.[323] Most tangible to this particular case, there are gender biases in sex tech as brought to the spotlight through the experiences of companies at the annual Consumer Electronics Show (CES). At CES in 2019, sex toy company Osé was selected as an honoree in Robotics and Drones but later had the distinction taken away because it was labeled "immoral" and "ineligible."[324] The Gismodo article that helped break the story, aptly titled "CES Will Honor Your Innovation so Long as it Doesn't Fuck," highlights that other women focused tech and platforms have been excluded in past years—including Lioness—despite the fact that sex robots and VR porn have been frequent exhibitors in the past.[325] The difference is, those instances of sex tech were often oriented toward men—like Naughty America's VR/AR Stripper

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[323] Matveeva, Sophia. "Why Tech Products for Women Are Underfunded and Why This Is a Great Opportunity." Forbes, 2018. https://www.forbes.com/sites/sophiamatveeva/2018/08/16/why-tech-products-for-women-are-underfunded-and-why-it-is-a-great-opportunity/#36e19aaa3145.

Volkman, Elliot. "In Startups and Business, Women Receive Less Money [Infographic]." Tech.Co. (2017). https://tech.co/news/startups-women-less-money-infographic-2017-05.

Titlow, John Paul. "These Women Entrepreneurs Created a Fake Male Cofounder to Dodge Startup Sexism." Fast Company, 2017. https://www.fastcompany.com/40456604/these-women-entrepreneurs-created-a-fake-male-cofounder-to-dodge-startup-sexism.

Titlow, John Paul. "Here's Why That Story About a Fake Male Cofounder Went Insanely Viral." Fast Company, 2017. https://www.fastcompany.com/40462125/heres-why-that-story-about-a-fake-male-cofounder-went-insanely-viral.

Segran, Elizabeth. "Here's Why Nobody Wants to Buy Birchbox, Even after Vcs Spent $90m." Fast Company, 2018. https://www.fastcompany.com/40567670/heres-why-nobody-wants-to-buy-birchbox-even-after-vcs-spent-90m.

[324] "CES Will Honor Your Innovation So Long as It Doesn't Fuck." 2019, 2019, https://gizmodo.com/ces-will-honor-your-innovation-so-long-as-it-doesnt-fuc-1831621873?rev=1547076565381.

[325] Dreyfuss, Emily. "Women's Sexuality Is Still Taboo for Tech - at Least at Ces." Wired, 2019. https://www.wired.com/story/ose-vibrator-ces-controversy/.

Safronova, Valeriya. "What's So 'Indecent' About Female Pleasure." The New York Times (NYC, NY), 2019. https://www.nytimes.com/2019/01/18/style/sex-toy-ces.html.

demo that include many female models and only a single male.[326] These challenges make thriving in this industry a certain challenge.

Reflection on the privacy interests at stake

Information and content involving sex and money often rank highly among privacy-sensitive data. The data-driven vibrator evokes immediate responses from others about the privacy risks and security vulnerabilities, but these snap judgements require further probing. For instance, the binary of whether or not someone owns a vibrator may be seen as sensitive to others or sexual partners, and the frequency and timing of use might be sensitive. Beyond these attributes, the biosensing data collected by Lioness is less provocative in a privacy sense. Does an individual woman's unique physiological orgasm experience compared to others matter? Can an individualized temperature and muscle contraction pattern be captured for discriminatory or monetary ransom? These perspectives, values, and risks are—much like orgasms—unique to each person. Data that seems to be the most sensitive may actually be less privacy sensitive than banking or personal communication data. The privacy sensitivities of these data derive more from the ownership binary and use than the underlying biosensed data. This requires a deeper probing of how privacy interests and public good utility should be balanced.

Further, most of our sexual explorations involve some compromise on personal privacy, by design. For something so deeply personal and intimate, there's a paradox in practices that seem counter to how we protect other types of sensitive information and data. Hook ups with strangers are common among singles and non-monogamous individuals. Pornography is also a very large, digitized industry. It is notoriously hard to estimate the size of the porn industry[327]. According to Crunchbase, Pornhub—a popular online pornography site—has over 3 billion monthly visits and ranks as one of the 8th most visited websites on the internet.[328] There are numerous documentaries, personal accounts, and conversations around gender bias in the pornography industry, including the treatment of performers, health and safety, content skewed for the preferences of heterosexual men, and issues with the financing and ownership of the industry that further exasperate gender bias. These are issues that are

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[326] Joho, Jess. "Female Sex Toys Are Immoral, but Vr Porn Is a-Ok at Ces." Mashable (Mashable.com), 2019. https://mashable.com/article/ces-2019-sex-toy-controversy-lora-dicarlo-ose/#TPLa8D7vPmqE.

[327] Pinsker, Joe. "The Hidden Economics of Porn." The Atlantic, 2016. https://www.theatlantic.com/business/archive/2016/04/pornography-industry-economics-tarrant/476580/.

[328] "Organization Overview." 2019, 2019, https://www.crunchbase.com/organization/lioness#section-overview.

difficult to study[329] and it is difficult to estimate which gender consumes more porn. Regardless, this is a massive industry that operates under a fair amount of opacity on the internet.

Both in-person hook ups (e.g., strangers in your home), web interactions with others or "Cam Girls," and accessing online porn all involve privacy compromising activities. These activities are prevalent in modern American society. Yet when I bring up the Lioness case with others, the first reaction I usually received was censure and judgement that this is something that should not include data collection because it was too private and security sensitive.

I had a privacy enlightening conversation with Liz after a talk at Berkeley, where predictably many of the questions centered around how privacy infringing and vulnerable Lioness data could be—despite a technical discussion about the measures taken to protect users and minimize data collection as discussed above. In a slightly exasperated yet seasoned and measured tone, Liz told me she felt privacy was being used almost as a proxy excuse for controlling data that could empower women. Pornography, which is often widely thought to be consumed primarily by men given some of the biases within that industry discussed above (or at least within the mainstream industry—there are certainly notable and important exceptions) is taken largely as normal erotica and a popular aspect of male sexuality in the Internet Age. There are rarely lectures on the dangers of ISPs and website hosts collecting data about users accessing porn. Nor are there public censures and shaming of anyone who accesses pornographic material from the "privacy" of their own computers on the open internet without assurances. Instead there are often industry led pushes to make the industry more data secure by advocating for security certificates that allow for HTTPS connections and even broader internet health advocacy for net-neutrality legislation.[330] The difference here is it's rare to find consensus that nobody should access pornographic erotica online because there are leaks and vulnerabilities in the data flows. And yet a smart vibrator intended to empower women in their own bodies is seen as a superfluous and privacy dangerous activity. When Strava released its aggregate data as heat maps, it uncovered hidden military bases in

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[329] Grudzen, C. R., G. Ryan, W. Margold, J. Torres, and L. Gelberg. "Pathways to Health Risk Exposure in Adult Film Performers." [In eng]. J Urban Health 86, no. 1 (Jan 2009): 67-78. https://doi.org/10.1007/s11524-008-9309-4. https://www.ncbi.nlm.nih.gov/pubmed/18709554.

Klaassen, M. J., and J. Peter. "Gender (in)Equality in Internet Pornography: A Content Analysis of Popular Pornographic Internet Videos." [In eng]. J Sex Res 52, no. 7 (2015): 721-35. https://doi.org/10.1080/00224499.2014.976781. https://www.ncbi.nlm.nih.gov/pubmed/25420868.

[330] Garun, Natt. "Pornhub Now Turns on Encryption by Default." The Verge,, 2017. https://www.theverge.com/2017/3/30/15125048/pornhub-youporn-https-encryption-privacy.

Dale, Brandy. "Pornhub and Youporn Move to Keep Your Taste in Privates Private." Observer, 2017. https://observer.com/2017/03/pornhub-youporn-tls-secure/.

foreign countries and had international security implications. It is doubtful anyone's—even Helen of Troy's—pelvic floor contractions could incite a national security crisis.

In thinking about privacy and security implications of data collection, it is particularly important for scholars to examine their own personal biases and gendered views on internet-empowered and sensor-enabled sexual experience. Any data collection exposes opportunity to uncover risks or expose personal information, but in this smart world of gadgets the choices we choose to make on what we don't measure has implications.

Conclusions

The Lioness illustrative case represents not just a provocative data type, but a provocative portrayal of the role private companies—including startups—can play in the research ecosystem. In this case, data previously unmeasurable and uncollected by traditional research actors is held by the private sector, and the firm in procession of these data needs more fundamental research in order to continue to improve the product services. At the urging of both users and driven by internal need for research in the absence of federal investment in women's sexuality research, Lioness is in a unique position to provide data and guide novel research. Generating basic scientific understanding can inform the firm in their product design, as well as the greater research community. However even when incentives to share and collaborate align, there are many challenges to setting up the research-specific infrastructure to ethically collect and safely share these data.

These intimate sexuality data are uniquely held by the private sector, and challenges persist to accomplish these responsible exchanges without friction even when incentives align. Lioness' voluntary data about users has potential as both a fertile repository for novel research inquiry, as well as illustrating an important long-term pivot for the company that could fill a literature gap in order to design a better and more empowered vibrator using algorithms derived from science.

Hot Takes: Using Kinsa Private Temperature Data to Augment Public Health Information Systems and Fuel Public Interest Feedback Loops

Introduction

Kinsa is a San Francisco based startup that designed a smart thermometer and app service to create a distributed real-time data generating network with public good uses. This information infrastructure was designed to be used by public health officials, researchers, and policymakers to generate new insights—insights that could in turn feed back into algorithmic development and better serve Kinsa users, as well as the public good. This unique business model and innovation strategy—informed by a founder's past experiences working on the ground in a data-poor health policy environment—to work with distributed research stakeholders represents a unique alignment of interests evolving around sharing user-generated biodata. Unlike other Silicon Valley innovation models in Chapter 2 that are usually unidirectional with knowledge flows feeding into the firm, Kinsa represents a firm that has mutually beneficial and porous potential from the data infrastructure built into their smart device and platform. However, associated data sharing agreements and research collaborations are not always easy to broker, and this case illustrates the need for established models that facilitate these partnerships and information flows. This public interest orientation additionally opens up other market opportunities for users as they select between smart products and have the additional selections to choose a platform that contributes aggregate data to the greater public good and research-derived policymaking.

Public Health Information Primer

Public health is the science aimed at protecting and improving the quality of health of individuals and their community.[331] Public health operates at a population level, while focusing on regions (geographical and political) and individual communities in order to target responses or prevention efforts. Public health efforts include a range of actions including:[332] 1) identifying, tracking, and remediating communicable diseases or pathogen outbreaks; 2) researching new prevention methods and treatments; 3) improving access to medical care within communities; and 4) addressing long-term and chronic conditions including social and behavioral actions that create population health risks.

Public health has been around for over a century, and has a long-standing relationship to the collection of social or community data to inform centralized decisions. For instance, in 1854 a large cholera outbreak was spreading through London and there was no centralized and accepted theory for how cholera spread from patient to patient. British Physician John Snow began talking to residents and charting the cases of cholera on a map, which revealed that most of the cases centered around one particular water well. Microbes were too small to be visualized with equipment at the time, so examination of the water was futile.[333] This founding instance of epidemiology research, however, coupled with one of the most canonical examples of data visualization helped to curb the deadly outbreak. The efforts Snow took to gather data from individuals and synthesize the data for study are similar to public health efforts still in effect in contemporary society. For instance, in a large-scale foodbourne illness outbreak, samples from patients are sent to CDC approved labs and bacterial genomes are sampled to track common infectious agents. If the source is unclear epidemiologists are sent to patients to talk about what they ate and find common sources (e.g., contaminated food from a restaurant or bought from a larger national distributor). These information sharing systems are set up so that they trigger automatically when possible, and help identify cases that may be geographically dispersed and asynchronous in timing.

Within the United States, data that are collected and distributed by the Centers for Disease Control and Prevention (CDC) are from a diverse network of public health agencies and private actors, and do not all originate from data

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[331] "What Is Public Health?", 2019, accessed February, 2019, https://www.cdcfoundation.org/what-public-health.

[332] Loosely based on the CDC website's categorization of activities. "About." Centers for Disease Control and Prevention,, 2019, accessed January, 2019, https://www.cdc.gov/about/organization/mission.htm.

Note: The link had already expired by the time archiving took place and it could not be retrieved on the WayBack Machine. It appears it was similar to https://www.cdc.gov/about/organization/cio.htm (April 2019)

[333] Interestingly, this investigation even without microbial proof showed that a local brewery—whose water came from the contaminated well—did not have any infections because the water had been boiled before consumption.

"1854 Broad Street Cholera Outbreak." Wikipedia, 2019, 2019, https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak.

collected by the CDC itself. A variety of data are held by the CDC including disease surveillance data, population health statistics and demographics, behavioral survey data, and merged datasets from diverse sources. These data may be entirely collected by the CDC (e.g., survey data), other federal agencies (e.g., NIH, VA, Centers for Medicare & Medicaid Services), international partners (e.g., WHO, other national health departments), state/local health departments (e.g., mandatory disease reporting or state level data such as morbidity data), non-profits or foundations (e.g., Kaiser Family Foundation), and private entities such as health insurance companies.[334] Each of these broad categories breaks down into practitioners and healthcare providers who are among first reporting entities. This network of private and public institutions is vast and distributed, and most often relies on voluntary reporting that has been fostered over time through trust and mutual partnerships. As much data as possible are made publicly accessible through reports, memos, and open data so that researchers, healthcare providers, pharmaceutical companies, non profits, community organizers, and private citizens can access data that will help inform decisions and generate prevention/remediation efforts that improve public health. An extensive discussion of this sharing ecosystem and how privacy concerns and governance decisions are made is included in the paper “Public Health as a Model for Cybersecurity Information Sharing.”[335]

Big Data Cataclysm: Google Flu Trends

Flu tracking and Silicon Valley have a somewhat complicated recent history. In 2008 and in the foreshadow of the swelling “Swine Flu” epidemic, Google researchers published in Nature a method of detecting influenza outbreaks using Google search queries to find a highly correlated trend to physician visits and reported influenza-like symptoms.[336] Google boasted a 1 day reporting lag,

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[334] See for example data sources for:

“eWorld Appendix." Center for Disease Control and Prevention, 2019, accessed January, 2019, https://wwwn.cdc.gov/eworld/Appendix/SourcesOfData.

"Cancer Prevention and Control." 2019, accessed January, 2019, https://www.cdc.gov/cancer/dcpc/data/other.htm.

"HIV Statistics." Center for Disease Control and Prevention,, 2019, accessed January, 2019, https://www.cdc.gov/hiv/pdf/statistics_Lab_reporting_DCL_final.pdf.

"Datasets CDC Wonder Systems." Center for Disease Control and Prevention, 2019, accessed January, 2019, https://wonder.cdc.gov/datasets.html.

[335] Sedenberg, Elaine M, and Deirdre K Mulligan. Public Health as a Model for Cybersecurity Information Sharing. University of California Berkeley (Berkeley Technology Law Journal: 2015). http://btlj.org/data/articles2015/vol30/30_3/1687-1740%20Sedenberg.pdf.

[336] The paper made a correction to the reference list, so the updated February 2009 is often cited as the reference date.

whereas the CDC took 1-2 weeks in order publish data on regions hit by the flu.[337] The time lag for federal data is caused by the logistics of collecting data from distributed sources, but also because the CDC and most federally-released dataset require an extensive amount of quality assurance and cleaning to make sure data are accurate and representative. This decreased reporting time could improve response and prevention actions by public health officials, and help with allocating resources—particularly in a severe influenza outbreak like the Swine Flu. Big data had delivered on its promise to usurp conventional information sharing mechanisms and offer convenient insights from our perfunctory routines into matters of life an death. However by 2013, Google Flu Trends had missed the peak of flu season by 140% and researchers documented these failures in Science.[338] The takeaway was not to discredit attempts to utilize big data generated by the private sector to supplement or replace traditional models—in fact their calls state the opposite and underscore the responsibility to use these data in the public interest—but rather intended to call out the "big data hubris" that clouds the potential uses of these data. In the case of Google Flu Trends, the methods and data were kept opaque so that policymakers would not have been able to interrogate these data if real high-stakes decisions were being made around it. The algorithm tailor to track these outbreaks was also left vulnerable to overfitting to other terms that seasonally occurred at the same time as outbreaks over time. Google also introduced suggested search features and health based add-ons that helped users find information relevant to their illness, but had an unintended side effect of driving more clicks and searches relating to the flu.[339] Google stopped producing the trends around 2014, including their efforts to track Dengue Fever.[340]

Despite the failures and cautionary "big data" parable, Google Flu Trends represented an important shift in thinking about how public good oriented research—including public health—could leverage real-time data from the private sector to enable new analyses and research. Further, this seeded a larger theme: that data held by the private sector was beginning to offer granularity and insights unmet by the traditional and canonical government data sources and methods. This belief was not cured by the failure of this one instance of execution and data source.

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[337] Ginsberg, J., M. H. Mohebbi, R. S. Patel, L. Brammer, M. S. Smolinski, and L. Brilliant. "Detecting Influenza Epidemics Using Search Engine Query Data." Nature 457, no. 7232 (Feb 19 2009): 1012-4. https://doi.org/10.1038/nature07634. https://www.ncbi.nlm.nih.gov/pubmed/19020500.

[338] Lazer, David, Ryan Kennedy, Gary King, and Alessandro Vespignani. "The Parable of Google Flu: Traps in Big Data Analysis." Science 343, no. 6176 (2014): 1203-05. http://science.sciencemag.org/content/343/6176/1203.full.

[339] Lazer, David, and Ryan Kennedy. "What We Can Learn from the Epic Failure of Google Flu Trends." Wired, 2015. https://www.wired.com/2015/10/can-learn-epic-failure-google-flu-trends/.

[340] "Google Flu Trends Data: Thank You for Stopping By." https://www.google.org/flutrends/about/.

Flu Data

The CDC tracks multiple elements of influenza throughout the flu season, and works with other countries (e.g., Australia in the Southern Hemisphere which indicates the severity and type of influenza to hit during Northern Hemisphere winter) to understand the trends and make decisions. Data on the influenza virus and severity inform the vaccine formulation for each year.[341] The CDC collects data on influenza from many different partners including public health and clinical laboratories located in all states and territories as part of the WHO Collaborating Laboratory system and the National Respiratory and Enteric Virus Surveillance System (NREVSS). These laboratories test for the type and strain of influenza, and share viral specimens with partners and the CDC for testing so that antiviral resistance and the antigenic or genetic characterization can be documented and tracked. The CDC also collects data from over 3,500 healthcare providers on all "influenza-like illness" through the US Outpatient Influenza-like Illness Surveillance Network (ILINet) on age profiles and number of cases seen. These data are also reported automatically when enabled by electronic health records. Further, each state health department reports an estimated level of influenza cases each week and documents it through the State and territorial Epidemiologists Reports which serve as a summary of influenza activity and does not relay the severity of an outbreak. To track more severe illnesses, the CDC collects data from the Influenza Hospitalization Surveillance Network (FluSurv-Net) that reports laboratory confirmed cases (as opposed to NREVSS which reports all cases with flu-like symptoms). This network includes 70 countries, but does not include all states (only ten participate)—it also contains data gaps in cases where testing is not performed or symptoms are attributed to other similar illnesses. Finally, mortality surveillance is conducted through two larger mortality surveillance systems that monitor cause of death in adults and minors and report "Pneumonia and Influenza (P&I)" as a cause of death code.

These systems are distributed and not perfect, but designed to have representation among geographic regions, socio-economic statuses, ages, and levels of healthcare. There is also redundancy and known gaps in the information systems that are meant to be taken together in order to inform public health decisions and preparation for future influenza seasons. These data include information from private healthcare providers, but do not leverage other types of sensors or "big data' surveillance.

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[341] Center for Disease Control and Prevention. Overview of Influenza Surveillance in the United States. (Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD): 2018). https://www.cdc.gov/flu/weekly/overview.htm.

Kinsa

Motivations

Kinsa was founded in 2012 by Inder Singh, who was a former Executive Vice President of the Clinton Foundation's Health Access Initiative (CHAI) which worked with over 70 governments and 22 pharmaceutical companies to decrease the cost of diagnostics and drugs for HIV/AIDS, malaria, and TB.[342] According to one employee, Inder became frustrated by the lack of current data about outbreaks and incidence levels in countries where the disease spread rapidly.

> "He was incredibly frustrated by the lack of quality information and data around where people needed those medicines and even just how to allocate billions of dollars of funding. If you asked one team how many people get malaria every year and you ask another team, we'll get orders of magnitude different answers and that was just crazy."

Believing that modern sensors could provide more frequent and granular data, Inder founded Kinsa as a company that could distribute a product and service while collecting population—or at least community—level data. Kinsa has a stated mission to create "the world's first real-time map of human health."[343] This knowledge and analysis could then be leveraged on an individual level to algorithmic predictions and feedback to users.

Thermometers have been around as a biosensing modality since 1625,[344] but the acceptance of use and normalized body temperature was not made until around 1868. The first electronic thermometer based on a Carboloy thermistor was invented in 1954.[345] Since then, digital thermometers of improving accuracy as well as decreasing size and cost have become a part of at home and professional medical care. Unlike other biosensing companies where the sensor,

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[342] "Inder Singh, Kinsa Founder & Ceo." CrunchBase, 2019, accessed January, 2019, https://www.crunchbase.com/person/inder-singh#section-overview.

[343] "Kinsa Organization Overview." Crunch Base, 2019, accessed January, 2019, https://www.crunchbase.com/organization/kinsa-inc#section-overview.

[344] Pearce, J. M. "A Brief History of the Clinical Thermometer." [In eng]. QJM 95, no. 4 (Apr 2002): 251-2. https://www.ncbi.nlm.nih.gov/pubmed/11937653.

Impressively, Carl Wunderlich published over 1 million readings from 25,000 patients in order to establish the normal temperature range of a healthy person. One can imagine how much easier these data collections could have been in the modern digital world.

[345] "Fast Clinical Thermometer Takes Temperature in Seconds." Popular Mechanics, 1954, 123. https://books.google.com/books?id=sdwDAAAAMBAJ&pg=PA123&dq=1954+Popular+Mechanics+January&hl=en&sa=X&ei=Pv4YT5SlG5PoggekxISEDA&ved=0CDgQ6AEwAg#v=onepage&q&f=true.

or set of sensors, has not been used in orchestration for that particular purpose before (e.g., Lioness) or where algorithmic development and choices on sensor design are still being developed (e.g., Basis), the digital thermometer has an established history. What makes the newest generation of "smart" digital thermometers unique are the platforms to help organize data for tracking or healthcare appointments, as well as the recommendations and personalized suggestions based on other demographic health information (i.e., personalizing responses based on if the individual measured is an infant which follows different guidelines).

Kinsa has a platform that organizes user data and information, and offers recommendations on treatment and when to see a healthcare professional. The device is available for purchase at stores like Target and Walgreens, and connects to a mobile app. There are also enterprise versions of the device—service packages designed to connect communities like workplaces and schools—that have been used to track illness at a smaller scale and offer guidance to promote proper care and limit spread.[346] The enterprise modeling of this smart device is a standout example of an innovative biosensing business model that focuses on not only larger population health trends, but trends within smaller communities.

> "Kinsa was founded and the initial phase of the company was building the first smart thermometer, first FDA cleared smart thermometer, and proving that consumers see value in this device and building out the sensor network to have sufficient scale. And now that we have over one point 5 million users across the United States and three years of history of data that we can validate the end of the value of that aggregated information."

The founders of Kinsa made a deliberate choice to not make the company a nonprofit so that they were not relying on small grants and gifts in order to sustain data operations, all of which can be unreliable and under pressure from political trends over time. The company also wanted to prove that they could collect these real time health data and establish private public health information infrastructure, all while providing a product that consumers wanted to buy. As of June 2018 when this interview was conducted, Kinsa had over 1.5 million users.

Kinsa worked with academics to establish how their data could be used by external entities for study and as a way to obtain external validation:

"As a part of our development process, we knew that for most customers they need to have some sort of external validation that this data is accurate, that is accurately

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[346] It should be noted that this coordination can occur without sharing others' individual health data.

representing their illness, some sort of that real world behavior. So we started reaching out to several academic groups that have done a lot of work in the flu forecasting space, knowing that they would likely be really interested in working with us because no one's ever access to this kind of data before."

The startup reached out to researchers who had done flu surveillance work before to propose the partnership. By providing the clean data, many academic partners felt there was only minimal work left to provide a literature review and run the correlation analysis to see how well the data tracked to flu trends. In one case, a researcher had moved away from that line of influenza tracking research but was able to give the data to a graduate student for their own research. The structuring of the hypothesis and execution of the research was conducted wholly on the academic side. These data would not have been possible to collect and study without the partnership of a private firm like Kinsa—both in its scale, overall feasibility from a university research perspective, and on the return on investment for creating the sensor infrastructure at scale for these fundamental questions. Yet this exchange provided mutual benefit: enabling academic inquiry by supplying fundamental data, and by helping the startup validate their models and approach.[347]

When asking about barriers and friction to these academic partnerships, an employee told me that timelines were the biggest hurdle. Academic timelines predictably run much more slowly than the highly competitive startup space, and there were concerns about properly constructing the data use agreement so that it could not be generally released for non-academic purposes. Additionally, Kinsa confided there were fears that these data could be used to show that these data did not correlate to influenza trends and released publicly before the company had any recourse to examine why or make adjustments. To be clear, this did not happen and the independent review showed there was a correlation between Kinsa data and influenza patterns. However, this illustrates the challenge of companies—particularly small and vulnerable startups—sharing their data with external partners. For instance, it is possible that research could make a mistake with the data and publish a damaging, albeit incorrect, result. Whether or not this error is later fixed still damages the reputation of the young company. Further, identifying a true problem without offering recourse to find a solution would likely sink a young company. Taking a risk and having these academic partnerships led to commercial validation and future research partnerships that have been important to the continued development of the company, but introduces friction by forcing startups to create mechanisms that decrease the chances of these occurrences. Without accepted practices on how to broker these relationships, each company interviewed had to come up with their own way of creating a collaborative review process—Kinsa illustrates this point clearly.

[347] See, for example: https://www.ncbi.nlm.nih.gov/pubmed/29432526

Google Flu Trends, though a vanguard in private sector public health data surveillance, has also clouded the ability of other companies to break through in the wake of the big data failure—despite some key differences to other business models. One team member reflected:

> “Well, I think on the positive side, Google Flu Trends drew a lot of attention to the need for illness surveillance and the fact that it's a pain point for a lot of organizations. So in that sense it was really good at raising awareness. I think it's not just in my time at Kinsa, but my prior world in data analytics, you know, it was just a classic example of, of hubris in many senses. To be fair to Google, they never intended for this to be a product. It was a free tool. It was just the PR hype machine really amped this up to another level. And then they set expectations on the performance of the product that they weren't investing in. Where for us, I think it becomes a strong point of comparison. Like, “hey, you all latched onto Google Flu Trends because there's clearly an unmet need in what you're doing today. Understood that you feel a little burned by that in some capacity. Here's the difference.” Like the raw data itself, the signal to noise ratio for us is extraordinarily high. You know, we're getting a medically accurate signal from an FDA cleared device. They're looking at a proxy of a proxy like, um, to our entire company is focused on building this [public health] surveillance system. This is our mission and our core point of being for Google that was a side project and like 20 percent time. So this is not something that we're just gonna launch it and put a press release out and not invest in anymore. Like this is our sole reason for being. So it's, I think that we haven't ever gotten any serious pushback because people are like, oh, Google Flu Trends didn't work so this won't work. But it is pretty fascinating. The people that are like, yeah, we tried that thing. Tech companies have burned us in the past. We're going to approach with caution.”

Kinsa clearly articulates how Google Flu Trends illustrated a need for fundamental data that did not exist, and that their sensor platform was creating a novel public health surveillance system that would fill a fundamental data need within the community. This sensor network arguably is best suited to be deployed by the private sector, and a public sector deployment of sensors for these data would not only be a prohibitively high investment but probably be contracted and purchased from private sector contractors.

Many startups simply synthesize open data from public health agencies as part of their business model, such as Benetech, to serve communities and healthcare providers, but generating data specifically to contribute to the system created a unique case.

Rethinking a data-rich public health world

It is unlikely that any supplemental data would supplant traditional influenza surveillance systems—particularly because some are built into monitoring other illnesses and causes of death. However, rethinking how private sector, sensor generated data could complement these public health initiatives is provocative and worth policy consideration. Beyond the obvious real-time tracking of reported illness and general geographic region, a platform like Kinsa offers unique opportunities to assess the severity of the illness (something notably lacking in many distributed surveillance reporting mechanisms) and offers real-time health interventions by watching for dangerous symptoms or urging caregivers to seek healthcare (or refrain and save time/money). Kinsa also could benefit from improved public health analyses stemming from a more integrated and robust system. A private firm like Kinsa could not only use its user-level data and proprietary algorithms to make recommendations, but supplement it with trends and data from the improved and integrated public health information system in order to make their product better—creating a public interest feedback loop where their own microdata contributes to a better system overall.

Brokering relationships with health officials is difficult, and understandably large government agencies like the CDC may be wary to work with each individual startup. Kinsa's approach to work with local health officials first is a prudent and logical step, since state and local public health departments feed into the larger system and may be more aware of local needs, as well as more receptive to on the ground data.

Creating programs to collect and experiment with the public/private data partnerships outside of the mainstream data reporting ecosystem should be a priority for public health agencies. The CDC published a Surveillance Strategy Report entitled "How Sharing Data Digitally Benefits Heath" but mostly focuses on digitizing existing sharing infrastructure and including new types of information like digital health records[348]. The report broadly states a desire to build strong relationships with the private sector by leveraging innovation through public-private partnerships, but does not mention the use of user-generated sensor data. However, understanding the fiscal realities of public health agencies and existing lack of resources, simply making tools and

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[348] Center for Disease Control and Prevention. Surveillance Strategy Report - How Sharing Data Digitally Benefits Health. (Atlanta, GA: 2018). https://www.cdc.gov/surveillance/innovation/sharing-data-digitally.html.

Center for Disease Control and Prevention. Public Health Surveillance Preparing for the Future. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (2018). https://www.cdc.gov/surveillance/pdfs/Surveillance-Series-Bookleth.pdf.

recommendations on the types of data and analyses that could be easily picked up by decision makers and public health officials could stretch resources further and encourage these types of novel exchanges. This is particularly important in considering the potential for passive or active biosensor use, since many of the firms that run these devices are not considered (or otherwise involve) traditional health care providers.

The Kinsa case reiterates the need to have boilerplate data sharing agreements available for not only brokering exchanges with researchers or academics, but also larger institutions like public health entities. Creating clear mechanisms that simply accept input, data, analyses and ideas from the private sector at local and national levels is a first step that can later lead to incentives that help bridge the public/private divide and better leverage the strengths of the private sector for public interest technology applications.

Representation across SES, age groups, and regions may be one of the biggest challenges smart-device enabled platforms face. At a price point of $18[349] (compared to $4 for a traditional oral digital thermometer), not everyone can afford the device nor does every individual trust how these devices use their data. Underrepresented populations that have felt the burden and harm of past research (e.g., Tuskegee deterred African American men from seeking healthcare for decades and may avoid blatant data collection.[350] Establishing programs to distribute devices outside of the average smart device purchaser is an important step, as is acknowledging openly where there may be limitations in the data collection and how it might be addressed in the analysis or in future work.[351]

There is a public tradeoff present when the monitoring devices and public health analyses enter the home. Most individuals have no idea their data has been reported in the past to public health agencies—the collection and sharing was invisible. With a tangible device like Kinsa, this collection and exchange may become more clear to the individual. While that might cause some discontent with individuals, it opens an opportunity to educate citizens about these important data systems and offer a direct point of public health intervention—instead of disseminating all information through doctors/healthcare providers,

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[349] This price point was from Amazon in February of 2019, and the price has fallen over time.

[350] Alsan, Marcella, and Marianne Wanamaker. Tuskegee and the Health of Black Men. Stanford University (2016). https://economics.stanford.edu/sites/g/files/sbiybj9386/f/tuskegee_22may2016-1.pdf.

Scharff, D. P., K. J. Mathews, P. Jackson, J. Hoffsuemmer, E. Martin, and D. Edwards. "More Than Tuskegee: Understanding Mistrust About Research Participation." J Health Care Poor Underserved 21, no. 3 (Aug 2010): 879-97. https://doi.org/10.1353/hpu.0.0323. https://www.ncbi.nlm.nih.gov/pubmed/20693733.

[351] There are of course limitations in privately funded infrastructures. In lieu of public data alternatives and without awareness of these limitations, private data may be used to make policy decisions that disproportionately impact those not in the data. See, for example: Crawford, Kate. "The Hidden Biases in Big Data." Harvard Business Review (2013). https://hbr.org/2013/04/the-hidden-biases-in-big-data.

community advocates, or even the popular press.

Lack of understanding

There is a lot of misunderstanding in how information flows from the private sector (or any entity) into databases that inform decision-making public health.[352] For instance, on April 18, 2018 US Representative Ryan Costello told NPR: "Well, for one, when you post on Facebook that you're not feeling well or you may have the flu, oftentimes that's a signal to the CDC that the flu virus is evolving in ways or in geographic areas that we may not be aware of. The issue of artificial intelligence and being able to understand how people are feeling or what is being said and to be able to self-police or self-regulate ourselves is another broad area."[353] This is—according to public information—not yet a real program or practice. There is great potential to incorporate AI into public health decision making, particularly as it relates to incorporating private sector data.[354]

The business model and approach to collecting sensor-based public health data makes for a provocative framework for future companies to design their product around the generation of public good-oriented data. By understanding the incentives to construct a business model that incorporates these public good data sharing initiatives, Kinsa can help illustrate how public good orientations can make a successful company (as opposed to a non-profit model or closed information firm). The barriers encountered by Kinsa to augment existing public health information exchanges also illustrate policy opportunities that help incorporate this type of supplementary information while maintaining and growing existing information systems.

Conclusions

Kinsa was designed to generate a network of real-time health surveillance that could fill a void in current public health information systems, and offer the opportunity to build fundamental research that could feedback into their platform and provide microtrend-based health recommendations to users. Filling in the information gap left by Google Flu trends, Kinsa represents a new model for building a private information infrastructure that can also benefit researchers and public health officials—both of which have insight that can provide basic

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[352] This not exclusively a public health problem, but given the salience of health decisions it is often a common example of fictitious AI and data sharing examples.

[353] King, Noel. "Rep. Costello Hopes House Facebook Hearings Will Dig Deeper." NPR, 2018. https://www.npr.org/2018/04/11/601437148/rep-costello-hopes-house-facebook-hearings-will-dig-deeper.

[354] Canadian Institutes of Health Research. Application of Artificial Intelligence Approaches to Tackle Public Health Challenges - Workshop Report. (Toronto, ON: 2018). http://www.cihr-irsc.gc.ca/e/51018.html.

It should be noted Elaine was a participant at this workshop.

scientific findings to improve the firm's algorithmic development.

This firm illustrates the potential for companies to build and market their data-driven services off of public or social good intents, and use networked biosensed data to generate social externalities that are rooted in research. Kinsa reinforces the importance of external academics in providing validation and research input for small companies who do not have the ability to hire devoted researchers. However, this case and others suggest that larger companies benefit from external and independent researchers to provide validation. This case also points to the challenges faced by small businesses when attempting to work with government entities, and demonstrates the need to have more accessible points of contact and posted mechanisms for data agreements, exchanges, and methods of collaboration. Especially considering public/private partnerships are often touted as a goal by governments—particularly the US government—there needs to be more clear avenues to enable these relationships without placing all of the burden on small startups.

On the Basis of Science: Internal R&D and External Complements

"If an academic institution can somewhat be involved with that early on, in a startup process that's more valuable than any investor investing in a startup. Because I've been in situations where I'm juggling both of trying to collect data and trying to develop the product and it's difficult doing both at the same time."
—Former Basis Engineer

Introduction

Basis Science,[355] commonly referred to simply as "Basis" or by their product name "Basis Peak," was a wrist-based health tracker that provided an online and mobile analysis hub for their health data. The company was founded in 2010 in San Francisco with a wrist-worn biosensor product designed to measure steps, calories burned, sleep quality, and physiological metrics including heart rate. The startup had a long kickoff, and took over a year before they launched their first product. The product was known for its data portability that allowed users autonomy over downloading and analyzing their own data, in addition to using the analysis provided by the firm. This data portability distinguished the device from others on the market, like the products offered by FitBit and Jawbone. The startup was acquired by Intel in 2014,[356] and in August of 2016 the product was recalled after an overheating issue—pulling the device from the market and effectively shutting down the product.[357] When the product was discontinued, the tech columnists mourned the loss with "digital obituaries" like one entitled "RIP Basis Peak: The Best Wearable You've Never Heard Of, too hot to handle in more ways than one."[358]

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[355] According to Crunchbase's records (where the firm is under Basis Science), the legal name was Basis Labs.

[356] "Intel Completes Acquisition of Basis Science Inc." Intel News Release, 2014, 2018, https://newsroom.intel.com/news-releases/intel-completes-acquisition-of-basis-science-inc/#gs.1xzc98.

[357] "Safety Recall Notice for All Basis Peak Watches." Intel, 2016, accessed December, 2018, https://www.intel.com/content/www/us/en/support/articles/000025310/emerging-technologies/wearable-devices.html.

[358] Cooper, Daniel, "Rip Basis Peak: The Best Wearable You've Never Heard Of," Dana Wollman ed. Endgadget, 2016, https://www.engadget.com/2016/08/09/basis-peak-obituary/.

Basis was a biosensing startup with a robust internal research and algorithms team that focused on fundamental research inquiries about measurement and prediction of biorhythms. Yet even with this strong internal team, the firm was pushed to pursue external research partnerships in order to leverage external research infrastructure, outsource knowledge sharing publications, and obtain external "truth data" to validate internal algorithms. The strategy of Basis demonstrates how information-intensive firms continue in the model of Saxenian and Chesbrough (Chapter 2) in outsourcing expertise, but differentiate themselves in that these emerging strategies are lack consistent structure and rely more heavily on researchers than other specialized private firms and services. This reliance on researchers and their infrastructure illustrates the importance of fundamental research inquiry to information-intensive firms. Additionally, Basis provides unique insight into emerging ethical challenges research teams face as their research becomes more personal to users.

This particularly in-depth view was made possible because participants could talk freely about the product, and most importantly, their process creating and improving their algorithms and sensors since it is no longer on the market. As former employees of a dissolved company, it was easier to talk about their experiences and reflect on the process.[359] The startup was acquired because of its success, but illustrates how the culture and market whims of a larger company can stifle the innovative spirit and momentum of a product.

Product Development, Direction, and the R&D Team

Basis was notable in part because of how active their "research" team was throughout the development of the product, and the focus this team had on fundamental research questions. As a result, many technical individuals and sensor experts viewed the Basis product as one of the superior smart watches on the market. This firm exemplifies an advanced strategy pursued as a result of competitive pressure from information-intensive innovation in that the team not only focused their internal research on basic science, but leveraged outside academic partnerships to provide necessary (and missing) research infrastructure. Access to past employees and their reflections made this in-depth analysis possible. Though Basis was exemplary, the strategies employed are not unique to this one firm.

One of the engineers gave a lengthy and informative description of how the "R&D team" evolved over time, which gives a glimpse into how a research-based startup morphs based on the internal location of talent and drive of the company.

[359] It should be noted that even though all interviewees for Basis still worked the field for sensing companies, they did not feel comfortable even anonymously talking about their current experiences.

“When Basis started, there was a science team, which did algorithms and firmware. There was a hardware team, and a software team, and I think a product team. Then, I’m just gonna leave manufacturing and marketing off to the sides, cuz they’re always there, and they’re stable.

Then, we ended up merging. The firmware team went to the hardware team, cuz that made sense. Then, I was on the firmware team. Then firmware team was basically translating algorithms of the algorithms team. Then, we ended up writing our own algorithms that were just as good, if not better, than the algorithms team. Then basically, at some point, the algorithms team dissolved. Then, I went from firmware to becoming algorithms, and led algorithms, some of the people that stuck around from algorithms, as well as some of the firmware people that were doing algorithms, too.

Then, we basically hired a new firmware team. Then algorithms basically, because of that, stayed under hardware, for whatever reason, because a lot of the —so, I say that, but all the while, there was one small research component, with one engineer that was still not on algorithms, but doing algorithm research.

Then, after Intel, my team and that team of two or three merged together. Then I just went back to doing engineering stuff, which was a good consolidation. We were all colluding on stuff anyway, so it was nice to be all under the same roof. Yeah, still stayed under hardware, for whatever reason, which made things —so, that was the—so, in terms of background of people, on that team it was very much EE folks that had done signal stuff, or biomedical people that have done signal stuff, those types of folks.

Then, there was also this business Intel team, which is [under] this huge umbrella of data science. You have, at one end, your very mathematical, machine learning folks that are doing math all day. Then you have your analysts that are trolling, doing word heap maps of user reviews, and just basic statistics, nothing too crazy. That was on the product testing and development side.

In terms of time series data analysis and generating new features, that was definitely on the research side, with strong machine learning folk, and EE [electrical engineering] signals folks. Then, the product testing development stuff was more biz Intel analyst folks, which I think makes sense, cuz I don’t think there’s—I don’t think either group would wanna necessarily switch jobs. I think it worked well. Yeah, it’s weird, cuz now data science involves all of that. Hiring for data science is awful. I won’t even use the term in a job title anymore. It’s like I need a machine learning/signals engineer, or product is looking for a business analyst. It’s totally different thing. Resumes is like oh, I analyze click-through data of marketing, or online ads, and did—that's certain its own niche field."

What was commonly referred to by the interviewees as the "R&D team" was not officially labeled that within the firm. It loosely included titles of firmware, algorithms engineers, data scientists and some researchers. Many individuals changed titles as the company evolved, and everyone I spoke with felt they had at least in part contributed to the R&D of the product. There were several teams (with some overlap) that included a science team, then after that was disbanded the algorithms and development team took over the work. Eventually the team was loosely known for research and development on the whole—illustrating the fluidity of research teams from an organizational perspective.

Engineers reflected that data acquisition was a key goal early on, which quickly led them to external partnerships.

> "So data acquisition was probably one of the key goals early on, in terms of looking at different hardware prototypes, acquiring data from that, processing the data, storing the data, and then developing algorithms around the data. I think that's usually the steps you need in an R&D team from start to finish. The data acquisition process, it's pretty important, and then quality control, and then pre-processing, storing, and then developing algorithms and then implementing them into prototypes, essentially."

Data was collected internally, usually from fellow employees and then friends/family (a popular test category for testing startups). There were also what the engineers referred to as "beta users" early on, and participants that were recruited by the firm using TaskRabbit or Craigslist, though no one could remember the particulars.[360] External recruits were given a consent form, and paid to wear the device in the lab so that the team could get a variety of data to test if the sensor was working.

"So there were a lot of different phases where we would get data. Early on, it was just internal data collection between whoever's on the company team. When we started growing and getting a little more funding, we were able to build partnerships with some institutions and some clinics, where they would give us data, and they would also give us reference data as well from calibrated devices, which we could essentially do anything with. And as we grew, we started building more partnerships, so that internal data collection was still there, still constant, but we also had a parallel stream of a third party source, which was more trusted, going on at the same time as well... Internal data collection was more for our own purposes, where we can test out futuristic devices and future concepts. The external validation source where we team up with institutions and

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[360] It is also possible interviewees felt uncomfortable telling me the details since they knew I study in part research ethics. Usually in the interviews I attempted to signal that this was all in attempt to understand practices, not place blame or judgment.

clinics, was more for where we currently stand and how we compare ourselves to anything else on the market."

Others on the team remember more of the struggles to coordinate the initial data collection, and reflected on how important this step is to making or breaking a startup R&D team

> "Yeah the whole data collection process I think starting from recruiting subjects, developing the protocol and then consistently getting quality data is very difficult for early stage startups because usually an R&D team is small for an early stage startup, so it's like their time spent on collecting data it's essential but it's not the best use of their time on a small R&D team [given other priorities]....and that data collection process can kill or make a startup."

While in some ways this reflects Chesbrough's Open Innovation paradigm where firms need to look outside the firm at different stages for specialized input, but challenges this construct in that specialized data flows are hard to scale and lack institutionalized forms. This pushes the firm to create ad hoc, and more involved research partnerships tailored to fit the exact innovation needs of the firm.

The team also had to grapple with ethical questions stemming from their data collection efforts, especially since in the beginning they were testing on each other and friends or family.

> "There were times where the algorithms would be doing something clearly wrong and narrowed it down to a piece of someone's day and then you were wanting to know what they were doing, but depending on who it was, you can't ask people. And sometimes you don't ... And a lot of times when it was friends and family, you wouldn't exactly know who it was. If it was an employee, like if it was [Name redacted of a close colleague] or someone I'd try to dig into [the anomaly], but it was one of those things that, every now and then, it was an employee and you couldn't go ask them. And I remember one time there was someone who was someone's friend who had a particular pattern and it look like they had some sort of arrhythmia. [We discussed], 'Should we tell this person?' I think it was like an employee's friend or something."

The team had discussed, but they didn't feel qualified to make a diagnosis.

> "It's kind of like you can't ... I feel like there's an ethics thing, I can't try and diagnose someone, but if you just say, 'You might want to check this out.' I don't know how that evolves within that category...We obviously weren't qualified to diagnose people, but at the same time there are things that you can tell are fairly obvious."

These ethical dilemmas demonstrate how sensitive these data and analysis could be at a core level, and how lack of protocol and norms led to ad hoc decision making and internal discussions.

Research Direction

The research team at Basis usually got a lot of discretion on what they wanted to do. Several engineers remarked that they were able to decide what problem or question to work on next, and had the support to start tinkering. The team self described as having "pretty good drive" and they felt they had both the autonomy and motivation to push forward. One engineer remarked that the team all had similar personalities, so they had a lot of self-direction and internal motivation. "We didn't really need to be told to go do something, it was our curiosity taking us to the next technical limitation."

Despite some fuzziness around their title, and the small status of the firm—which meant they were not an R&D team that could be isolated from others and insulated from bureaucracy like a traditional corporate lab—the research team was able to hold some of the coveted R&D traits including autonomy and freedom to tinker. This is remarkable not in that it differs from fundamental elements in Bush's linear model of innovation, or Stokes' quadrant model of motivation, but it is remarkable that this research climate could be found at a lean and scrappy startup developing biosensor algorithms.

However, this culture was not without traditional economic and pragmatic pressures. There were several ideas that did not make it into the final product, due to some of the growing pressures to perform well on the market against smart watch competitors.

> "One idea we were looking at was—this is where I think, for a triathlete wearable, is just really keeping track of how recovered that person's body is, and really being prescriptive in how much training you're gonna do that day. We actually started looking at that stuff, and had some cool preliminary results, but just didn't really fit in with what the company was trying to do, I guess."

One of the engineers remarked on how the most interesting problems to the research team were not always what the users wanted, and thus were not prioritized and able to be released.

> "We were looking at body recovery as a research. We were looking at stress as research. We were looking at swimming as research. Also, on this open-ended, unsupervised activity clustering per user research. None of that, unfortunately, saw the light of day. What did see the light of day was a lot of data export, smart alarm, more product-type stuff, which was—I think one of the most requested features, actually, despite all that data, was just having your watch vibrate you awake. Then, the next one was, I think, data export. Not as glamorous, for the scientists at the company."

The R&D team expressed dissatisfaction because they were held to an arbitrary holiday shopping season market, which was when the startup could expect to make more of a profit. Additionally, the key features that users wanted and were featured in their competitors product determined what the R&D team could prioritize.

> "One reason why swimming never probably saw the light of day is because people were super keen on smart alarm, or smart vibrate awake, or whatever it was called. There was limited product and iOS resources, so they went to building out that feature. Despite the fact that the algorithm was close to done, it didn't really get the support it needed to be productized, essentially. Yeah, you make some algorithm to do something, and you say that it's this accurate, or it's got these classification performance numbers. Then, there's definitely that time to say how are we gonna present this to a user. What is the feature? Detecting swim is one thing. Do we just say this is how many minutes you were swimming? Is it how many laps you did? Is it how many laps you did of each stroke? Is it what was your average number of strokes per length? It's all this. It really creates a rabbit hole—like MVP, I don't know if you've heard of that. It's the name of the game around—Minimum Viable Product. It's always just—so, MVP is always just like yeah, start time, end time, basically, for activities."

As an interesting point, the company would regularly deploy product testing and development, and release user surveys and ask how the update was working. Frequently, users would respond commenting how one feature got worse, while another got better—while none of these features had been altered. This was seen with more rigorous Q&As with the beta test group, who would also randomly rate things that had not been changed as better or worse.

In developing the initial algorithms, the team felt it was very important to be able to follow up with the users who were testing the device. But once the team was acquired by Intel, general privacy protocols—put in place to protect even early beta or inside users—interfered with the ability to conduct work.

> "I would say Basis took users' privacy pretty seriously. Only a few people had keys to the castle, in terms of being able to associate a user account with the user data. There was definitely internal data collection studies, which was less—until Intel acquired us, we didn't anonymize it. Then Intel legal was like you have to anonymize this stuff. It was only vaguely anonymized, because it's like, when something didn't go right in an experiment, we'd always wanna follow up directly with the person that did it, so we'd always—one person had the key. I'd just be like hey, who did this, and then she'd tell me. Yeah, just random—I guess one thing that was definitely, I think—that I told my team to keep hush was just vague how healthy—we had personal assessments around how healthy some people in the office were, based on how they performed in these studies."

Had the team been able to run large studies and have identified data in a controlled setting once acquired by Intel, this anonymization policy likely would not have been a problem.

Reflections on wearable business models

The team separately all shared reservations about the current business model for wearables and the implication it had on internal R&D and longevity of the products.

> "Having been through the whole Basis thing, I think we all have different perspectives on the value proposition of wearables now. Some of us are, I think, more pessimistic than others… I'd say wearables, as a consumer product, I think, when your goal is shipping hardware and market capitalization, you're not necessarily—I don't think there is a large value proposition, because you just buy this thing, you wear it, and then you get bored of it. If you were to go after very specific demographics with smaller market cap, I think there's huge value, especially the triathlete thing, which is you're doing one device. It needs to track running really well, swimming really well, bicycling really well, and have really good heart rate. Then, just check heart rate while sleeping, and build out this whole over-training thing, that someone that is a triathlete can digest, but doesn't need to have so much product or find—a lay user's like I don't care if I shouldn't run that far today. A triathlete cares very much about that. I think that's really where these small niche areas it would be really helpful, I think."

There are issues when hardware is purchased, and there is not a built-in subscription model. This was the case with Basis.

> Interviewee A: "I think that's a huge business model problem for wearables, because I think very strongly that it should be subsidized hardware. It should be subscription-based. Then you can add on features. Because I think that kinda revenue stream would really support the development of those features, whereas I think a lot of these companies are struggling to make money in one month of the year. All focus is on what are we doing to make this holiday season great. It's not necessarily answering that value proposition, the long-term value proposition. It's about answering short-term sales."

> Interviewee B: "The market incentives to create a product that can truly last a long time are not there."

> Interviewee C: "If you ask a company what they wanted to do, in terms of a single product, it's never, 'We want this product to last 10 years.'"

In thinking of the future of wearables, understanding the market incentives that drive the true innovation are important from a business and policy perspective.

Truth Data and a Reverse Information Flow

In much of this dissertation research, the emphasis has been on data flows from the private firm to the researcher to enable new questions. In Basis' case—and some other sensing startups—devices were given to researchers and researchers shared data back as part of the partnership.

During the development of a sensor-based algorithm, there is a need for (as one engineer put it): truth data. Truth data is used to validate and see if the algorithms synthesizing the data collected from the sensor are working, and accurately making readings.

"There were a couple [researchers] that approached us, which we were really surprised, because at the time we were needing data, because we needed a truth validation source, and they had heard about us through our marketing applications essentially, like Facebook possibly. I don't know exactly how they found us, but this was pretty surprising to us that they approached us, and they wanted to run their own studies using our devices so we were able to supply them devices, and we were able to gather all this truth data in return, which helped classify our algorithms' accuracies, and further develop them."

It is interesting and important to note that the firm was approached by potential academic research partners, and not the other way around. So called 'truth data' from partnered researchers was used a number of different ways.

> "So a couple different applications [for the truth data]. The truth data, we would parse it and kind of organize it in a way where a certain percentage of it would be used for training purposes, and we would isolate that. And when I say training, I mean developing algorithms and improving those algorithms. Another set would be isolated for validation purposes, so we wouldn't ever touch that, that would just stand by itself and say, okay, whenever we make these improvements, let's test it on an isolated set. To understand that these improvements are actually real and they're not conflicted in any sort of way. And then the third set would just be a free for all. We can do as we please with it. If we wanted to use it for marketing purposes, we would use it. If we wanted to have interns play with it, or kind of grow on that set of data to improve their own skills, we would let them use it."

Not all of the data from the external research partner was shared, and these splits would be decided upfront. According to one engineer, the split was usually 60/40 or 50/50 so that there was data the firm would need see. This would be a way to confirm the algorithm would not just be tailored to the data provided and not the intended ground truth of the readings.

> "That would be essentially a way for them to confirm that the algorithms are not going to be changed if a white paper was supposed to be written. For example, if we had access to all 100% of that data, we could essentially make our algorithms work perfectly on that data set. And that white paper would essentially be perfect, in terms of results. If we didn't have access to 50% of that data, it's a way for them to say, 'Okay, this is kind of set in stone, and this is what the results were at the time of data collection, and this is what the results are.' It's just a way for us to be blinded by making adjustments that are wrong."

This data arrangement was seen as common in the partnerships Basis formed with various external researchers. It was also common for the startup to depend on external research partners to provide specialized equipment that the internal team otherwise would not have access to, such as a metabolic cart and equipment for a full sleep study. This infrastructure extends as well to other forms of expertise, knowledge sharing, and ethics infrastructure as seen in Chapter 6.

Some partnerships that relied on contracts when the partnership was based on a very specific need or requirements, such as the study of "normal" participants (those without sleep disorders) in a partnership to study sleep using sleep study equipment. The engineers usually did not remember the particulars of the agreement, just that one was in place and why.

> "There were [contracts in place]. Depending on the size of the study, depending on the invasiveness of the study, depending on the type of subjects we would need. All of this would need to get agreed upon. For example, for the sleep studies we were mainly interested in subjects that had normal sleep patterns, and not any issues with sleep. So we had to make sure that that study would confirm that these are normal sleepers. So they had to go through a series of questions and analysis for that subject, before they could enroll them, make sure they're not taking any other drugs, things like that."

Partnerships were fluid with this firm, and matched experiences the engineers had at other similar sensing startups.

> "That [forming agile partnerships] was pretty normal. I mean usually in the cases, for startups, they don't tend to go on and on. It's pretty quick. Once we agree upon it, it's like both parties don't really want to dwell over these little litigations, and they just want to get the study rolling."

Partners needed to be able to move quickly, since the startup was on a rapid live-or-die timeline.

> Interviewee: We would usually push for that to happen, because we're on a time base, we're on a time crunch. Academia is usually not on a time crunch, things go a lot more slower.
>
> Elaine: Oh.... I know that.
>
> Interviewee: So we would have to usually light the fire and keep pushing for that, until they topple over.

Sometimes the partnerships resulted in coauthored papers, usually white papers that could be turned out more quickly. Some findings made it to conferences, but the preferred method of sharing new knowledge was through the use of technical white papers found on the website. The Basis engineers tended to view the data as the sensitive and valuable asset that needed to be protected from public disclosure.

> "When we'd talk about algorithms, it's not like the person hearing about the conversation is really gonna go out to a computer and go do something about it. It's more about the data integrity itself, and if they don't have access to that similar data, it's going to be hard to reproduce those results anyways. So it was more about keeping the data confidential."

Other Facets of External Research Partnerships

There were more salient features of the external partnerships Basis formed during their startup years. Another benefit of the academic partnerships were that the studies were covered under their respective IRBs, and the interviewees from Basis recognized this as a feature of the alliance. This is echoed by other firms and see within Chapter 7.

In another version of loose externalized partnerships, sometimes companies who ordered large sets of the devices provided feedback on its use case to the company. Even if these aren't externalized research partnerships, it was still a case where casual but applied knowledge generated from use cases flowed between the firm and users.

> "Here's another really weird one, is we had a—some company tested our product and thought it was the best sleep tracker that they could get for a reasonable price. It was a South American gold mining company. They wanted to strap it on

> their truck drivers, who would—if they didn't sleep well, would drive trucks' gold off the road in the middle of the night. They reached out and just bought a ton of units, for whatever reason. I don't know where that falls."

In general, Basis viewed external research partners as a mutually beneficial relationship.

> "I know from talking to people recently that they can get a lot of inbound requests for stuff, but usually it was like mutual ... If it was research, it would be mutually beneficial. Whereas that, the one I remember, at least the first one, and I think they did subsequence settings after I left, but the original was very just like forward Basis, it wasn't like a "we're going to partner and we're interested, the universities are interested in this" and I think it was like we contracted them to do it for us kind of deal."

Some of the partnerships were difficult to form, and one team member felt that universities could do a better job of connecting to local startups and helping bridge these academic and private connections.

> "The one thing I really want to see change is the academic relationship between let's say a school for example and a growing company, a startup company…If there was something to help the startup validate their sense of technology or help them grow in terms of data collection I think it could be very beneficial mutually for both if there was an easier way to establish that connection."

A theme that emerged over and over in the Basis interviews was how important the academic partnerships were both for Basis and other companies the scattered team went on to support.

> "Yeah for sure, even taking the data collection aspect of it, if an academic institution can somewhat be involved with that early on, in a startup process that's more valuable than any investor investing in a startup. Because I've been in situations where I'm juggling both of trying to collect data and trying to develop the product and it's difficult doing both at the same time. "

Publishing

> "I'm not sure if Intel Labs published. We didn't really keep track on them. I don't think we published externally because a lot of the—it was all trade secreted algorithm stuff—outside of like—a couple, I'd say, "white papers," cuz they're not white papers, but scientific/marketing. It made sense. It was like here's the protocol we did. Here's how many subjects. This is the—this is the data. These are the activities. It'd just show it. It was also—okay, so we did it in cahoots with another university, but we don't talk how the algorithm works or whatever. Just this is how the data compares to truth, or ECG."

Sharing knowledge through public postings, even unofficial ones, also helps employees because otherwise they often cannot talk about or reference what they did while at the firm. Having a reputation for talented staff, not to mention the advancements themselves, provides some incentives to firms to allow information to be shared externally. This incentive is more powerful in the absence of a strong reputation, like those from a larger firm.

"I think we put them out on blog posts. I don't know where they actually landed, cuz I was actually, unfortunately, gone. Then they validated my algorithm and wrote a paper about it. I fortunately got my hands on them, on those documents, cuz I obviously keep those for resumes and stuff."

One engineer remembered that they used a blog post from another company on how to use heart rate data to detect heart arrhythmias, and that it was specifically just a simple blog post and not a validated published paper. Knowledge did not have to come from formal or traditional sources to be useful, and these networks of "unofficial" knowledge shared on the startups websites was a useful way to exchange findings.

Interesting findings

There were interesting findings on general knowledge on applications and accuracy of wearable sensors that generated more generalizable knowledge.

> "Another fun, interesting tidbit is that the calories algorithm ended up being more accurate, using the heart rate data coming off the—if you were just to take the calories algorithm and send in the heart rate data stream from the Basis watch, versus the heart rate data stream in from the 12 lead ECG, and then compare its outputs to the caloric cart, the Basis path was actually more accurate than the ECG path. I think it's because people were like oh, we need medical FDA-grade certified stuff, but you put 12 leads on people and have them run on a treadmill. You have so much—you have so many noise problems. It's almost like you're just as inaccurate—you're more inaccurate than you were using the Basis watch, which is interesting. I don't think FDA equipment, unless it's a good chest

> strap, isn't necessarily designed around working for exercise, which was something interesting."

On reflecting on an observational study the group ran, one recalled a humorous accidental finding of trying to understand sleep patterns.

> "We had a motion camera, to monitor sleep, to see how many times people moved in the middle of the night. People knew what it was. Obviously, they didn't engage in any activities that would've been compromising. Yeah, actually one funny story. This lady had these cats, and they'd fly across the screen in the middle of the night. We'd be like this is not helpful…."

Learning on the job

The Basis team had interesting reflections on how they continued learning on the job. They mentioned that some of the team would occasionally attend conferences, but the most useful time spent was on MOOCs, which they would take and help each other out with.

> "The one thing we did often do, though, is sometimes we'd all enroll in MOOCs together, and try to get better at stuff. I had taken it, and another guy had taken it. It was really helping us a lot, in our daily work. I actually told a guy that I was managing, take this class. Spend work time doing it. It's fine. You'll be better, as a result. He did. I think it worked out well."

Acquisition

Once Basis was acquired by Intel, the motivation of the team began to fizzle due to new constraints and cultural influences that stymied the momentum of the R&D team.

> "This was right after Intel picked us up, so it was like, what's our road map? We don't really know. We had just launched, so we were dealing with press and feedback and that kinda stuff. Rather than dive headfirst into the new features, people really wanted to try to figure out the splash that happened. What do we need to do now? Mind you, I don't think they ever figured that out, because they still haven't done anything. I still talk to people there. I'm not gonna say anything else."

The motivations of Intel in picking up Basis also seemed unclear, other than an obvious superficial status-quo play to invest in a smart watch.

> "One of the big groups at Intel that was really keen on our device was Intel Labs. They were really interested in having a [smart sensing] watch, but having a phone

> [and other sensors] with all of it's better. Then everything else in your life is even better. They were really keen on trying to figure out how to do this huge multi-modal sensing thing, and what all of it can tell you about people. That was very high on the research. Frankly, I think that's all it really was."

Another engineer mused similar motivations.

> "I think the motivation [to acquire Basis] was to ... Or at least they said they wanted ... I think they ultimately wanted to develop wearable technology or at least capability for it. Intel I think wants to make their processors more than just desktop. That was our understanding. "

Moving the team into the larger environment and muddying the product goals was challenging.

> "Within the team ... the R&D team was still pretty focused on making improvements and developing features, and what not. That wasn't really effected the first year of the acquisition. So we were still on that mode of, "Hey, let's try to make this product better, let's be a little more consistent with developing new features, or whatever we want to do." There came a point after the acquisition where things started getting layered in terms of management and production direction wasn't really coming directly from the R&D team at this point now. It was like, "Hey, someone from up above was saying you guys should do this," or, "Let's wait on figuring on what we want to do before we actually do it." So that started slowing the ship down a little bit, which caused just the sense of and drive of wanting to go out and do something creative or new."

It may not have been the bureaucracy, but rather the lack of direction that led the teams to stall.

> "Well, they didn't want slow R&D down specifically. I think they were more confused about what direction to take the product in, because when they acquired us, we didn't know if we were going to be an everyday consumer, like day to day wearable device, or were we going to be more on like the high end sporting device? Or were we going to be a medical grade for clinics and hospitals and researchers? So we didn't really know that ourselves. They were given the responsibility after the acquisition to figure that out for us, and give us that sense of direction, but it seemed like they weren't really sure on which direction to take either. And not making a decision sometimes is not a good decision."

Some of the team felt stifled by the rules Intel imposed on them, and the lack of intellectual freedom. Others felt the product had run its course.

> "We kind of hit diminishing returns on what we were able to do and change, so before we launched, and even a little bit after, there was a lot of improvements we could make or features we could add and just kind of stopped and we weren't sure another product was in the pipelines."

It is unclear what, if anything, is happening now with the technology developed by Basis, and data collected by the team. The Intel website only contains information on the product recall.

> "I think they're just going to sit on it. I mean they haven't really announced any wearable type product. Last I heard on the Intel Labs Group was they're trying to focus more on artificial intelligence...There could've been for sure. Yeah I mean there's a lot of apps and interest there on the backend data processing side where it's, just you can imagine personalized medicine like for personalized tracking. All the data was available. We have data for over three years of system users which was just sitting there if they decided to do something with that data, or analyze it in AI type ways, there's a lot of things that could've happened."

This point was corroborated by one of the other interviewees. "I think they just forgot about it. Yeah I would've heard something that, they're doing something with that data but I don't think so."

Conclusion

Basis exemplifies an advanced strategy arising from the competitive pressure of information-intensive innovation. Their research and algorithms team focused heavily on basic scientific inquiry, but still needed to leverage outside academic partnerships for research infrastructure, expertise, validation, and knowledge sharing.

There are several other notable takeaways from the Basis illustrative case. The "R&D team" was not officially labeled the R&D team for most of the time, yet identified and functioned through their other capacities as data scientists, algorithms engineers, and firmware engineers as such. The loose formation of this team is indicative of the lab-less innovation structure in open innovation paradigms, yet there was a fair amount of autonomy given to Basis' team that enabled deeper internal inquiry and the pursuit of external partnerships.

The importance of considering the impact of gray literature, in the form of blog posts and white papers, was reinforce several times by most interviewees. Not only was this a way Basis picked up on what other firms were doing and advancing the underlying science, but it was a way for their team to demonstrate the viability of their own product. External research partners helped produce some of these publications, and also lent some credibility to the work. These publications were later used once employees left after the acquisition.

There are also lessons in how an acquisition can interfere with the innovative cohesion of a team, and stifle the key new elements of open innovation that require customized partnerships and internal freedom. It is also important to consider the reflections on the wearable industry as whole, and how challenging it is to move beyond market pressures to produce only the minimum viable product and need to establish subscription based services so that these improvements can continue over time.

> "Yeah, and internally obviously we had a bias on how great the product was, but we ran a lot of studies on competing devices. And it's like the numbers don't lie at that point, so we were really pleased with where we all kind of left it, but certain things happen after acquisitions that are out of our hands so."

As an interesting final note, just because a product has been discontinued does not mean it stopped its user base. Because of the way the product was designed, allowing users to download and synthesize their own data, it is still possible to use the recalled device.

> "I had a lot of friends that had to send it back, too. Yeah, some people have still got them. I see them out on the street. People just deal with it not sending data to the cloud. I'm like oh, that's cool."

Chapter 6

Emerging practices, changing definitions, and new collaboration strategies for information-intensive innovation

The illustrative cases provide in-depth examples of how information-intensive firms are pursuing partnerships and internal inquiry in a way that is increasingly focused on fundamental research. These strategies arise from competitive pressure keep up with the demands of data science-derived inquiry and algorithm development, resulting in new strategies and formations of research—both through internal pursuits, external academic partnerships, and new forms of collaborative data sharing instances. These cases and strategies provide evidence of the changing position of private firms in the R&D ecosystem.

This chapter builds upon key elements and findings from the illustrative cases within the context of other interviews and firms. This chapter presents additional analysis on important shifts and emerging trends in how private firms are working within data-rich and information-driven innovation. These findings help support the argument that the role of firms within the research ecosystem is fundamentally shifting as private companies both hold data valuable for researchers, and basic inquiry in turn is driving commercial innovation.

This chapter first explores the changing boundaries and evolving definitions of research through the explanations and mental models of interviewees. In contrast to definitions that were dependent upon assumptions within the linear model of innovation presented in Chapter 2 and within the “Key Concepts” section, this section highlights how the porous nature of research activity influences what is viewed as “official” research and what is viewed less concretely. It further adds color to challenges practitioners have in categorizing their own work, especially in their understanding of how their inquiry and work within UX research blends experience, methods, and motivation. Further, this section highlights the important nuance approaches that separates firms which dive deep into fundamental questions that probe the "why's" of phenomena, rather than only seeking correlations that achieve limited ends.

Next this chapter explicates changes to knowledge sharing processes, and how they are evolving to fit the changing research ecosystem and needs of private firms, with increasing reliance on outside academics. As the private firm becomes more interested in fundamental and basic research questions, there are new challenges with allocating resources or embracing mechanisms that allow the freer flow of research findings—as well as publication challenges working with outside researchers. Knowledge sharing is heavily influenced by larger external forces shaping how firms seek competitive advantage in the age of information-intensive innovation, and where firms place perceived risks.

Complicating factors to these new research and innovation strategies are explored in the following Section III on research ethics, specifically focusing on the role individuals and organizations play in instituting discussions around privacy and ethics—as well as the growing reliance on external research partners to provide research ethics review infrastructure via Institutional Review Board (IRB) access. Finally, this chapter presents new practices of secrecy that are counteracting open and innovative models that require external collaborators and input, which is complicating tech firm cultures from the Silicon Valley models of innovation. These emerging practices and policies are in tension with other strategies and values, and likely to cause challenges moving forward.

This chapter, alongside Chapter 5, present findings that support the claim the private firm's role within the larger research ecosystem is changing, and challenging the existing models and theories of research and innovation. This analysis offers findings about how firms are adapting to these new pressures through external collaborations and pushing internal definitional boundaries, and how emerging practices to grapple with ethics and secrecy are complicating these practices.

Section I: Changing Boundaries and Evolving Definitions: exploring the boundaries between UX and R&D

As illustrated in the key concepts in Chapter 2, the definitions around research have always been fuzzy. These definitions were built primarily around definitions that embed assumptions about the linear model of innovation, and have challenges when taken out of traditional laboratory contexts or applied to contemporary information-intensive inquiry. Some research inquiry carried out on fundamental and basic research about the social, behavioral, health, and public health aspects of individuals and society are obvious—others challenge traditional notions of what constitutes a research activity. This section explores the definitions offered by interviewees on what constituted research activities within their practices and firms, and the ways in which these offered definitions align and contrast to traditional definitions. This section also considers important nuances to research and information-intensive innovation within the private firm. These nuances are partially weighed by grappling with the surface studies of mere correlation compared to deeper inquiry that aims to understand the fundamentals and "underlying why" in contemporary practice. These challenges and explorations on the boundaries of research illustrate the pressures on traditional linear-derived definitions that constrain activities to particular contexts or assume limitations in motivation depending on the researcher.

There is rarely consensus in public statements or documentation or among practitioners on exactly which practices constitute R&D, or how their organizations define and structure these activities. Interviewees were asked about their experiences and mental models about this boundary of research and practice, including the distinction between UX (user experience) research and research that contributes to general knowledge.[361] Many interviewees understood that many of the practices within their firms or daily jobs involved gray areas: making inferences about users, writing algorithms based on user-generated data, designing new interfaces or hardware with user feedback, or conducting A/B style testing in real time. For the private sector, the distinction between product development and research—or more generally R&D—remains blurry. As this

[361] "Generalizable Knowledge" is a term frequently used in policy to determine what counts as research. For example, if your findings are only interesting and applicable to your team or supervisor, then it would not be considered generalizable knowledge. However, if your research, say in UX, uncovers something about human biorhythms, the findings may be important for experts (or research) in that field, not to mention the general population. This blurry line is further discussed in this section.

section will put into context, this distinction has always been vague and contested, yet understanding the contested points and boundary space can help frame what is included (or not) from additional discussions in this dissertation and beyond.

Contemporary Boundaries of Research

The boundaries of research, particularly as it is practiced within the tech industry, are placing new pressures on existing definitions of what counts as research. The introduction of user experience (UX) researchers and data scientists present new questions into professional categories and classifications of industry inquiries and knowledge acquisition. Additionally, increasing numbers of PhDs are being hired by industry for their research skills and subject matter expertise, but for research ambiguous positions.

The Basis illustrative case (Chapter 5) introduced a discussion on the differences between what the interviewees described as “business analytics” in contrast to the descriptions of the role of the research team within a sensing startup. Other interviewees frequently categorized academic style research, design (including UX, as well as some parts of product design), and business analytics articulated as three different areas of “research”—each with their own varying levels of rigor, relevance, and generalizability. Continuing to build off of the traditional definitions of R&D above, often practitioners interviewed used place (e.g., context of a lab or formal R&D team), the motivation of inquiry (e.g., to develop generalizable knowledge), and metrics used to evaluate success (e.g., peer reviewed publications) as elements of a definition. Often in practice, however, these constructs were messy and operated in boundary challenging ways.

Interviewees often used methodology, scientific rigor, and the qualifications of those on the team as qualities and elements to reflect on differences in research outputs within the firm.

> “I don’t think there’s anything flagrantly wrong with the other groups and their research, but we have a very academic approach from how we do things and think it through. [We do this by] making sure the study design is as objective as possible, [considering] where the participants are at, and what they are representative of and so on. It’s just not the same kind of rigor because other groups tend to be scrappier on ‘let’s get data and just move with it,’ and at the end of the day they are just a product group….”

In grappling specifically with UX research, there were mixed reflections. For instance, some interviewees stated that it mattered what the UX team found, and how actionable the findings were outside of the team. This implies that it is possible for a UX researcher, who does not traditionally produce generalizable knowledge, to begin depending on the subject matter at hand—meaning UX research cannot be wholly cast as non-research but rather operates at the boundaries. One of the missions of UX teams is to find where users get stuck in using the platform or device, and improving the usability and experience of the user. If that friction was caused by a deeper underlying behavior or need within the app, there was sometimes crossover in teams to handoff developing and understanding these capabilities. One engineer from Basis reflected on this handoff:

> "Studies about user experience. That's, I think, probably…probably more on the business intelligence side. They would see where things are going well, where things are going not so well. Then, if that information was actionable, by the algorithms team, then we would start researching ideas on how to improve it."

This perspective introduces UX as an important gateway to other research (either by the same individuals or a different team) and almost like an exploratory or feasibility study to prepare for more formal inquiry. Many other interviewees talked about the motivation for conducting the user experience. If the study was narrowly focused and very applied to fixing one particular functional problem, practitioners classified UX as less of a traditional research activity. This directly relates to the traditional definitions, where the formal research activities depends on the goal and generalizability of the findings.

> Interviewee A: "It feels like UX research tends to be a little bit more short lived and singularly focused, whereas research with a big R is a bit more longitudinal. It's sort of, yeah, I would say it's longer lived and it's more rigorous in way, and reproducible."

> Interviewee B: "UX research is more connected to, there's a business opportunity and we're building a thing. And that can start at any point, right? From really early research about the [customers], but it's product oriented, or output oriented, whatever that output is, and big R research is being much, much more exploratory and the output is the discovery itself.

Other interviewees added nuance, that exploratory UX work could lead to more fundamental investigations, that potentially opened up larger questions.

> "I would tend to lose sight of this because my training is in people, and sociology and such, but like, there is also the test of like, can we build this thing at all? Can the technology be made to do the thing we're trying to do? Which is maybe a third kind of, half uppercase R. Whatever you want to call that."

This interviewee was reflecting on how sometimes the UX teams within their firm led to some broader underlying questions about human behavior and technological limits, which they found to fall between the two classifications of research and non-research.

Many practitioners interviewed also thought research, in its most pure sense, was not for any applied knowledge—thus framing only within the definition of traditional "basic research" classifications, even in technology fields that were from the onset of contemporary research heavily focused on applied uses. This framing focuses only on the goal of the activity.

"[Formal research is] without like, a goal of how you would actually apply that knowledge, it's more ...it's more for the discovery and the knowledge."

Similarly, another interviewee underscored the importance academic style outputs—thus further reinforcing the definition linkage to the goal. One interviewee who had worked within UX at a formal lab commented: "It's for the knowledge and the output. I mean, the measurement of how successful people were in that role was how many papers you're publishing. So, it really was like you're a professor essentially."

Location and designation within the company mattered to respondents, thus relying on institutional designations and professional contexts to define the underlying activity. For instance, Interviewee A referenced above made an immediate disclaimer after their statement about UX research being more short lived and singularly focused: "Unless of course like you're a UX researcher in a research lab, like at Microsoft or Intel or something." This respondent overrode their previous caveat by placing the institutional context as the most important designation in determining what constituted a "formal" research activity.

This perspective was echoed by other interviewees. In these cases, the location (or institutional context) under these formalized institutions trumped, for many practitioners, any other discussion of research motivation, applicability of findings, methodological rigor, etc. If the UX activity was done at these formalized research places, then it must be research.

Definitions reflected by the practitioners included the ways in which data collected about users were used, not just the type of data. For instance, one engineer provided the following classification in reflecting how his own team sectioned data for algorithms and research and how it was used by others like those on the UX team within the startup.

> "Well, I guess there's maybe three buckets. There's the sensors, which we're passively monitoring. Then, the data that we use—the derivative data, like were you sleeping and what's your heart rate. That's the sensor data. The user inputs might be self-login. Some apps, you can add activities. Then, there's, I'd say, user or almost usage data, which is where are people spending time in the app, what buttons are they pressing, where are they getting hung up. That latter one is definitely, for me, [related to] product testing, because that's a lot of how the product designers really critique their designs. They wanna see where people are

> getting hung up, what's confusing, where people are spending time in the app. Then, that drives product iteration."

Not every practitioner I spoke with reflected the canonical arguments that "basic" research was a "pure" line of inquiry. One UX researcher, in thinking aloud about the differences and boundaries between UX and traditional research pushed back on the idea that industry UX was always biased because it was oriented toward a product or articulated goal. This researcher pointed out in her reflection that both industry UX and university research—despite the protestations of academics—are both money (i.e., grant or profit) oriented, and that both are aimed at finding something that worked.

> "That also like reminds me things that kind of happen in the sciences a lot where you are looking for a gap because it presents a grant opportunity, and so everything is still, in its own way, motivated by money. So even for like the UX research, there's a clear business opportunity and it's got to be stated up front like, 'Okay, we want people to shop more so we're going to do this research.' Whereas even the academic research guy has a cloud that may not be right on top of you, but it's in the near horizon... Science is supposed to be tangible and it's supposed to produce direct output , then there's kind of this, this need to [make it] work because this will get us funding, or this will get us an invention or something. So that's kind of like, that's always been like a weird issue to me, research."

Many industry UX interviewees, or interviewees who worked with UX teams, reflected that the culture of the firm directly influenced the style of approach, and thus the resemblance of UX to more traditional research. This often had to do with the way activities were labeled, or expressed goals of the activities either in the formation of questions or the framing of outputs.

"It's not necessarily a number of studies, even though like, different leadership has different interest and investment in promoting a culture of testing, and learning, and iterating."

Many interviewees also felt frustration that since they worked between the boundaries of pure research and simple product testing, that they were frustrated they did not have more clear ways to evaluate success on their jobs clearly for the management.

There may not be a clear line between UX and formalized research, but characteristics here including professional organizational context, goal of inquiry, flexibility to iterate and use rigorous methods all define the boundary space between these two concepts. A formal line is not necessary to begin to consider where UX activities may bleed into research, and should be considered part of knowledge production within firms.

Correlations and Asking "Why?"

Several interviewees reflected more generally on a key difference between academic research and similar activities within industry. One of the key components reflected was the drive industry practitioners had to achieve a result (e.g., click the button), identify a pattern (e.g., blue pill achieves more purchases than red pill), or optimize prediction without understanding the underlying and deeper questions of "why." The "why" sometimes corresponds to deeper human behaviors or underlying causes in why reaction was occurring. In industry, particularly in fields and jobs generally related to data science, the emphasis was on prediction and performance, not deeper understanding. The questions these data scientists were trying to answer stopped at achieving a practical result.

> "I feel like I'm really old school, like I'm just like the old school academic there. But I do know that, like I was saying, at Intel Labs there are like, and probably at IBM too, there's like groups of people who they bring them in who are really trained scientists who are adding a lot of rigor to how they are thinking about the future of technology and the relevance of where it fits. The folks that I worked with at Intel would be great to talk to about that because they're doing really interesting research that's applicable about kind of probing into the whys to understand the cultural context for technology because if they're gonna make a new thing they need to know really what people want this and where it's going to fit, and they're doing real research. But what I've seen in kind of this more smaller scale setting is very parochial kind of just focused on optimization or something. Like, making a repetitive task faster or automated or improving the performance of an ad campaign and all that kind of stuff. But not really invested in knowledge advancement or theory testing or solving long standing conundrums of the human condition or something like that."

This interviewee also commented: "There's no thinking, there's no understanding and just getting to your point about it. The research that goes into machine learning is generally focused on prediction and performance not an understanding. So, there isn't that kind of that mindset of inquiry about, like, why is this model doing that? Why is it predicting that? And is it something we want to be doing?"

Understanding the deeper and sometimes more philosophical "whys" is not without some drawbacks, as the interviewee noted.

> "Yeah, and it's funny now because I've been [working in industry] and now, when I come here and go to a seminar, I'm just like, 'Oh my God. You guys are so in the weeds.' It just feels so esoteric and so like, 'What are you doing?' In some of the ecology seminars I'm like, "Why are you doing that?" You know, like, where is the ... And it's kind of cool but because it seems like there's a lot where you can

> tell that it's science for a career so I just need to find this little niche and publish the least, you know. Like, just get as many papers as I can out and I don't care how kind of weirdly just sort of narrow it is."[362]

An engineer, when talking about how they use data on their own research team within a startup, expressed the same difference between straight forward analysis and deeper inferences.

> "Inferring user behavior habits, that one's like—for me, it's both, very much so, in that, if we know—for example, you're like I wanna go out and detect slang, or walking, that's something that we know is doable. You just go out, get the data, and develop it. If it's more of this higher-level—or, I guess, more abstract, like how are people spending their times, we don't know necessarily what they're doing, but let's do something on—let's do something with activity that no one's really done before, but maybe it doesn't work out. That would be very much on the research side, if that makes sense."

Interestingly, James Wang of Lioness had previous experience working at a hedge fund, where the whys underlying market correlations mattered a lot, and was emphasized by the firm. He reflected during his interview on the need to understand the deeper root causes of identified correlations, and the ways in which Lioness requires more correlation than a marketing company, but still less demand on resolution on the underlying causes.

> "Which is interesting, and this is now going a little farther afield. I think it's an interesting comparison. For example, at Bridgewater, the hedge fund that I worked at before, we were very concerned about root causes. The reason is because if you didn't actually find the correct root cause, guess what? You might actually have this signal. You might have this thing that you expected would work suddenly snap back in your face and oh it didn't work at all because something, the correlation we thought was true will become false in a different market environment or something.
>
> This is far closer to what we do, just because of the nature of the consumers that we're with, or looks far closer to what a lot of marketing companies have in terms of their attitude towards their marketing research. They're still pretty rigorous in terms of it. They still try to do as much as they can to try to figure out why's, but they're fine with correlational views. For the most part, in terms of consumer environments, it works. The problem with trying to do that in markets is they

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[362] This interviewee quickly went on to assure me this particular study was not one of those useless ones in the weeds. "And not to ... I think what you're doing is really interesting and very important and it's, like, really timely."

mutate on you far more.

> In terms of consumer behavior and whatnot, there's far more consistency, especially in the aggregate and in our particular case when we're trying to give insights that are similar in the sense of consumer consistency or user consistency, correlational tends to work fine and doesn't suddenly change or have super bad consequences generally speaking. There are some, where there are areas where there might actually be super bad consequences, at least psychologically if you say the wrong thing. We've been actually pretty careful with some of those areas."

In the case of Lioness, (See full case in Chapter 5) as long as the correlation appeared to work for the user they did not feel a need to hold back on a release until it was fully validated.

> "That's a big difference, and for us we're okay with it seems to work. Most users seem to say, "Hey this thing does correctly or accurately reflect my experience and that's a really interesting insight that you're giving me." We're totally fine with that and if it turns out that root cause-wise it's different, it was correlation or whatever it was, we are largely fine with that. That's more the job in terms of academic researchers, which we are actually talking about working with and some folks we are working with to get to. Different roles, for us, it's like correlation is fine because if it works we're running with it and we're launching it. We're not going to wait until it's completely validated."

However, this choice to release the correlations within the product's analysis features was something James and his team had carefully evaluated—knowing what they were giving up and gaining for users experiences. This is not to say Lioness in this particular case did not care about underlying causes, which is why there was an emphasis to work with academics and propel basic research in women's sexuality as discussed in the illustrative case.

In discussing these underlying motivations, the emphasis in the definitions of research as activities that contribute to generalizable knowledge and advancing scientific/technological fields is reemphasized within these industry applications. Understanding the "whys" and deeper meaning of correlations is not impossible within industry, but varies by firm and even by team. Even when the explicit goal of the inquiry was not to uncover the why, in order to build successful behavioral models moving into the future it is possible that data science and UX teams will begin to stumble upon deeper meaning by the developing demands of the industry—even when this intent was not expressed in the beginning. This tension in explicit (and implicit) motivation suggests a key strategic nuance between firms that cannot be sussed out on the surface of methods and mode of inquiry, but rather only understood through deeper consideration of the practitioners and organizational structure. Further study is required to understand the implications these internal commitments to underlying "why's" have in the success for firms seeking competitive advantage in information-intensive innovation inquiries.

Conclusion

Definitions, as much as they can present "false dichotomies," are important constructs and institutional framings that have important implications on how actions are pursued, shared, and reviewed by the internal teams and outsiders. This section explores how interviewees viewed the line between research and practice, particularly in areas like UX research where pressures and potential within the industry are further blurring previous boundaries. Interviewees reflected that the goal of the research (in the form of the inquiry and by proxy the output goal of the activity) and organizational labels lend credibility and categorization to a research-like activity. Further, this section discussed additional differences within the industry context of distinctions in practice seeking only correlation when this leads (or does not) to deeper probing on the underlying "why."

Ultimately, these challenges and explorations on the boundaries of research illustrate the pressures on traditional linear-derived definitions that constrain activities to particular contexts or assume limitations in motivation depending on the researcher. (See Chapter 2) This section did not intend to clearly determine the boundary between research and practice, but rather clearly establish known definitions and how interviewees viewed their work within industry at different places within the boundary space. These reflections are merely meant to illustrate how subjective some determinations of what constitutes research—and thus should be shared, ethically reviewed, or made more rigorous—and how these boundary spaces are under some flux because of changes within the industry and insight potential of data collected.

Section II: Knowledge Sharing: Private Firm Reliance on Academic Partners and New Informal Publishing Methods to Externalize Knowledge

Publications, patents, and other forms of knowledge transfer and sharing within private sector research are often misunderstood historically. Though publications and other mechanisms for exporting research knowledge out of the firm for the public benefit was possible, it was not always as seamless as it appears in retrospection. There are lessons from how knowledge stemming from internal research (and external partnerships) is transferred out of the firm and into the public sphere, as well as new complications to consider moving forward. As the private firm becomes more interested in fundamental and basic research questions, there are new challenges with allocating resources or embracing mechanisms that allow the freer flow of research findings—as well as publication challenges working with outside researchers. This section explores how these knowledge sharing practices are evolving to fit the changing research strategies, and the increasing reliance on outside academics to assist in knowledge transfer from the private firm.

Historical Perceptions and Transformation

Bell Labs is often cited as the golden standard for private sector research. Yet many internal policies are misrepresented in the contemporary and constructed history recounting the place and practices. For instances, many state there were no publication reviews for researchers employed. This is inaccurate. Bell Labs had deep ties to national security partnerships, and often worked with entities that had tight control and review over research, determining what was made classified or approved for release. For instance. Claude Shannon wrote a 114 page paper on "A Mathematical Theory of Cryptography" in 1945 which introduces the concept of the Theory of Information for the first time.[363] The paper was immediately classified and thus kept out of public discourse for 12 years because it revealed too much about cryptographic practices.[364] Later as Bell Labs

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[363] Gertner, Jon. *The Idea Factory : Bell Labs and the Great Age of American Innovation.* (New York: Penguin Press, 2012), 124.

https://www.iacr.org/museum/shannon/shannon45.pdf

[364] An important detail relevant to current practices is that Shannon was allowed to write the paper, and even though the information was controlled for a set period of time the paper and ideas within were documented so that they could later be released and studied by the academic community. If the control

distanced itself from national security work, there were still procedures put in place.

Even outside of national security controls there were publication review processes at Bell Labs. The lab had a Book Review Board which reviewed all books that were set to be released under Bell's affiliation. The review board used internal reviewers to ensure that the book was worthy of the Bell brand, and had technical integrity. There were competing interests though at times with internal and sometimes competing Bell products, which Narain Gehani former researcher (and eventual Research Vice President) at Bell Labs describes in his memoir.[365] Paper publications similarly also went through a publication review board, which Gehani notes was very liberal in approving papers since publishing was seen as validation for the work done within Bell Labs by the greater scientific community. The review board was used to screen for proprietor information or any information that could have given competitors a head start or competitive edge. Gehani notes that only a few papers in his time were flagged, and usually resolved after some negotiation about modifying key parts. The notion there are no precedents for handling research coming out of firms with proprietary interests in these studies is false. These models, though often even historically private either intentionally or through record obscurity, are important to learn from in thinking through new paradigms in information and knowledge sharing from private firms.

Based on several background interviews, research review in contemporary firms often goes through public relations/communications and/or legal instead of emphasizing other subject matter experts. However, getting an accurate assessment across firms is impossible since these processes change over time and as a firm grows (according to interviewees), the lack of transparency, and variance in the types of research being vetted. Large firms relevant to this dissertation are not transparent about the internal review process (if there is one established), and often former employees were uncertain about this process and what they could go on the record for—even when their interview was anonymous. Sometimes firms would tell me their process was so complex it would be too difficult to explain, which is a ridiculous assertion given much of the process when handling classified material is known at least in abstract.

Many firms (mostly the startups) were too young and too small to devote resources to formalized internal processes and handled publications on an ad hoc basis. Medium to younger large firms may not have a process in place, and a few interviewees reflected that they did not institute publication review requirements until there was a high profile press event related to an academic publication.

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happens before the paper is allowed to be written, even once the knowledge contained is no longer viewed as sensitive it can never be released later—especially since the scholars will have likely moved on to something else or forgotten the keys to even their own meaningful ideas.

[365] Gehani, Narain. *Bell Labs : Life in the Crown Jewel*. (1st ed. Summit, NJ: Silicon Press, 2003), 90.

Knowledge Sharing

"Knowledge Sharing" can imply several different activities that result in the transfer of private resources that then generate knowledge (e.g., device or data sharing for research purposes) or in sharing knowledge gained internally or through partnerships. For the purposes here, knowledge sharing means any activity that translates and makes knowledge learned within a firm or using a proprietary device/underlying data accessible to individuals outside of the firm itself. Knowledge sharing may be achieved through traditional publications, gray literature (e.g., reports, blogs), patents, peer-based exchanges through conference presentations or informal networks, or by sharing underlying resources like devices or data that enable knowledge generation by others (namely, researchers). Without knowledge sharing, society risks losing out on advancements made within firms unless the firm is able to fully capture and use these advancements within the firm. However, in most cases knowledge only kept within a firm languishes based on market whims and inefficiencies, thus missing an opportunity to be picked up by outsiders and utilized in other ways.

Patents

A traditional way new industry knowledge has been shared was through the design of the patent system, which makes patent applications public generally 18 months after filing. This design was intended to offer inventors (or inventing firms) the intellectual property rights to monetize their discovery, but made it public so that others could learn from the design and test it. This can lead to other tangential discoveries, but also serves as a way for those outside of the firm to learn about inventions and work coming from inside the firm. Patents are a form of knowledge sharing, but as the information economics of tech firms evolve so do the intellectual property regimes. Now tech companies make their profit off of the network effects of platforms and their data holdings—through better algorithmic offerings, data science insights, or data-as-a-product—which means core business assets cannot be protected under patents but rather trade secrets. Trade secrets depend upon maintaining secrecy, unlike patents which require a form of eventual public disclosure and documentation. Secrecy as a result within these companies may be on the rise, but the practices and strategies around maintaining secrecy are still emerging (and outlined in Section IV). This intellectual property shift is additionally impacting broader knowledge sharing and taking away an existing mechanism of disclosure and documentation.

One interviewee remarked after saying they wouldn't feel comfortable asking permission to write an article using data collected during their research job:

"Mainly because the IP that I create is bigger, so I don't think I would even think about doing that."

Blogs and other gray literature

"Research[366] blogs" have also become a popular way for firms—large and small, though smaller firms usually have general blogs that may feature research posts—to publicize the interesting findings coming from within the firm. Though blogs are often small scale insights, lack peer review, and may come with a heavy dose of promotional up-sell, they are still a low barrier way for researchers in firms to post about what they are doing. For instance, in the Basis illustrative case (see Chapter 5) blogs were a way for researchers at the startup to learn about new ways to detect heart arrhythmias from heart rate alone, and one particular post from another firm was reportedly widely circulated among engineers designing heart rate algorithms. Several Basis team members also remember publishing blogs as a form of sharing. Blogs were used to help identify firms to approach for interviews for this dissertation, and also at times are cited within this research as evidence of claims and findings within the firm (see Lioness in Chapter 5).

Some in the academic community assume that if something is published in a blog it is not generalizable finding because it does not pass the bar of peer review. However, by sharing widely on a blog a finding or method for an audience outside of their firm it suggests that the topic is generalizable and relevant to people outside of the firm—the audience just may be other practitioners. The reason these individuals published a blog as their work teetered between practice and research boundaries or emerged as is because they did not have the time or resources to devote to an academic publication—not to mention the year or more timescale is not applicable with industry. As illustrated in the previous section, the boundaries between research and practice are fuzzy.

In a less charitable light, blogs can be seen as thinly veiled PR and recruiting tactics. One interviewee described his perspective on the role blogs played.

> "Another example would be in the recruiting environment. A lot of places like Uber and everything, whatever, they will start to have really active blogs where they publish reports and they publish open source tools. The main reason for that is to build their brand as a serious engineering team to attract good people who think it's a really vibrant environment.
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> [...]

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[366] These blogs are actually self labeled research blogs, this is not a categorization placed on them by this analysis.

> So, yeah. [Name Redacted] did that. They have a whole team just trying to find fun little stories in consumer data so they can get [our] name out there, and they've done an amazing job of making [our startup] seem like it's a much bigger company than it is.
>
> It's all about...trying to address little culturally interesting questions but with super simple approaches and correlations that are inferred as causation and all sorts of stuff, you know. But they try their best to try to be rigorous. But, like, the people who are doing them are recent undergraduates who are just kind of mucking around or who don't have a background in research and they're cranking out this story. It's like a news story, they're cranking it out in a little data story in two days."

The quality of the blog certainly depends on the writer, the firm, and the time within company growth. Even if there is uneven quality, it should be noted that blogs are a mechanism that allows companies to distribute information from employees—at firms large and small. Even when the message has been carefully tailored to fit a public relations or marketing narrative, they are still one avenue to bring knowledge or insight into inter-firm workings into the public eye. One may just have to scour in order to find practical knowledge, or learn how to read in between the lines.

Shades of Gray Knowledge sharing: Opportunities and Barriers from the Firm

Other reports, white papers, newsletters, and gray literature are also important aspects of knowledge sharing from firms. One Basis engineer made the following statement about how their team shared knowledge they were learning designing the underlying algorithms for the product:

> "I don't think we published externally because a lot of the—it was all trade secreted algorithm stuff—outside of like—I can send them to you, if you want—a couple, I'd say, "white papers," because they're not white papers, but scientific—slash marketing. It made sense. It was like here's the protocol we did. Here's how many subjects. This is the—this is the data. These are the activities. It'd just show it. It was also—okay, so we did it in cahoots with another university, but we don't talk how the algorithm works or whatever. Just this is how the data compares to truth, or ECG."

This perspective tees up one of the most obvious barriers to sharing, which is fears of intellectual property disclosure. However it does show how highly innovative and functioning research and algorithms teams can share what they are doing in a transparent way. Also by sharing a limited amount of data, the team can validate—or more likely simply demonstrate—some of their work publicly. Others with similar data (e.g., biosensing data) could then try and replicate with their own data and not require the Basis dataset, thus avoiding proprietary conflicts, privacy issues, and other barriers to data sharing. As also mentioned in the Basis case, publishing was beneficial to employees as they changed jobs following the acquisition since it made their contributions solidly public and able to be referenced on CVs. Additionally, understanding what knowledge and activities can be shared when interviewing at new jobs is a current challenge among many individuals as changes occur around secrecy practices within firms.

Many firms did not feel they conducted the right level of methodological rigor to publish, and accepted this as something that should be left to academics.

> "In terms of an aggregate pool level, similar to what we do in the newsletter. We've considered doing publications. Actual formal publication studies if we actually wanted to. We do probably survey level studies, like ourselves. We probably wouldn't have the nice, controlled, global standard studies. That would probably be working with researchers. We have sent abstracts to different conferences, just in terms of, 'Hey this is an interesting finding that we've had. Yes, it is not a particularly well controlled population. No, we didn't do a stratified cluster, no, we didn't do any of that. This is basically pure volunteer self-selected study, but hey here's the information. Do with it what you will.'" - James Wong, Lioness

However, these acknowledgements do not keep startups like Lioness from seeking to be in academic settings, whether it be in conference venues or as research partners.

> "Not really [a problem], especially since our orientation is far ... I think we understand the research sector well enough that we are well oriented towards it. There's definitely not been no serious antipathy towards us and we belong or fit, even though we aren't researchers. I'll say that again. We essentially fit well. There have been horror stories in terms of other companies who come in and run roughshod over it and have been rejected quite hardily. 23andMe probably being one of the more famous examples, but no, we've had a lot of positive perception. Probably because we're so open about our limitations as well, since I think some companies don't recognize that they have any limitations." -James Wong Lioness

In being open to the role industry can play, even small startups, there is ample room to reimagine the space for public-private partnerships.

Several practitioners expressed frustrations about their desire to publish but inability to once they got started for vague (corporate strategy) and sometimes indefinite reasons. This was particularly true for those with a PhD who now work in industry in research-esque but applied positions.

Time was a large factor in why many interviewees reported they could not pursue publications. For instance, one interviewee remarked: “We don't do that much internal research that can lead to publishable results, but there's a lot of opportunity to go that way but there's little obstacles in the way such as finding the time to do it.” Not only would writing up a paper take time, there is a long time horizon of getting peer reviewed feedback after going through any internal formalized or informal approvals. By the time a paper could get published outside of a firm, so much time would have passed that the writer would have already gone through one or two (or more) performance review cycles and some of the interest within the firm in the subject may have passed. This is in part why gray literature and informal mechanisms of knowledge sharing is so popular—even if it only gets out rough and unscientifically-vetted ideas. This mismatch on time horizons is a problem not just for research professionals within the firm, but a lost opportunity for academics and the public to learn about cutting edge research and innovation that might otherwise have gotten past secrecy and sensitivity concerns. In thinking through opportunities to improve knowledge sharing from the firm, coming up with alternative ways to publish in venues that are not only scene by academic researchers, but involving some expedited input or comment exchange. The academic model for publishing is challenging enough for individuals within academia, but the incentives to endure it are very small for those outside of the ivory tower.

One of the engineers from Basis reflected on publishing both at Basis and at other companies.

> “I think we have plans. We always have plans to write a bunch of white papers. What I go to is always talking about writing white papers and very excited about sharing interesting things they do, always low priority. Never just kind of happens. I think we wanted to do ... I don't remember much about Basis, but I know at previous and current companies it's always like a ... It seems like it's low priority, or not low priority. It's just like, maybe, it gets you more funding, but surely there's no ... I, as an engineer, who have worked on things want to do [and make public, but then then the] CEO maybe they think like, "I don't want them spending weeks on a paper that might make us look cool." I know there were at least a couple of plans to do it at my last company, but we still haven't seen anything.”

One interviewee pointed out that there is a cultural difference between how academics view papers, and how a firm does. For an academic, at times, the paper is the end goal of a project, whereas for a firm the paper is a means to an end or a partial public benchmark.

> “There's also a misunderstanding on what constitutes a finished work. And a

> paper is a finished work for a scientist but for a company it's like saying "I have the rough draft of a script and then therefore I got a movie." And movies make a $100 million right? So my rough draft of a script should cost, maybe half of that so may $50 million. Rough draft of a script, you haven't found any actors, you haven't created any production value, you haven't shot the darn thing or edited it or created the production wheels or promoted it with millions and millions of dollars of advertisement and so forth and taken any risk. And so an academic will say "I invented this." We didn't really invent anything since nothing exists yet. You invented some thought and to make something exist changes the nature of that thought towards it's early conception to the product a billion times. And takes potentially, literally a billion dollars to do so."

Another comment from those in the private sector, particularly from smaller startups, is that having a private sector affiliation makes it harder to publish.

> [After clarification they list their startup as their affiliation on published papers]

> "And that decreases are ability to publish. We probably have to go to lesser journals just 'cause true academics are suspicious of that and saying what I said before. But we'll just keep at it and I'll prove to the system that you can do good science as a company."

The extent to which industry researchers feel comfortable sharing practices or ideas outside of the firm is highly subjective. This is even true in conversations.

> "I think depending on who you are, your privy to certain confidential information or not, and that might affect how much you believe in the sharing of information but it probably has some effect of who you are individually and what you believe in philosophically. Is it okay to have a coffee with someone and talk about some stuff that maybe you shouldn't? And do you believe in that?"

There are key differences in strategy for sharing any knowledge. Specifically, a smaller firm needs to the publicity and to appear successful in order to be acquired, invested in, or taken seriously. A larger firm has the resources to devote to documented and reasoned sharing, but has less of an immediate motivation to. For instance in reflecting on exchanges between practitioners at MeetUps, they remarked on this difference.

> "I imagine there's an aspect of skill to that too, like you go to even now, you go to like MeetUps with people who are trying to start their own thing and man, they will share everything with you, but then you go to a company who has $10M of funding and they're probably not going to share much with you."

The auras of secrecy impacted firm sharing at conferences too, even when about researcher. One interviewee explained:

> "And well, from a person who came from going to academic research conferences where a research presentation is very detailed, it's very, 'here are our methods, here are our samples, here are our statistics,' and I went to research presentations at [industry conference name redacted], and this is a retail kind of like, the future of innovation of retail conference. In the research track, and here's how they resented a research finding. 'Six percent of people will be using [Product Name] by 2012. Next slide. As you can see, [Product Name] is super cool.'
>
> I was shocked. I was like, it removed so much credibility for me, and like, I understand oh you're trying to be secret, you don't want to tell, like, when I walked in thinking, 'Oh, good, they're going to present research,' like that is not what I expected in any way."

There are always counter examples, usually subfield specific. Such as graphics, which fostered a subfield of a high amount of sharing.

> "There are then conferences like SIGGRAPH in L.A. for computer graphics, where you go there and like, they're telling you the exact algorithms that they've been doing developing to have more realistic animations and you know, that could be for all intents and purposes to a company like Nvidia, proprietary knowledge and they're just sharing everything."

Interviewees and individuals encountered during the course of this dissertation research from larger firms repeatedly referenced the need to go through both legal and public relations/communications teams in order to get approval for any outside sharing. There was often a large amount of uncertainty about this process, and skepticism about being able to get anything approved without a struggle. Often pushing was something interviewees said they would do, but at the end of the day just did not have the time to take to completion.

> "I, personally, have been sort of nudging the boundary and so far it's been received well. It's just a matter of having the bandwidth to go and do it on top of everything else I have to do."

Often, the researchers or research-oriented positions do not benefit from the trainings others receive in what they can say publicly about their work, or the company. This continues to have a chilling effect, and was expressed to me as a barrier to trying to figure out how to translate work outside of the firm and discussing their struggles working with these teams.

> "It's just a little bit weird because it's uncontrolled. Sales people go through trainings. They know exactly what to say. Not that they have anything to worry about with me but it was a little more of a wild card, I guess. I don't think it was a fear of me betraying the company but it was more of there's a certain way of doing things and a certain way of discussing the company that I haven't gotten formal guidance in, I guess. Maybe that's it. I'm not sure."

There are important existential questions to ask ourselves, as communication and legal teams become the arbiters of knowledge shared outside of the firm, and by proxy what research efforts are undertaken within the firm. Research that is never expected to see the light of day because of defensive and subjective review policies is unlikely to occur—especially if it is at the fringes of research-oriented employees' primary responsibilities. Review and controls of knowledge sharing within the private sector is not this issue itself, given that it has been in corporate laboratories for decades. However uncertainty about these processes, and unclear rulings made by individuals who themselves are unlikely to have research training or research-based educational backgrounds provokes some important questions. Sharing data often steals the thunder, but being able to read and learn from those inside the firm who are experts in the data collected and how it is used is something that should be getting much more attention and emphasis.

Internal Knowledge Sharing

Sometimes firms reported that research reports were written (within medium and large companies) and circulated around, but never shared outside of the firm due to issues around secrecy and wanting to protect the firm's strategy.

> "Yes, I mean coming on board I was told research was taken seriously and you will have the ability to publish once we reveal what we're doing, so, yes, I'll be at CHI soon, but we cannot publish anything we are doing until kind of the big reveal. And then there still might be some limitations on depending on what it is, but I was told, and the understanding was, "yes absolutely we will send you conferences and we encourage publishing.' We want that, but so far it's been internal reports and collecting project data with the thought toward this is something we can publish once we can talk about what we are doing."- Anonymous interviewee at midsize firm

There are other ways that information learned through research activities is shared within the firm. Informal networks through management were used to connect project leads from sometimes failed projects to others who could benefit from their experience.

> “From a procedural level, what I've noticed happening, is that we have a project, or in my experience, we've had a project, I've done a research project on it and there are results, and then the product manager who's been networking a lot with HQ sees those results, and he or she is often times the one kind of like putting the thesis together and has come to me and been like, 'Hey [name redacted], I'm going to schedule a share out with you for x, y, and z teams over at core,' which has happened a couple of times, and that's on the procedural level. I think that other times I've noticed research we've done here would probably have value to some other team, then I either, again it's communicating through the project manager, and then creating the opportunity to let that team know that, 'Hey, come to us if you're interested and we might have some answers to questions you're working on.'”

However, often there are no reliable ways to share knowledge inside the firm, let alone outside.

> “Cool, but I would say also, in general, something that we've talked about a bit is that [Name of Firm] doesn't have a really good way to share findings and make them searchable, like there's no data web of science, database that we can search that actually helps us find things that's like several hodgepodges in several different locations that may or may not be able to just like, there isn't really a good system for sharing work.”

This desire for knowledge is often reflected when management is seeking to learn what has failed within a firm. For instance, one interviewee when talking about publishing outside of the firm recalled a recent conversation about handling and capturing the results of research failures. “That kind of reminds me of a comment that someone asked today to one of our leaders like, 'Is there a post mortem somewhere, like if projects have died in the past, is there a way for us to know about what happened? Was it just not the right time? Was it a communication issue? Like, what was the cost of failure of that project?'”

Within small and physically isolated research organizations, knowing about failed projects and the appropriate point person to ask is more tacit and omnipresent. As firms have embraced the large, open “everyone innovate” model, it is harder for information to flow within firms relating to research projects.

The frustration and lack of clear research communities within large firms was echoed by interviewees.

> "I realize that there's not really opportunities to socialize research either, so you know like there's academic conferences or whatever, or so many other communication and computation conferences that give people the opportunity to share those results…or journals, or what have you. It's not even like, so much, like I wouldn't necessarily expect people at [name of firm] to publish research for the public or internally, but at [our annual corporate meeting/conference]…it would be an opportunity to be a stream for people to get together and learn about the different research that's been done, or some of the projects that have been done regardless of their outcomes just so that people can apply that to their work."

The clear research community enabled by physical proximity and team association was notably missing and emphasized from many industry researchers' work.

Another challenge firms faced was difficulty fully capturing the capacity of acquisitions or teams as they change over time. For instance, Intel reportedly has been unable to make use of the Basis research team's data—assets they paid for in the acquisition.

> Interviewee: If anyone on the R&D team had access to it, anyone outside of the R&D team they had to go through either us or the backend software team to get that. And usually what would happen is like even anyone outside of the R&D team, if they got their hands on that data, they wouldn't have the tools to do really anything with it. Parsing tools, and plotting tools, and any other utilities that you would need. Because we all developed those on our own so it's like if they even have the data, it'd be really hard for them to do .
>
> That is a pretty consistent problem I'm seeing right now too, you give people across industries or even out of industry your data, they can't do anything with it up until two or three months after that just because they don't have the tools necessary to do anything. And that even being longer between the industry itself and academia I think. That process is significantly slower.
>
> Elaine: And why is it? Is it just the nature of the data, the format it's in, and the combination of different data types in terms of ….
>
> Interviewee: Yeah like data types, data formats, understanding how the data was collected. If you didn't collect the data yourself it's like there are going to be certain caveats that you don't know about. And just, yeah data parsing and aggregation and all that takes a little bit of time.

This raises important issues not only in the issues of knowledge transfer within firms—in this case on how to use data acquired through an acquisition—but broader themes relevant to data sharing between entities.

Outsourcing Publishing to Academics

Throughout the interviews, practitioners repeatedly stated that partnering with academics for the publication of papers was an intended benefit or positive externality for the firm. From the perspective of startups, they may not have the expertise or time/resources to conduct research at the level of academic rigor. Startups also sometimes lacked the knowledge of how to get a paper successfully through the peer-review process, or lacked knowledge on where to publish. Larger firms had similar challenges, but usually had more resources and research-capable staff—these staff were often just overworked. Much like access to ethical review, partnering with academics offered not only additional intellectual and analytical power, but also the possibility to publish.

The outsourcing of different aspects of research is illustrated in all three of the illustrative cases. The exact motivations to partners with academics, and the method of curating a relationship (e.g., arranging data sharing and device donations) is slightly different in each case, but represent the evolving incentives to broker these connections.

Time continues to be a constraint—even when the firm and practitioners are willing to engage in academic partnerships and knowledge-sharing activities.

> "It really will [come down] to a matter of resources because my job title involves demos and training and workshops. Anything on the side, whether it's working on a publication or partnering with somebody is sort of like passion project which is entirely welcome but should not detract from the primary objective of my position. If that makes sense."

There was a lot of uncertainty and angst expressed when trying to handle and structure partnerships with academics. These partnerships provided intellectual power, but many interviewees expressed fears that they would publish negative results based on the device or data—in addition to predicted fears about intellectual property rights and data privacy. For instance on interviewee described the way they approached a recent partnerships of exchanging data for particular research.

> "And I have view the relationship with academics right now is largely external R&D, You know, it's, it's an extra set of hands. I'm the one, I think the larger risk outside of publishing negative results is, is just kind of IP ownership and to own the ideas, uh, where the academics themselves we've worked with are very reasonable and rational and um, that hasn't been an issue. It's more the

> university level. Like there's this kind of standard desire to ensure that anything your tenured professors work on is owned by the university. And so we've had to negotiate on the IP side a little bit just to ensure that, hey, no, actually this data and our brainstorms about what can be done with this data. Just because we're, we're discussing the world of possibilities doesn't mean that we don't own the right to develop these algorithms and house and own those algorithms."

Several interviewees sheepishly admitted they instituted some type of prior review when working with academics. On quick judgment, this makes an impression that firms are controlling of the message put out and could impede scientific objectivity by interfering. However, it is rational firms want to ensure that data published does not have any privacy or IP sensitivities, and that findings are accurate. If an academic made a mistake in analysis—which happens—it could ruin the chances for a small firm, or cause a large public headache for large one. Both large and small firms risk financial and regulatory blowback if a mistake is made. Conversely, an academic should value their integrity but in reality only needs to file a correction if such an error is discovered.

There is no easy answer for handling publication reviews, which is why a team member ideally from the firm who donated the sensor/product or data should be part of the study. Given these factors, there is a need to rethink the options available (and known) to firms on how to work with academics and structure these relationships and review requirements. Upon pressing, many individuals who set prior publication review in place felt that was the only way to ensure correct information was being published, and to monitor any potential risk to the firm. Many who were executing these contracts had no prior experience working with academics or structuring such agreements—the same goes for academics who are most often not attorneys and may have never had a partnership with industry before.

Academic Data Sharing

Data itself is not knowledge, but may be shared with others in the pursuit of new knowledge. It should be established there are not many established guidelines and tools available to help with industry data sharing. Universities are often ill equipped (see quote above on wanting to sign all IP from a partnership to the institutional academic), and there are not many models for privacy-preserving data sharing and risk-minimizing strategies for the firm. When data are on a smaller scale, and with a subject well known to the firm, these negotiations may be easier and done more casually.

Conclusion

Knowledge sharing is heavily influenced by larger external forces shaping how firms seek competitive advantage in the age of information-intensive innovation, and where firms place perceived risks. Barriers to share include IP and strategy secrecy concerns, challenges over sharing data to validate research or partnering with academics, unclear approval processes to proceed with publications, and ambiguous benefit to firms. Time is predictably a huge factor as well, both in time to write a paper (stemming for work already being done), time to get internal approval, time to go through the long time horizon of academic publishing, and time to foster relationships with external partners.

There are times when knowledge sharing helps promote a firm, valuation, or demonstrate expertise. Some firms may see the value of visibility, demonstration of technical competency, and employee development but may not have the resources to promote it. Often, however, there are challenges in monetizing the value of the long-term investment and value to individual employees.

As IP and guarding corporate secrets have grown as challenges, PR /Comms/ Legal teams have become increasing gatekeepers of knowledge or knowledge-enabling data. Secrecy practices control how information is released it ends up being about knowledge sharing, and the impacts of these decisions need to be carefully considered.

Academics continued to be important external partners in helping firms transition knowledge outside of the firm, but these collaborations and models are haphazard and vary greatly between firms. By studying how these changes were manifesting in firms, it is possible to begin crafting cohesive innovation strategies that leverage the positive potential and aim to minimize negative outcomes. Without knowledge sharing mechanisms that fit information-intensive innovation models, society and other firms will fail to benefit from findings of internal research activities.

Section III: Research Ethics in the Wild

In the contemporary information economy, questions and tensions around technology ethics abound. It is consequently unsurprising that firms performing information-intensive inquiries grapple internally with how to deal with questions of research ethics and user privacy—particularly because they were often trained PhD researchers themselves and accepted this as part of their professional responsibilities. Additionally interesting, this research reveals the growing reliance private firms have on external academic research partners to provide access to Institutional Review Boards (IRBs) within universities and research hospitals. Access to these accepted forms of ethical reviews were seen as a resource external research partnerships could provide to help cover activities within the firm which was an added incentive to find such partners. In the absence of external partners, many interviewees discussed the limited ways their firms attempted to deal (or ignore) research ethics, and how they took extra responsibilities upon themselves to incorporate ethics into their practice.

Asking research participants about their views and practices instituting "ethics" in their daily research, design, or professional practice was the most sensitive question topics posed during this dissertation study. Topics related to "technology ethics" and "research ethics" within companies has become a topic of heated debate among technologists, academics, and the public alike. With no clear rules or lines of acceptability, interviewees were often reluctant to discuss any of their firm's or their own practices. Many participants were also not sure about formal policies and procedures, even on studies they may have assisted with.

This portion of the study was not intended to be comprehensive in terms of understanding how each firm conducted ethical review, but rather aimed to simply understand and document how interviewees viewed their ethics on the ground within their roles. Some were more willing than others to discuss their personal and company's approach to ethics, but several key themes emerging including cultures of questioning, duty stemming from academic training prior to working in industry, reliance on university partnerships, creation of ad hoc rules, and novel approaches legal agreements and consent forms to find ways to enable activities in thoughtful manners. By understanding some of the ways ethics is instituted in practice or perceived as a barrier in research, more comprehensive recommendations can be made.

Brief Industry Research Ethics Background

Technology ethics usually encompasses more broad moral issues and questions around technology development and application. By contrast, research ethics focuses specifically on the context of moral and ethical issues around research and development. Many research ethics issues involve the discussion around the use of human subjects, including the implications of human subjects within research conducted inside tech firms or on data garnered from users.

For much of human history the practice of medicine was experimental—healers and doctors did whatever they could to save the patient and were governed loosely under the Hippocratic Oath to do no harm. However as science and medicine progressed, the use of humans as research subjects introduced horrifying instances of harm where elements of voluntariness, informedness, and autonomy forced the creation and development of research ethics. There are several early 20th century frameworks for research ethics, the Nuremberg Code in 1947 generated from the atrocities of the Nazi clinical trials is one of the most internationally accepted research ethics policy frameworks.[367] Within the United States, policy discussions coalesced over time as several public research harms made the press (e.g., Tuskegee syphilis experiments, Willowbrook State School hepatitis experiment, Brooklyn's Jewish Chronic Disease Hospital cancer cell experiment) and the NIH clinical hospital began grappling with testing on healthy participants (often called at the time "normals") who did not stand to directly benefit from research interventions. The US government was also beginning to fund extramural (non-governmental) research, which implied a new liability dynamic and research context where the government could no longer dictate implementation processes (including ethics).[368] This public and government push to grapple with ethics resulted in the Belmont Report (1979) which identified three core principles: respect for persons, beneficence, and justice.[369] These principles and actionable tenets such as informed consent and balancing of risks and benefits were later codified in in 1974 as Title 45 section 46 of the Code of Federal Regulation[370] (45 CFR 46; usually known as the "Common Rule"). It is through this law, as well as additional policies like Federal-Wide Assurance Contract that makes all research at universities—not just studies funded by the US Government—subject to ethical review guidelines including the use of Institutional Review Boards (IRBs).

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[367] The Nuremberg Code (1947). US Government Printing Office (Washington DC: 1949). https://history.nih.gov/research/downloads/nuremberg.pdf.

[368] A detailed history of this debate and the foundations of IRBs as an institutionalization of ethics can be found in Rebecca Stark's book.

Stark, Laura Jeanine Morris. *Behind Closed Doors:IRBs and the Making of Ethical Research*. Morality and Society Series. Chicago ; London: The University of Chicago Press, 2012.

[369] The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research. Department of Health, Education, and Welfare (1979). https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html.

[370] This law has been updated and amended several times over the decades.

These research ethics guidelines have known limitations in application and context. The guidelines, though intended to be extensible and flexible, were not initially designed to apply to all areas of research. For instance, the initial rules and guidelines were developed with medical or psychological experiments in mind—not social science studies.[371] Additionally, at the time these policies were developed, private sector research involving human subjects was limited to pharmaceutical and medical studies and thus regulated under the FDA guidelines.[372] (See history Chapter 4; specifically on the discussion of limited social science research within large labs like Bell Labs)

In 2014 private industry as a site of research hit a public flashpoint with the publication of a study on emotion contagion within social networks.[373] An experiment was run on Facebook's newsfeed, and the analysis was conducted by university research partners, leaving open a question of who was responsible for running an ethical review. A lengthy debate ensued in the public media and within academic circles about the new opportunities "big data" (or what would now be called more broadly data science) offered through these partnerships, and the ways in which human subjects research ethics frameworks were unable to extend for this new research reality and context.[374] Other digital manipulations

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[371] See, for instance:

Bledsoe, Caroline H., Bruce Sherin, Adam G. Galinsky, Nathalia M. Headley, Carol A. Heimer, Erik Kjeldgaard, James Lindgren, et al. "Regulating Creativity: Research and Survival in the Irb Iron Cage." Northwestern University Law Review 101, no. 2 (2007). https://heinonline.org/HOL/LandingPage?handle=hein.journals/illlr101&div=24&id=&page=.

Schrag, Zachary M. "How Talking Became Human Subjects Research: The Federal Regulation of the Social Sciences, 1965-1991." Cambridge University Press 21, no. 1 (2009). https://www.cambridge.org/core/journals/journal-of-policy-history/article/how-talking-became-human-subjects-research-the-federal-regulation-of-the-social-sciences-19651991/097169CC72ACEF36DC8B5BD80859C615.

Zachary Schrag in "How Talking Became Human Subjects Research: The Federal Regulation of the Social Sciences, 1965-1991" (2009) details the policy and regulatory tussle that occurred to extend the coverage of IRBs, and the ways in which these policies were not designed for social science research. He states: "At best, they offered a few adaptations or exceptions to the regulations developed for medical experimentation, but a basketball court with some holes in the floor is not a golf course. From the first version of the policies, the social sciences were included, but only in the marginal position they still occupy today."

[372] Vitak, Jessica, Nicholas Proferes, Katie Shilton, and Zahra Ashktorab. "Ethics Regulation in Social Computing Research: Examining the Role of Institutional Review Boards." Journal of Empirical Research on Human Research Ethics 12, no. 5 (2017). https://journals.sagepub.com/doi/abs/10.1177/1556264617725200.

[373] A full discussion of this event and the nuances of the study and public fallout are beyond the scope of this dissertation, but some selected discussions are cited below.

Kramer, Adam D., Jamie E. Guillory, and Jeffrey T. Hancock. "Emotional Contagion through Social Networks." PNAS Proceedings of the National Academy of Sciences of the United States of America (2014). https://www.pnas.org/content/111/24/8788.

[374] See for instance:

Metcalf, Jacob, and Kate Crawford. "Where Are Human Subjects in Big Data Research? The Emerging Ethics Divide." Big Data and Society (2016). https://journals.sagepub.com/doi/full/10.1177/2053951716650211.

(not just observational studies) were divulged at companies like OKCupid, and questions were raised about the ethics of these practices even when the results are not published.[375] Research conducted in the dark, or research that is simply unlabeled but looks and feels like research, is not by default ethical. This moment raised important questions about what classified as human subject research within industry (see definitions in previous section), how research ethics could be brought into the private sector, and whose responsibility it was to monitor and regulate these activities. Unlike the US government that had grant making authority to require all universities to accept the operationalized research ethics policies, the Federal Trade Commission and other privacy and data regulators are the only entities left to evaluate ethical boundaries under consumer protection authorities.

In the absence of clear answers to these challenges, this section sets to seek to understand how ethics are reviewed in practice by practitioners and firms to not only understand the research ecosystem but also what possible remedies and recommendations might be considered to shape the system.

Ethics in Practice

Grimmelmann, James. "The Law and Ethics of Experiments on Social Media Users." Colorado Technology Law Journal 13 (2015): 219. https://james.grimmelmann.net/files/articles/social-media-experiments.pdf.

Editorial Board. "Editorial Expression of Concern: Experimental Evidence of Massivescale Emotional Contagion through Social Networks." Proceedings of the National Academy of Sciences 29 (2014): 111. https://europepmc.org/articles/pmc4115552.

Flick, Catherine. "Informed Consent and the Facebook Emotional Manipulation Study." Research Ethics 12, no. 1 (2016). https://journals.sagepub.com/doi/full/10.1177/1747016115599568.

Kleinsman, John., and Sue Buckley. "Facebook Study: A Little Bit Unethical but Worth It?". Journal of Bioethical Inquiry 12, no. 2 (2015): 179-82. https://link.springer.com/article/10.1007/s11673-015-9621-0.

boyd, danah. "Untangling Research and Practice: What Facebook's "Emotional Contagion" Study Teaches Us." Research Ethics 12, no. 1 (2016). https://journals.sagepub.com/doi/full/10.1177/1747016115583379.

Panger, Galen. "Reassessing the Facebook Experiment: Critical Thinking About the Validity of Big Data Research." Information, Communication & Society 19, no. Issue 8 (2015): 1108-26. https://www.tandfonline.com/doi/full/10.1080/1369118X.2015.1093525.

[375] The original OKCupid blogpost has since been deleted (original URL is https://theblog.okcupid.com/we-experiment-on-human-beings-5dd9fe280cd5?gi=ec8ced4aead) and unfortunately it does not appear to be archived at the Wayback Machine. A copy of the blog appears to be found here (https://hackerfall.com/story/we-experiment-on-human-beings) and is covered in many news stories.

See also: https://slate.com/technology/2014/07/facebook-okcupid-experiments-what-other-companies-are-conducting-secret-psychology-studies.html

This research revealed that there were two primary ways ethics were put into practice: first, was through the individual within firms based on their training or opening up questions about practices and outcomes. Because startups are usually very small, the individuals within startups had more influence over firm practices and outcomes than an individual within a larger firm, and it was usually the individual who was able to shape the startups culture around ethics. Second, there were some organizational strategies that emerged in instituting research ethics, including academic partnerships, private IRBs, and some references to internal processes.

Part I: Individual Actors

Cultures of questioning

One thing my interviewees felt is that just because there were not formal reviews at all firms where they worked, they didn't feel they were necessarily lacking the ability to question practices of their teams, other teams, or practices within the company. Formalized organizational structures were not required to promote these cultures of questioning. One interviewee, who had recently completed a PhD and moved into industry reflected: "I think within our group we're pretty close knit … we've had this back and forth of 'hey this doesn't seem ok' and then talk about it as a group and talk about what makes ethical sense here."

This interviewee went on to reflect on the challenges as the company grew and they were exposed to research or research-like activities outside of their control or research unit. "Where it gets fuzzier is when other groups with product and UX and where it's not within our control and domain of experience, and we are brought in as consults on study design. There hasn't been something where I felt completely "OMG this!" And even if I was just consulting I would take it to whoever in research and head of their group or it's a casual company where you can just ping someone on Slack and I would feel pretty comfortable talking to some and say "this is not alright" in the nicest way possible. But at the same time there's a lack of control because I can only do so much, and as the company grows it's its own entity. In a university if there was another researchers group you disagreed with, and you were brought in part time and saw it, how would you handle it? You would hopefully, if you felt strongly about it, flag it and voice it. But at the end of the day it's their group and their decision, and mentally I do treat it differently, too. I hold myself and our group to different standards."

This reflection points out that cultures of questioning are hard to scale in a growing organization, and difficult to replicate. Cultures of questioning are certainly better than no questioning and blind execution of tasks that invariably have moral and tangible consequences for others eventually, but they are impossible to audit or examine objectively for shifts over time.

Lioness: an example of a broader ethical discussion and dedication to user wellness

The ways in which Lioness thought about how to offer an explicit "opt in" to any research that tied to deeper fundamental questions, on top of the statements within their privacy policy are discussed within the illustrative case in Chapter 5. It was interesting to reflect with James on how the company carefully weighed the less tangible harms that could occur not necessarily in formal research but in their internal product and algorithmic development. Separate from "research ethics" discussions, this conversation illustrates when questions of ethics and user well-being are brought into the conversation, even within very small firms (startups) and are an important part of understanding how ethics may be executed on the ground. This is a detailed example of how individuals acting within small firms grapple with larger issues, and illustrates some of the positive discussions that are often overshadowed by poor decisions and outcomes made by firms.

"In terms of consumer behavior and whatnot, there's far more consistency, especially in the aggregate and in our particular case when we're trying to give insights that are similar in the sense of consumer consistency or user consistency, correlational tends to work fine and doesn't suddenly change or have super bad consequences generally speaking. There are some, where there are areas where there might actually be super bad consequences, at least psychologically if you say the wrong thing. We've been actually pretty careful with some of those areas."

The acknowledgement that there is low risk, however depending how the product delivers readings and analysis could be harmful the psychological and emotional wellness of the user, given the sensitivity of the data.

> "Anyway, the time's off. The person goes, "Your time is off." It's kind of annoying but it's not deeply traumatic or problematic in any sort of way. On the other hand, we've been working on an orgasm predictor for a long time because it's basically something that we've gotten requested quite a bit. For some women, they actually are not sure, "Is this an orgasm? Is this not an orgasm? How do you even know in terms of subjective experience and everything, especially with this? Oh, there's actually a physiological way of telling? I'd like to know." If you don't do it accurately in terms of either false positive or false negative, that could actually be an issue. That we're being pretty careful of, both in terms of level of accuracy we're comfortable with having it roll out with. It's going to be hard to find the true bounds of it. In terms of pretty damn accurate, just in terms of how we would see it, but also with the right caveats and the right language around it,

helping people understand. No matter what, it's going to fail somewhere and it's going to be wrong somewhere. The part of the thing is making sure it's wrong less of the time first, but also just the language around it helps people understand and put it into context what this is." — James Wang, Lioness CTO

This nuanced discussion of potential harms and actions that could be detrimental to the wellness of users would not traditionally be cast as research ethics. However this culture of questioning should be recognized as necessary and important conversations to have within firms and teams—not to mention possibly outside stakeholders and users.

Training as an Academic

The importance of research training within academia as a professional guide for PhDs (or Master's with research experience)[376] was often reflected within cultures of questioning through their perceived duty or obligation to perform checks on study design and practices—whether they involved data analysis or actual testing on users.

IRBs or some form of accepted ethical review is seen as a barrier to getting their internal private sector research published. Many expressed a challenge trying to find a way to satisfy this requirement in order to publish or carry out the work in a systematic way like they wanted to based on their research training.

Many interviewees who had conducted research during their training knew the shortcomings of IRBs, and that seeking an IRB-style review may not help them think through their dilemmas.

> "My role recently on the academic side the cloud has changed so much and that IRBs don't understand storage and the implications of that. It's true on the academic side, and also true on the industry side." -Anonymous Interviewee

Regardless, the training of individuals within industry was an important component of when ethical review and ethical discussions took place in firms, particularly smaller ones.

Part II: Organizational Strategies for Grappling with Ethics

There are three primary themes that emerged as organizational strategies for grappling with ethical issues and instantiating processes and approaches for

[376] This is not meant to exclude those with Bachelor's training and exposure to research, but those who reflected on their perceived professional duties and knowledge about ethical review processes overall had PhDs or Master's degrees.

employees and projects: 1) Using academic and medical research partnerships as a way to access traditional IRB infrastructure; 2) Hiring Private IRBs to review internal projects and practices; and 3) An acknowledgement large firms sometimes have internal documents, but these documents like other research-related practices are kept secret.

Access to Academic IRBs and Outsourcing Ethics through University (or Medical) Partnerships

For many, partnering with a university or research hospital was seen as a way to assist with research, publications, and most relevant to this section: a way of accessing validated ethical review processes.

Many interviewees, all of whom had academic research training (mostly PhDs) prior to working within industry saw university partnerships as a way to access ethical review so they could conduct their research. Once again, their training carried over into their professional lives in industry.

> “We don't do that much internal research that can lead to publishable results but there's a lot of opportunity to go that way. But there's little obstacles in the way, such as finding the time to do it, having it be worthwhile for the company, and also little academic loopholes like getting on an IRB, for example. ...I did human research for my PhD so to me IRB's were the end all be all and I talked about this with some of my coworkers where I was like, "Hey, if you're in industry, how do you stay involved academically?" And people are like, "Well, you basically have to find a way into the university either to become like a visiting scholar or partner up with an academic who can sort of bring you in as part-time staff so at least you're counted as being part of the institution. And then that way you can get listed on the IRB and then you have clearance after that." - Anonymous Interviewee

Another remarked on using their personal network to form collaborations that also allowed for IRB access.

“I came into this with a lot of friends. Those are my friends in different places doing cool stuff and I'd say over a beer how can we get together. Well we can't because we don't have your capability and you don't have ours and the IRB is in between.”

Numerous firms told me the way they dealt with ethical questions and reviews was to “outsource” this to their academic partnerships. A few interviewees sheepishly admitted that they simply assumed the IRBs had done an ethics review on the research given the requirements of their academic partners, but that they were not involved with the process. Others were more involved in the review process, and many saw this opportunity to use the existing ethics infrastructure as an asset and incentive to work with academic/medical researchers.

This illustrates how IRBs are able to extend their mandated coverage to new contexts, specifically, private industry. However, it also points on additional pressures placed on an already overextended infrastructure, and the ways in which this ethical handoff may not result in improved ethical outcomes by actors within private industry, but rather a mechanism to cover private industry's legal and public relations behind.

Buying Ethical Review: Hiring Private IRBs

Some firms said they used private IRBs for studies run internally, but nobody could offer me any details about those experiences either because they didn't execute them or maybe simply forgot. It is possible that interviewees also felt uncomfortable during these questions and felt compelled to provide me with some answer out of guilt and a desire to protect their own (or their firm's) reputation. Research notes often reflected interviewees were uncomfortable during these questions, likely because there are few accepted practices that give cover for activities done within the firm, and individuals know this is an issue that is often criticized by academics.

Regardless of the veracity of the answers, several interviewees brought up private IRBs as either resources used or alternatives they thought to explore. For instance, one interviewee discussed their hesitation to use one because they felt it was an insufficient mechanism to achieve better ethical ends in their work.

> "The other alternative is to go for private IRB companies, which apparently exist. I didn't know that. Basically, it's just this outside company that you send in a proposal and you give them some exorbitant amount of money, like $2,000 or something, and they approve it. Then, that way you can include that disclaimer when you submit for publication that our protocols have been approved by an IRB sort of deal. I have colleagues who used to work in government and have published papers that have gone to independent IRB companies before just to check that box off, you know? How rigorous those companies are, I have no absolutely no idea." - Anonymous Interviewee

There is not a lot of existing scholarship on private IRBs, how they function under self-regulation, and the ways in which it is a productive means to promoting better ethical outcomes. This is an important topic for future research.

Ethics Protocols in Secret

Small startups, for the reasons discussed above, operate at an individual level but it was near impossible to get any large firms on the record. The only folks interviewed from large firms were under strict agreements with me on anonymity for both them and their company, or were strictly background conversations to inform my work. From what I know, there are some large firms that are proactively creating human subject review guidelines, and IRB-like structures for any research or market research style internal activity. These documents are often labeled as confidential or designated as "not for public release." There are little to no incentives for firms to publish and share these practices, and thus placing themselves under scrutiny for voluntary activities (given there is no legal requirement for them to do these reviews). What is important to distinguish is that these protocols are not published because of fears of being poached on an idea or new pending innovation, but rather for concerns about public criticism and potential liability by exposing practices.

Conclusion

This section sought to understand the spectrum of ethics practices and how ethical questions are considered by interviewees. There were also plenty of interviewees who had no idea what the practices of ethical review were (if any) during product development and testing. Usually these cases were more in the gray fringes of what could be considered research versus product development, and those who had formal research training almost always responded with what reviews were practiced or not. Individuals often took research ethics practices upon themselves, and attempted to make do given constrained resources and lack of accepted best practices for industry. The snapshots from the viewpoints of interviewees establish some of the barriers to research, challenges of institutions' ethical research practices within firms, the role of the individual professional and their academic training, and the opportunities afforded by university/research hospital partnerships. The extra incentive to leverage academic research institutions for their ethics review infrastructure was a novel finding, and helps to understand how new models for research and research collaboration are evolving around information-intensive innovation.

Section IV: Information-intensive innovation secrecy out of open innovation

One of the greatest ironies of Silicon Valley (and tech companies more broadly) is that the very firms that promise to connect the world and instrument our entire personal lives is that the industry seemingly thrives on paranoia and secrecy. While the average persons' life is becoming more transparent and permeable to private sector data collectors, the actions of the curating companies have become opaque to not only public scrutiny, but peer and expert gaze.

Chapter 2 illustrated how the Silicon Valley model of innovation via Saxenain and Chesbrough's work created fluid information flows between firms that often had implications for parts of research and practice. As evidenced in the historical chapter and part of the appendix, not all aspects of research in tech firms was open. However, this dissertation research uncovered new barriers to general information flows—specifically concerns around leaking as well as the proliferation of NDAs—and the impact these legal and organizational structures are having on research conversations.

This section first explores the uncertainty and blurry boundaries over employee's mental models of what should be kept secret, and then examines the ways in which operational information security are in tension with other cultural norms like open office plans and flat organizational models. Then this section examines NDAs, and the impact of employee NDAs and visitor NDAs are having upon the research landscape, and how general perceptions are causing a broader chilling effect. These emerging secrecy practices threaten to counteract other strategies to collaborate with external researchers, contribute dialog and findings to the larger research discourse, and creating institutional and legal barriers to adapting research demands.

Which part is the secret? Employee mental models and work arounds

Not all engineers and programmers I spoke to felt they could not share information. One engineer who worked with wearable data made it clear he did not feel stymied from discussing the results of their internal R&D team broadly. "Not really. When we'd talk about algorithms, it's not like the person hearing about the conversation is really gonna go out to a computer and go do something about it. It's more about the data integrity itself, and if they don't have access to that similar data, it's going to be hard to reproduce those results anyway. So it was more about keeping the data confidential." Secrecy practices are often based in employees mental models, and the emphasis on what should be kept secret (let alone how) varied between employees and especially between firms.

Individuals executing research or possible research-related investigations within data science and user studies talked about how they got around not being exactly sure what parts of their job they could discuss. When attending MeetUps —a platform for connecting individuals on similar interests in person, including particular coding languages and tools—several individuals felt they could talk strictly about methods and skills without worry. Employees I spoke with felt like this did enough to satiate their need to seek outside professional development and exchange ideas. However, this type of communication from an outsiders' perspective only serves to improve the underlying methodologies and strategies used to solve problems, not discussing the possible findings, applications, and the impact implications of such algorithms and platforms. This limitation on knowledge sharing, stemming primarily from uncertainty on how to communicate with peers, ultimately impacts the professional development (and thus suggests impact on corporate efficiency and quality) as well as society as a whole by taking entire subjects off the discussion table.

The pressures of secrecy impacts employees in other ways. One user experience researcher admitted to me that she was having trouble applying for other jobs, because she did not know what she could claim credit for or boast about since none of her projects were ever made public by the company. This was not a point she could seek guidance on from her managers because they did not know she was applying for other jobs. She also worried that if she did go into another company and say too much, the other company would view her as a "snitch" and think she would not keep their practices and projects on close enough hold. This was a struggle she both expressed frustration with and helplessness because it was not an issue widely discussed.

The ways in which employees viewed which part of their jobs were secret, and how they could interact with others and exchange knowledge or practices varied. However the uncertainty, caution, and very specific mental models (based on their interpretation of corporate policies) on how to conduct themselves were common themes.

Operational Information Security Tensions

There is clear tension within many firms (e.g., Apple may be an exception) that there was a desire to appear open, transparent, and with a flat, peer or merit based management structure. Many offices are open floorpans, where employee desks are open for all other employees and visitors to see. Open floorpans also relate to the open and omnipresent innovation strategy that seems to dominate contemporary tech companies. Every employee can be an innovator, so there is no need to invest in large insulated teams with set aside resources. Startups also often use shared spaces to operate, like the popular WeWork locations that include hot desks, open desks, and shared conference rooms (not to mention amenities). Understanding the shared and communal culture of these spaces and the differing impact on innovation culture—certainly there are plenty of good ideas spread this way—is out of scope of this work. However, these open spaces compete with, and perhaps fuel the confusion over, what exactly should be kept secret within firms.

From an operational security perspective, these open practices run directly counter to any information and physical controls that are designed to keep secrets and compartmentalize knowledge as protection. Recent historical examples (explored in previous section) suggest that in order to truly run agile and clandestine innovation operations, tight physical security and information security is necessary. The information controls in current technology companies are scattered and unclear, unlike national security information controls which clearly label all classified information and compartmentalize both the physical processes as well as making it clear who can know what. Guests are frequently allowed within open floorpans so long as they are escorted by an employee, and at times academic or outside partner engagements are held within the facilities as well—adjacent to places of work.

There is also an unclear hierarchy for approval to speak to outsiders or understand what information should be kept secret. When I asked an interviewee how he would go about receiving approval to be on the record for our conversation, if he had wanted to, he replied:

> "Basically I would email a coworker (or slack a coworker) who is in change of IP and patents who is in charge of this stuff and here's what's going on I'm doing this interview for a dissertation, what would you be OK with or not. And this is, yeah, so not a formal route but it would be …yeah."

Other interviewees had no idea who they would talk to to figure out what on their project needed to be kept secret, or how they could best engage with outsiders. They usually just wanted to speak off the record, and felt they were not supposed to talk to anyone.

Perhaps the confusion over what should be kept secret in these employees' work lives comes from a certain amount of denial among those in the industry that practices are not as open, even within particular regions like Silicon Valley, as they once were. The resulting employee paranoia from all the NDAs, private investigators (referenced below), and chastising at all hands briefings is not an effective or rational information management strategy. This chaotic and threatening culture is difficult for even well intentioned employees to meaningfully enforce. The tacit "keep everything secret" that results from unclear protocols and missions dilutes the focus of those entrusted with real secrets.

These findings were also contradictory to other studies run focused on particular types of information sharing between industry partners. Sedenberg and Dempsey[377] illustrate there is a high degree of sharing within highly vetted, exclusive trust-based sharing groups that are based on individual membership not their employing organizations. Even though the information exchanged in these groups was highly sensitive from a cybersecurity perspective—which has investment and public relations consequences for firms—these sub-groups had a concrete understanding of what they could share to receive feedback and help, and these information sharing networks often worked together among competing firms. This dissertation did not find evidence of established networks where individuals felt they could share and learn from others, perhaps because the types of roles and information were so highly varied, finding clear missions and purpose are impossible. Given the nature of some of their jobs, perhaps methods-based meet ups are sufficient. However in an age where there are questions on algorithm's design impacts and ethics, this aura of secrecy seems only to be fueling a cultural gap by limiting the dissenting and constructive voices that could otherwise be included in the conversations.

NDAs For Everyone

NDAs for employees has grown the scope and intensity of contracts signed by employees, creating significant monetary and career consequences if a leak occurs. The use of NDAs are no longer limited to exiting a role, particularly privileged roles as advisors or team members on special projects, or used during business negotiations where sensitive and vulnerable information needs to be exchanged. In mid-sized and larger firms, NDAs are present on iPads-style touchscreens at each entry, and some firms require employees to be under multiple NDAs[378] for their own job. Visitor NDAs (or NDA-like agreements) are required to enter regardless of the level of access or purpose of the meeting, has become a new chilling factor that extends beyond the firm and theoretically locks any academic (as well as activists or journalists) who signs into language that may prevent them writing about a firm in general after attending a meeting, happy hour, or giving a talk on a premise. NDAs are poorly understood by many people, and have a vague holding power for many years. Language in many NDAs is vague on what counts as proprietary or sensitive information, and how this classification of information will be signaled to the signee. This proliferation of

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[377] Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In Rewired: Cybersecurity Governance, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

[378] MacInnis, Matt. "How I Survived and Thrived in Apple's Legendary Environment of Super-Secrecy." recode, 2017.

NDAs counters the limited use and trust-base relationships of tech firms of the past, and based on this research are having a much greater chilling effect on intellectual and social discourse around technology.

It is unfortunately out of scope of this dissertation study but the impact these practices have on journalists covering tech and corporate leakers should be considered. Journalists are sometimes bound to the same rigid NDAs, and the the culture to prosecute leakers to the press about internal practices creates a culture of employee fear that feeds back and impacts conversations that relate to R&D and innovation.

Employee NDAs

Employee NDAs were a behemoth and referenced repeatedly during this research, particularly by individuals who were cautious about what they could and could not say. One acquaintance, upon talking about her recent NDA experience at a large and prominent tech firm in the Bay Area, nervously joked she did not even want to tell me about how long or how many NDAs she had signed, because it was probably against a clause in the contract. She expressed frustration about how she had tried to use her graduate training and prior exposure to tech law to read through the contract, but failed to fully understand what she was signing. All she knew was that a lot of money was on the line and the language was "scary," and that she better not say anything to anyone and risk her hiring bonus.

It was frequent for employees to not be sure about exactly what they had signed, or even how to go back and reference particular clauses. But the NDA was repeatedly alluded to with respect and deference—illustrating how seriously employees took the document.

Visitor NDAs—Reflection on my own experiences

I am not completely certain[379] how many NDAs I have signed throughout the course of this research, or in my lifetime. I have no ability to audit these contracts, no concept of how long they may be in effect, or what type of content they may cover.

When signing into companies for social and professional visits, the NDA was usually presented on a screen as if it was a TOS (Terms of Service) you would agree to after downloading software or a new app—except with the NDA you usually have to digitally sign with your finger. Typically about a page long for visitors, there was often no way to send a copy to yourself and I frequently befuddled the front desk staff by asking for a copy—which I made a practice of doing after a time. One time I was told the printer was broken, was given a copy "identical" blank copy, other times I was asked to follow up with my host for a

[379] I do however have a good idea, and know for a fact which companies I have not signed one for. For the last two years I have attempted to collect copies of all NDAs I was forced to sign. This uncertainty

digital copy—one she admitted sheepishly she'd have to figure out the process for obtaining a copy. Once the NDA was signed, I was given a temporary badge. In each of these cases, it would have been easy to enter my email address and have a copy sent to me automatically—one company does this with financial receipts on their platform service but that wasn't not an option for the NDA.

Signing an NDA for routine meetings—though perhaps overly cautious and obsessively thorough—is not entirely shocking. However, the NDA signing at most large companies and their subsidiaries (i.e. Facebook, Amazon, Google, Twitter) are automatically triggered regardless of visit purpose and levels of access. In some cases, the agreement is not a full NDA but a shorter code of conduct agreement. It is impossible to know since I did not request (and often having to insist) to have a copy printed for me, and the policies change over time.

Once at Twitch (owned by Amazon), I had to sign an NDA to visit a friend for an afterwork happy hour social at the company bar/cafeteria next door to the front desk. In 2017 I attended an event that was only co-sponsored by Facebook and was also required to sign yet another Facebook NDA—I've signed several iterations at many tech firms due to friends working at these companies and before I realized exactly what I was signing. Ironically, the event was about privacy and ethics, and one invitee asked to negotiate on the spot a particular clause—jeopardizing their ability to even participate in the invite only event. Another time, I was an invited speaker at Square (a company led by Twitter CEO Jack Dorsey) to discuss my own research and was asked to sign an NDA before I could enter and give a talk about my own developing research ideas to employees. This experience is not uncommon for academics or startups (particularly the academic oriented ones) who go to share their work and ideas within companies.

One startup CEO who holds a PhD and bridges the academic and startup worlds talked about the challenges working with big companies: "I'm learning about the business world and applied science and so forth all and these are part of our origin story to your point because I'm here, I'm finding out that here's a company inviting me as an academic to give an academic talk. And when I do I have to sign certain documents and that's part of the friction that you're talking talking about which scare me. And I try to establish good will while I'm there and hopefully that will help 'cause this is a company that is based on good will, but it's scary and then the process of talking to my colleagues while I'm contemplating this is a weird one for me existentially because I'm worried they're thinking I'm selling out 'cause I'm going to the big bad corporate world and they're wondering if I'm going to get the money because their grants are drying up."

The anxiety around simultaneously learning how to navigate corporate entities—and their opaque processes—to protect your own interests is difficult and adds uncertainty to these ventures for both academics and small companies alike. This uneasiness is further fed since many academics feel sheepish, admitting to others that they are pursuing these connections in the first place, harkening back to historical moments where academic researchers valued “pure” science research over industrial research. (See history section Chapter 4) Signing an NDA to go present your own work not only has the appearance of disingenuous discourse and one-sided protections for the firm that has the large legal team, but also may prevent certain individuals with personal stances on signing (or who lack the stomach to negotiate on the spot) to avoid these exchanges altogether.

Certainly not all companies employ the blanket visitor NDA strategy. Many sites I visited who were not necessarily “tech” giants but were otherwise large companies did not require an NDA, possibly because there was no internal threat model to desire one. The unpredictable nature of when an NDA might present itself is in and of itself part of the problem.

The Powerful Perception of NDAs

As is common with many policies or laws, sometimes the perception of the breadth and power of it is more powerful than the actual legal grounding. This perception and often expanding pervasiveness should not be underplayed as it holds very real consequences for how average people conduct themselves. The average person is not going to know the intricacies of what clauses will hold up in court, nor does the average organization or individual, including professionals like journalists, want to fight a public and expensive legal battle to win the right to repeat information or say something. This uneven playing field enables prominent tech companies to place a document before all visitors and employees whose power arguably lies more in the posturing than the actual strength (at least in many fringe cases). It also has allowed the NDA to take on a mythical level of might and prowess.

Throughout the course of this work, NDAs were catch all legal documents. It was common for interviewees to say things like: “I’m sure there’s something in my NDA about how or what I can say, but I don’t recall what that is.” NDAs operate like ephemeral oaths of silence, that instead of rooting their power in the documented language are often inaccessible to the signee and held only within the signee’s mind.

> “Again, I’d have to refer back to the NDA to know exactly how things are formulated but basically the sense is absolutely nothing. Completely zipped. You are not supposed to talk to partners, spouses, family, um, yeah. Completely tight lipped about it.”-Anonymous interviewee

It has also been reported that journalists who visit tech companies and refuse an NDA, if they are allowed in at all, are asked to wear a large red badge announcing to everyone they have not signed an NDA. This is unlikely to change any information that was disclosed to a journalist, because what rationale firm would disclose sensitive information they don’t want reported on to a journalist, but rather serves as mechanism to increase social pressure on visiting individuals.

Frequently when I have signed NDAs, it has been with my host and the receptionist staring intently at me. At times, I've had other visitors waiting to use the iPad next. This situational context makes understanding the clauses I'm agreeing to very difficult, even with familiarity into contracts and legal language, and resonates with discussions about privacy policies as unintelligible and unreasonable legal agreements for consumers to click through out of habit. Though NDAs and privacy policies differ in the situation and type of agreement, there are many parallels between the contexts of signing and broad future implications to users and average employees or visitors.

NDAs equipped with broad language and presented on small screens during a sign in procedure make it easy to seem like the contract "covers everything" and has a clear chilling effect on visitors and employees. In reality, it is relatively hard to prove in many cases that a disclosure and thus contract breach has occurred. However, in cases where journalists (or even an academic) writes about a company, the difficult burden of proof falls on the writer to prove information they learned did not come from a visit or "meeting" at a company during which the NDA was signed.

NDAs also frequently have vague termination dates, amounting to "when the information is publicly known" so that theoretically signing an NDA with a large tech firm means anything written after that time could be scrutinized and subject to legal action. Overall, there was great confusion about the staying power of NDAs. For instance at a dinner party, several technology NGO employees discussed a recent meeting and how they thought the NDA only covered that particular meeting and they had resolved not to sign any more (this is not the case). As discussed in Appendix D, the actual power of these contracts is disputed but hardly anyone wants to risk a lawsuit. Journalists rarely want a costly and public legal fight, and most academics and employees have no idea what their rights are or want to threaten their reputations and careers.

NDAs have a broad and hard to define chilling effect on employees and visitors to tech firms who use them as part of the "Welcome Mat" badge procedures. There are entire companies dedicated to facilitating the NDA service for companies[380]. They are also a legal mechanism that once triggered is virtually impossible to undo. Given the broad language of many NDAs found at visitor check ins, it potentially could stymie discourse about particular companies well into the future as people's careers evolve and technology changes. Even if it could be argued that information in question was learned outside of the company, or that information learned in future "meetings" was not even created at the time of the NDA, the chilling effect remains.

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[380] See for example: Envoy (https://envoy.com/features/nda/) Easy NDA (https://www.easynda.com/) and The Receptionist. https://thereceptionist.com/

NDAs are also negotiated by the individual, not the individual's professional institution (e.g., university). This lessens the negotiating power and ability to fully understand the contract. Other agreements signed by academics, like data sharing agreements, are usually negotiated and handled by offices within universities.

Startups are often an exception to this trend, because they are not yet saddled with a legal team or have the capacity to implement protocols that are not absolutely necessary. That is in part why most of the identified cases and interviewees are from startups.

Contexts from the past, exposure to leakers, and consequential corporate retaliation

The press around technology firms has evolved to become more participatory in critiques of the influence of technology on society, and larger social movements—#MeToo, issues gender and racial equality, national political division, free speech in the digital era, etc.— reach into the previously hip and exempt heroes of modern tech.[381] These issues make tech firms of high interest to investigative journalists, academics, activists, and users worldwide. Companies now seek to prevent their latest strategy or product release from being leaked to the press—a sometimes counterintuitive strategy to the desire to build press and hype—so they can control the narrative and maintain a competitive advantage among competitors. But companies also must seek to cultivate their public image and reputation. This section grapples with the chilling effects and efforts made by companies to prevent information leaks to the press and other sources.

"Every Friday we have a company wide meeting and that's a time that if there's something happened in terms of a potential leak they touch base and say 'hey remember this' or 'be careful of what you say'" -Anonymous interviewee

Many people I interviewed or spoke to in general had had personal experience with colleagues or friends getting in trouble for talking about what they do. This lore was found across companies and from individuals in my different positions. For example, one anonymous interviewee summed up their personal experience once we had established a rapport discussing other topics:

> "I had a colleague who was representing a company at a conference and a podcaster came up to him for some related field like AI or something like that and said, "Hey, can we talk about this kind of work you do for podcast?" Which

[381] Though in 2019 it may seem like a distant memory, at one time large technology companies were seen as innovators and "cool" companies, not problematic behemoths.

> he did. But, it talked about technology and the kind of stuff that they do and the different applications for it. At the very end, the podcaster asked, "Hey, what are your opinions on the ethics of what it is that you're doing?"
>
> And my colleague had his own thoughts on it and they talked about it for a good 10 minutes. Just sort of like a pie in the sky sort of discussion that really didn't mean much but because he was affiliated with the company in the podcast, it was not taken over very well because it's not the company's job to comment on the ethics of the research that people use our software for. It ended up being a little bit of a kerfuffle. Well, okay, these interactions have to be approved beforehand and hence my edginess about sharing the company name." -Anonymous interviewee about their anonymity

Employees were aware of the many ways their company would be able to surveil their activities and that these leaks (even small ones) are no longer ignored but actively chased. Stories in the press also contributed to the growing paranoia about leaking something—even accidentally. For instance, a story in The Guardian from March 2018 titled "'They'll Squash You Like a Bug': how Silicon Valley keeps a lid on leakers" details the technical measures by large technology firms to detect and find employees who leak material to the press.[382] The secondary headline sums up the relevance to this chapter succinctly by stating "working for a tech company may sound like all fun and ping-pong, but behind the facade is a ruthless code of secrecy — and retribution for those who break it."

Career experience also may have been a factor in level of comfort with discussing work practices. Despite the fact those who had personal exposure to a colleague or friend who had been punished were more skittish and less likely to talk on the record, the opposite was true for general experience. I found that industry veterans had their own clear mental models of what would be appropriate to discuss and what wouldn't be—whereas younger professionals did not have this internal guiding compass. This intuitive point is made significant when considering how young many startups and leading companies are. When the cutting edge is forged by a generation made paranoid about leakers and corporate retribution, knowledge transfer and an open society suffers.

Conclusion

Saxenian begins *Regional Advantage* describing the Massachusetts Route 128 and the ways in which it fell behind the innovative pace of Silicon Valley. "Practices of secrecy and corporate loyalty govern relations between firms and

[382] Solon, Olivia. "'They'll Squash You Like a Bug': How Silicon Valley Keeps a Lid on Leakers." The Gaurdian, 2018. https://www.theguardian.com/technology/2018/mar/16/silicon-valley-internal-work-spying-surveillance-leakers.

their customers, suppliers, and competitors, reinforcing a regional culture that encourages stability and self-reliance."[383] This contrasted with the dynamic and networked firms, where information flowed freely and firms fostered mutual trust despite fierce competitions. This section detailed the ways in which practices of secrecy and a new demand for corporate loyalty by employees has impacted employee activities and discourse around research, and suggests broader cultural impact. This section only begins to scratch the surface on larger phenomena, however. Reporting and writing like the coverage of "Bad Blood: Secrets and Lies in a Silicon Valley Startup"[384] detail how secrecy enabled massive fraud to persist even with the media spotlight. The practices of secrecy within technology firms are impacting not only research discourse and knowledge sharing, but information-intensive innovation strategies and issues of broader public interest.

[383] Saxenian, AnnaLee. Regional Advantage : Culture and Competition in Silicon Valley and Route 128. Cambridge, Mass.: Harvard University Press, 1994.

[384] Carreyrou, John. Bad Blood : Secrets and Lies in a Silicon Valley Startup. New York: Alfred A. Knopf, 2018.

Chapter 7: Conclusions

This dissertation study suggests that the role of the private firm within the R&D ecosystem is fundamentally changing, and challenging traditional data infrastructures and sites of research. This study establishes the key aspects and driving forces of change within Silicon Valley and contemporary tech firms' approach to research and development, via a focus and emphasis on information-intensive innovation for competitive advantage.

The success of many of these firms turns on the use of algorithms and design to respond to and shape human behavior, thus they demand the ability to leverage fundamental research in entirely new ways through internal practices, outside partnerships, and data sharing. These emerging practices have occurred both within traditional academic contexts as well as by forming new internal modalities that account for evolving concepts of research within the private firm. In addition to challenging prior theories of research and innovation, these shifts present new challenges to individual privacy, research ethics, and are generating new questions about the management of these issues through corporate governance and risk management practices. This shift toward information-intensive innovation and the affordances this allows has fundamentally altered the role of the private firm within the research ecosystem in a way that demands new policy considerations and strategy adjustments.

Policy Considerations

This analysis on how firms are managing and adapting to information-intensive innovation challenges the foundational models of research and innovation, builds off of practices from early Silicon Valley tech firms, and presents new opportunities for research moving forward. This dissertation research shows that many firms are outsourcing different aspects of their research to academic research partners: relying on external expertise, specialized equipment, academic publishing, and university/institution research ethics infrastructure to supplement in-house efforts. This research reconsiders the definitional boundaries of what activities are considered "formal research" from the perspective of interviewees, and in light of the changing embedded definitional assumptions derived from the linear innovation model. Recasting a broader scope of what could be considered research and contribute to the larger R&D ecosystem is important not only to thinking critically about what activities should (and could) be shared for public interests, but also in considering how traditional sites of research within industry are expanding. These changes accommodate the pressures of information-intensive innovation and the quest for more fundamental questions about our human nature.

Large tech firms often demand more of the public attention and scrutiny for their research and data sharing practices. However, this dissertation research shows small startups are also important actors within the information-intensive innovation ecosystem. Though large firms have more financial and infrastructure resources (as well as larger datasets), acknowledging the contributions and collaborations of smaller firms will be important to fully understanding emerging practices. Policies and programs should consider the diverse size of firms, and the different incentives and capacities both large and small firms have to collaborate and contribute to the knowledge ecosystem.

Similarly, in considering small companies (e.g., startups): there are policy opportunities to incentivize later data sharing as the firm grows but including it as a stipulation in Small Business Administration (SBA) grants in the US, for example. Additionally, socially good motivated VCs could require some allocation of future resources if the startup becomes successful to participate in these social good and research data sharing initiatives. It is out of the scope of this dissertation to dive into the details or limitations of such approaches, but the ways in which early funders or partners can "bake in" obligations for data sharing and research partnerships should be considered. Often attention is placed only on large companies with public shareholders and large legal surface areas, but creating cultures of social good and attention to sources for potential research partnerships from the beginning should be a strategy considered as well.

Many science and technology policies claim to encourage these types of industry/academic collaborations, but have not provided suggested practices and mechanisms that could be more readily adapted by firms—particularly startups. There is a need for established processes that create legal and technical infrastructure that more easily allows for data sharing and information-intensive research collaborations. Creating these tools and infrastructures will be vital to incentivizing firms to participate in these fundamental research activities and fostering these activities in a way that protects users but leverages research potential. Many of the firms interviewed struggled to determine how to collaborate and share data, and felt they each had to assume the burden of individual risk and creative ingenuity to make these aspirations fruitful.

Further, private data may be able to expand the reach and breadth of public infrastructure in an evolving, digitally-mediated society and with the proper considerations and new infrastructure help bridge to public interest applications, like research. In 2018, France announced plans to explore policies that require private sector sharing of data for use by governments, and ideally others,[385] in order to capitalize on the public benefit of privately-owned data. There are similar proposals in the UK, and cities like New York City are working on mandating data sharing in particular sectors like ride sharing.[386] However, mandating information sharing from the private sector is fraught in many sectors and often does not have the intended effects.[387] Creating incentives and policies that offer various forms of liability protection or external infrastructure/tools could help foster a healthier and more efficient public/private data sharing and research ecosystem. Grants from governments or foundations could also help incentivize public/private research partnerships, particularly for smaller firms that lack resources to devote time to create these mechanisms from scratch. However, if such grants were created the barrier to apply should kept at a minimum, since startups often lack grant writing expertise and are time/resource strapped.

The emerging secrecy practices and the proliferation of NDAs requires further study, but is growing in opposition to many of the other strategies for information-intensive innovation. This unresolved (and often unrecognized) tension needs to be addressed by firms, and considered by scholars more broadly as it relates to the larger ecosystem. Secrecy practices are having unintended effects. The strategy of making everyone within a company a key innovator has resulted in everyone feeling uncertain, and fosters an environment where everyone feels the need to stay quiet to protect their jobs and bonuses. This has had a damaging impact on the innovation culture under the facade of openness and egalitarian opportunity. NDA procedures, particularly for academic guests (as within the bounds of this dissertation study), should be reconsidered to foster a healthy and mutually beneficial relationship. The pervasiveness of visitor NDAs likely offers little protection to the firm unless it is an NDA put in place for a particular targeted partnership and exchange of ideas/information. Instead, visitor NDAs create an adversarial relationship and presents a chilling factor for engagement (e.g., some people will not visit or work with private companies even

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[385] Villani, Cedric. For a Meaningful Artificial Intelligence: Towards a French and European Strategy. *AI For Humanity* (2018). https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf.

Wallace, Nick. "Countries Can Learn from France’s Plan for Public Interest Data and Ai." *Center for Data Innovation*, 2018. https://www.datainnovation.org/2018/08/countries-can-learn-from-frances-plan-for-public-interest-data-and-ai/.

[386] Marshall, Aarian. "NYC Now Knows More Than Ever About Your Uber and Lyft Trips." Wired, 2019. https://www.wired.com/story/nyc-uber-lyft-ride-hail-data/.

[387] See, for instance the discussion of the downsides to mandated information sharing in: Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In Rewired: Cybersecurity Governance, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

on non-sensitive matters) as well as public/academic discourse. Rolling back ubiquitous NDA usage for academic engagement and limiting NDAs only to cases where sensitive information is being shared or exchanged would improve collaborations and early research discussions, without introducing meaningful risk to the private firm.

Limitations and Future Work

The findings of this dissertation are not meant to be representative of the experiences and processes of all firms and stakeholders in R&D or made generalizable to the point that all granularity from this study are abstracted and pixelated to the point of futility. The findings generated by this research is unlikely to be fully encompassing of all geographic localities throughout large spans of time. Mechanisms and theory developed should, however, contain the relevant details to contextualize findings that are dependent upon location and specific time constraints. The descriptions and analysis are meant to provide empirical evidence for contemporary and future discussions within the broader scope of this research, and inform a theories of practice described.

This dissertation is not intended to be my final professional contribution to the field, but rather a body of research I continue to build upon throughout my post-graduate work experience embedded in industry and future research opportunities. The inquiry included within this dissertation is merely a start for a lifelong pursuit of these foundational research questions.

Bibliography

"Google Flu Trends Data: Thank You for Stopping By." https://www.google.org/flutrends/about/.

"Skunk Works® Legal Notice." accessed February, 2019, https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunk-works-legal-notice.html.

"Skunk Works Origin Story." accessed February, 2019, https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunk-works-origin-story.html.

The Nuremberg Code (1947). US Government Printing Office (Washington DC: 1949). https://history.nih.gov/research/downloads/nuremberg.pdf.

"Fast Clinical Thermometer Takes Temperature in Seconds." Popular Mechanics, 1954, 123. https://books.google.com/books?id=sdwDAAAAMBAJ&pg=PA123&dq=1954+Popular+Mechanics+January&hl=en&sa=X&ei=Pv4YT5SlG5PoggekxISEDA&ved=0CDgQ6AEwAg#v=onepage&q&f=true.

The Institutional Guide to Dhew Policy on Protection of Human Subjects. Washington DC: DHEW Publication No (NIH) 72-102, 1971.

The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research. Department of Health, Education, and Welfare (1979). https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html.

"Apple's Morning After: Lots of Competition." Business Week December 29, 1980 (1980): 47-48.

"Skunkworks." The Economist, 2008. https://www.economist.com/news/2008/08/25/skunkworks.

"Head Skunk." Air & Space, 2010. https://www.airspacemag.com/history-of-flight/head-skunk-5960121/.

Evidence-Based Policymaking: A Guide for Effective Government. The PEW Charitable

Trust

MacArthur Foundation (2014). http://www.pewtrusts.org/~/media/assets/2014/11/-evidencebasedpolicymakingaguideforeffectivegovernment.pdf.

"Pregnancy and Lactation Labeling (Drugs) Final Rule." US Food and Drug Administration, 2014, accessed January, 2019, https://www.fda.gov/drugs/labeling/pregnancy-and-lactation-labeling-drugs-final-rule.

"Subpart a—Basic Hhs Policy for Protection of Human Research Subjects." In 5 U.S.C. 301; 42 U.S.C. 289(a); 42 U.S.C. 300v-1(b), 2017. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=83cd09e1c0f5c6937cd9d7513160fc3f&pitd=20180719&n=pt45.1.46&r=PART&ty=HTML#se45.1.46_1102.

"Hugo Campos: 10 Years with an Implantable Cardiac Device and *Almost* No Data Access." In QS Symposium 2018. Medium, February 2019 2018. https://medium.com/quantified-self-public-health/hugo-campos-10-years-with-an-implantable-cardiac-device-and-almost-no-data-access-71018b39b938.

"Revised Common Rule Regulatory Text." In 45 CFR 46, 2018. https://www.hhs.gov/ohrp/regulations-and-policy/regulations/revised-common-rule-regulatory-text/index.html.

"Inder Singh, Kinsa Founder & Ceo." CrunchBase, 2019, accessed January, 2019, https://www.crunchbase.com/person/inder-singh#section-overview.

"Evidence-Based Policymaking Collaborative." Brookings, nd, accessed August, 2018, https://www.brookings.edu/evidence-based-policymaking-collaborative/.

"Store.Alivecor." 2019, March 2019, https://store.alivecor.com.

Allen, Greg. "Zillow Data Used to Project Impact of Sea Level Rise on Real Estate." NPR, 2018. https://www.npr.org/2018/06/18/620939197/zillow-data-used-to-project-impact-of-sea-level-rise-on-real-estate.

Allen, Judith A. The Kinsey Institute : The First Seventy Years. Bloomington, Indiana: Indiana University Press, 2017.

Alsan, Marcella, and Marianne Wanamaker. Tuskegee and the Health of Black Men. Stanford University (2016). https://economics.stanford.edu/sites/g/files/sbiybj9386/f/tuskegee_22may2016-1.pdf.

Ansoff, H. Igor, and John M. Steward. "Strategies for a Technology Based Business." Harvard Business Review November/December (1967): 71-83.

Armstrong, John. "Reinventing Research at Ibm." Chap. 5 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p151-54. Boston, Mass.: Harvard Business School Press, 1996.

Athey, Susan, and Michael Luca. Economists (and Economics) in Tech Companies. https://www.hbs.edu/faculty/Publication%20Files/19-027_7e890058-c225-4803-a6f1-a6eb1db74027.pdf.

Aubrey, Allison. "Xanax or Zoloft for Moms-to-Be: A New Study Assesses Safety." NPR (NPR - Morning Edition), 2017. https://www.npr.org/sections/health-shots/2017/09/18/551020800/xanax-or-zoloft-for-moms-to-be-a-new-study-assesses-safety.

Bailey, Carol A. A Guide to Qualitative Field Research. Third Edition. ed. Los Angeles: SAGE Publications, 2018.

Bartlett, Howard R. "The Development of Industrial Research in the United States." Journal of the Patent Office Society 23 (1941).

"Kinsa Organization Overview." Crunch Base, 2019, accessed January, 2019, https://www.crunchbase.com/organization/kinsa-inc#section-overview.

Baxter, James Phinney. Scientists against Time. Boston,: Little, Brown and company, 1946.

Benderly, Beryl Lieff. "The Downs and Ups of Corporate Research." Science Magazine, 2017. https://www.sciencemag.org/careers/2017/05/downs-and-ups-corporate-research.

Bernard, H. Russell, and Gery Wayne Ryan. Analyzing Qualitative Data : Systematic Approaches. Los Angeles Calif.: SAGE, 2010.

Bichell, Rae Ellen. "A Fix for Gender-Bias in Animal Research Could Help Humans." NPR - All Things Considered, 2016. https://www.npr.org/sections/health-shots/2016/02/10/464697905/a-fix-for-gender-bias-in-animal-research-could-help-humans.

Bledsoe, Caroline H., Bruce Sherin, Adam G. Galinsky, Nathalia M. Headley, Carol A. Heimer, Erik Kjeldgaard, James Lindgren, et al. "Regulating Creativity: Research and Survival in the Irb Iron Cage." Northwestern University Law Review 101, no. 2 (2007). https://heinonline.org/HOL/LandingPage?handle=hein.journals/illlr101&div=24&id=&page=.

Bloomberg, Linda Dale, and Marie Volpe. Completing Your Qualitative Dissertation : A Road Map from Beginning to End. 2nd ed. Thousand Oaks, Calif.: SAGE Publications, 2012.

Bohn, Lauren. "Syrian History Is Unfolding on Whatsapp." Backchannel, 2017. https://www.wired.com/2017/02/syrian-history-is-unfolding-on-whatsapp/.

Bousquet, Chris. "Where Is Gentrification Happening in Your City?" Data-Smart City Solutions, 2017. https://datasmart.ash.harvard.edu/news/article/where-is-gentrification-happening-in-your-city-1055.

boyd, danah. "Untangling Research and Practice: What Facebook's "Emotional Contagion" Study Teaches Us." Research Ethics 12, no. 1 (2016). https://journals.sagepub.com/doi/full/10.1177/1747016115583379.

Bridenbaugh, Peter R. "The Future of Industrial R&D, or, Postcards from the Edge of the Abyss." Chap. 6 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p155-64. Boston, Mass.: Harvard Business School Press, 1996.

"Why Can't I Find 1890 Census Records?" Genealogy FAQs, 2019, https://www.census.gov/history/www/faqs/genealogy_faqs/why_cant_i_find_1890_census_records.html.

"1820 Overview." 2019, https://www.census.gov/history/www/through_the_decades/overview/1820.html.

Bush, Vannevar. Science the Endless Frontier. Washington, DC: US Government Printing Office, 1945.

Campbell, D.T. "Reforms as Experiments." American Psychologist 24, no. 4 (1969): 409-29.

Campos, Hugo. "The Heart of the Matter." 2015. https://slate.com/technology/2015/03/patients-should-be-allowed-to-access-data-generated-by-implanted-devices.html.

Canadian Institutes of Health Research. Application of Artificial Intelligence Approaches to Tackle Public Health Challenges - Workshop Report. (Toronto, ON: 2018). http://www.cihr-irsc.gc.ca/e/51018.html.

Carafano, James. "The Origins of American Think Tanks." The Daily Signal, October 23, 2015. https://www.dailysignal.com/2015/10/23/the-origins-of-american-think-tanks/.

Carafano, James Jay. "Next President Shouldn't Be a Mad Scientist." Washington DC: The Heritage Foundation, June 28, 2016. https://www.heritage.org/government-regulation/commentary/next-president-shouldnt-be-mad-scientist.

Cardell, Kylie. "Is a Fitbit a Diary? Self-Tracking and Autobiography." M/C Journal Vol 21, No 2 (2018). journal.media-culture.org.au/index.php/mcjournal/article/view/1348.

Carreyrou, John. Bad Blood : Secrets and Lies in a Silicon Valley Startup. New York: Alfred A. Knopf, 2018.

Carter, Bill. "A.C. Nielsen Jr., Who Built Ratings Firm, Dies at 92." New York Times (New York City, NY), October 4, 2011. https://www.nytimes.com/2011/10/05/business/media/ac-nielsen-jr-who-transformed-research-firm-dies-at-92.html.

Carvell, Tim. "Lockheed Raises a Stink over 'Skunkworks' Brought to You by Aspirin, Corn Flakes, and the Yellow Pages." Fortune Magazine, 2000. https://archive.fortune.com/magazines/fortune/fortune_archive/2000/03/06/275258/index.htm.

"What Is Public Health?", 2019, accessed February, 2019, https://www.cdcfoundation.org/what-public-health.

Center for American Progress. "Foster Partnerships between Universities and Industry to Address New Challenges." Washington DC, April 11, 2008. https://www.americanprogress.org/issues/general/news/2008/04/11/4244/foster-partnerships-between-universities-and-industry-to-address-new-challenges/.

Center for Disease Control and Prevention. Overview of Influenza Surveillance in the United States. (Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD): 2018). https://www.cdc.gov/flu/weekly/overview.htm.

———. Surveillance Strategy Report - How Sharing Data Digitally Benefits Health. (Atlanta, GA: 2018). https://www.cdc.gov/surveillance/innovation/sharing-data-digitally.html.

———. Public Health Surveillance Preparing for the Future. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (2018). https://www.cdc.gov/surveillance/pdfs/Surveillance-Series-Bookleth.pdf.

"Hiv Statistics." Center for Disease Control and Prevention,, 2019, accessed January, 2019, https://www.cdc.gov/hiv/pdf/statistics_Lab_reporting_DCL_final.pdf.

"About." Centers for Disease Control and Prevention,, 2019, accessed January, 2019, https://www.cdc.gov/about/organization/mission.htm.

Check Hayden, Erika. "Tech Titans Lure Life-Sciences Elite." Nature 526 (2015).

Chesbrough, Henry William. Open Innovation : The New Imperative for Creating and Profiting from Technology. Boston, Mass.: Harvard Business School Press, 2003.

———. "Open Innovation: A New Paradigm for Understanding Industrial Innovation." In Open Innovation : Researching a New Paradigm, edited by Henry William Chesbrough, Wim Vanhaverbeke and Joel West, xvii, 373 p. Oxford: Oxford University Press, 2006.

Chesbrough, Henry William, and Richard S. Rosenbloom. "The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spin-Off Companies." Industrial and Corporate Change 11, no. 3 (2002): 529-55.

Chesbrough, Henry William, Wim Vanhaverbeke, and Joel West. Open Innovation : Researching a New Paradigm. Oxford: Oxford University Press, 2006. Publisher description http://www.loc.gov/catdir/enhancements/fy0725/2006299758-d.html.

———. New Frontiers in Open Innovation. First edition. ed. Oxford: Oxford University Press, 2014.

Clayton, Janine A., and Francis S. Collins. "Policy: Nih to Balance Sex in Cell and Animal Studies." Nature International Weekly Journal of Science 509, no. 7500 (2014). https://www.nature.com/news/policy-nih-to-balance-sex-in-cell-and-animal-studies-1.15195#/b1.

Committee on Women's Health Research. Women's Health Research: Progress, Pitfalls, and Promise. National Academies Press (2010). https://www.nap.edu/read/12908/chapter/2.

Conrad, Clifton F. "A Grounded Theory of Academic Charge." Sociology of Education 51, no. 2 (1978): 101-12. https://www.jstor.org/stable/2112242?seq=1#page_scan_tab_contents.

Cooper, Daniel, "Rip Basis Peak: The Best Wearable You've Never Heard Of," Dana Wollman ed. Endgadget, 2016, https://www.engadget.com/2016/08/09/basis-peak-obituary/.

"Sarnoff Corporation, Wikipedia." 2019, https://en.wikipedia.org/wiki/Sarnoff_Corporation.

Cortada, James W. All the Facts : A History of Information in the United States since 1870. New York, NY: Oxford University Press, 2016.

Cowan, Jill. "California Today: Silicon Valley's Hot Holiday Gift." The New York Times,

2018. https://www.nytimes.com/2018/12/05/us/california-today-air-pollution-monitors.html.

Crawford, Kate. "The Hidden Biases in Big Data." Harvard Business Review (2013). https://hbr.org/2013/04/the-hidden-biases-in-big-data.

Creswell, John W. Research Design : Qualitative, Quantitative, and Mixed Methods Approaches. 3rd ed. Thousand Oaks, Calif.: Sage Publications, 2009. Table of contents only http://www.loc.gov/catdir/toc/ecip0810/2008006242.html.

———. Qualitative Inquiry and Research Design : Choosing among Five Approaches. 3rd ed. Los Angeles: SAGE Publications, 2013.

Creswell, John W., and John W. Creswell. Qualitative Inquiry & Research Design : Choosing among Five Approaches. 2nd ed. Thousand Oaks: Sage Publications, 2007.

———. Qualitative Inquiry and Research Design : Choosing among Five Approaches. 3rd ed. Los Angeles: SAGE Publications, 2013.

Creswell, John W., and Vicki L. Plano Clark. Designing and Conducting Mixed Methods Research. 2nd ed. Los Angeles: SAGE Publications, 2011.

Dale, Brandy. "Pornhub and Youporn Move to Keep Your Taste in Privates Private." Observer, 2017. https://observer.com/2017/03/pornhub-youporn-tls-secure/.

Davidow, William H., and Michael S. Malone. The Virtual Corporation : Structuring and Revitalizing the Corporation for the 21st Century. 1st ed. New York: HarperCollinsPublishers, 1992.

Dean, Michelle. "Contracts of Silence." Columbia Journalism Review (2018). https://www.cjr.org/special_report/nda-agreement.php.

Derry, Min, "Writing Strategies: What’s Your Positionality?," WEINGARTENLEARNINGRESOURCES ed., 2017, https://weingartenlrc.wordpress.com/2017/01/09/research-writing-whats-your-positionality/.

Dinatale, Miriam. Presentation: Two Years In: Lessons Learned with the Pregnancy and Lactation Labeling Ruleapproaches to Human Data. (2017). https://www.fda.gov/media/111774/download.

Dretske, Fred I. Knowledge & the Flow of Information. 1st MIT Press ed. Cambridge, Mass.: MIT Press, 1981.

Dreyfuss, Emily. "Women's Sexuality Is Still Taboo for Tech - at Least at Ces." Wired,

2019. https://www.wired.com/story/ose-vibrator-ces-controversy/.

Editorial Board. "Editorial Expression of Concern: Experimental Evidence of Massivescale Emotional Contagion through Social Networks." Proceedings of the National Academy of Sciences 29 (2014): 111. https://europepmc.org/articles/pmc4115552.

"Ces Will Honor Your Innovation So Long as It Doesn't Fuck." 2019, 2019, https://gizmodo.com/ces-will-honor-your-innovation-so-long-as-it-doesnt-fuc-1831621873?rev=1547076565381.

Einav, L., and J. Levin. "Economics in the Age of Big Data." Science 346, no. 6210 (Nov 7 2014): 1243089. https://doi.org/10.1126/science.1243089. https://www.ncbi.nlm.nih.gov/pubmed/25378629.

Eschner, Kat. "The Surprising Origins of Kotex Pads." Smithsonian Magazine, August 11, 2017. https://www.smithsonianmag.com/innovation/surprising-origins-kotex-pads-180964466/.

Fassler, Joe. "How Doctors Take Women's Pain Less Seriously." The Atlantic, 2015. https://www.theatlantic.com/health/archive/2015/10/emergency-room-wait-times-sexism/410515/.

Fast, Norman D. The Rise and Fall of Corporate New Venture Divisions. Research for Business Decisions. Ann Arbor, Mich.: UMI Research Press, 1978.

"Wcb Archived Data and Statistical Reports." nd, accessed April, 2019, https://www.fcc.gov/oea-archived-data-and-statistical-reports.

Fetters, Ashley. "The Doctor Doesn't Listen to Her. But the Media Is Starting To." The Atlantic, 2018. https://www.theatlantic.com/family/archive/2018/08/womens-health-care-gaslighting/567149/.

———. "The Tampon: A History." The Atlantic, June 1, 2015. https://www.theatlantic.com/health/archive/2015/06/history-of-the-tampon/394334/.

Fisk, Catherine L. Working Knowledge : Employee Innovation and the Rise of Corporate Intellectual Property, 1800-1930. Studies in Legal History. Chapel Hill: University of North Carolina Press, 2009.

Flick, Catherine. "Informed Consent and the Facebook Emotional Manipulation Study." Research Ethics 12, no. 1 (2016). https://journals.sagepub.com/doi/full/10.1177/1747016115599568.

Florida, Richard. "The Gentrification Puzzle." 2013. https://www.citylab.com/equity/2013/11/why-some-places-gentrify-more-others/7588/.

Floridi, Luciano. The Philosophy of Information. Oxford ; New York: Oxford University Press, 2011.

Food & Drug Administration. Development & Approval Process (Drugs). (2018). https://www.fda.gov/Drugs/DevelopmentApprovalProcess/.

Food and Drug Administration. "Content and Format of Labeling for Human Prescription Drug and Biological Products; Requirements for Pregnancy and Lactation Labeling." Federal Register, 79 FR 72063 (2014). https://www.federalregister.gov/documents/2014/12/04/2014-28241/content-and-format-of-labeling-for-human-prescription-drug-and-biological-products-requirements-for#citation-6-p72075.

Franconi, Flavia, Sandra Brunelleschi, Luca Steardo, and Vincenzo Cuomo. "Gender Differences in Drug Responses." Pharmacological Research 55, no. 2 (2007): 81-95. https://www.sciencedirect.com/science/article/abs/pii/S1043661806002040.

Franklin, Benjamin. The Autobiography of Benjamin Franklin : The Illustrated Edition. Minneapolis, MN: Voyageur Press, 2016.

Fraser, Jill Andresky. "Keeping Your Numbers Secret." 16, no. 2 (1994).

Garrison, Laura Turner. "10 Scientists Who Experimented on Themselves." Mental Floss, November 12, 2011 2011. http://mentalfloss.com/article/29241/10-scientists-who-experimented-themselves.

Garrison, Peter. "Head Skunk." Air & Space (2010). https://www.airspacemag.com/history-of-flight/head-skunk-5960121/.

Garun, Natt. "Pornhub Now Turns on Encryption by Default." The Verge,, 2017. https://www.theverge.com/2017/3/30/15125048/pornhub-youporn-https-encryption-privacy.

Gehani, Narain. Bell Labs : Life in the Crown Jewel. 1st ed. Summit, NJ: Silicon Press, 2003. Table of contents http://www.loc.gov/catdir/toc/fy043/2002012730.html.

George, Alexander L., and Andrew Bennett. Case Studies and Theory Development in the Social Sciences. Bcsia Studies in International Security. Cambridge, Mass.: MIT Press, 2005.

Gertner, Jon. The Idea Factory : Bell Labs and the Great Age of American Innovation. New York: Penguin Press, 2012.

———. "Like Building Refrigerators: Bell Labs and the End of Game-Changing Innovation." Time, March 27, 2012. http://business.time.com/2012/03/27/like-building-refrigerators-bell-labs-and-the-end-of-game-changing-innovation/.

Gigerenzer, Gerd. "Can Search Engine Data Predict Pancreatic Cancer?". The BMJ 358:j3159 (2017). https://www.bmj.com/content/358/bmj.j3159.

Ginsberg, J., M. H. Mohebbi, R. S. Patel, L. Brammer, M. S. Smolinski, and L. Brilliant. "Detecting Influenza Epidemics Using Search Engine Query Data." Nature 457, no. 7232 (Feb 19 2009): 1012-4. https://doi.org/10.1038/nature07634. https://www.ncbi.nlm.nih.gov/pubmed/19020500.

Gitelman, Lisa. "Raw Data" Is an Oxymoron. Infrastructures Series. Cambridge, Massachusetts ; London, England: The MIT Press, 2013.

Goodkind, Nicole. "Stormy Daniels and Donald Trump Non-Disclosure Was Bungled by Texas Notary: Report." Newsweek, 2018. https://www.newsweek.com/stormy-daniels-notary-texas-trump-cohen-nda-1122464.

Goodman, Robert M. "Rewriting David and Goliath: A Small Company's Experience in Collaborative R&D." In Managing R&D and Technology: Competition and Collaboration, edited by Evelyn Samore and James K. Brown, 39: The Conference Board, 1988.

Gostin, Lawrence O., and Lindsay F. Wiley. Public Health Law : Power, Duty, Restraint. Third edition. ed. Oakland, California: University of California Press, 2016.

Grimmelmann, James. "The Law and Ethics of Experiments on Social Media Users." Colorado Technology Law Journal 13 (2015): 219. https://james.grimmelmann.net/files/articles/social-media-experiments.pdf.

Grindley, Peter, David C. Mowery, and Brian Silverman. "Sematech and Collaborative Research: Lessons in the Design of High-Technology." Journal of Policy Analysis and Management 13, no. 4 (1994): 723-58.

Grudzen, C. R., G. Ryan, W. Margold, J. Torres, and L. Gelberg. "Pathways to Health Risk Exposure in Adult Film Performers." [In eng]. J Urban Health 86, no. 1 (Jan 2009): 67-78. https://doi.org/10.1007/s11524-008-9309-4. https://www.ncbi.nlm.nih.gov/pubmed/18709554.

Gunter, Chase. "How Government Data Is at Risk." FCW The Business of Federal Technology (2018). https://fcw.com/articles/2018/02/27/open-data-policy-gunter.aspx.

Guston, David H. "Understanding 'Anticipatory Governance'." Social Studies of Science 44, no. 2 (2014): 218-42.

Haghi, M., K. Thurow, and R. Stoll. "Wearable Devices in Medical Internet of Things: Scientific Research and Commercially Available Devices." [In eng]. Healthc Inform Res 23, no. 1 (Jan 2017): 4-15. https://doi.org/10.4258/hir.2017.23.1.4. https://www.ncbi.nlm.nih.gov/pubmed/28261526.

Hall, Mark. "Secrecy Eating at Apple." (2004). https://www.computerworld.com/article/2565666/secrecy-eating-at-apple.html.

Hamilton, Jon. "Female Athletes Are Closing the Gender Gap When It Comes to Concussions." NPR - Health News, 2017. https://www.npr.org/sections/health-shots/2017/07/24/538294331/female-athletes-are-closing-the-gender-gap-when-it-comes-to-concussions.

Hansen, Mark. "To Reduce Privacy Risks, the Census Plans to Report Less Accurate Data." The New York Times, 2018. https://www.nytimes.com/2018/12/05/upshot/to-reduce-privacy-risks-the-census-plans-to-report-less-accurate-data.html.

Hanson, B. L. "A Brief History of Applied Behvioral Science at Bell Laboratories." The Bell System Technical Journal 62, no. 6 (1983): 1571-90.

Haskell, Rob. "Serena Williams on Motherhood, Marriage, and Making Her Comeback." Vogue, 2018. https://www.vogue.com/article/serena-williams-vogue-cover-interview-february-2018.

Hayden, Erika Check. "Tech Titans Lure Life-Sciences Elite." Nature, 2015.

"Hematology-Oncology/Gynecologic Cancer." 2019, accessed March 2019, https://www.healio.com/hematology-oncology/gynecologic-cancer/news/online/%7b3a17f7e9-435c-4f11-9e44-211c4a44537d%7d/gynecologic-cancer-research-disproportionally-underfunded.

Health, National Institute of. Nih Policy and Guidelines on the Inclusion of Women and Minorities as Subjects in Clinical Research. US Department of Health & Human Services (2017). https://grants.nih.gov/grants/funding/women_min/guidelines.htm.

Heinrich, Janet. "Drug Safety: Most Drugs Withdrawn in Recent Years Had Greater Health Risks for Women." United States General Accounting Office (GAO.gov), 2001. https://www.gao.gov/new.items/d01286r.pdf.

Hilts, Philip J. "Abortion Debate Clouds Research on Fetal Tissue." The New York Times (NYC, NY), 1989. https://www.nytimes.com/1989/10/16/us/abortion-debate-clouds-research-on-fetal-tissue.html.

Hochheiser, Sheldon. "Your Engineering Heritage: Bell Labs and the Transistor." IEEE

InSight (Piscataway, NJ), 2009. https://insight.ieeeusa.org/articles/your-engineering-heritage-bell-labs-and-the-transistor/.

Hoffman, Anna Lauren. "Data Violence and How Bad Engineering Choices Can Damage Society." Medium, 2018. https://medium.com/s/story/data-violence-and-how-bad-engineering-choices-can-damagesociety-39e44150e1d4.

Holstein, James A., and Jaber F. Gubrium. The Active Interview. Qualitative Research Methods. Thousand Oaks: SAGE Publications, 1995.

Homer, Brady. "Studying Female Physiology a Priority in the New Era of Exercise Science." Medium.com, 2018. https://medium.com/@bradyholmer/studying-female-physiology-a-priority-in-the-new-era-of-exercise-science-e01aaf0b8d06.

Hounshell, David A. "The Evolution of Industrial Research in the United States." Chap. 1 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p. 13-86. Boston, Mass.: Harvard Business School Press, 1996.

Hounshell, David A., and John K. Smith. Science and Corporate Strategy : Du Pont R&D, 1902-1980. Studies in Economic History and Policy. Cambridge Cambridgeshire ; New York: Cambridge University Press, 1988.

"Research, Ibm." nd, 2019, http://www.research.ibm.com/history/.

"About/Budget/Data/Research Funding." 2019, accessed March 2019, https://www.cancer.gov/about-nci/budget/fact-book/data/research-funding.

"Intel Completes Acquisition of Basis Science Inc." Intel News Release, 2014, 2018, https://newsroom.intel.com/news-releases/intel-completes-acquisition-of-basis-science-inc/#gs.1xzc98.

"Safety Recall Notice for All Basis Peak Watches." Intel, 2016, accessed December, 2018, https://www.intel.com/content/www/us/en/support/articles/000025310/emerging-technologies/wearable-devices.html.

Israel, David, and John Perry. "What Is Information?". In Information, Language and Cognition, edited by Philip P. Hanson: University of British Columbia Press, 1990.

Isreal, Paul B. "Inventing Industrial Research: Thomas Edison and the Menlo Park Laboratory." Endeavour 26, no. 2 (2002): 48-54.

Jewett, Frank. "The Academy—Its Charter, Its Functions, and Relations to the Government (as Originally Read before the Academy November 17, 1947)."

Proceedings of the National Academy of Sciences 48, no. 4 (1962): 481-90.

Johnson, Kelly, "Kelly's 14 Rules and Practices," https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/kelly-14-rules.html.

Joho, Jess. "Female Sex Toys Are Immoral, but Vr Porn Is a-Ok at Ces." Mashable (Mashable.com), 2019. https://mashable.com/article/ces-2019-sex-toy-controversy-lora-dicarlo-ose/#TPLa8D7vPmqE.

Jordan, Matthew, and Nikki Pfarr. "Forget the Quantified Self. We Need to Build the Quantified Us." Wired, 2014. https://www.wired.com/2014/04/forget-the-quantified-self-we-need-to-build-the-quantified-us/.

Journal, HIPAA. "Wearable Devices Carry High Risk of Causing Hipaa Violations." HIPAA Journal (2015). https://www.hipaajournal.com/wearable-devices-carry-high-risk-of-causing-hipaa-violations-023/.

———. "New Report Published on Privacy Risks of Personal Health Wearable Devices." HIPAA Journal (2016). https://www.hipaajournal.com/new-report-published-privacy-risks-personal-health-wearable-devices-8626/.

Kadar, Andrew G. "The Sex-Bias Myth in Medicine." The Atlantic Monthly Digital Edition 274. (1994): 66-70. https://www.theatlantic.com/past/docs/issues/96jun/cancer/kadar.htm.

Kaihla, Paul, and Paul Sloan. "The Secrecy of Success." Business 2.0 6, no. 3 (2005): 78-78.

Katz, R. V., B. L. Green, and B. A. Dearing. "Re: Scharff Dp, Matthews Kj, Jackson P, Hoffsuemmer J, Martin E, Edwards D. More Than Tuskegee: Understanding Mistrust About Research Participation. J Health Care Poor Underserved. 2010 Aug;21(3):879–97." [In eng]. J Health Care Poor Underserved 22, no. 1 (Feb 2011): 397-8; author reply 99-400. https://www.ncbi.nlm.nih.gov/pubmed/21409850.

Kenney, Martin. Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region. Stanford, Calif.: Stanford University Press, 2000. Publisher description http://www.loc.gov/catdir/description/cam021/00034523.html

———. "Introduction." Chap. 1 In Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region, edited by Martin Kenney, xvi, 285 p. Stanford, Calif.: Stanford University Press, 2000.

Kevles, Daniel J. "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944-46." Technology and Culture 16, no. 1 (1975): 20-47. https://www.jstor.org/stable/3102364.

———. The Physicists: The History of a Scientific Community in Modern America. Alfred

A. Knope, 1978.

———. Principles and Politics in Federal R&D Policy, 1945-1990: An Appreciation of the Bush Report. National Science Foundation (1990). http://onlinebooks.library.upenn.edu/webbin/book/lookupname?key=Kevles%2c%20Daniel%20J%2e%20Principles%20and%20politics%20in%20federal%20R%26amp%3bD%20policy%2c%201945-1990%3a%20an%20appreciation%20of%20the%20Bush%20report.

Kidder, Tracy. "The Talk of Boca." PC Magazine, November 1983, 1983, 163-70.

Kiesel, Laura, "Women and Pain: Disparities in Experience and Treatment," Harvard Health Publishing ed. Harvard Health Blog, 2017, https://www.health.harvard.edu/blog/women-and-pain-disparities-in-experience-and-treatment-2017100912562.

King, Noel. "Rep. Costello Hopes House Facebook Hearings Will Dig Deeper." NPR, 2018. https://www.npr.org/2018/04/11/601437148/rep-costello-hopes-house-facebook-hearings-will-dig-deeper.

Klaassen, M. J., and J. Peter. "Gender (in)Equality in Internet Pornography: A Content Analysis of Popular Pornographic Internet Videos." [In eng]. J Sex Res 52, no. 7 (2015): 721-35. https://doi.org/10.1080/00224499.2014.976781. https://www.ncbi.nlm.nih.gov/pubmed/25420868.

Kleinman, Daniel Lee. Politics on the Endless Frontier : Postwar Research Policy in the United States. Durham: Duke University Press, 1995.

Kleinsman, John., and Sue Buckley. "Facebook Study: A Little Bit Unethical but Worth It?". Journal of Bioethical Inquiry 12, no. 2 (2015): 179-82. https://link.springer.com/article/10.1007/s11673-015-9621-0.

Kodjak, Alison. "Research Gaps Leave Doctors Guessing About Treatments for Pregnant Women." NPR Health News (NPR - All Things Considered), 2018. https://www.npr.org/sections/health-shots/2018/12/10/673897043/research-gaps-leave-doctors-guessing-about-treatments-for-pregnant-women.

Kramer, Adam D., Jamie E. Guillory, and Jeffrey T. Hancock. "Emotional Contagion through Social Networks." PNAS Proceedings of the National Academy of Sciences of the United States of America (2014). https://www.pnas.org/content/111/24/8788.

Lazer, David, and Ryan Kennedy. "What We Can Learn from the Epic Failure of Google Flu Trends." Wired, 2015. https://www.wired.com/2015/10/can-learn-epic-failure-google-flu-trends/.

Lazer, David, Ryan Kennedy, Gary King, and Alessandro Vespignani. "The Parable of Google Flu: Traps in Big Data Analysis." Science 343, no. 6176 (2014): 1203-05. http://science.sciencemag.org/content/343/6176/1203.full.

Lee, Anna Sohee, "I Dped Myself to Prove That Asses and Vaginas Do the Same Thing During Orgasm," Lioness, February 22, 2019, 2019, https://blog.lioness.io/i-dped-myself-to-prove-that-asses-and-vaginas-do-the-same-thing-during-orgasm-76c22e1b4d7a.

"Pragmatism." Stanford Encyclopedia of Philosophy, 2008, 2018, https://plato.stanford.edu/entries/pragmatism/.

Lenyoun, Hanson. "Health and Fitness Data Is Useless." 2016. https://techcrunch.com/2016/02/08/health-and-fitness-data-is-useless/.

Levine, Steve. "What Obama Could Learn from Bell Labs." The FP Group (Washington DC), March 15, 2012. https://foreignpolicy.com/2012/03/15/what-obama-could-learn-from-bell-labs/.

Lieberman, Hallie. "Desexing the Kinsey Institute." The New York Review of Books (2018). https://www.nybooks.com/daily/2018/03/20/desexing-the-kinsey-institute/.

Lioness, "Orgasm Patterns Using the Lioness Vibrator," Lioness, 2017, https://blog.lioness.io/orgasm-patterns-using-the-lioness-f9b55b7834de.

"Organization Overview." 2019, 2019, https://www.crunchbase.com/organization/lioness#section-overview.

"Frequently Asked Questions." 2019, accessed 2019, https://lioness.io/pages/frequently-asked-questions.

Love, Julia. "Why Has Innovative Apple Spawned So Few Startups? The Company's Strict Code of Secrecy, Insular Culture Could Be a Factor." The Record, 2015, C8.

MacInnis, Matt. "How I Survived and Thrived in Apple's Legendary Environment of Super-Secrecy." recode, 2017. https://www.recode.net/2017/9/11/16288896/apple-secrecy-inkling-culture-leadership-transparency-values.

———. "How I Survived and Thrived in Apple's Legendary Environment of Super-Secrecy." recode, 2017.

MacMillan, Douglas. "Apple Swears Ipad Partners to Secrecy." Bloomberg.com, 2010.

Magoun, Alexander B. David Sarnoff Research Center : Rca Labs to Sarnoff Corporation. Images of America. Charleston, S.C.: Arcadia, 2003. Publisher description http://

www.loc.gov/catdir/enhancements/fy0615/2003108748-d.html.

Main, Jeremy, and Rahul Jacob. "How to Steal the Best Ideas Around." Fortune, 1992.

Manwani, Archana R. "The Latest and Greatest Updates About Non-Compete and Non-Solicitation Agreements in California." The National Law Review (2018). https://www.natlawreview.com/article/latest-and-greatest-updates-about-non-compete-and-non-solicitation-agreements.

Marshall, Aarian.
———. "The Tragedy of Canada's Census." Citylab, 2015. https://www.citylab.com/equity/2015/02/the-tragedy-of-canadas-census/385846/.
———. "Nyc Now Knows More Than Ever About Your Uber and Lyft Trips." Wired, 2019. https://www.wired.com/story/nyc-uber-lyft-ride-hail-data/.

Masterson, Karen. The Malaria Project : The U.S. Government's Secret Mission to Find a Miracle Cure. New York, New York: New American Library, 2014.
———. The Malaria Project : The U.S. Government's Secret Mission to Find a Miracle Cure. New York, New York: New American Library, 2014.

Matveeva, Sophia. "Why Tech Products for Women Are Underfunded and Why This Is a Great Opportunity." Forbes, 2018. https://www.forbes.com/sites/sophiamatveeva/2018/08/16/why-tech-products-for-women-are-underfunded-and-why-it-is-a-great-opportunity/#36e19aaa3145.

Mayor, S. "Pfizer Will Not Apply for a Licence for Sildenafil for Women." BMJ 328, no. 7439 (Mar 6 2004): 542. https://doi.org/10.1136/bmj.328.7439.542. https://www.ncbi.nlm.nih.gov/pubmed/15001492.

McCracken, Grant David. The Long Interview. Qualitative Research Methods. Newbury Park, Calif.: Sage Publications, 1988.

McElhatton, P. R. "The Effects of Benzodiazepine Use During Pregnancy and Lactation." [In eng]. Reprod Toxicol 8, no. 6 (1994 Nov-Dec 1994): 461-75. https://www.ncbi.nlm.nih.gov/pubmed/7881198.

Mees, C. E. Kenneth. "The Organization of Industrial Scientific Research." Science, New Series 43, no. 1118 (1916): 763-73.
———. The Organization of Industrial Scientific Research. 1 ed. New York, NY: McGraw-Hill Book Company Inc. , 1920.

"Keeping Safari a Secret." 2013, https://donmelton.com/2013/01/03/keeping-safari-a-secret/.

Metcalf, Jacob, and Kate Crawford. "Where Are Human Subjects in Big Data Research?

The Emerging Ethics Divide." Big Data and Society (2016). https://journals.sagepub.com/doi/full/10.1177/2053951716650211.

Moore, Gordon E. "Some Personal Perspectives on Research in the Semiconductor Industry." Chap. 7 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p165-74. Boston, Mass.: Harvard Business School Press, 1996.

Morgan, David L. Focus Groups as Qualitative Research. Qualitative Research Methods Series. 2nd ed. Thousand Oaks, Calif.: Sage Publications, 1997. Publisher description http://www.loc.gov/catdir/enhancements/fy0655/96025389-d.html

Table of contents only http://www.loc.gov/catdir/enhancements/fy0655/96025389-t.html.

Mowery, David C. "The Emergence and Growth of Industrial Research in America Manufacturing, 1899-1946." PhD Dissertation Stanford University, 1981.

———. "Industrial Research and Firm Size, Survival, and Growth in American Manufacturing, 1921–1946: An Assessment." The Journal of Economic History 43, no. 4 (1983): 953-80.

Mowery, David C., and Nathan Rosenberg. "New Developments in U.S. Technology Policy: Implications for Competitiveness and International Trade Policy." Business and Public Policy (1989).

Mowery, David C., and David J. Teece. "Strategic Alliances and Industrial Research." Chap. 3 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p.111-30. Boston, Mass.: Harvard Business School Press, 1996.

Murphy, Carrie. "The Husband Stitch Isn't Just a Horrifying Childbirth Myth." In Healthline, 2018. https://www.healthline.com/health-news/husband-stitch-is-not-just-myth#1.

Murphy, William J. R & D Cooperation among Marketplace Competitors. New York: Quorum Books, 1991.

Myers, Mark B. "Research and Change Management in Xerox." Chap. 4 In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, p.133-50. Boston, Mass.: Harvard Business School Press, 1996.

Nabel, E. G. "Coronary Heart Disease in Women--an Ounce of Prevention." [In eng]. N Engl J Med 343, no. 8 (Aug 2000): 572-4. https://doi.org/10.1056/NEJM200008243430809. https://www.ncbi.nlm.nih.gov/pubmed/10954767.

Narayanamurti, Venkatesh, and Toluwalogo Odumosu. Cycles of Invention and Discovery : Rethinking the Endless Frontier. Cambridge, Massachusetts: Harvard University Press, 2016.
———. Cycles of Invention and Discovery : Rethinking the Endless Frontier. Cambridge, Massachusetts: Harvard University Press, 2016.

National Science Foundation. Definitions of Research and Development: An Annotated Compilation of Official Sources. (2018). https://www.nsf.gov/statistics/randdef/rd-definitions.pdf.

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick. Beyond Sputnik : U.S. Science Policy in the Twenty-First Century. Ann Arbor: University of Michigan Press, 2008. Table of contents only http://www.loc.gov/catdir/toc/ecip0811/2008007854.html.

Neff, Gina, and Dawn Nafus. Self-Tracking. The Mit Press Essential Knowledge Series. Cambridge, Massachusetts: The MIT Press, 2016.

Nelson, Richard R. "The Economics of Invention: A Survey of the Literature." The Journal of Business, no. 32 (1959): 101-27.

Nisen, Max. "17 of the Most Mysterious Corporate Labs Coolest Skunk Works." Business Insider (2013). https://www.businessinsider.com/coolest-skunk-works-2013-2.

Noll, A. Michael. "Bell System R&D Activities." Telecommunications Policy (1987).

O'Reilly, Brian. "Steve Jobs Tries to Do It Again." Fortune May 23, 1988 (1988): P 83-84.

OECD. Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development (2015). http://www.oecd.org/sti/inno/Frascati-Manual.htm.

Online, PBS. "Another Giant Is Born: The Founding of Intel." Arlington, VA, 1999. http://www.pbs.org/transistor/background1/events/intelfounded.html.

"Global Report." 2017, https://opendatabarometer.org/4thedition/report/.

Orlans, Harold. "Developments in Government Policies toward Science and Technology." Chap. 9 In Public Science Policy and Administration, edited by Albert H. Rosenthal. Albuquerque, NM: University of New Mexico Press, 1973.

Panger, Galen. "Reassessing the Facebook Experiment: Critical Thinking About the Validity of Big Data Research." Information, Communication & Society 19, no.

Issue 8 (2015): 1108-26. https://www.tandfonline.com/doi/full/10.1080/1369118X.2015.1093525.

Patton, Michael Quinn, and Michael Quinn Patton. Qualitative Evaluation and Research Methods. 2nd ed. Newbury Park, Calif.: Sage Publications, 1990. Publisher description http://www.loc.gov/catdir/enhancements/fy0658/89024244-d.html

Pawson, Ray. Evidence-Based Policy: A Realist Perspective. Sage Publishing, 2006.

Pearce, J. M. "A Brief History of the Clinical Thermometer." [In eng]. QJM 95, no. 4 (Apr 2002): 251-2. https://www.ncbi.nlm.nih.gov/pubmed/11937653.

Pinsker, Joe. "The Hidden Economics of Porn." The Atlantic, 2016. https://www.theatlantic.com/business/archive/2016/04/pornography-industry-economics-tarrant/476580/.

Plano Clark, Vicki L., and John W. Creswell. The Mixed Methods Reader. Thousand Oaks, Calif.: Sage Publications, 2008. Table of contents only http://www.loc.gov/catdir/toc/ecip0720/2007023770.html.

Post, Tom. "Bill Gates's Soft Landing." Newsweek 124, no. 4 (1994): 40.

Prendergast, B. J., K. G. Onishi, and I. Zucker. "Female Mice Liberated for Inclusion in Neuroscience and Biomedical Research." [In eng]. Neurosci Biobehav Rev 40 (Mar 2014): 1-5. https://doi.org/10.1016/j.neubiorev.2014.01.001. https://www.ncbi.nlm.nih.gov/pubmed/24456941.

"Summary Background." 2019, accessed March 2019, https://www.nap.edu/read/12908/chapter/2.

"Eworld Appendix." Center for Disease Control and Prevention, 2019, accessed January, 2019, https://wwwn.cdc.gov/eworld/Appendix/SourcesOfData.

"Cancer Prevention and Control." 2019, accessed January, 2019, https://www.cdc.gov/cancer/dcpc/data/other.htm.

"Datasets Cdc Wonder Systems." Center for Disease Control and Prevention, 2019, accessed January, 2019, https://wonder.cdc.gov/datasets.html.

Quartz Staff. "Big Little Blue Pill: After 20 Years, Viagra Has Impacted So Much More Than Just Sex." Quartz, 2018. https://qz.com/quartzy/1238783/its-the-20th-anniversary-of-viagra-heres-how-its-changed-the-world/.

Rabin, Roni Caryn. "Major Study of Drinking Will Be Shut Down." The New York Times

(New York City, NY), 2018. https://www.nytimes.com/2018/06/15/health/alcohol-nih-drinking.html?login=smartlock&auth=login-smartlock.

Rademaker, M. "Do Women Have More Adverse Drug Reactions?" [In eng]. Am J Clin Dermatol 2, no. 6 (2001): 349-51. https://doi.org/10.2165/00128071-200102060-00001. https://www.ncbi.nlm.nih.gov/pubmed/11770389.

Ramirez, Ernesto, "The Wearables Revolution: Personal Health Information as the Key to Precision Medicine." Bill of Health, 2017, http://blog.petrieflom.law.harvard.edu/2017/03/06/the-wearables-revolution-personal-health-information-as-the-key-to-precision-medicine/.

Reich, Leonard S. The Making of American Industrial Research : Science and Business at Ge and Bell, 1876-1926. Studies in Economic History and Policy. Cambridge Cambridgeshire ; New York: Cambridge University Press, 1985. Sample text http://www.loc.gov/catdir/samples/cam031/85006645.html

———. The Making of American Industrial Research : Science and Business at Ge and Bell, 1876-1926. Studies in Economic History and Policy. Cambridge Cambridgeshire ; New York: Cambridge University Press, 1985. Sample text http://www.loc.gov/catdir/samples/cam031/85006645.html

Ritz, S. A., D. M. Antle, J. Côté, K. Deroy, N. Fraleigh, K. Messing, L. Parent, et al. "First Steps for Integrating Sex and Gender Considerations into Basic Experimental Biomedical Research." [In eng]. FASEB J 28, no. 1 (Jan 2014): 4-13. https://doi.org/10.1096/fj.13-233395. https://www.ncbi.nlm.nih.gov/pubmed/24056086.

Rosenberg, Nathan, and Richard R. Nelson. "The Roles of Universities in the Advance of Industrial Technology." In Engines of Innovation : U.S. Industrial Research at the End of an Era, edited by Richard S. Rosenbloom and William J. Spencer, viii, 278 p. Boston, Mass.: Harvard Business School Press, 1996.

Rosenbloom, Richard S., and William J. Spencer. Engines of Innovation : U.S. Industrial Research at the End of an Era. Boston, Mass.: Harvard Business School Press, 1996.

Rosenthal, Albert H. "Approaches to Public Science Policy and Administration." Chap. 9 In Public Science Policy and Administration, edited by Albert H. Rosenthal. Albuquerque, NM: University of New Mexico Press, 1973.

Rudder, Christian, "We Experiment on Human Beings!
(So Does Everyone Else.)." OKCupid, 2014, https://web.archive.org/web/20170216190818/https://theblog.okcupid.com/we-experiment-on-human-beings-5dd9fe280cd5.

Sachdeva, P., B. G. Patel, and B. K. Patel. "Drug Use in Pregnancy; a Point to Ponder!" [In eng]. Indian J Pharm Sci 71, no. 1 (Jan 2009): 1-7. https://doi.org/10.4103/0250-474X.51941. https://www.ncbi.nlm.nih.gov/pubmed/20177448.

Safronova, Valeriya. "What's So 'Indecent' About Female Pleasure." The New York Times (NYC, NY), 2019. https://www.nytimes.com/2019/01/18/style/sex-toy-ces.html.

Saldaña, Johnny. The Coding Manual for Qualitative Researchers. 2nd ed. Los Angeles: SAGE, 2013.

Saxenian, AnnaLee. "The Origins and Dynamics of Production Networks in Silicon Valley." Research Policy 20 (1991): 423-37.

———. Regional Advantage : Culture and Competition in Silicon Valley and Route 128. Cambridge, Mass.: Harvard University Press, 1994.

Scharff, D. P., K. J. Mathews, P. Jackson, J. Hoffsuemmer, E. Martin, and D. Edwards. "More Than Tuskegee: Understanding Mistrust About Research Participation." J Health Care Poor Underserved 21, no. 3 (Aug 2010): 879-97. https://doi.org/10.1353/hpu.0.0323. https://www.ncbi.nlm.nih.gov/pubmed/20693733.

Schrag, Zachary M. "How Talking Became Human Subjects Research: The Federal Regulation of the Social Sciences, 1965-1991." Cambridge University Press 21, no. 1 (2009). https://www.cambridge.org/core/journals/journal-of-policy-history/article/how-talking-became-human-subjects-research-the-federal-regulation-of-the-social-sciences-19651991/097169CC72ACEF36DC8B5BD80859C615.

Sedenberg, Elaine, John Chuang, and Deirdre Mulligan. "Designing Commercial Therapeutic Robots for
Privacy Preserving Systems and Ethical
Research Practices within the Home." International Journal of Social Robotics (2016): 575-87. https://arxiv.org/pdf/1606.04033.pdf.

Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In Rewired: Cybersecurity Governance, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

Sedenberg, Elaine, Richmond Wong, and John Chuang. "A Window into the Soul: Biosensing in Public." In Surveillance, Privacy and Public Space: Routledge, 2018.

Sedenberg, Elaine M, and Deirdre K Mulligan. Public Health as a Model for Cybersecurity Information Sharing. University of California Berkeley (Berkeley

Technology Law Journal: 2015). http://btlj.org/data/articles2015/vol30/30_3/1687-1740%20Sedenberg.pdf.

Segran, Elizabeth. "Here's Why Nobody Wants to Buy Birchbox, Even after Vcs Spent $90m." Fast Company, 2018. https://www.fastcompany.com/40567670/heres-why-nobody-wants-to-buy-birchbox-even-after-vcs-spent-90m.

Shannon, C.E. "A Mathematical Theory of Communication." Bell Systems Technical Journal July & October (Reprinted in ACM SIGMOBILE) 5, no. 1 (1948 (2001)): 3-55.

———. A Mathematical Theory of Cryptography - Case 20878 (U). (September 1, 1945). https://www.iacr.org/museum/shannon/shannon45.pdf.

Shenkin, H.A. Medical Ethics: Evolution, Rights and the Physician. Springer, 1991. https://books.google.com/books?id=7azsCAAAQBAJ&pg=PA320&lpg=PA320&dq=reagan+ban+on+IVF+research&source=bl&ots=wwoH7K9hiS&sig=ACfU3U0uKHjkjCXSDT1hors7s09Ovr6sPA&hl=en&sa=X&ved=2ahUKEwjSjtTDwr7gAhUnSN8KHVPOB20Q6AEwEXoECAYQAQ#v=onepage&q=reagan%20ban%20on%20IVF%20research&f=false.

Silverio-Fernández, Manuel. "What Is a Smart Device? - a Conceptualisation within the Paradigm of the Internet of Things." Visualization in Engineering 6, no. 3 (2018). https://doi.org/7-018-0063-8. https://link.springer.com/article/10.1186/s40327-018-0063-8.

Slywotzky, Adrian. "Where Have You Gone, Bell Labs?" Bloomberg Businessweek (New York, NY), August 27, 2009. https://www.bloomberg.com/news/articles/2009-08-27/where-have-you-gone-bell-labs.

Smith, Douglas K., and Robert C. Alexander. Fumbling the Future : How Xerox Invented, Then Ignored, the First Personal Computer. 1st ed. New York: W. Morrow, 1988.

Smith, John Kenly. "The Scientific Tradition in American Industrial Research." Technology and Culture 31, no. 1 (1990): 121-31. http://www.jstor.org/stable/3105763.

Solon, Olivia. "'They'll Squash You Like a Bug': How Silicon Valley Keeps a Lid on Leakers." The Gaurdian, 2018. https://www.theguardian.com/technology/2018/mar/16/silicon-valley-internal-work-spying-surveillance-leakers.

Sorge, R. E., J. C. Mapplebeck, S. Rosen, S. Beggs, S. Taves, J. K. Alexander, L. J. Martin, et al. "Different Immune Cells Mediate Mechanical Pain Hypersensitivity in Male and Female Mice." [In eng]. Nat Neurosci 18, no. 8 (Aug 2015): 1081-3. https://doi.org/10.1038/nn.4053. https://www.ncbi.nlm.nih.gov/pubmed/

26120961.

Spencer, William J. "Some Thoughts on the Internationalization of Research." In Managing R&D and Technology: Competition and Collaboration, edited by Evelyn Samore and James K. Brown, 3: The Conference Board, 1988.

Spielman, Seth E., and Alex Singleton. "Studying Neighborhoods Using Uncertain Data from the American Community Survey: A Contextual Approach." Annals of the Association of American Geographers 105, no. 5 (2015). https://www.tandfonline.com/doi/full/10.1080/00045608.2015.1052335.

Stark, Laura Jeanine Morris. Behind Closed Doors : Irbs and the Making of Ethical Research. Morality and Society Series. Chicago ; London: The University of Chicago Press, 2012.

Stiglitz, J. "Knowledge as a Global Public Good." In Global Public Goods: International Cooperation in the 21st Century, edited by I. Kaul, I. Grunberg and M.A. Stern. New York: The United Nations Development Programme, 1999.

Stokes, Donald E. Pasteur's Quadrant : Basic Science and Technological Innovation. Washington, D.C.: Brookings Institution Press, 1997.

Stone, Brad. "Inside Google's Secret Lab: Google X's Silicon Valley Nerd Heaven—America's Last Great Corporate Research Lab." Bloomberg Business, 2013. https://www.bloomberg.com/news/articles/2013-05-22/inside-googles-secret-lab.

Stone, Brad, and Ashlee Vance. "Apple's Obsession with Secrecy Grows Stronger." The New York Times, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." The New York Times, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

Strauss, A., and J. Corbin. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Thousand Oaks, CA: Sage Publications, Inc., 1998.

Sturgeon, Timothy J. "How Silicon Valley Came to Be." In Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region, edited by Martin Kenney, xvi, 285 p. Stanford, Calif.: Stanford University Press, 2000.

Swan, Melanie. "The Quantified Self: Fundamental Disruption in Big Data Science and Biological Discovery." Big Data 1, no. 2 (2013). https://www.liebertpub.com/doi/

full/10.1089/big.2012.0002.

Tavani, Herman T. "Informational Privacy: Concepts, Theories, and Controversies." Chap. 6 In The Handbook of Information and Computer Ethics, edited by Kenneth Einar Himma and Herman T. Tavani, 2008.

———. "Informational Privacy: Concepts, Theories, and Controversies." In The Handbook of Information and Computer Ethics, edited by Kenneth E. Himma and Herman T. Tavani, 131-64. Hoboken, NJ: John Wiley & Sons, Inc., 2008.

Teece, David J. "Business Models, Business Strategy and Innovation." Long Range Planning 43 (2010): 172-94.

Thackray, A., J.L. Sturchio, P.T. Carroll, and R.F. Bud. Chemistry in America 1876–1976. 1985.

Tiffany, Paul A. The Decline of American Steel : How Management, Labor, and Government Went Wrong. New York: Oxford University Press, 1988. \

Titlow, John Paul. "These Women Entrepreneurs Created a Fake Male Cofounder to Dodge Startup Sexism." Fast Company, 2017. https://www.fastcompany.com/40456604/these-women-entrepreneurs-created-a-fake-male-cofounder-to-dodge-startup-sexism.

———. "Here's Why That Story About a Fake Male Cofounder Went Insanely Viral." Fast Company, 2017. https://www.fastcompany.com/40462125/heres-why-that-story-about-a-fake-male-cofounder-went-insanely-viral.

Townly, Preston. "From the President." In Managing R&D and Technology: Competition and Collaboration, edited by Evelyn Samore and James K. Brown, v: The Conference Board, 1988.

United States. Office of scientific research and development., and Vannevar Bush. Science, the Endless Frontier. A Report to the President. Washington,: U.S. Govt. print. off., 1945.

UPI. "Researcher Says Women Less Likely to Get Painkillers." UPI - United Press International, 1989. https://www.upi.com/Archives/1989/03/11/Researcher-says-women-less-likely-to-get-painkillers/2047605595600/.

"Postal Facts: A Decade of Facts & Figures." 2018, accessed April, 2019, https://facts.usps.com/table-facts/.

Usselman, Steven W. "Running the Machine: The Management of Technological Change on American Railroads, 1850-1910." Business and Economic History 17 (1988): 213-18. https://www.jstor.org/stable/23702974?seq=1#page_scan_tab_contents.

Villani, Cedric. For a Meaningful Artificial Intelligence: Towards a French and European Strategy. AI For Humanity (2018). https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf.

Villapol, S., D. J. Loane, and M. P. Burns. "Sexual Dimorphism in the Inflammatory Response to Traumatic Brain Injury." [In eng]. Glia 65, no. 9 (09 2017): 1423-38. https://doi.org/10.1002/glia.23171. https://www.ncbi.nlm.nih.gov/pubmed/28608978.

Vitak, Jessica, Nicholas Proferes, Katie Shilton, and Zahra Ashktorab. "Ethics Regulation in Social Computing Research: Examining the Role of Institutional Review Boards." Journal of Empirical Research on Human Research Ethics 12, no. 5 (2017). https://journals.sagepub.com/doi/abs/10.1177/1556264617725200.

Volkman, Elliot. "In Startups and Business, Women Receive Less Money [Infographic]." Tech.Co. (2017). https://tech.co/news/startups-women-less-money-infographic-2017-05.

Wallace, Nick. "Countries Can Learn from France's Plan for Public Interest Data and Ai." Center For Data Innovation, 2018. https://www.datainnovation.org/2018/08/countries-can-learn-from-frances-plan-for-public-interest-data-and-ai/.

———. "Countries Can Learn from France's Plan for Public Interest Data and Ai." Center for Data Innovation, 2018. https://www.datainnovation.org/2018/08/countries-can-learn-from-frances-plan-for-public-interest-data-and-ai/.

Wang, Lo Hansi. "Rhode Island Gets a Sneak Peek at New Census Questions." Morning Edition (NPR), 2018. https://www.npr.org/2018/03/26/596942363/rhode-island-gets-a-sneak-peek-at-new-census-questions.

Wasserman, Todd. "Has the Strategy, Which Once Worked in Steve Jobs' Favor, Begun to Backfire?" Technology Marketing Intelligence, 2000, 56.

Weiss, Robert Stuart. Learning from Strangers : The Art and Method of Qualitative Interview Studies. New York; Toronto: Free Press ; Maxwell Macmillan Canada ; Maxwell Macmillan International, 1994.

White, Ryen W., and Eric Horvitz. "Evaluation of the Feasibility of Screening Patients for Early Signs of Lung Carcinoma in Web Search Logs." JAMA Oncology 3 (2017): 398-401. https://jamanetwork.com/journals/jamaoncology/fullarticle/2580709.

Whitson, Jennifer R. "Gaming the Quantified Self." Surveillance & Society 11(1/2) (2013): 163-76. click4it.org/images/1/1f/

Gaming_the_Quantified_Self_Whitson.pdf.

Wickens, Barbara. "Keeping Secrets." Maclean's 106, no. 35 (1993).
"1854 Broad Street Cholera Outbreak." Wikipedia, 2019, 2019, https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak.

Wilder, Gene. "From the People Archives: Gene Wilder's Tearful Goodbye to Wife Gilda Radner." People, 1991/2016. https://people.com/movies/gene-wilders-tearful-goodbye-to-wife-gilda-radner/.

Williams, H. L. "How Do Patents Affect Research Investments?" [In eng]. Annu Rev Econom 9 (Aug 2017): 441-69. https://doi.org/10.1146/annurev-economics-110216-100959. https://www.ncbi.nlm.nih.gov/pubmed/29104716.

Wingfield, Nick. "Core Value: At Apple, Secrecy Complicates Life but Maintains Buzz; Maker of Mac and Ipod Keeps Customers, Workers in Dark; Watermark on the Memo; Frustration for Business Buyers." Wall Street Journal (New York, NY), 2006, Eastern.

Wise, George. Willis R. Whitney, General Electric and the Origins of U.S. Industrial Research. Columbia University Press, 1985.

Wood, James Playsted. "Leaders in Marketing: Arthur C. Nielsen." Journal of Marketing 26, no. 3 (1962): 77.

Wymelenberg, Suzanne, and Institute of Medicine (U.S.). Science and Babies : Private Decisions, Public Dilemmas. Washington, DC: National Academy Press, 1990.

"About Fuji Xerox, Company Profile, History." 2018, 2019, https://www.fujixerox.com/eng/company/profile/history/corporate.html.

Zachary, G. Pascal. Endless Frontier : Vannevar Bush, Engineer of the American Century. 1st MIT Press ed. Cambridge, MA: MIT Press, 1999.

Zarrelli, Natalie. "Dial-a-Ghost on Thomas Edison's Least Successful Invention: The Spirit Phone." Atlas Obscura, October 18, 2016. https://www.atlasobscura.com/articles/dial-a-ghost-on-thomas-edisons-least-successful-invention-the-spirit-phone.amp.

Zuckerman, Brian L. , Rachel A. Parker, Thomas W. Jones, Brian Q. Rieksts, Ian D. Simon, Gilbert J. Watson III, Elaine M. Sedenberg, et al. Evaluation of the National Science Foundation's Experimental Program to Stimulate Competitive Research (Epscor): Final Report. IDA Science and Technology Policy Institute (Washington DC: 2014). https://www.ida.org/~/media/Corporate/Files/Publications/STPIPubs/2015/P-5221.ashx.

Appendices

Appendix A:

Essential background on existing public data infrastructures: new pressures and limitations

The rise of private sector data holdings is notable because it corresponds with important changes and evolutions in who holds valuable population (or large scale) data based on government changes, as well as social ones. We previously relied on government systems and information to conduct our lives and access data to make policy decisions or guide research. Governments, though obviously at the whim of politics and subject to competing ideologies, are institutions that are there to serve and protect citizens. Governments are often intended to be stable and consistent, which translates to the information systems that have been expanded over time to provide input to policymaking decisions and provide outside parties, including researchers, with data and information with consistent and reliable standards.

These information systems were created through a patchwork of public infrastructure and services, stemming from local municipalities, federal programs, and a complicated web of global services through international arrangements.

Canonical US data sources[388] came from agencies like the Census Bureau,[389] Centers for Disease Control and Prevention (CDC) and the National Center for Health Statistics,[390] US Department of Commerce Bureau of Economic Analysis,[391] Bureau of Labor Statistics,[392] Health and Human Services,[393] Federal Bureau of Investigations (FBI)[394] and numerous sources of scientific data from federal science agencies.[395] These data have also been made more interoperable and accessible through centralized portals such as Data.gov. These information systems are vital parts of public infrastructure, used by researchers, citizens,

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[388] This dissertation has a focus on US firms and policy, but obviously other countries and NGOs have data sources that are central to many areas of research.

[389] E.g., the Decennial US Census, also known as the Population and Housing Census; American Community Survey; American FactFinder; etc.

[390] E.g., Youth Risk Behavior Survey, National Death Index, National Vital Statistics System, CDC WONDER, etc.

[391] I.e., GDPs for states and cities, state and local income levels

[392] I.e., labor market activity data etc.

[393] E.g., HealthData.gov which includes data about Medicaid/Medicare, etc.

[394] i.e., Uniform Crime Reports

[395] e.g., EPA, NASA, NOAA etc.

private companies, policymakers, and journalists alike.

These longstanding resources will continue, but are being tested due to political and functional limitations. Private firm data obtained through individual data sharing agreements are superseding traditional and publicly available economic data in new economics research because of the increased granularity and scope available from these private data as opposed to public systems.[396] Fluctuations in investments for these resources question some data source continuity and restrict efforts to make these data more accessible and interoperable.[397] The 2020 Census is under scrutiny due to concerns over adding a citizenship question that may decrease response rates and thus impact data quality.[398] The US Census, around since 1790,[399] has had lost years in the past

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[396] Einav, Liran, and Jonathan Levin. "Economics in the Age of Big Data." *Science*, 2014.

[397] See for instance:

Gunter, Chase. "How Government Data Is at Risk." *FCW The Business of Federal Technology* (2018). https://fcw.com/articles/2018/02/27/open-data-policy-gunter.aspx.

"Global Report." 2017, https://opendatabarometer.org/4thedition/report/.

[398] Sometimes changes are also made to federal data that impact the ability to parse questions. Federal data is not without risk to changes that impact researchers. For instance, the 2000 Census was the last one to contain the longform sample that collected additional socioeconomic information. Between 2005-2009 the first series of the American Community Survey was released after years of testing to provide a shorter time horizon on socio-economic data about neighborhoods and is conducted on a rolling basis. This change coincided with an economic recession, and complicated analyses on changing neighborhoods and gentrification during this time. Even though there were ways to account for these changes, one researcher remarked in a talk that having Craigslist data would have given better data about changes in rent prices in the Bay Area, and alleviated problems associated with this change during a key economic shift in the US. As public government data infrastructures face pressures and political forces, privately collected datasets offer and opportunity to supplement these official records—such as the theoretical access to Craigslist data over time. These social and technological changes present important questions about the role private data plays as they become a part of new public services (e.g., new messaging systems, transportation) and their underlying data is not part of the public access infrastructure.

Florida, Richard. "The Gentrification Puzzle." 2013. https://www.citylab.com/equity/2013/11/why-some-places-gentrify-more-others/7588/.

Bousquet, Chris. "Where Is Gentrification Happening in Your City?" *Data-Smart City Solutions*, 2017. https://datasmart.ash.harvard.edu/news/article/where-is-gentrification-happening-in-your-city-1055.

Spielman, Seth E., and Alex Singleton. "Studying Neighborhoods Using Uncertain Data from the American Community Survey: A Contextual Approach." *Annals of the Association of American Geographers* 105, no. 5 (2015). https://www.tandfonline.com/doi/full/10.1080/00045608.2015.1052335.

[399] See for instance:

Hansen, Mark. "To Reduce Privacy Risks, the Census Plans to Report Less Accurate Data." *The New York Times*, 2018. https://www.nytimes.com/2018/12/05/upshot/to-reduce-privacy-risks-the-census-plans-to-report-less-accurate-data.html.

Wang, Lo Hansi. "Rhode Island Gets a Sneak Peek at New Census Questions." *Morning Edition* (NPR), 2018. https://www.npr.org/2018/03/26/596942363/rhode-island-gets-a-sneak-peek-at-new-census-questions.

due to collection issues and accidental destruction of records,[400] and other countries like Canada have had similar challenges when the 2011 census was deemed virtually useless after completion was made voluntary and response rates dropped significantly[401].

Other social changes pressure the traditional data collection systems by directing previous public or publicly-mediated services wholly to the private sector. Online communication on private (let alone encrypted) apps like WhatsApp are mediated by private companies instead of mail routes or telecommunications infrastructure.[402] Infrastructure like public transportation is being augmented by platform enabled gig-based economy in the case of Uber and Lyft, which in turn collect valuable data on traffic and commute patterns—not to mention employment patterns. Recently New York City has established requirements to share these data with the city in order to operate.[403] In another case, a non-governmental organization (NGO) used Zillow data to project the impact of rising sea levels on real estate.[404]

Similarly, there are many cases where private sector or crowdsourced data collection (sometimes through the use of private sector devices) are augmenting existing systems and increasing data and data granularity. Recent air quality issues from existing pollution and episodic crises have increased the use of a crowdsourced network of private air quality sensors developed by the company Purple Air.[405] Even though the EPA has air quality sensors deployed, there was a

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[400] "Why Can't I Find 1890 Census Records?" Genealogy FAQs, 2019, https://www.census.gov/history/www/faqs/genealogy_faqs/why_cant_i_find_1890_census_records.html.

"1820 Overview." 2019, https://www.census.gov/history/www/through_the_decades/overview/1820.html.

[401] Marshall, Aarian. "The Tragedy of Canada's Census." *Citylab*, 2015. https://www.citylab.com/equity/2015/02/the-tragedy-of-canadas-census/385846/.

[402] See for instance, the data collected by the US Postal Service or retired FCC information systems to track usage. Then compare to the challenges researchers and humanitarian organizations face in understanding crises as they unfold using private apps like WhatsApp where usage and histories are invisible.

"Wcb Archived Data and Statistical Reports." nd, accessed April, 2019, https://www.fcc.gov/oea-archived-data-and-statistical-reports.

"Postal Facts: A Decade of Facts & Figures." 2018, accessed April, 2019, https://facts.usps.com/table-facts/.

Bohn, Lauren. "Syrian History Is Unfolding on Whatsapp." *Backchannel*, 2017. https://www.wired.com/2017/02/syrian-history-is-unfolding-on-whatsapp/.

[403] Marshall, Aarian. "Nyc Now Knows More Than Ever About Your Uber and Lyft Trips." *Wired*, 2019. https://www.wired.com/story/nyc-uber-lyft-ride-hail-data/.

[404] Allen, Greg. "Zillow Data Used to Project Impact of Sea Level Rise on Real Estate." *NPR*, 2018. https://www.npr.org/2018/06/18/620939197/zillow-data-used-to-project-impact-of-sea-level-rise-on-real-estate.

[405] Cowan, Jill. "California Today: Silicon Valley's Hot Holiday Gift." *The New York Times*, 2018. https://www.nytimes.com/2018/12/05/us/california-today-air-pollution-monitors.html.

need for more granular data in neighborhoods far from a sensor station, and during recent wildfires the EPA website crashed making it difficult for citizens to assess the safety of their air. Whether for lack of investment, maintenance, or just a continued limitation of resources, the private sector augmentation offered an easy and somewhat affordable solution to citizens. Even though the EPA data may be available later to researchers, even more granular data—including information potentially about users who wanted better air quality data—remains in control of a private company and under unclear access to researchers or even policymakers.

There will always be reasons why government data is reliable and vital to the research ecosystem. Federal data are—in most cases except for some of the examples described above—assured to continue, enabling long-term and consistent study of a topic over time. Access to the data are also kept consistent, and changes would be likely to occur only if special access had already been granted to sensitive data or was already difficult to access (e.g., only data available through public record requests). Federal data also pays particular attention to equal representation in the data throughout the population, and spends resources to fill in gaps to ensure that the data take into account rural, homeless, and high non-response populations. These considerations are often not present in private sector data because these information systems were not explicitly designed for research, record keeping, or policymaking uses.

Private data may be able to expand the reach and breadth of public infrastructure in an evolving, digitally-mediated society and with the proper considerations and new infrastructure help bridge to public interest applications, like research. In 2018, France announced plans to explore policies that require private sector sharing of data for use by governments, and ideally others,[406] in order to capitalize on the public benefit of privately-owned data. There are similar proposals in the UK, and cities like New York City are working on mandating data sharing in particular sectors like ride sharing.[407]

[406] Villani, Cedric. For a Meaningful Artificial Intelligence: Towards a French and European Strategy. *AI For Humanity* (2018). https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf.

Wallace, Nick. "Countries Can Learn from France's Plan for Public Interest Data and Ai." *Center for Data Innovation*, 2018. https://www.datainnovation.org/2018/08/countries-can-learn-from-frances-plan-for-public-interest-data-and-ai/.

[407] Marshall, Aarian. "Nyc Now Knows More Than Ever About Your Uber and Lyft Trips." Wired, 2019. https://www.wired.com/story/nyc-uber-lyft-ride-hail-data/.

Appendix B:

Methodological Reflection: Secrecy practices impact on this research

In pursuing my research and recruiting interviewees, I received many non-responses, some would agree to chat with me then suddenly change their minds, and almost all wanted to be anonymous. Encountering individuals who are uninterested in your research or unwilling to participate is not exceptional, but the patterns and frequency of these non-responses—coupled with numerous off the record or anonymous interviews with individualized boundaries—presented an insightful alternative view by examining contemporary tech culture's opaque access. The barriers to achieving on the record conversations, skittishness around particular subjects, and secrecy lore propagated throughout this research provided an unplanned opportunity for reflections. The evolution of legal mechanisms within tech companies (like NDAs), information based innovation strategies, and uncertainty around intellectual property protections emerged as key external (and sometimes internal) forces impacting the flow of knowledge and data/information exchanges studied within this dissertation.

Foundations of this reflection: "Why isn't this experience part of your study?"

In the fall of 2017, I was increasingly discouraged about my dissertation data gathering. At the 2017 Association of Internet Researchers (AoIR) conference, I was talking out my early findings and the parts I was struggling with—namely that many people ignored my emails or had very strange response patterns. A senior faculty member, after sympathizing, made a constructive and now embarrassingly obvious suggestion: examine the lack of access and interview struggle as part of the story, and use this as an opportunity to understand the internal and external factors influencing the underlying foundation of my research questions.

With that moment of clarity, along with several key informants, this reflection took shape to use access (or lack thereof) as a way to uncover key trends that impact the private sector driven research and information sharing ecosystem. My experiences and interviews, which had to operate within the system of study, became a tool for probing the cultural and legal forces that shaped internal research and information sharing activities. The pattern and consistency of this challenge in finding individuals willing to talk to me—a barrier anecdotally unmet by colleagues conducting similar style research on different topics and in a previous study seeking high ranking cybersecurity experts in the private sector[408] —hinted that this might indicate it's a larger social symptom resulting from legal, cultural, and a myriad of other mixed pressures. Also of note, AnnaLee Saxenian's book "Regional Advantage" published in 1994 includes a list of interviewees by name with their affiliation at the end.[409] Even in my wildest research design dreams, this level of transparency and attribution would not occur today on any subject of occupational substance. Additionally, a gray zone of off the record, background, and anonymous conversations informed this research.

Non-response patterns

There are two primary reasons many of my emails to startups went unanswered. It is likely many startup companies' general contact email account goes unanswered, or that the website remained as vestiges of a startup that had since disbanded. The general contact email inference was corroborated by other startups who participated in interviews and guessed that in many cases the 'info@<company name>.com' email found on the majority of startup webpages was unassigned and/or blatantly ignored. In the case of disbanded startups, it's common for founders of very small startups to leave up the website until the expiration of the domain name—even after funding has dried up and the team has gone on to other employment. Without a press release, it is hard to distinguish these non-active startups when going through an incubator's recent members.

For individual contact emails that remained unanswered, contact information was almost always obtained through in person networking at topically related events or via introductions by another interviewee. In these cases, a non-response could be from several different reasons including:

1) The individual was too busy to respond and forgot;

2) Did not think responding was worth their time, or felt uncertain about their desire or freedom to talk to me;

3) Interviewees felt unqualified to talk to me or felt they did not have anything valuable to contribute to my research. This was a common response challenge in

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[408] This is the study referenced below provided insight and lessons in the structure of this study. Compared to the security industry where people are just as busy, but much more willing to chat. Some of that is just the security industry is primed for communication and sharing; donating to the public good. Whereas that is not the case with research oddly enough.

Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In Rewired: Cybersecurity Governance, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

[409] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 211.

my past studies of industry because interviewees assumed their daily working knowledge was mundane and uninteresting to others[410];

4) My positionality as a female graduate student was not enough to establish credibility with a short introduction email or they did not value—or likely understand—this type of qualitative research; (See comments in Chapter 3)

5) Given I never received a response to the effect of "I am sorry I am unable or unwilling to talk with you" ignoring the email could be either conflict avoiding or simply path of least effort.

Depending upon my connection to the potential interviewee—I was not within my ethical parameters as dictated by the Berkeley IRB to follow up with individuals I did not know—I would only follow up as I felt was appropriate and professional. It is likely that pestering could have increased response rates, but that had the potential to burden the interviewee.

Individuals often to agreed[411] or offered to talk with me after an email introduction or in person meeting where they volunteered their contact information. However, some of these contacts never responded to my follow up emails. It is impossible to ascertain whether this was related to perfunctory reasons described above, a realization that they were—or could be—limited in their ability to grant an interview which made them uncomfortable to participate, or new restrictions invisible to the public like a pending acquisition or media ban within the company. This specific agreement and following non response happened to me nine times.

There were several (three) people who agreed to be interviewed, and would send dates/times they were free to talk and then suddenly stop responding or not call at the time. Follow up emails then went unanswered. The pattern of cat and mouse was bizarre, and appeared to be the research equivalent of "ghosting[412]." In one case, for instance, someone agreed in person to be interviewed and gave me their email. I followed up shortly thereafter, and received no response. A month later I replied again, also received no response. Then, almost 6 months later, the person reached out saying they were sorry they got behind on emails and had time to talk on Friday (two days later). I replied within hours, saying any time on Friday would work and provided additional information. I never received another response from this individual (even after one last good faith follow up a

[410] This was often stated in a previously reference study on cybersecurity practitioners. Sedenberg, Elaine, and James X. Dempsey. "Cybersecurity Information-Sharing Governance Structures: An Ecosystem of Diversity, Trust, and Trade-Offs." Chap. 1 In Rewired: Cybersecurity Governance, edited by Ryan Ellis and Vivek Mohan: John Wiley & Sons, Inc., 2019.

[411] There were many individuals who declined to be interviewed and are not included in this count.

[412] "Ghosting" loosely means instead of breaking up with someone and expressing any disinterest or desire to pursue other interests, someone simply stops responding to all texts/calls and disappears off the planet with no explanation or goodbye. Fittingly, this was a common phenomena in the social world of the Bay Area during the time of this dissertation research.

few weeks later). This either points to the banal and obvious possibility that this person was disorganized and busy even though they were able (and in theory willing) to talk with me, or that there was some fear/avoidance/uncertainty/disinterest that led to a second silence—because after all, if they truly did not care, why reply at all with a willingness to chat? Could a single 6 month belated reply be enough to allay any guilt for ignoring a PhD student researcher?

This type of email courting and scheduling fanfare was frequent on my part. In another case, a potential interviewee finally replied after months of no response and two introductions, apologized and asked me to follow up at the end of the month when they were back from vacation. When I did as instructed they never replied again. While there are other examples mirroring almost exactly this case, a mutual colleague speculated based on personal knowledge that this person "felt badly because [s/he] would not be able to actually tell me anything on the record" and that it was out of character for this individual to act in this manner—especially to a student. This context about our puzzling interaction provided more evidence that these response patterns may have meant more than my emails were easy to ignore.

At a fundamental level—and pushing back on any urge to read more into this pattern than necessary—it signals a closed and inaccessible culture. Considering most of the tech industry prides itself on open concept office designs, outwardly performed transparency, and in many cases (particularly within sensing technologies) builds an industry off of other people sharing private data, this contradiction invites questions.

Meta Interviews about Reticence and Anonymity

It takes a unique individual to hold a researcher or their topic in suspicion, yet be willing to talk to them with a pseudo-on the record, and pseudo-off the record[413] agreement. Against their safer judgement and assuming some level of personal risk—even if only perceived risk, because once again this study was designed to avoid any sensitive content—several interviewees gave me a rare glimpse into the decision making and risk assessment models of potential interviewees, and snapshots into a culture shrouded by secrecy. Once this patterned emerged, those interviewed who were uncomfortable with my normal attribution and transcription process were switched into a separate category of interview. This new interview took an opportunity to examine the interviewees perceptions and hesitancy to talk with a researcher, instead of focusing exclusively on their company (which they were already uncomfortable doing) or

[413] My process for protecting interviewees and deciding level of anonymity are detailed at length in Chapter 3.

their exact professional activities. Giving these interviewees an opportunity to reflect on their position within this private sector research and data sharing ecosystem helped to probe at the boundaries of these activities, as well as uncover separately the tangible artifacts (e.g., contracts and press leakage meetings) not to mention the invisible (e.g., uncertainty, fear, peer pressure) forces at play.

Often these rare individuals who had agreed to chat, despite strong hesitations and interview constraints, had been PhDs themselves. They frequently admitted they would chat with me, in spite of their reservations, out of pity—or perhaps just a sympathy that is only possible from someone who has walked through the fire for a PhD themselves. Usually this also meant these individuals were socialized and receptive to academic research, even if social science methods and policy orientation were outside of their training and previous exposure.

The reasons individuals did not want to talk to me—on the record or only with special and customized anonymity—included the following non-mutually exclusive reasons:

- Personal experience with someone who was reprimanded for speaking outside of the company
- Opaque and un-parsable NDAs (particularly to non-lawyers)
- Dusty NDAs that had been locked away and are inaccessible for reference by the employees[414]
- Cultures where leakers are publicly reprimanded and/or fired
- Lack of approval process to discuss any material outside of the company
- Lack of clarity on what is sensitive and what is not about their jobs (and consequential casting that everything and every job is sensitive)
- Lack of management hierarchy to ask permission or clarify
- Confusion between the role of researcher and a journalist
- General and unspecific anxiety, nervousness, and spooked attitude about discussing their professional jobs

These categories distill down to shared concepts that map onto trends echoed by attributed interviews and firms. These include themes of cultures of secrecy, opaque (or at least intimidating) legal controls, contexts from the past or personal exposure to leakers and corporate retaliation, or an unclear processes for approval or sharing. Each of these are discussed in more detail in the next section, and corroborated by other interviews, public documentation, and my own personal experiences in Bay Area tech companies.

Each of these anonymous interviewees crafted their own privacy protection

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[414] Note this may be because the employee did not keep a copy for themselves, or know where they saved it, but it points to a larger problem where signed forms are not always readily accessible to parties other than the firm.

mechanisms, which was a point I was happy—and by design choice ethically obligated—to negotiate. In some cases, anonymity of the individual and the firm was an acceptable level and I was still allowed to record the interview for transcription. Usually in these cases we were careful to only use terminology like “your company” in the recording, and then spoke relatively freely about process and practices. Others wanted any mention of their name in my notes to be deleted, and in one case the interviewee insisted I transcribe the interview myself because no transcription company or machine learning transcription service could be trusted with even the sound of this individual’s voice. Had we been discussing sensitive material, this level of caution would not be remarkable. Once again, the material discussed without any company name or product specifics. Yet, the interviewee felt the need to establish privacy protections that could have only been made better with voice distortion and a VPN encrypted communication line. Even more bizarrely, this interview was done while the interviewee was still at work while located in a vacant conference room. This may be contrasted with others who were willing to chat on the record, but preferred to leave the premise of their company for legal reasons. During interviews, some interviewees were happy to discuss their experiences at past companies, but requested before we began the interview (or recording) that we make no mention of their current company or current role.

Sometimes interviewees would speak freely on background material about particular events that had happened to shape internal policies around research or data sharing. These interviews would help inform my thinking and approach to this research, but made documenting my knowledge difficult. In one interview, I was not allowed to use names but I asked to take notes for my own use. After probably scribbling too quickly—a habit formed after years as a research assistant and during graduate level coursework—I was making the interviewee uncomfortable and they asked me to stop.

At times, it felt like gossip grounded in facts but altered by imperfect memories and incomplete firsthand knowledge. These conversations about corporate cultures and practices were littered with colorful antagonists and wounded, nerdy protagonists. The tales felt both pedestrian and epic underdog tales at the struggle and eventual defeat at the helm of massive tech bureaucracies. At first I thought these stories were rare, but then I realized how important these sophisticated gossip chains were to shaping technology corporate culture as actors moved between companies—taking lessons from bad experiences and letting them shape the next company. The hesitancy to talk continued to plague individuals even after leaving previous companies given how small and incestuous talent pools can be at high levels. These publicly toxic narratives were embarrassing, legally risky, reputation damaging, and simply messy at their worst. Despite the fact these tales would heavily caveat publicly known versions or supplement much needed detail, they were instead shrouded in these hushed tones. Despite the fail fast and fail often open mantras of the tech industry, these epic failures reaped limited lessons to those outside of the internal corporate shockwaves. I consider this a shame, because many of these tales could have been dissertation studies on their own.

In all of my interviews, establishing trust and credibility quickly was a persistent challenge for me. Beyond an email introduction, I had only minutes to introduce myself and not only earn the trust of a stranger but establish myself as a knowledgeable expert. This additionally made it difficult since negotiations about attribution were done in the beginning, but at times were left open to negotiation afterwards. It was not uncommon for interviewees to build a professional relationship with me, and send me items of interest or updates after our initial interview was complete—even when they were initially approached with hesitancy and anonymity.

The Startup Exception

Gaining initial access to the big firms (or even well-known mid-sized firms) was straight forward because their employees were often well connected, visible, friendly, and eager to engage the academic community—particularly at schools like Berkeley. Getting on the record access, however, was near impossible.

The majority of the firms used in this dissertation by name are startups, who not only agreed to name the company but also often the interviewee themselves—someone who often was in a leadership position within the company, thus enabling them to confidently know what they can and cannot say publicly. At startups, the chain of command is straightforward, accessible, or simply nonexistent given the small size. In cases where I did not speak to the founder or otherwise top manager, the individual almost always had asked permission from the founder in order to do the interview.

The value proposition for startups was also more favorable to agreeing to take an interview. Even though startup employees are often overworked and individuals each take on many roles within the firm to get things off the ground, the prospect of getting free publicity—preferably positive but any press at all—could be helpful to expand the reach of the company. Interviews also provided an opportunity for reflection, and even if this was not apparent at the start of the interview it was common for interviewees to comment on how they appreciated the ability to reflect on these nuanced points, specifically industry R&D and academic partnership strategies, since they are often not intentional decisions but driven by subconscious forces set in motion by the desire to gain an intended result. At a larger firm with excess resources and existing user bases as well as public reputations to foster, there is often a more intentional discussion of how to allocate funding. These programs may consider longer termed impact for the company—and most generously within the public interest, as well as less virtuous ambitions such as attracting and securing talent or using these initiatives to drum up positive public relations. Yet startups are trying only to stay alive, keep fundraising, and in the time period of this dissertation usually angling to be acquired by a large firm.

Startups I spoke with were actively learning about how to succeed in the current tech marketplace, and were very receptive to wanting to learn from my research experience or other companies contained within my dissertation. This openness to rethinking their own strategy and my ability to offer relevant research to their business and innovation models helped further align our incentives to chat.

Startups are unencumbered from an in house legal team and public relations department, who have become accidental arbiters of research findings and general knowledge sharing in larger firms. Startups often only contract out with law firms—who often specialize in the needs of technology startups—for as needed tasks like writing a privacy policy or financial agreements involved with negotiating stake in companies. Without in-house access and when every consultation costs a high price, startups are forced to use common sense and their own mental models for risk assessment. In the absence of the endless number of people who need to approve a conversation, there was room to openly discuss and reflect on practices and strategies.

However, startups were not immune from concerns about secrecy and imagining their own threat models in order to maintain a competitive edge while balancing their need for press, financing, and partnerships. For instance, at an artificial intelligence event, I was talking to vendors about their products and practices, and I met a CEO who was primarily there to hire new talent but also promote the company. As soon as I began asking questions about the product, he clammed up and refused to say anything other than the slogans on the actual box. At the time, I was befuddled by the mixed signals and sudden unwillingness to talk about a product he was there to demo, but finished my dissertation pitch and gave him my card. At the next event break he chased me down to apologize for his cagey behavior and explained competitors and engineers from competing companies and large firms who were looking to expand their in house technology were also at the table around me asking suspicious questions, and he didn't want to give too much away. He graciously offered to sit down with me the next day, and in the interview part of our exchange at the event was discussed:

> Interviewee: "There's a lot and people who are really strange about privacy and people are strange about privacy around their data and their company, right at that event, I didn't talk to you at first because I didn't know-"

Elaine: "I just though you didn't like me but it's fine."

Interviewee: "But actually and then was a woman shortly after you, she was really convinced I didn't like her and she was actually kind of insulted and I said why won't you talk to me and just tell me what's in this and what are selling and what's in this box and like no, go away, we're not talking. And later at the happy hour she came back up to me and we were talking and she's like I saw your panel, I know what you do and you're not a competitor, don't worry what's up and I was like I don't know. She's like I just thought you were so rude and was it something about the way I was dressed or what was going on? I was like why would that be your assumption? That's funny."

This particular exchange helps to illustrate a general anxiety over interactions with outsiders, and the lack of a specific threat model other than not to reveal too much information. The pressures on startups, stem more about fears of getting poached early on for ideas that cannot be patented, or inventions that have not yet been patented because of cost. Despite these pressures, many startups were willing to not only participate in this study, but be more open in general about their practices. This general anxiety manifests in odd ways, such as shutting down outsiders at an open information fair when they ask basic information about the company. Yet when the individual reconsiders the interaction, the reverse course in this case was enough to motivate them to privately track down individuals to pursue the conversation separately. There is a competing imperative—to be both open for publicity and outreach yet protective—that makes these interactions complicated.

Secrecy impacted and shaped not only my dissertation study, but also impacts and influences the subject of my study directly—making it a finding in and of itself. The system of research and data sharing under examination plays under the same rules and forces that collided with my research study, and offered a unique opportunity to press on the boundaries and constraints as methods of investigation, rather than just of necessity.

Appendix C:

From Skunkworks to stealth mode: R&D and product development in the Shadows

Skunkworks—or more specifically a skunkworks project—is known as a small cluster of individuals who are working together on a clandestine R&D project, usually united around a very specific mission to complete an articulated goal.[415] By design, these groups are insulated from the mundane intricacies of large bureaucracies, which can be viewed as impediments to the creativity needed for the "radical innovation" required in order to reach the goal. Skunkworks got its name during WWII at Lockheed Aircraft Corporation (later Lockheed Martin) when a group of engineers was formed in a hand-selected team to work on the XP-80 project—a fighter jet that was needed within 150 days. The team succeeded, and named itself after the group leader's favorite cartoon about a moonshine operation in the middle of a forest.[416] The term "Skunk Works" took off not only within Lockheed, but in other companies as well to refer to isolated teams working on secret R&D projects. The team at Lockheed continued a streak of R&D successes with other now infamous innovations such as the U2 spy plane. Skunkworks came to epitomize highly exclusive and agile teams, and signal to others that rapid innovation they were not privy to was occurring within their firm. Kelly Johnson, the "head skunk,"[417] wrote a set of 14 principles that are necessary to inform a skunkworks-style R&D project.[418] The rules predictably reflect the military/national security roots of the endeavor, focusing on information security controls and administration of the project funding and employee reports.

Skunkworks became a popular moniker in early Silicon Valley and other technology-driven industries. In 1988, William J. Spencer (then Vice President of the Corporate Research Group of the Xerox Corporation) described how R&D,

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[415] I have seen this referred to as Skunkworks or Skunk Works, and it should be noted that now the term is trademarked by Lockheed.

"Skunk Works® Legal Notice." accessed February, 2019, https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunk-works-legal-notice.html.

[416] "Skunk Works Origin Story." accessed February, 2019, https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunk-works-origin-story.html.

[417] Garrison, Peter. "Head Skunk." Air & Space (2010). https://www.airspacemag.com/history-of-flight/head-skunk-5960121/.

[418] Johnson, Kelly, "Kelly's 14 Rules and Practices," https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/kelly-14-rules.html.

particularly secretive R&D, contributed to developing new product lines:

"There's another whole area, and that is in research in new businesses. If you look at a place where the pace of innovation is taking us, we're not so much fighting for market share in old businesses as creating entirely new businesses. Personal computers didn't exist a decade ago and today they represent a $30-$40 billion business. Laser printers came on the market in the late 1970s and onto the desk top in the mid 1980s—a multibillion dollar business that didn't exist even five years ago. The area I see important for research to focus on—and quite often there isn't a corresponding part of the cooperation—is in important new businesses. That really complicates the process of technology transfer and leads to the development, at least in Xerox, of "Skunk works". We sometimes spare no expense to make them look like decrepit, run down labs, but they've been fairly effective in developing products where we didn't have an existing product organization, for markets that we hadn't traditionally been in."[419] In reflection, it is interesting how openly the skunkworks operation was discussed in this case, and also the admitted performativity of making the operation look like a garage-tinkering operation.

Based on my research and despite its previous utility within the tech industry, Skunkworks was not mentioned by any company or interviewee I spoke with, perhaps in part because Skunkworks is now a registered trademark of Lockheed[420] (evidence of Lockheed going after those who used the term was found around 2000).[421] An article in the Economist from 2008 states that the "skunkworks concept fell into disrepute when it began to be seen as just another cost centre—and one with attitude at that"[422] which matches the decline of isolated (aka non-collaborative) and internal R&D in large firms in the 1970s and 1980s mentioned in Chapter 4. The Economist claims that in 2008, when the article was published, there had been a revival on the structure of teamwork environments in corporations and skunkworks style innovation had made a rebound. The article cites Motorola's Razr mobile phone which was set up in a facility that aesthetically looked different and was 50 miles away from the main R&D facility in Illinois. However the facility was not left alone and isolated for scientific innovation, but in constant contact with the marketing/design/accounting divisions. The article makes the motivations of this bastardized revival concept of skunkworks clear: "The idea is not (as it used to be) that those

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[419] Spencer, William J. "Some Thoughts on the Internationalization of Research." In Managing R&D and Technology: Competition and Collaboration, edited by Evelyn Samore and James K. Brown, 3: The Conference Board, 1988, 15.

[420] "Skunk Works® Legal Notice." accessed February, 2019, https://www.lockheedmartin.com/en-us/who-we-are/business-areas/aeronautics/skunkworks/skunk-works-legal-notice.html.

[421] Carvell, Tim. "Lockheed Raises a Stink over 'Skunkworks' Brought to You by Aspirin, Corn Flakes, and the Yellow Pages." Fortune Magazine, 2000. https://archive.fortune.com/magazines/fortune/fortune_archive/2000/03/06/275258/index.htm.

[422] "Skunkworks." The Economist, 2008. https://www.economist.com/news/2008/08/25/skunkworks.

in the skunkworks emerge at the end of the day with something that makes their competitors say 'Wow'. The idea is that they come out with something that makes their competitors' customers say 'Wow'."[423]

Skunkworks in a way created environments that were like the small agile startup teams, but with the resources and insulation of a large company. The original skunkworks operations had a small and clearly defined mission, which is something that has been later misinterpreted as the ability to innovate openly and on a broad range of products. There are many covert labs within the tech industry—Google X, Amazon's Lab126 and A9, Jony Ive's design lab at Apple, IBM's Thomas J. Watson Research Center—but many are larger R&D divisions not specific project or goal oriented innovation centers.[424] For instance, skunkworks has been used to refer to Google X, but is more of a permanent distinction rather than a special operation.[425]

During the course of this study, many interviewees referred to "stealth mode" within the firm, but a key difference is that stealthy mode—a term traditionally used to describe a startup in the first phases of development before it has gone public with its concept and strategy—involves the entire company rather than one central strategic part. This is further evidence to suggest secrecy has bled into all aspects of contemporary tech firms, and thus stagnating many conversations and knowledge exchanges, not just concentrated R&D efforts. This also signals that by tampering down on all discourse, the elite teams that were required to make technically daunting missions like the XP-80 less set apart from the rest of the organization, thus possibly diluting the impact of such a core group of experts immune to any other organizational forces. When all activities within a firm turn into innovation and development, the entire company becomes a clandestine operation in practice—open office spaces and culture or not.

This strategy shift away from the core tenants of skunkworks style operations not only has an impact on the innovation style and approach, but also the ability to exchange ideas and effectively control knowledge and information within technology firms.

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[423] "Skunkworks." The Economist, 2008. https://www.economist.com/news/2008/08/25/skunkworks.

[424] See for example this list from 2013 of corporate laboratories:
Nisen, Max. "17 of the Most Mysterious Corporate Labs Coolest Skunk Works." Business Insider (2013). https://www.businessinsider.com/coolest-skunk-works-2013-2.

[425] See, for instance: Stone, Brad and Vance, Ashlee. "Apple's Obsession with Secrecy Grows Stronger." The New York Times, 2009. https://www.nytimes.com/2009/06/23/technology/23apple.html.

Appendix D:

Essential Background on NDAs

NDA Overview

Non-disclosure agreements (NDAs) are contracts that restrict parties (usually employees or individuals involved in a negotiation) from divulging trade secrets or sensitive, proprietary, or confidential information learned during employment or negotiation discussions. NDAs are also sometimes referred to as Confidentiality Agreements. NDAs are different from non-compete agreements which prevent employees from leaving a company and going to work for a direct competitor. Non-compete agreements are regulated in certain states like California—making it easier for employees to refuse to sign. Those states that limited non-competes and allowed employees to move fluidly between even competing firms enabled new knowledge flows and is credited as one component that helped early Silicon Valley succeed as one of the most innovative regions in the world.[426] The changing role of the NDA in Silicon Valley tech culture will be explored below.

Traditionally, there has been friction when NDAs have been used to stymie whistle blowers internal to companies—such as former tobacco R&D VP Jeffrey Wigand who was hushed briefly out of CBS's uncertainty on how to handle his confidentiality agreement in the early 1990s.[427] Now NDAs have evolved as a legal mechanism, and are used as silencing legal mechanisms to limit open discussion about incidents, press coverage, and now even researchers. NDAs were also frequently mentioned in the news during 2017-2018 because of the #MeToo movement where sexual assault and harassment victims were forced to sign NDAs during settlements to block their communication with journalists or the public. NDAs were also prominent legal mechanisms used in the Trump administration to try and prevent leaks to the press, as well as to silence former paramours like Stormy Daniels.[428] Unsurprisingly, the use of NDAs in each of

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[426] See for instance key themes and findings from *Regional Advantage*.

More information about the California law may be found here:

Manwani, Archana R. "The Latest and Greatest Updates About Non-Compete and Non-Solicitation Agreements in California." The National Law Review (2018). https://www.natlawreview.com/article/latest-and-greatest-updates-about-non-compete-and-non-solicitation-agreements.

[427] Dean, Michelle. "Contracts of Silence." Columbia Journalism Review (2018). https://www.cjr.org/special_report/nda-agreement.php.

[428] Goodkind, Nicole. "Stormy Daniels and Donald Trump Non-Disclosure Was Bungled by Texas Notary: Report." Newsweek, 2018. https://www.newsweek.com/stormy-daniels-notary-texas-trump-cohen-nda-1122464.

these cases has been disputed and argued, both on ethical grounds as well as their legal standing.

NDAs may be unilateral (one sided), bilateral (two sided), or multilateral (many parties involved). NDAs during the time of this study were ubiquitous at major tech firms in Silicon Valley, serving as omnipresent reminders that running afoul of language you may not understand could come with heavy consequences. There were three primary categories of occasions where NDAs were signed: 1) When employees were hired; 2) By visitors (including researchers, journalists, activists, etc.) upon entering a premise for any reason; 3) During a negotiation, like a merger or acquisition. In cases 1 and 2, it is almost always a unilateral NDA. This dissertation research dealt primarily with the first two categories, from the perspective of employees grappling with what could be said about their work to my own personal experiences and the experiences of other researchers signing NDAs during office and event visits.

Early Documentation of NDAs and Tech

Despite NDAs prevalence today, this was not a common legal contract in the early-mid 20th century. Dean traced their origin back using a search of newspaper databases to the 1940s within the context of maritime law.[429] NDAs later began to pop up at tech firms like IBM, which probably corresponded to the secret Boca Raton facilities and policies described previously. Dean traces the use of NDAs to other contexts, including its use in the late 1970s during a House Select Committee on Assassinations hearings on the Kennedy and King assassinations in order to silence reporters for matters of national security.[430] Dean describes NDAs as a "quirk" of the technology industry, and details the ways in which they have impacted journalism and used as silencing mechanisms. She notes, "NDAs are enormously controversial, even within the legal community. From one vantage—say that of an exceptionally cautious lawyer, or an exceptionally frightened employee—keeping silent is thought necessary to avoid hefty financial penalties. Another view holds that NDAs are often unenforceable, most clearly if the activity meant to be kept secret is illegal, and that even where a court might uphold the agreement, a lot of potential plaintiffs don't want to have to give the other side discovery on their bad behavior."[431]

Understanding how and when they were used within the technology industry is difficult, even when many note the change. Using limited public and historic corporate documentation to prove the absence of any process, including the use

[429] Dean, Michelle. "Contracts of Silence." Columbia Journalism Review (2018). https://www.cjr.org/special_report/nda-agreement.php.

[430] In researching this portion of the dissertation, additional uses of NDAs within national security contexts popped up for the next several decades.

[431] Dean, Michelle. "Contracts of Silence." Columbia Journalism Review (2018). https://www.cjr.org/special_report/nda-agreement.php.

of NDAs, is an impossible task. This section accepts evidence from the past, in order to highlight that the NDA uses of today are exceptional, even when once considered a "quick" of the tech industry, and are having impacts far beyond protecting confidential information.

NDAs were used early on for some employees leaving firms. Saxenian described the use but limited control over general knowledge flows within Silicon Valley technology culture. "This decentralized and fluid environment accelerated the diffusion of technological capabilities and know-how within the region. Departing employees were typically required to sign nondisclosure statement that prevented them from revealing company secrets; however, much of the useful knowledge in the industry grew out of the experience of developing technology. When engineers moved between companies, they took with them the knowledge, skills, and experience acquired at their previous jobs. This localized accumulation of technical knowledge enhanced the viability of Silicon Valley startups and reinforced a shared technical culture." [432]NDAs were also beginning to be used during negotiations, but with limited power as Saxenian further documents.[433] "While nondisclosure agreements and contracts were normally signed in these alliances, few believed that they really mattered, especially in an environment of high employee turnover like that in Silicon Valley. Firms recognized they had a mutual interest in one another's success, and that their relationships generally defied legal enforcement." Saxenian goes on to quote a manager at Apple who comments that they do not always need a formal contract in most negotiations. Another industry consultant quoted by Saxenian stated: "Company lawyers are trained to write 90 paragraphs to protect their client, but in the end, the relationship is based on mutual trust. If you don't have that mutual trust, then you probably shouldn't have the marriage in the first place."[434]

The emphasis on trust, not legal contracts, was reflected by other stakeholders. John Seely-Brown wrote in 2000[435] that "knowledge may travel more easily around a network of practice that lies across several different firms than between two different communities of practice in the same firm" because of the mobility of labor. He added that startups, who have less turn over and less outward knowledge flows in either direction, tended to build a "rich and shared context for trust" by working closely on a singular goal. Seely-Brown continues that "The same is true for specialty shops and boutique consulting firms, firms whose reputations in the Valley can replace the need for detailed legal contracts

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[432] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 37.

[433] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 149.

[434] Saxenian, AnnaLee. *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*. (Cambridge, Mass.: Harvard University Press, 1994), 149.

[435] Kenney, Martin. *Understanding Silicon Valley : The Anatomy of an Entrepreneurial Region*. (Stanford, Calif.: Stanford University Press, 2000), xv.

and whose reputations, earned through performance with many different customers, makes them easy to trust at a technical level."

One article from 1988 discusses Steve Job's venture Next Inc. after his first departure from Apple, and quotes Peter Lyman (then faculty member at USC, later a faculty member at Berkeley's I School) who cannot comment on the actual machine—only how much he was impressed by it—because he and others signed a nondisclosure agreement as part of Next's advisory board.[436]

As outlined in the history section in Chapter 4, corporate innovation in the 80s and 90s began to take on more supply chain integration and cooperative partnerships. In 1992, one article describes "friendly" processes for learning about competitors' practices through "benchmarking."

"Benchmarking should not be confused with industrial espionage. Rather, it is the art of finding out, in a perfectly legal and aboveboard way, how others do something better than you do so you can imitate -- and perhaps improve upon -- their techniques. It may or may not involve tearing down a competing product to see how it's built. Through research and field trips conducted by small teams, you can compare your products and processes with those of competitors -- yes, they sometimes cooperate -- or with those of noncompeting companies in your industry or enterprises in completely different businesses."[437] The discussion of the practice reflects the somewhat open and fluid nature of the tech culture, while warning the pitfalls might be in wasting effort where technology might outpace the firm. For instance, Xerox spent 6 years benchmarking the handling of toners and typewriters in the early 1980s, only to have the personal computer supplant and make all the efforts redundant. There is no mention of NDAs on the site visits prescribed in the article.

In 1994 Microsoft was sued in an antitrust case for the use of particular licensing practices and the use of "restrictive" NDAs which restricted any software company that had had a preview of an upcoming product from dealing with any other operating systems for three years.[438] This practice was banned by a consent decree. The recommendation of using NDAs during business negotiations was still being circulated in 1994 as a novel best practice.[439]

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[436] O'Reilly, Brian. "Steve Jobs Tries to Do It Again." Fortune May 23, 1988 (1988): P 83-84.
[437] Main, Jeremy, and Rahul Jacob. "How to Steal the Best Ideas Around." Fortune, 1992.
[438] Post, Tom. "Bill Gates's Soft Landing." Newsweek 124, no. 4 (1994): 40.
[439] Fraser, Jill Andresky. "Keeping Your Numbers Secret." 16, no. 2 (1994).