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Model City: Technologies of Government in the San Francisco Bay Area

By

John W Elrick

A dissertation in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Geography

and the Designated Emphasis

in

Global Metropolitan Studies

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Jake Kosek, Chair
Professor Richard Walker
Professor Wendy Brown

Spring 2021

Model City: Technologies of Government in the San Francisco Bay Area

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By

John W Elrick

Abstract

Model City: Technologies of Government in the San Francisco Bay Area

By

John W Elrick
Doctor of Philosophy in Geography
Designated Emphasis in Global Metropolitan Studies
University of California, Berkeley
Professor Jake Kosek, Chair

In this dissertation, I explore how novel techniques of urban governance converged with new planning technologies to transform postwar space and politics in the San Francisco Bay Area. I argue that the terms and practices girding contemporary forms of government in metropolises like the Bay Area were forged through modeling and simulation initiatives undertaken by administrators and experts in the decades after World War II.

After surveying the political landscape today, I trace a broad historical shift in the way cities have been understood and acted upon as governmental problems. In current policy discourse, cities are posited as complex systems amenable to market-driven forms of technological management. This formulation stands in contrast to earlier ones. Whereas governing authorities during the early twentieth century sought to secure social order in cities as physical forms by intervening in the built environment to mold moral subjects, contemporary administrators aim to optimize the performance of cities as feedback systems by promoting the conditions under which enterprising patterns of behavior might flourish.

To account for this shift, I probe three postwar initiatives pursued in the Bay Area. Together, they helped constitute the grounds upon which market-based modes of urban rule now unfold: a concrete hydraulic model of the San Francisco Bay framed the metropolis as both a set of environmental processes and an object of regional governance; an effort to simulate the housing market in San Francisco on behalf of renewal rendered up the city as a racialized system of communication and surveillance; and the creation of a novel public science museum laid the groundwork for a pedagogical tool now deployed to shape the conduct of urban subjects. Examining the historical construction and political effects of these urban projects contextualizes the governmental scene today.

While Bay Area administrators drew upon wider notions about the city as a managerial problem during the twentieth century, the metropolis itself has since emerged as a kind of neoliberal model. It is a global hearth for the technology industry and home to firms like Google, Facebook, and Twitter among others. It is also a burgeoning site of inequality and precarity. Though critical assessments of the region's transformation abound, less attention has been paid to the political vision – the governmental reason – that animates it. This work highlights the historical conditions that continue to underwrite such a circumscribed and market-oriented picture of the world. In so doing, I hope it contributes to our collective ability to build a more just urban future.

For You Know Who

Table of Contents

List of Figures……...……iv

Acknowledgements……..…….……v

Introduction: Histories of the Urban Present…….1

The Urban Present…….…....2
Histories of the Present……6
Mapping the Dissertation……..…11

Chapter 1: Frameworks for Rule……...**14**

An Overview of the Task……...……15
The Problem of the City…….....17
From the Discipline of Form to the Management of Process……...…….20
Milieus of Complexity……...…22
Models as Political Technologies…...……...……24
Technologies of Government in the Bay Area……..……26

Chapter 2: Modeling the System……**27**

A Concrete Abstraction……..…28
Birth of the Model……..……31
The Model and the Bay……..…38
The World a Model Makes……52
The Angel of History at Richardson Bay……...…63

Chapter 3: Simulating Renewal……..…**65**

Governing Cities as Systems of Information……...…..66
Renewal: Race, Real Estate, and the Machinery of War…….…..….70
Simulation: Community Renewal Programming…….……..78
Appraisals: Critiquing the Model, Affirming the System…….….84
Renewal Simulation and Civic Innovation……....87

Chapter 4: Staging Interactivity……..……...**90**

The Capital of Innovation: Monuments as Political Technologies……..……..91
The Bomb and the Blacklist……...…95
A Model Museum……..99
An Infusion of Market Logics……..……....104
Staging the City as a Laboratory for Innovation……..……109

Conclusion: Back to the Present……...……**113**

Points of Departure……...…114

References……...……**117**

List of Figures

Figure 1: A Frame……..……**1**

Figure 2: The Plat of Zion…….....……..……**14**

Figure 3: A Visualization of the City as a Complex System…….…....…….**14**

Figure 4: The Bay Model During Construction…….....……..**27**

Figure 5: Ruins of the Mississippi River Basin Model……...……..**36**

Figure 6: Army Corps of Engineers Aerial Survey Photos…....……..…..….**41**

Figure 7: The Tide Generator at the Bay Model…….....……..**49**

Figure 8: The Bay Model in its Current Instantiation……...……**52**

Figure 9: Debris Collection Dock at the Corps' Operation Base Yard…….....**63**

Figure 10: A Demolished Block Along Geary Boulevard…….....….....**65**

.

Figure 11: Residential Security Map of San Francisco……...…....**74**

Figure 12: Abbreviated Flow Chart for the CRP's Simulation Model…….....…**78**

Figure 13: Visualization Prototyped at the Urban Data Canvas Challenge……...…..….**87**

Figure 14: Interactive Exhibit at the Exploratorium……...…….....**90**

Figure 15: Unveiling of the First Living Innovation Zone……...……..…..**94**

Figure 16: A View of the City from the Museum's Observatory……...……**109**

Figure 17: A Window……...……..**113**

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A number of other faculty and staff members at Berkeley and beyond also deserve hearty thanks. Paul Groth was an early mentor and imparted upon me a method of landscape analysis that I continue to draw upon. Graduate seminars with Michael Watts, Gillian Hart, You-tien Hsing, David Henkin, and Alison Post proved crucial to my formation as a researcher and writer. Conversations with Gray Brechin, Nathan Sayre, and David O'Sullivan helped me formulate and clarify particular research questions. Likewise, Fred Turner and Andrew Barry offered generous remarks at key junctures during the writing of this work. The folks who make sure that the Berkeley Geography Department functions smoothly as both a social environment and administrative unit on a daily basis merit special recognition. Many thanks to Marjorie Ensor, Sarah Varner, Josh Mandel, and Eron Budi for steering the ship.

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Introduction:

Histories of the Urban Present

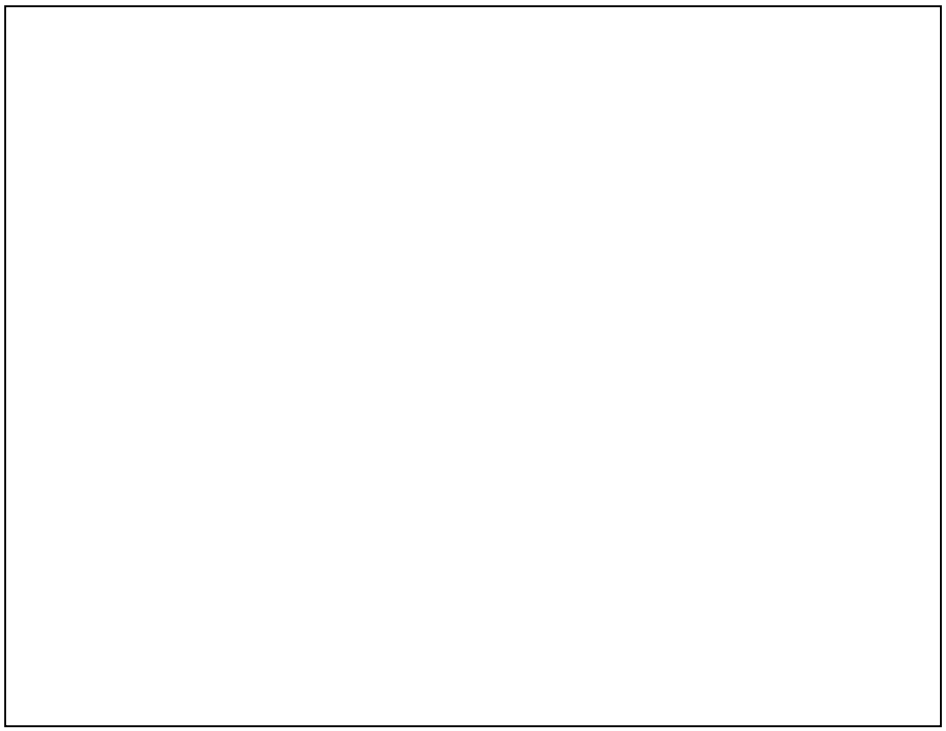


Figure 1: A frame. **Source:** Author.

Out of my answers grew new questions, inquiries, conjectures, probabilities – until at length I had a country of my own, an entire discrete, flourishing world, like a secret garden the existence of which no one expected.[1]

-Friedrich Nietzsche

This secret garden is what genealogy intends to produce: this other way of conceiving the familiar, this radical displacement of the lay of the land through which we think and perceive ourselves, our problems, our imperatives.[2]

-Wendy Brown

[1] Friedrich Nietzsche, *On the Genealogy of Morals*, trans. Walter Kaufmann and R.J. Hollingdale (New York: Vintage, 1969) p. 17.
[2] Wendy Brown, *Politics Out of History* (Princeton University Press, 2001) p. 96.

Twitter / Twitter me!
Facebook / Facebook me!
Hey, girl, did you tag me in that pic?

Silicone / Silicone Valley!
Silicone / Silicone Valley!
Hey, girl, did you get that eviction notice?

Google Google / Apps Apps
Gringa Gringa / Apps Apps
Hey, girl, where the fuck are you moving to?

Google Street View images flick across my computer screen. Household items pile up haphazardly on a sidewalk. Notice posted. Electronic music pulses while performers dance and sing over a projected Google map of evictions in San Francisco. They reenact an everyday occurrence in the city: the displacement of longtime residents, artists, line cooks, drag performers, teachers, poets, retirees, mechanics, immigrant families, and city dwellers at their most vulnerable. Though the scene performed is an all too familiar one, the stage upon which it unfolds is curious, unsettling even. A snap shot technological world infused with power, affects, and effects. This stage disorients. It begs questions. It provokes.

The Urban Present in the San Francisco Bay Area

The future™ has arrived in the San Francisco Bay Area. It has done so on the heels of sweeping social, political, and technological changes. And it basks in the shadow of Google.[3] Home to a vibrant IT and electronics sector, the Bay Area – and especially Silicon Valley to the south – has long been considered a hearth of innovation, entrepreneurialism, and corporate investment in high-tech.[4] While large firms with extensive fixed capital outlays in the southern suburbs such as Apple, Facebook, and Cisco dominate the sector, the industry's center of gravity has begun in recent years to shift northward.[5] A decade after the first dot-com bubble secured San Francisco's reputation as a startup hotbed, new crops of investment made possible by cloud-

[3] The introductory section of this chapter draws upon two previously published pieces: John Elrick and Will Payne, "Model City: Rule of Innovation." In Robby Herbst, ed., *New New Games* (San Francisco: Southern Exposure, 2016) pp. 10-11; John Elrick, "Visionary Politics: Technologies of Government in the Capital of Innovation," *Society and Natural Resources* 30: 2 (March 2017) pp. 860-876.
[4] Annalee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1994).
[5] Richard Florida, "Why San Francisco May Be the New Silicon Valley," *CityLab,* August 5, 2013. http://www.citylab.com/work/2013/08/why-san-francisco-may-be-new-silicon- valley/6295/ (last accessed June 15, 2016).

computing and web-based media have proliferated throughout the city.[6] In 2011, the city's mayoral administration cultivated this growth along San Francisco's Mid-Market corridor by pushing through the Central Market Payroll Tax Exclusion. Enacted to transform Market Street into an "innovation district," the policy waived payroll taxes for any firm planting roots within designated parcels.[7] In addition to Twitter's new corporate headquarters, the area now hosts an assortment of startups and smaller companies. This growth, combined with firm expansion in the development-restricted municipalities of Silicon Valley, has triggered an infusion of skilled workers into the metropolis as well as a market-rate development boom.[8]

The effects of the latest boom have been dramatic and uneven. On one side, the dynamics of urban transformation have simultaneously remade the physical landscape of the city and reshaped the parameters of political discourse within it. While officials like to tout the city's high credit rating as evidence of the success of business-friendly policy initiatives, urban innovation strategists point to the fact that San Francisco pulls in more venture capital than Silicon Valley as proof that the right kind of environment facilitates both broad economic growth and collective well-being.[9] On the other, as startups and workers began to flood into San Francisco looking for housing, office space, and amenities, they ushered in new rounds of property speculation, tenant displacement, and social protest.[10] A boom in the price of housing, exacerbated by the establishment of a private bus system designed to move workers between San Francisco and Silicon Valley, continues to underwrite controversies regarding the fate of the city.[11] While municipal officials are quick to celebrate San Francisco as the "Innovation Capital of the World," the city also boasts the second highest ratio of income inequality among big cities in the United States – and the largest increase since 2007.[12]

Tension over the changing character of San Francisco was perhaps best illustrated by the release a few years ago of an electro-dance protest anthem produced by the Bay Area's Black Glitter Collective. Originally written for a live performance at a benefit

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[6] Richard Walker, "The Boom and the Bombshell: The New Economy Bubble and the San Francisco Bay Area." In G. Vertova ed., *The Changing Economic Geography of Globalization (*London: Routledge, 2006); Zoe Corbyn, "Is San Francisco Losing its Soul?" *The Guardian*, February 23, 2014.

[7] San Francisco Office of Economic and Workforce Development, "Central Market Economic Strategy Draft," (2011). http://www.sfgsa.org/index.aspx?page=5482 (last accessed on June 16, 2016). Bruce Katz and Julie Wagner, *The Rise of Innovation Districts: A New Geography of Innovation in America* (Washington D.C.: Brookings Institution, 2014).

[8] John Stehlin, "The Post-Industrial 'Shop Floor': Emerging Forms of Gentrification in San Francisco's Innovation Economy," *Antipode* 48: 2 (2015): 474-493.

[9] City and County of San Francisco, Office of the Mayor, "Mayor Lee Highlights Three Years of Continuing Revitalization," March 14, 2014. http://www.sfmayor.org/index.aspx? (last accessed June 16, 2016); Richard Florida, "America's Leading Metros for Venture Capital," *CityLab,* June 17, 2013. http://www.citylab.com/work/2013/06/americas-top-metros-venture-capital/3284/ (last accessed June 16, 2016).

[10] Anti-Eviction Mapping Project, http://www.antievictionmap.com/ (last accessed June 15, 2016); Urban Displacement Project, http://www.urbandisplacement.org/map/sf (last accessed November 6, 2017).

[11] Rebecca Solnit, "Get Off the Bus," *London Review of Books,* February 22, 2014.

[12] Ed Lee, "San Francisco Action Plan," *U.S. Conference of Mayors: Technology Innovation Task Force, Open Government Innovation Partnership (*No date, in author's possession); Alan Berube, "All Cities Are Not Created Unequal," *Brookings Institution*, February 20, 2014. https://www.brookings.edu/research/all-cities-are-not-created-unequal/ (last accessed November 6, 2017).

show in support of Esta Noche, a Latino gay bar facing eviction in San Francisco's Mission district neighborhood, *Google Google Apps Apps* – a video version of the performance – soon went viral online, ushering in a wave of local commentary on the internet and in print. While some commentators celebrated it as a timely expression of anti-displacement sentiment, others bemoaned it in the comment sections of online forums for "hating white people." In front of a projected montage of Google Map and Street View screenshots and satellite images of the Bay Area, the video features drag performers and visual artists Persia and Daddie$ Pla$tik reenacting the eviction and dislocation of queer people of color from San Francisco. In infectious verses accompanying the exodus, the performers link high-tech money in Silicon Valley, mobile devices, and a platform for market-based innovation – the app – to gentrification and the social power of whiteness. Moreover, while the video makes a political claim connecting technical ways of seeing to the organization of collective life, it does so by appropriating some of those very ways of seeing.[13] Esta Noche lost its lease and was forced to shutter its doors for good in 2014. Today the building is home to an austere cocktail lounge. I've walked past this bar – as well as the makeshift encampments that rise and fall around it – nearly every day for the past five years.

Though critical assessments of the Bay Area's transformation abound, relatively scant attention has been paid to the political vision – the mode of governmental reason – that animates it.[14] Within the context of quickening innovation and growing inequality, a "civic innovation" coalition has worked to apply the principles and practices of high-tech enterprise to the management of urban affairs more broadly. From new media artists and entrepreneurs to urban policy wonks and planners, proponents of civic innovation encompass a variety of actors. As an institutional project, its strongest expression can be found in the Mayor's Office of Civic Innovation. Formed in 2011 by members of Ed Lee's mayoral administration, the office works to "embed startup DNA into government" and manage the metabolism of the city as an ecosystem of innovation.[15] In addition to sponsoring the expansion of technical infrastructures, building public-private partnerships, and spreading a culture of innovation across municipal agencies, the central charge of the office is to put public information and space to entrepreneurial ends.[16]

In principle, contemporary forms of 'innovative governance' call for both a redefinition of the role of city government and its reorganization along startup lines. While scholars have traced the rise of urban entrepreneurialism as a late-capitalist governance strategy and critiqued the attendant discourse of "creative cities," it is worth

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[13] "Google Google Apps Apps," <https://www.youtube.com/watch?v=5xyqbc7SQ4w&has_verified=1> (last accessed September,1 2020)

[14] An exception to this silence occurred when one city supervisor lambasted the Entrepreneurship-in-Residence program as an example of "corporate welfare." Yet, even this appraisal neglected the project's more radical dimension: not only does it mobilize public resources on behalf of private interests but it sets out to reconstitute the public itself on the model of a startup. Jonah Owen Lamb, "S.F. Opens Door to Public Tech Incubator Expecting No Return," *San Francisco Examiner*, May 18, 2014. http://www.sfexaminer.com/sf-opens-doors-to-public-tech-incubator-expecting-no-return/ (last accessed November 6, 2017).

[15] Luke Fretwell, "New SF effort will embed startup DNA into government," *govfresh*, October 2, 2013. http://www.govfresh.com/2013/10/san-franciscos-entrepreneurship-residence-program/ (last accessed November 6, 2017).

[16] San Francisco Mayor's Office of Civic Innovation, *A Startup Called Government: Our First Year in Retrospect* (San Francisco: Innovate SF, 2013).

highlighting some of the normative assumptions that underwrite civic innovation as a governmental project.[17] From this perspective, municipal governments should be lean and flexible; they should be willing to take risks and adopt new technologies; and they should embrace transparency as a competitive strategy. That is, they should mobilize public resources to attract capital – human and financial alike – within a global field of urban competition.[18] Moreover, remaking government into an enterprise entails re-envisioning the relationship between urban subjects and the institutions of democratic government: Customers (citizens) should be understood to co-produce services with market suppliers (governments) via web-based platforms and processes of information feedback.[19] Still, an important difference between enterprising government and private enterprise animates this understanding. Though modeled on the principles of a startup and evaluated in terms of its performance as one, government here should be relegated to laying the groundwork for market innovation. "In this model," media entrepreneur and marketization advocate Tim O'Reilly argues, "government is a convener and an enabler" of market activity, not "the first mover of civic action."[20] Rather than pursue social welfare through regulation or the redistribution of wealth, government in this view should attend solely to the conditions for market competition as a normative good.[21]

San Francisco offers a striking example of the way in which market-driven innovation has become a governing principle. A variety of public and private entities have employed a variety of strategies – from city-sponsored entrepreneurship programs and computer coding camps to urban redesign and revitalization schemes – to render the public realm into the site of potential innovation. At root, all of these initiatives share a singular goal: they aim to instill in city dwellers the value of investing in one's self as human capital. As opposed to the classical liberal capitalist subject of the free worker who sells his or her labor power on the market as a commodity, the figure of human capital—popularized by Gary Becker of the Chicago School—denotes a self-investing subject who perpetually seeks to enhance his or her value and attract investors across all spheres of life, including those not previously qualified in economic terms.[22] Michel Feher suggests that human capital designates a "type of subjectivity" that is "simultaneously presupposed and targeted by neoliberal policies."[23] If attending to the conditions of market innovation frames the purpose of urban government today, then fostering an urban public capable of innovative behavior – a crucial feature to any effort

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[17] David Harvey, "From Managerialism to Entrepreneurialism: The Transformation in Urban Governance in Late Capitalism," *Geografiska Annaler,* 71:1 (1989): 3-17; Jamie Peck, "Struggling with the Creative Class," *International Journal of Urban and Regional Research* 29: 4 (2005): 740-770; Heather McLean, "Digging into the Creative City: A Feminist Critique" *Antipode* 46: 3 (2014): 669-690.

[18] On the political effects of financialization, see Michel Feher, *Rated Agency: Investee Politics in a Speculative Age,* trans. Gregory Elliot (New York: Zone Books, 2018).

[19] Jay Nath, "Reimagining Government in a Digital Age," *National Civic Review* 100: 3 (2011): 19-23.

[20] Tim O'Reilly, "Government as a Platform," *Innovations: Technology, Governance Globalization* 6: 1 (2011): p. 15.

[21] Michel Foucault, *The Birth of Biopolitics*: *Lectures at the Collège de France, 1978-1979* (New York: Picador, 2008).

[22] Foucault, *The Birth of Biopolitics*, pp. 215-233; Wendy Brown, *Undoing the Demos: Neoliberalism's Stealth Revolution* (New York: Zone Books, 2015) pp. 30-42.

[23] Michel Feher, "Self-Appreciation; or, The Aspirations of Human Capital," *Public Culture* 21 (2009) p. 23.

to optimize the performance of urban systems – is an increasingly central governmental preoccupation.

These are the conditions of urban social and political life that frame Persia and Daddie$ Pla$tik's critique of the city in *Google Google Apps Apps*. Not only does the song and accompanying video performance shine a spotlight on the uneven social effects and human toll of inequality and displacement in the world's capital of innovation, it implicates the very technologies and political rationalities that gird those processes in narrowing the political horizon of possible redress. The performance certainly puts current forms of gentrification on blast – the lyrics aren't exactly subtle in lambasting the transformation of San Francisco at the hands of technology industrialists and skilled workers. But it also indicts the tools of the trade, the ways of seeing and acting and thinking that accompany market-driven innovation, in reshaping what the geographer Richard Walker has described as "a city that captures the imagination of an era and embodies the spirit of the times."[24] In their reenactment of contemporary urban processes in San Francisco, Persia and Daddie$ Pla$tik refuse any neat distinctions between political economy and cultural convention, politics and technology, identity and materiality, or social power and technical expertise. They are all of a piece. Indeed, they collectively infuse the spirit of the urban times.

To my eyes, *Google Google Apps Apps* paints a portrait of the contemporary techno-capitalist city and critiques the governmental framework through which efforts to address its uneven conditions are pursued. The song and performance lambaste not urban change *per se* but the distinct *kinds* of changes wrought in the Bay Area over the past decade and a half. The piece rails unapologetically against the effects of so-called disruptive innovation and tech-driven urbanization – obnoxious and overlapping disparities, skyrocketing rates of displacement, and a horizon of political possibility increasingly dimmed by the market logics of the information technology industry. It is a portrait of an urban world where self-driving cars bump into homeless encampments; a world in which the very means and methods that underwrite the production of social problems and inequalities insidiously emerge in political discourse and practice as the solution to those problems. At root, *Google Google Apps Apps* provides a critique of a particular type of urban political practice and rationality simultaneously bolstered and facilitated by a distinct object: the contemporary city as a problem-space of government. This dissertation takes that object – the city conceived of and materially worked upon as a complex interconnected system of social, ecological, and economic processes amenable to managerial optimization – as its starting point. I work in the dissertation pages that follow to describe and delineate the specific characteristics and historical emergence of this city.

Histories of the Present

While the contemporary social and political scene in the San Francisco Bay Area animates my research, this dissertation is principally concerned with the historical

[24] Richard A. Walker, *Pictures of a Gone City: Tech and the Dark Side of Prosperity in the San Francisco Bay Area* (Oakland, CA: PM Press, 2018) p. 2.

formation of the conditions that frame and underwrite it. No doubt, as I formulated and researched the chapters that follow – with their focus on the political implications of planning and design techniques and technologies – I was deeply informed by the indignities of everyday life in the Bay Area today. In the field of urban studies, there have been a number of stellar recent works highlighting in astute detail the political economic and historical basis of contemporary inequality in American cities, especially those ongoing forms of racial segregation, class stratification, and neighborhood gentrification.[25] These works provide a critically important lens through which to understand urban change today. Yet, in observing and analyzing the political economic processes through which American cities are currently being transformed, these studies by and large leave the very stage upon which those processes unfold as taken for granted. In an effort to deepen and expand a critical understanding of the political stakes of urban life in contemporary technological society, this dissertation examines the historical formation of the stage of the city itself – a conceptual and material object of potential intervention – as a governmental problem.

It is worth discussing briefly here how my genealogical approach to the contemporary American city might provide a framework for thinking about the relationship between history and politics as well as the past and the present. I take to heart those theoretical interventions within Marxism made by the likes of Stuart Hall and others to eschew recourse to guarantees in political life.[26] Indeed, efforts to root radical political projects in transcendent ideals – in a theology that entails an outside to power and the possibility (let alone inevitability) of unmediated mastery – both suppose and propose that resolutions to social problems in the human world can be achieved through other-worldly channels. But if the critical insight that social and material conditions are *only* produced in this world still holds, any theoretical claim about purpose in history or transcendence in politics should give pause. This raises important questions: If the left must remain on guard against the role of transcendent ideals in urban democratic practice, what egalitarian aims or sustained purposes for the city as it exists today might be forged? How might those aims be formulated, and to what end? And, more broadly, what is the relationship between democratic politics and intellectual life in the world of contemporary cities?

Wendy Brown tackles these questions head on in her essay "Politics without Banisters" by considering "how the notion of genealogy formulated by Nietzsche and revised by Foucault might function as an alternative ground for generating political aims – a ground that, unlike conviction, embraces the contingent elements of political life and also faces forthrightly the relative arbitrariness of political values."[27] Brown highlights

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[25] For a taste of this recent approach, see: Walker, *Pictures of a Gone City*; Samuel Stein, *Capital City: Gentrification and the Real Estate State* (Verso: 1999); Peter Moskowitz, *How to Kill a City: Gentrification, Inequality, and the Fight for the Neighborhood* (Hachette, 2017); Richard Rothstein, *The Color of Law: A Forgotten History of How Our Government Segregated America* (New York: Liveright, 2017).

[26] Stuart Hall, "The Problem with Ideology: Marxism without Guarantees," *Journal of Communication Inquiry* 10 (2) 1986: pp. 28-44; Ernesto Laclau and Chantal Mouffe. *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics* (New York: Verso, 1985).

[27] Wendy Brown, "Politics without Banisters: Genealogical Politics in Nietzsche and Foucault." In *Politics Out of History.* (Princeton University Press, 2001) p. 94.

two aspects of genealogical knowledge, "the deconstructive and historical dimensions," to argue that together they "enable the crafting of a theoretical frame for a historically conscious critique of the present that recurs neither to universal norms nor convictions."[28] From the genealogical perspective, democratic politics demands not religious beliefs, adherence to universal principles, or transcendent visions, but an eye towards the horizon of possibility within a given social configuration and historical ensemble of political values and forces. Indeed, genealogy takes seriously the insight that there is no – can be no – outside to power or history. That is, critical thinkers should work to discover the possibilities *imminent* to existing relationships and forms rather than their *transcendence* through other-worldly channels. From this perspective, the most seemingly obvious presuppositions about the nature of the urban problematic today must be interrogated and implicated as a terrain of contest.

In the preface to *On the Genealogy of Morals*, Friedrich Nietzsche offers a resounding indictment of the metaphysical conceit that locates the character of values and moral categories outside of human history. "I learned early to separate theological prejudice from moral prejudice," he writes, "and ceased to look for the origin of evil *behind the world.*"[29] Through a strategy that calls into question the norms and values we live by and considers the work performed by those norms and values, Nietzsche begins to ask other, hitherto undeveloped questions: "out of my answers there grew new questions, inquiries, conjectures, probabilities – until at length I had a country of my own, a soil of my own, an entire discrete, thriving, flourishing world, like a secret garden the existence of which no one suspected."[30] Nietzsche's broader project in *On the Genealogy of Morals* can be said to be one in which the creation of distance between ourselves and how we commonly know ourselves is of paramount importance; he seeks to unsettle the ground upon which knowledge of ourselves stands; he attempts to make the ordinary strange so as to expose the emergence the of common values and morals *in* not *behind* the world. Thus, the project of tracing the history of the present – rather than identifying the present with the aims of the past – places a particular conception of history at the heart of genealogical politics. Importantly, Brown suggests, "genealogy permits "an examination of our condition that calls into question the very terms of its construction."[31] For a fuller political embrace of the urban condition today, this insight suggests that the character of the city as promulgated in governmental discourse today – as system or set of processes – needs to be approached and evaluated as an historical construction with particular conceptual parameters and distinct political effects.

Any critique of the city as it is conceived of in academic or professional realms must be accompanied by an appreciation of the way in which such discourses and rationalities have materially constituted it as such. In his polemic on behalf of genealogical inquiry, "Nietzsche, Genealogy, History," Foucault embraces much of Nietzsche's formulation in *On the Genealogy of Morals* – his eschewal of theological or conventional history, his emphasis on historical emergences rather than timeless universals and essential subjects, and his embrace of the productive capacity of the

[28] Brown, "Politics without Banisters," p. 95.
[29] Friedrich Nietzsche, "Good and Evil." In *On the Genealogy of Morals* (New York: Vintage, 1989 [1887]) p. 17.
[30] Nietzsche, "Good and Evil," p. 17.
[31] Brown, "Politics without Banisters," p. 95.

disruption of those common narratives by which we know ourselves. But Foucault drops the constitutive role Nietzsche gives to psychology – desire, ideals, the will to power – and their crucial part in producing the subject. Rather than desire or will, Foucault figures social power more broadly conceived as the transformer of subjects and the grounds of inquiry. Ideals and desires, in this iteration of genealogy, are the effects of power. In this sense, Foucault can be seen as offering a materialist corrective to Nietzsche's idealistic emphasis on desire or the will to power. drives. Moreover, in contrast to conventional history's emphasis on linearity, Foucault argues that genealogy is concerned with the contingent, accidental, heterogeneous, and non-inevitable configurations that mark out and produce space and bodies. In particular, Foucault suggests that the genealogist's task is to trace descent over origin; the analysis of the former allows for the disassociation from the self and thus clarifies how the self was formed. "The search for descent is not the erecting of foundations," he writes, "on the contrary, it disturbs what was previously considered immobile; it fragments what was thought unified; it shows the heterogeneity of what was imagined consistent with itself."[32] But while Foucault seeks to deconstruct essentialisms, his focus on the body, "the inscribed surface of events," in tracing descent he roots such a deconstruction in the material effects of power.[33] While empirical inquiries informed by the prospects of a genealogical approach undertaken by a number of scholars have yielded insights on identity, community, and "the economy," I hope to mobilize such an approach to make the figure of the city productively unfamiliar.[34]

The reformulation of the political proffered by Foucault is an effect of genealogy's displacements of conventional history and philosophy as well as its displacement of their conventional disidentification with one another. Brown outlines three aspects of this conception: an emphasis on fracture and historical accident (which suggests that the condition of the present need not be and reduces the need for total revolution), an emphasis on political rationality (which designates the legitimating structure of any government as well as its orders of practice and discourse), and the sundering of genealogical discovery from political prescription through the refutation of the logic of history. Taken together, these characteristics of Foucault's conception of the political highlight the parameters of genealogical politics. As Brown argues: "The point of genealogy is to map the discourses and political rationalities constitutive of our time such that they are brought into relief as historical, contingent, partial, and thus malleable, such that 'that-which-is' can be thought of as 'that-which-might-not-be.'"[35] Thus, genealogy has no necessary political entailments. "For Foucault," Brown points out, "the project of making the present appear as something that might not be as it is constitutes *the* distinctive contribution of intellectual work to political life."[36] From this perspective, left intellectuals and theorists are confronted by the absence of recourse to any forms of political prescription or theoretically sanctioned transcendent ideals. Yet, Brown suggests

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[32] Michel Foucault, "Nietzsche, Genealogy, and History." In *The Foucault Reader*, ed., Paul Rabinow (New York: Pantheon, 1984) p. 147.
[33] Foucault, "Nietzsche, Genealogy, and History," p. 83.
[34] Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002); Stuart Elden, *Mapping the Present*: *Heidegger, Foucault, and the Project of a Spatial History* (New York: Continuum, 2001); Jake Kosek, *Understories: The Political Life of Forests in Northern New Mexico*. (Durham: Duke University Press, 2006).
[35] Brown, "Politics without Banisters," p. 112.
[36] Brown, "Politics without Banisters," p. 113.

this is not something to bemoan. "Once the radical contingency of political views and judgments is avowed," she suggests, "it is possible to partially and productively depoliticize the theoretical enterprise without thereby rendering it apolitical. It becomes thinkable to distinguish between the political possibilities that a certain body of theory affords, the political uses to which it can be put, the political position of the theorist, and a particular political deployment of the theory. Political truth then ceases to be sought within a particular theory but is, rather, that which makes an explicit bid for hegemony in the political realm."[37] What is the historical and discursive framework and technopolitical field of urban contestation within which an avowedly leftist political project might make worldly bids for a more egalitarian and less stratified city today? This is precisely the kind of question I hope to address.

Drawing on such a genealogical framework and focusing on the San Francisco Bay Area with an eye toward the contemporary maelstrom, I discuss a set of broad and interrelated analytical threads throughout the chapters that follow. First, I outline an historical shift in the way 'the city' has been both conceived of and materially enacted as an object to govern. In the first chapter, I suggest that understandings about the character of the city as a problem-space among administrators underwent a transformation of sorts over the course of the previous century. Rather than solely a problem of spatial form, the figure of the city became known and worked upon in governmental circles as a dynamic system of socio-economic and ecological flows and processes amenable to managerial optimization. Second, I work to show how the emergence of this novel epistemological framework had (and continues to have) distinct political and material effects. Not only was the metropolitan region remade through socio-technical attempts to know and thus order it in specific ways, but those ways of knowing and remaking the urban landscape provide the terrain upon which market logics unfold in the face of growing desperation and socio-economic inequality today.

I offer these remarks, admittedly, in an anxious state. In the years since I've embarked on this dissertation, history has opened its wings only to be hurled upon a growing heap of debris in unsettling ways. Why, I've wondered, have I poured over historical and technical details regarding the figure of the city when forces supporting outright racism, misogyny, and xenophobia are becoming increasingly emboldened? Why have I delved (in sometimes excruciating detail) into the ways American cities have come to be known and governed via socio-technical practices when neo-fascist forces appear to be in ascendance? How does an historical study concerned with those conditions that frame the rise of market logics as a governing principle matter to a moment when right-wing nationalism threatens not just political institutions but the present and future of life on earth? To be sure, these are earnest questions. Though this study doesn't focus on the relatively recent events that color our moment today, I hope it provides some historical and political context – through a particular lens – for the emergence of a reactionary social and political movement embodied by a figure who gained national popularity through a catch phase – "You're Fired" – on a reality television program. Moreover, at the time of this writing, a global pandemic continues to affect people in disparate and sometimes fatal ways. Alas, readers will judge the political relevance of this untimely research for themselves.

[37] Brown, "Politics without Banisters," p. 120.

A number of notable scholars have paid astute attention to the social and economic logics and austerity-driven political effects of those late capitalist governing strategies that broadly fall under the tent of "neoliberalism."[38] I draw upon and widely concur with these critical takes – and my research generally supports their analyses. While critical scholars and theorists concerned with social and political life under contemporary conditions have focused on the role of corporate power, processes of economic restructuring, and the material consequences of political discourse, in this dissertation I provide an alternative yet related lens onto the current moment. Instead of focusing primarily on the nefarious practices of elite business interests or the rhetoric of market cheerleaders, I trace a history of the various ways in which technicians and administrators laid the groundwork upon which contemporary politics continues to unfold today. That is, I examine how urban life – environmental, economic, and personal – were studied, rendered, modeled, and thus materially remade after World War II. Indeed, I contend that certain postwar practices of knowledge production not only girded particular forms of liberal managerialism in U.S. cities but continue to frame urban politics and government to this day. Ways of knowing an infinitely complex urban world, I suggest, also help constitute collective ways of living in it.

Mapping the Dissertation

With an eye on the measured planks and mechanized beams of the contemporary urban stage, this dissertation examines the ways in which novel techniques of urban governance converged with new planning technologies to transform postwar space and politics in the San Francisco Bay Area. The dissertation is organized into four main chapters. Chapter 1, "Frameworks for Rule," frames a shift that I take as an invocation for research – an historical and conceptual shift in ways of thinking about the nature of cities as well as governmental approaches to intervening in them that guides my analyses in the empirical chapters that follow. I begin by illustrating he way in which the urban region is posited in policy debate today as a "complex adaptive system" of interconnected socio-ecological processes amenable to technical forms of evaluation and management. This conception of the city as "a problem of organized complexity" stands in stark contrast to the way it was imagined as a site of governmental intervention before World War II. Whereas contemporary planners and policy makers aim to optimize the performance of the city as a system of feedbacks by promoting the conditions under which enterprising patterns of behavior might flourish, urban authorities during the first half of the twentieth century sought to secure social order in the city as a physical form by intervening in the built environment to mold moral subjects. To account for this shift, I argue that urban designers, planners, engineers, and administrators in the Bay Area

[38] David Harvey, *A Brief History of Neoliberalism* (Oxford University Press, 2007); Jamie Peck, *Constructions of Neoliberal* Reason (Oxford University Press, 2010); Brown, *Undoing the Demos.*

constructed and imbibed new models for urban living and decision making to re-conceptualize and re-make the metropolis between 1950 and the 1980s.

I develop this argument through a detailed examination of three specific modeling initiatives – descending in scale from the metropolitan region to the individual urban subject – undertaken in the Bay Area over the course of the third quarter of the twentieth century. Chapter 3, "Modeling the System," focuses on the construction, use, and wider impact of the San Francisco Bay-Delta Hydraulic Model, a concrete and distorted-scale model of the bay-estuary built by the Army Corps of Engineers in the 1950s and 1960s to simulate tidal conditions, trace pollution dispersal patterns, and test the feasibility of various dredging and development plans. The construction of the model as an effective engineering tool not only required material and social interventions in the wider metropolitan landscape through ongoing procedures of measurement, verification, and calibration, but it also rendered the metropolis legible to policy makers and the public alike as "a complex estuarine system." In addition, through the data it generated about the interconnected nature of such a system, the Bay Model underwrote the formation of organizations of regional oversight. An examination of this hydraulic modeling project and its wider effects, I suggest, lends historical perspective on contemporary market-based approaches to environmental governance in the Bay Area.

On the heels of the first successful simulations run on the Bay Model, federal administrators, corporate consultants, and city planners in San Francisco embarked on a different experiment in model building and urban planning. With an eye toward current techno-utopian schemes and city-building initiatives, Chapter 3, "Simulating Renewal," examines the Community Renewal Program (CRP), an early simulation initiative sponsored by the federal government. After situating it in the context of racialized housing markets and policies, I probe the CRP's attempt to build a computer model capable of forecasting the effects of redevelopment on housing markets in San Francisco. Though the CRP model ultimately proved unviable as a planning tool, expert appraisals of it at the time simultaneously confirmed the characterization of cities as systems of market signals and affirmed in principle the ability to model and thus manage them given an appropriate technological infrastructure. In this light, current municipal design and development projects premised on interactive and remote-sensing technologies express something of the technocratic optimism of the mid twentieth century.

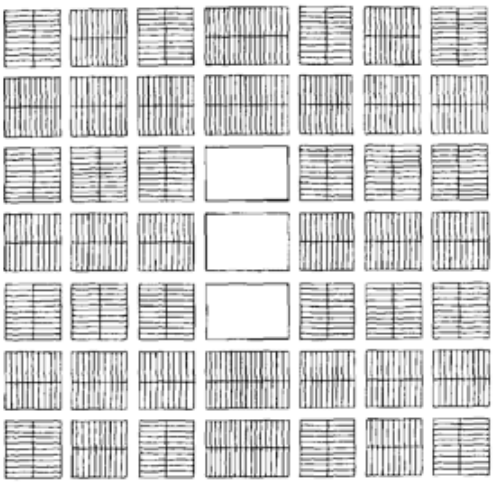
By the late 1960s and early 1970s, ways of understanding the city as a complex adaptive system of communication and socio-ecological processes had spread beyond the professional domains of planning and engineering to take hold in the Bay Area's counter-cultural arts and education scene. While the Bay Model and the Community Renewal Programming initiative constructed the city as a problem of organized complexity in technical terms from a managerial point of view, the establishment of the Exploratorium, an interactive science and technology museum founded in 1969, ushered in a new paradigm of science and technology pedagogy that encouraged city dwellers to engage with the urban environment as interactive subjects. Chapter 4, "Staging Interactivity," probes both the historical conditions that informed the founding of the Exploratorium as well as the formation of a novel pedagogical space. The museum's inaugural exhibit, Jasia Reichardt's famed "Cybernetic Serendipity" installation, modeled human-computer interaction as both a source of creative surplus and a normative form of urban conduct. This chapter suggests that the installation of the exhibit at the new museum foreshadowed

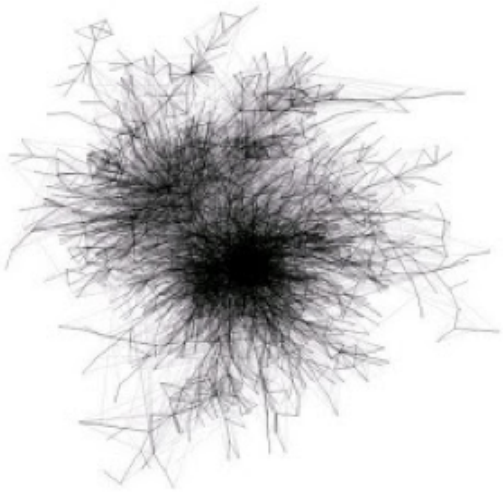
the emergence of "human capital" and "open innovation" as central terms within contemporary urban policy discourse.

To conclude, I briefly circle back to reflect on urban politics and predicaments as they present themselves today. The urban stage constructed over the course of the postwar decades, I suggest, frames an urgent set of questions concerning contemporary political contests over the (re)distribution of social wealth under racial capitalism, democratic (and antidemocratic) forms of governmental decision making, and collective modes of living together in cities. Raising such questions, I hope, might provoke consideration of a more just and egalitarian form of urban social and political life. There is another way of being.

Chapter 1:

Frameworks for Rule





Figures 2 and 3: The American town grid of the nineteenth century (Salt Lake City's "Plat of Zion") and a visualization of the contemporary city as a complex system. **Sources:** 99% Invisible (Fig. 2) and Urban Complexity: Cities as Complex Systems (Fig. 3) websites.

> *With the drawing of such plans, the achievement of order could be thought of in a particular way: as the relationship between the village and the plans. It could be achieved accordingly, with the conformity of village to plan reproduced in village after village, resulting in an ordered countryside of containers and contained.*[1]
>
> -Timothy Mitchell

> *Like a piece of architecture, the city is a construction in space, but one of vast scale, a thing perceived only in the course of long spans of time…At every instant, there is more than the eye can see, more than the ear can hear, a setting or view waiting to be explored. Nothing is experienced by itself, but always in relation to its surroundings, the sequences of events leading up to it, the memories of past experiences.*[2]
>
> -Kevin Lynch

[1] Timothy Mitchell, *Colonising Egypt* (Berkeley: University of California Press, 1991) p. 45.
[2] Kevin Lynch, *The Image of the City* (Cambridge: Massachusetts Institute of Technology Press, 1960) p. 1.

I'm at the library. I'm at the library in the stacks. A thousand cities perched above my head, bound and tattered. Smudged.

A decimal universe

I'm at the archive. I'm at the archive in a box. A thousand more dreams and nightmares. Dust.

A volume of plans

I'm on a laptop. I'm on a laptop connected to a network in a room. How many more? Multitudes.

A system of feedback

Paperback cities strewn across the sidewalk. Young and old people walk in and out of old and young buildings. Dollars apiece.

A light turns red

An Overview of the Task

Urban processes under capitalism have been indelibly tied to dynamics of creation and destruction, extraction and accumulation, exuberance and despair, celebration and lament. They have produced novel forms of measurement and expert analysis, freedom and subjugation, solidarity and conflict, order and disorder. As historical processes, they have also helped constitute the figure of the "the city" as an iterative series of problem-spaces – concrete social and physical situations that the administrators of governmental power have pondered over, policed, managed, and molded on the basis of shifting modalities of political reason.

In contemporary metropolises yoked to the market logics of technological innovation, the figure of the city has emerged as a kind of technocratic, anti-political vessel governed by the unwavering principles of socio-ecological optimization and self-investment in something called human capital. In addition to serving as ballast for "the city," these principles – and the political rationalities that gird them – have been simultaneously etched into the vessel's blueprint and built plank-by-plank into its deck.

For those conscripted into service (and to a differing degree those charged with steering the course), the alternatives are stark: comport oneself to the far-reaching socio-technical dictates of market-driven innovation with the hope of surviving the voyage or get thrown overboard.

A walk through the streets of almost any major American city today provides visceral proof of the intertwined albeit disparate effects of this expedition. And perhaps no other city embodies the combined ramifications of capitalist urbanization and neoliberal governmentality as does the San Francisco Bay Area. Long held up in popular and policy circles as a model for urban success within a global system of economic competition among cities, the Bay Area has recently been described in both academic quarters and the business press as the twenty-first century's Capital of Innovation.[3] Yet, for every self-driving car, zero-emissions initiative, IPO bonanza, startup incubator, disruptive phone app, LEED certified condo development, and entrepreneurial success story encountered in San Jose, Oakland, or San Francisco (let alone Chicago, New York, Seattle, or Toronto) there is an eviction or foreclosure, instances of growing indebtedness, overcrowding in public schools and hospital emergency rooms, precarious "non-skilled" employment opportunities, heightened environmental health risks, and the formation of sidewalk tent encampments. These twin worlds, it should be noted, are of a piece. The latter might even be seen as the constitutive outside of the former.

Inequality has always been a fundamental feature of capitalist urbanization and the capitalist mode of production more generally. But it is important to highlight the fact that – throughout the history of capital – governmental projects have actively shaped and inflected the character and workings of various capitalist social orders. Indeed, any supposedly absolute distinction between "the state" and "the economy" has consistently been blurred at the behest of either the private appropriation of surplus value or its social redistribution among other interventions.[4] Crucially, historical approaches to governing, managing, and planning cities in this regard have from the start been tied to authoritative formulations of the nature and character of the city as a social and physical object.

Today, in places like the San Francisco Bay Area, the essential nature of cities is understood by planning professionals and market actors to reside in their character as complex systems of socio-ecological, informational, and economic processes potentially amenable to management and guidance toward optimum performance. The government of this city-as-complex-system – the horizon of political possibility structuring potential redress of urban excess and inequality – is thus shaped by the very terms that define its character as a problem to manage on behalf of capital rather than the collective wellbeing of people. This is the North Star of my project. Though decidedly animated by a concern over the uneven social effects of political and economic dynamics in cities wedded to the market logics of technological innovation, this dissertation primarily focuses on the historical conditions and socio-technical developments that contributed to the formation of the contemporary city as a particular problem of government.

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[3] AnnaLee Saxenian, "The Silicon Valley Model: Economic Dynamism, Social Exclusion," in Manuel Castells and Pekka Himanen, eds., *Reconceptualizing Development in the Global Information Age* (Oxford University Press, 2014); Richard Walker, *Pictures of a Gone City: Tech and the Dark Side of Prosperity in the San Francisco Bay Area* (PM Press, 2018) ; Zoe Corbyn, "Is San Francisco Losing its Soul?" *The Guardian*. February 23, 2014.

[4] Timothy Mitchell, "The Limits to the State: Beyond Statist Approaches and Their Critics," *American Political Science Review* 85: 1 (1991) pp. 77-96.

This chapter lays out the conceptual parameters that frame and infuse my dissertation. In the pages that follow, I pursue four tasks. First, I identify and describe the object that this work intends to excavate via genealogical analysis: the contemporary American city as it is conceived of, reproduced as, and intervened in as a problem of neoliberal government. This object is a complex system of interconnected socio-ecological and economic processes and flows. In policy and planning circles, the best way to govern and manage this object is understood to reside in efforts to guide market behaviors and optimize socio-ecological processes rather than pursue top-down interventions in either spatial form or the distribution of resources. Second, I juxtapose current formulations regarding the character of the city as an object to govern and manage against the way it was understood prior to World War II. That is, I outline an historical shift in the way cities have been conceived of and thus intervened in as an object of governance. This historical shift emerges as my invocation for research.

With the object of my inquiry defined and its historical novelty outlined (see figs. 2 and 3 for a pictorial encapsulation), I, thirdly, paint a general portrait of the intellectual, scientific, and practical milieu out of which the city as a complex system was forged. Drawing on developments in the life and computational sciences, urban theorists, technicians, and professionals embarked on a rethinking of the very nature of the city during decades following the Second World War. Finally, I briefly discuss the political technologies – the means – by which the contemporary complex city was achieved. A host of scholarship in the history and politics of science and technology have probed the way in which technical practices of modeling and simulation – rather than merely represent preexisting bodies and processes – actually contribute to the production of those objects and flows. This insight colors the entirety of my dissertation. To conclude, I gesture toward the historical and empirical examples that constitute the remainder of this work. Collectively, they trace in specific and concrete detail the way in which technical efforts to survey, model, and intervene in the San Francisco Bay Area after World War II contributed to the remaking and re-conceptualization of the metropolis as a complex system. All told, then, this chapter provides a frame of reference with which to approach the genealogical ones that follow.

The Problem of the City

A growing concern over the increasingly urban character of life on earth has swept across global development and policy-making circles. As the world's population continues to shift from rural to urban settings, a heightened emphasis on the character of the city as the site of socio-economic dynamism and potential political strife has taken hold in the halls of both the academy and political and institutional power.[5] Likewise, as the effects of climate change intensify and appear to correlate with burgeoning processes of global urbanization, the city itself has emerged as a central lens through which

[5] United Nations, *World Urbanization Prospects: The 2011 Revision* (New York, 2012); UN-HABITAT, *State of the World's Cities, 2012/2013* (New York, 2013); World Bank, *World Development Report, 2009: Reshaping Economic Geography* (Washington, 2009); Rockefeller Foundation, *The 2013 Annual Report* (New York, 2013).

administrators, social scientists, a subsection of environmental activists, and policy wonks alike contemplate and seek to curtail environmental crises produced under the watch of modern industrial capitalism with all its attendant technological and social imperatives.[6] In addition to nitrogen, oxygen, carbon dioxide, and particulate matter of suspicious origin, the air we breathe today, so to speak, is infused with existential questions concerning sustainability, resilience, and urbanity itself. Whether at the scale of global policy discourse or local municipal administration, the figure of the city is increasingly an object of intense political concern.

This preoccupation has been met by a redoubled effort among urban scholars, designers, entrepreneurs, and planners to plumb the depths of the urban question and – with the help of novel computational methods and technologies – forge a "new science of cities."[7] While contemporary developments in the social scientific field of urban analysis continue to underwrite a variety of corporate governance initiatives under the alternative headings of "smart," "sustainable," and "resilient" city programs, perhaps the most far-reaching effect of these technical efforts to know the city resides precisely in the way that object has become defined. In contemporary urban theory and planning discourse, the city is posited as a "complex system" of land uses and social, technological, and ecological processes embedded within a global field of competition; the normative function of this city is to drive economic growth by facilitating dense interactions of human capital; and its defining feature is a capacity to evolve within a decision-making arena governed by market mechanisms. Tellingly, this characterization of the kind of problem a city poses remains consistent across a wide array of disciplinary backgrounds and ideological outlooks.[8]

For governing agencies, the formulation of the city as a complex system raises something of a dilemma. On the one hand, given the ability of the urban system to adapt in subtle and interconnected ways, officials shouldn't try to control the city as a whole from on high. Indeed, the nature of information in stochastic, adaptive systems requires that land-use decisions be left to up to local market actors, or more precisely, to the market itself. Central planning emerges as a kind of anathema under this rubric of thought and action. Yet, on the other hand, the normative function of the city as a driver of economic growth demands that political officials play an active role in urban affairs. Indeed, while urban systems can evolve, grow, and flourish as competitive enterprises, they might just as easily devolve, decay, and die without proper supports. A central question thus arises: what is the proper course of governmental action given the character of cities as complex systems?

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[6] Bruce Braun, "A New Urban Dispositif?" *Environment and Planning D: Society and Space* 32 (2014) pp. 49-64; Bruce Braun and Sarah Wakefield, "Governing the Resilient City," *Environment and Planning D: Society and Space* 32 (2014) pp. 4-11; Harriet Bulkeley, *Cities and Climate Change* (New York: Routledge, 2013).

[7] Michael Batty, *The New Science of Cities* (Cambridge: MIT Press, 2013); Anthony Townsend, "Cities of Data: Examining the New Urban Science," *Public Culture* 27: 2 (2015) 201-212; Shannon Mattern, "Interfacing Urban Intelligence," *Places Journal* (April 2014).

[8] For a brief but indicative survey, see: Allen Scott and Michael Storper, "The Nature of Cities: The Scope and Limit of Urban Theory," *International Journal of Urban and Regional Research* 39: 1 (2015) 1-15; Luis M.A. Bettencourt, "The Kind of Problem a City Is," Santa Fe Institute Working Paper 13-03-008; Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier* (New York: Penguin, 2011); Richard Florida, *The Rise of the Creative Class: How it's Transforming Work, Leisure, Community and Everyday life* (New York: Basic Books, 2002).

Planning and policy advocates have found a way around this dilemma by working to "strengthen the capacity of urban systems to tackle a wide variety of problems" instead of trying to regulate away specific ills.[9] That is, according to policy organizations like San Francisco Planning and Urban Research, municipal administrators should attend primarily to those conditions that encourage enterprising interactions, economic growth and innovation, and the efficient performance of the city as a complex system.[10] The role of urban government in this view is to facilitate, bolster, and guide the socio-economic processes that constitute the city. "In this model," media entrepreneur and "platform governance" booster Tim O'Reilly argues, "government is a convener and enabler" of market activity rather than "the first mover of civic action."[11] Increasingly, municipal efforts to bolster the capacity of urban systems and enable market innovation have come to hinge on opening up public resources on behalf of private enterprise and calling forth urban subjects as self-investing units of human capital through workforce initiatives and the production of interactive technological environments. From utility meters, emission gauges, and transportation apps to "smart" monitoring instruments and interactive media facades, technical infrastructures and devices have indeed become novel sites of governance.

In San Francisco, urban planners and municipal administrators have wholeheartedly imbibed both the formulation of the city as a complex system as well as an attendant mode of governmental reason premised on binding virtually all forms of urban subjectivity and activity to the dictates of market innovation. At the level of municipal administration, a number of institutional initiatives have resulted from such an uptake. In the realm of planning and economic development, corporate tax breaks and zoning instruments have been deployed by officials in an effort to physically and socially remake the city into an "innovation district" and a hub for information technology and social media firms; municipal agencies have developed an open data portal to put public information to greater potential market use; City Hall now hosts an Entrepreneurship-in-Residence program; technology education initiatives and job retraining service seek to instill in city dwellers the importance of acquiring new technical skills and types of literacy; and various administrative departments in the city continue to host a mind-numbing number of public-private partnerships and business conferences espousing the urban benefits of technological innovation.[12] But perhaps the clearest institutional expression of this emergent mode of urban government – understood as a governing or political rationality – is the Mayor's Office of Civic Innovation. Formed in 2011 by

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[9] Albert Meijer and Manuel Pedro Rodriguez Bolivar, "Governing the Smart City: A Review of the Literature on Smart Urban Governance," *International Review of Administrative Sciences* (2015) 1-17; Yosef Jabareen, "Planning the Resilient City," *Cities: The International Journal of Urban Policy and Planning* 31 (2013) 220-229.

[10] San Francisco Planning and Urban Research, "SPUR's Agenda for Change," *The Urbanist*. March 12, 2014.

[11] Tim O'Reilly, "Government as a Platform," *Innovations: Technology, Governance, Globalization* 6: 1 (2011) p. 15.

[12] Bruce Katz and Julie Wagner, *The Rise of Innovation Districts: A New Geography of Innovation in America* (Washington: Brookings Institution, 2014); J.O. Lamb, "SF Opens Door to Public Tech Incubator Expecting No Return," San Francisco *Examiner*, May 18, 2014; John Stehlin, "The Post-Industrial 'Shop Floor': Emerging Forms of Gentrification in San Francisco's Innovation Economy," *Antipode* 48: 2 (2015) pp. 474-493; John Elrick, "Visionary Politics: Technologies of Government in the Capital of Innovation," *Society and Natural Resources* 30: 2 (March 2017) pp. 860-876.

members of the administration of then-Mayor Ed Lee, the office continues to work to "embed startup DNA into government" and manage the metabolism of the city as an "ecosystem" of innovation.[13] For advocates of civic innovation, the role of urban government today is largely limited to fostering those conditions that support the economization and optimization of urban processes.

From the Discipline of Form to the Management of Process

The contemporary conception of the city as a problem of governmental intervention stands in stark contrast to the way it was imagined as such before World War II. While corporal metaphors for the city can be traced far back in western political thought, the outline of the city as a totality of distributions and circulations – as an organic or mechanical whole – began to take shape in the eighteenth century with the introduction of novel forms of political economic and statistical knowledge.[14] Notions about interconnected wholes undoubtedly continue to animate contemporary understandings of the city. Yet, as a number of scholars have demonstrated, the modern profession of city planning and its attendant forms of expertise emerged in earnest as a twentieth-century response to the "evils" of nineteenth-century urbanization – overcrowding, vice, crime, pollution, class antagonism, and the degeneration of bodily health of "the race" itself.[15] Tasked with alleviating the disorder that characterized laissez fare urban society, municipal planners and architects focused almost exclusively on the city as a spatial form.[16]

With the city posited as a physical container encompassing a local population, town planners and administrators sought to achieve the optimum distribution of – and spatial relationship between – sites of employment and housing, economic production and social reproduction, commerce and leisure. Indeed, from the birth of the Garden City and City Beautiful movements at the turn of the century to the rise of regional planning and modernist design during the 1920s and 1930s through the mid-century mandate for wholesale urban renewal, urban planning practitioners (if not always theorists) concentrated on the way in which the ornamentation and rational organization of space could shape society.[17] Throughout the late-nineteenth and early-twentieth centuries, in

[13] Luke Fretwell, "New SF Effort Will Embed Startup DNA into Government," govfresh, October 2, 2012 <http://www.govfresh.com/2013/10/san-franciscos-entrepreneurship-residence-program/> (Last accessed July 19, 2019); San Francisco Mayor's Office of Civic Innovation, *A Startup Called Government: Our First Year in Retrospect* (San Francisco: InnovateSF, 2013).
[14] Michel Foucault, *Security, Territory, Population: Lectures at the Collège de France*, *1977-1978* (New York: Picador, 2007).
[15] Thomas Osborne and Nikolas Rose, "Governing Cities: Notes on the Spatialization of Virtue," *Environment and Planning D: Society and* Space 17 (1999) 737-760; Matthew Gandy, "Rethinking Urban Metabolism," *City: Analysis of Urban Trends, Culture, Theory, Policy, Action* 8: 3 (2004) pp. 363-379.
[16] Peter Hall, *Cities of Tomorrow: An Intellectual History of Urban Planning and Design Since 1880* (Oxford: Blackwell, 2014); Mel Scott, *American City Planning Since 1890* (Berkeley: University of California Press, 1969).
[17] Ebenezer Howard, *Garden Cities of To-morrow* (London: Swan Sonnenschein, 1902); Daniel Burnham and Edward Bennett, *Plan of Chicago* (Commercial Club of Chicago, 1908); Patrick Geddes, *Cities in Evolution* (London: Williams and Norgate, 1915); Lewis Mumford, "Regions – To Live In," *The Survey* 54

other words, the city – as a problem of government – was widely understood as a physical stage upon which architectural and engineering projects among other interventions could help secure a virtuous urban public and a harmonious social order.

The contrast between the way cities were understood and acted upon as problems of government during the early twentieth century and how they are understood and acted upon as such today highlights an important yet under-examined historical shift. Whereas urban authorities before World War II sought to secure commercial progress and social order in the city as a physical form by intervening in the built environment to rationalize space and mold moral and disciplined subjects, contemporary urban planners and policy makers aim to optimize the performance of the city as a complex system by promoting the conditions under which the dense interaction of human capital and enterprising forms of conduct and management might flourish. To my mind, this historical shift in the city as a problem-space of government indicates something important about the constitutive character of space – and all those iterative and techno-political efforts to analyze, measure, classify, and build the city as a stage or a system – in the formation of political history writ large. To be sure, such a transformation in the very framework of urban rule also invites sustained investigation.

This dissertation pursues just such a course of investigation. It takes the social scientific, managerial, political economic, and technical production of space as its starting point. In turn, it probes how the construction of the city – as both a physical entity and an object of political preoccupation following World War II – continues to inflect and delimit contemporary urban politics and political imaginaries. How did the city of contemporary planning and policy discourse – a city understood and acted upon as a complex adaptive system rather than a relatively contained physical form – come to be? By what means was it forged? And what impact did the production of this city have on the way urban communities are governed?

Throughout my dissertation, I work to address these questions by exploring how administrators and other experts in the San Francisco Bay Area drew upon novel planning and design technologies to re-conceptualize and re-make the city during the postwar decades. While the metropolitan region is widely cited today as an "epicenter of America's information technology industry" and thus positioned as a kind of model for other cities to follow, municipal officials within the Bay Area have also taken the lead in advocating for a "whole systems" approach to urban governance that attempts to lay the foundations for open-ended urban growth, sustainability, and resiliency.[18] Moreover, while the Bay Area continues to be an influential site of socio-technical and political innovation today, it also served as a postwar hearth for the application and development of novel ideas about organized complexity and practices of urban modeling. Thus, by mobilizing it as a concrete site of historical inquiry, I hope to demonstrate not only how the San Francisco Bay Area was re-conceived and re-made during the postwar decades

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(1925) pp. 151-2; Le Corbusier, *The Radiant City* (London: Faber and Faber, 1967 [1933]); Federal Housing Administration, *A Handbook on Urban Redevelopment for Cities in the United States* (Washington, 1941).

[18] Zoe Corbyn, "Is San Francisco Losing its Soul?" *The Guardian*. February 23, 2014; Scott Edmondson, "Innovation in the Northern Section: San Francisco Takes the Leading Edge," *Northern News: A Publication of the Northern Section of the California Chapter of APA* (November 2012) 17.

but the ways in which it helped to reformulate cities as problems of government more broadly.

Milieus of Complexity

As a wholesale assault on urban renewal and the historical practice of city planning, Jane Jacobs's *The Death and Life of Great American Cities* offers a clue as to how one might go about studying the postwar transformation of U.S. cities. Lionized by the American Planning Association as "one of the must-read books of the planning profession" – and still widely cited across urban policy and professional circles in the Bay Area and beyond – the text concludes with a rumination on the nature of cities as well as a call to embrace a more scientific basis for governing them.[19] "[T]o think about cities and get somewhere," Jacobs suggested, "one of the main things to know is what *kind* of problem cities pose."[20] In formulating precisely "what *kind* of problem" the city posed, Jacobs and her postwar contemporaries worked to produce not just an understanding of cities as such but an appropriate way of governing them as well.

Drawing on wartime developments in communication theory and the life sciences, Jacobs argued that cities were "problems in organized complexity."[21] Unlike "problems of simplicity" in physics where a few variables directly affect the behavior of one another or "problems of disorganized complexity" where the average properties of millions of helter-skelter variables can be statistically formulated, cities, according to Jacobs, presented "situations" in which a dozen or so "quantities are all varying simultaneously and in subtly interconnected ways."[22] Like biological organisms, they involved "dealing simultaneously with a *sizable number of factors…introduced into an organic whole*."[23] From this perspective, urban planners, whatever their motivations, made a mistake when they confused cities for problems of simplicity or disorganized complexity. For Jacobs, the practice of planning could either hinder or support cities in their evolution, but it was ultimately those underlying processes (economic, cultural, natural) that defined and constituted cities as complex systems. The task of governing cities, as she saw it, required bringing those processes into view; "new mental methods" and "strategies of thought," forged in wartime laboratories, could be imbibed to model the behavior of cities as interconnected wholes.[24]

In advocating for this new way of seeing, Jacobs was not alone. Throughout the decades following World War II, intellectuals and professionals across a variety of domains – from national defense, cognitive psychology, and transportation planning to ecology, communications, and economics – turned to novel methods and technologies to model systems and simulate their behaviors. It is worth noting here that there were

[19] "The 100 Essential Books of Planning," American Planning Association (March 2009) 3.
[20] Jane Jacobs, *The Death and Life of Great American Cities* (New York: Penguin, 1964 [1961]) 442.
[21] Jacobs, *Death and Life*, 446. Jacobs's account is drawn from: Warren Weaver, "A Quarter Century in the Natural Sciences," *Annual Report of the Rockefeller Foundation* (New York: The Rockefeller Foundation, 1958) 1-91.
[22] Jacobs, *Death and Life*, 442-446.
[23] Jacobs, *Death and Life*, 445.
[24] Jacobs, *Death and Life*, 442.

prewar antecedents to postwar systems thinking in the realm of urban and regional planning. Indeed, the conceptual move away from the top-down imposition of form toward the management of flows or processes as an explicit planning rubric can be traced back to the work of Benton MacKaye, Lewis Mumford, and other members of the Regional Planning Association of America as well as their colleagues who took on regional development and planning projects during the New Deal.[25] Nonetheless, it was only in the aftermath of the massive mobilizations, demographic transformations, and metropolitan reconfigurations unleashed by World War II that systems thinking became disseminated across administrative circles and was widely put into planning practice. In the process, over the course of several decades following the war, technical experts and urban professionals helped build the world we inhabit today.[26]

When Jacobs and her postwar contemporaries called for a re-conceptualization of cities, they maintained that the methods and technologies needed to bring urban processes into view were determined by – and ultimately independent of – "the inherent nature" of complex systems themselves. Yet, with the benefit of hindsight, it seems clear that – to be modeled in the first place – the urban landscape itself had to be worked upon and actively remade. Any absolute distinction between the material city and the models that purported to merely represent it simply did not hold. Nonetheless, while it isn't too hard to deconstruct the metaphysical distinction between "space" and its representation, the practices that underwrote such a distinction had – and continue to have – powerful effects.[27]

In this dissertation, I draw on both this conceptual insight as well as the broad historical periodization sketched out above as guides for research. In order to better understand how cities came to be seen as and made into complex social, technological, and ecological systems, I focus on the way in which administrators and other experts in

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[25] For an early treatise on metropolitan "flow" and the importance of visualization to regional planning, see Benton MacKaye, *The New Exploration: A Philosophy of Regional Planning* (Urbana: The University of Illinois Press, 1990 [1928]). Both MacKaye and Mumford were deeply influenced by philosophical thinkers in the realm of planning like Ebenezer Howard and Patrick Geddes. See, Ebenezer Howard, *Garden Cities of To-morrow: A Peaceful Path to Real Reform* (London: Swan Sonnenschein, 1902) and Patrick Geddes, *Cities in Evolution: An Introduction to the Town Planning Movement and the Study of Civics* (London: Williams and Norgate, 1915). Historian Marc Weiss has shown how the collectivist and utopian impulses of earlier "Garden City" models were later taken up and stripped of their reform character to underwrite market-driven suburbanization in the United States: Marc Weiss, "Developing and Financing the 'Garden Metropolis': Urban Planning and Housing Policy in Twentieth-Century America," *Planning Perspective* 5:3 (1990): 307-319. Thanks to Peter Ekman for these insights.

[26] Orit Halpern, *Beautiful Data: A History of Vision and Reason since 1945* (Durham: Duke University Press, 2014); Agatha Hughes and Thomas Hughes, eds., *Systems, Experts, and Computers* (Cambridge: MIT Press, 2000); Paul Edwards, *The Closed World* (Cambridge: MIT Press, 1996) Peter Galison, "Computer Simulations and the Trading Zone," in *The Disunity of Science* (Stanford: Stanford University Press, 1996); Frank Golley, *A History of the Ecosystem Concept in Ecology* (New Haven: Yale University Press, 1996); Steve Heims, *The Cybernetics Group* (Ann Arbor: University of Michigan Press, 1991).

[27] Timothy Mitchell, *Colonising Egypt* (Berkeley: University of California Press, 1991); "The Stage of Modernity," in *Questions of Modernity* (Minneapolis: University of Minnesota Press, 2000); *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002); "The Work of Economics: How a Discipline Makes its World," *European Journal of Sociology,* 46: 2 (2005) 297-320; Toni Morrison, *Playing in the Dark: Whiteness and the Literary Imagination* (Cambridge: Harvard University Press, 1992). David Scott, *Conscripts of Modernity: The Tragedy of Colonial Enlightenment* (Durham: Duke University Press, 2004).

one particular metropolitan region – the San Francisco Bay Area – drew upon novel engineering technologies and scientific methods to model the city as such during the mid- to late-twentieth century. I thus probe a specific and concrete set of interventions in the realm of planning and design in an effort to put my theoretical and political claims into greater historical perspective.

Models as Political Technologies

If, as I have suggested, the city was simultaneously reimagined and remade as a complex system in the decades following World War II, then *the means* by which this city was achieved – *how* it came to be – surely emerges as a central question to explore. I have alluded throughout this chapter to the fact that the answer might reside at least in part in the tools themselves – the novel techniques and technologies – that postwar experts and intellectuals imbibed to characterize and thus govern the city as a particular problem. Tellingly, perhaps, the historical shift in planning practice from efforts to discipline subjects through the rationalization of spatial form to attempts to foster self-investing subjects through the management of socioeconomic and ecological processes coincided with a technological transformation in technical ways of seeing. Put simply, simulation – via either physical or computer models – eclipsed the type of static representation embodied by the map as the primary means of planning and managerial analysis. The model, in other words, eclipsed the map.

There are many ways to think about models: as toys (trains, planes, dolls, pedagogical games), as miniature representations of "the real thing" (static, three-dimensional scale representations of individual buildings or cities), as human embodiments of an artistic or political figure (the commercial fashion model, the artist's muse, the politician's death mask), as the means to expand and proliferate ideal spatial and social forms (town plans, architectural blueprints, financial programs), and as scientific tools formulated and used to understand and deal with collective socio-ecological problems (climate change models and computer simulations of socio-physical dynamics) among others. All of these definitions, in one way or another, inform my approach to models and modeling as historically significant arenas of analysis.

For my purposes, though, it is necessary to outline the import of "models" in a more specific way: they are, at root, political technologies – the means by which urban behaviors and social processes are rendered amenable to management along particular lines.[28] No doubt, models are technical devices developed and used by expert technicians, engineers, and scientists to describe urban phenomena and forecast potential scenarios. But the technical and scientific character of models and modeling do not relegate them to a world outside of power and politics. On the contrary, as Thomas Osborne and Nikolas Rose point out, at least since the nineteenth century, "the government of the city" has been "*inseparable from the continuous activity of generating truths about the city*."[29]

[28] Michel Foucault, *The Birth of Biopolitics: Lectures at the Collège de France, 1978-1979* (New York: Picador, 2008).
[29] Osborne and Rose, "Governing Cities," p. 739.

This understanding of models as political technologies animates my exploration and analysis of postwar urban planning and design interventions.

A host of critical scholars have examined the work that models do in the world at a variety of scales and in plethora of techno-political realms. In the fields of economics and finance, ecology and climate science, and urban planning and entertainment, models have been shown to *perform* and thus *bring into being* the objects and dynamics that they purport to describe and simulate.[30] Whether mathematical models of financial markets run on computers or interactive exhibits that model normatively appropriate forms of public conduct, these political technologies – rather than simply describe a pre-existing socio-technical world – actively help produce social relations, processes, and modes of behavior. Similar to the discipline of economics, modeling "should be approached not as a form of knowledge that pictures the world but as a performative activity," one that "participates in the per-formation of the worlds to which it belongs."[31] Staying attuned to the performativity and thus productivity of models allows for a fuller appreciation of their constitutive character as technologies of government.

When postwar planners, administrators, and urban experts in the Bay Area drew upon novel modeling techniques and technologies to highlight the dynamics of an urban system, they did not simply describe or simulate a preexisting city. At the most basic practical and political level, to model urban phenomena presupposed intervening in the city itself. Without data surveys and the accompanying processes of inscription, the construction of appropriate research and monitoring infrastructures, and the establishment of viable socio-technical institutions and frameworks in and of the urban world, it would have been impossible to model that world in the first place. At a more philosophical and political level, modeling the city as a complex socio-ecological system presupposed the authority of scientists and technical experts to intervene in and manage that system as they saw best fit regardless of democratic input. In his study of Howard T. Odum and the rise of systems ecology, for instance, Peter J. Taylor illustrates not only how technical models and modeling practices facilitated the shift toward a systems approach to ecological complexity but how that very transformation was born out of a "technocratic optimism" that saw expert intervention as a solution to the messy stuff of politics. "[M]ore than being the context of his work," Taylor suggests,

> technocratic optimism [was] constitutive of his concepts, methods, and organization of research. This interpretation of Odum's transformation of

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[30] Donald MacKenzie, *An Engine, Not a Camera: How Financial Models Shape Markets* (MIT Press, 2008); Morgan Robertson, "Measurement and Alienation: Making a World of Ecosystem Services," *Transaction of the Institute of British Geographers* 37: 3 (2012) pp. 386-401; Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (MIT Press, 2010); Jeremy Walker and Melinda Cooper, "Genealogies of Resilience: From Systems Ecology to the Political Economy of Crisis Adaptation," *Security Dialogue* 42: 2 (2011) pp. 143-160; Catharina Landstrom and Sarah J. Whatmore, "Virtually Expert: Modes of Environmental Computer Simulation Modeling" *Science in Context* 27: 4 (Dec. 2014) pp. 579-603; Orit Halpern, Jesse LeCavalier, Nerea Calvillo, and Wolfgang Pietsch, "Test-bed Urbanism," *Public Culture* 25: 2 (2013) pp. 273-306; Ipek Tureli, "Modeling Citizenship in Turkey's Miniature Park," *Traditional Dwellings and Settlements Review* 17: 2 (2006) pp. 55-69.

[31] Timothy Mitchell, "The Work of Economics: How a Discipline Makes its World," *European Journal of Sociology* 46: 2 (Aug. 2005) pp. 317; Michel Callon, ed., *The Laws of the Markets* (Oxford: Blackwell, 1998).

> metaphor for ecological complexity represents a partial reconciliation of strong externalist and realist interpretation of science. The realism, however, is not centered on the scientist's representation of nature, but instead on the scientist's interventions within nature – the interventions which society facilitates in actuality, as possibilities, or as powerful fantasies.[32]

Thus, alongside and in relation to their performative and productive character, it is crucial to situate models not solely as pictures of the world but as political technologies, which presuppose distinct forms of *intervention* in the world in terms of technical practice as well as the allocation of managerial authority. The model city, it might be said, is indeed an iterative one shot through with power relations and political rationalities.

Technologies of Government in the Bay Area

With an eye toward the social and political effects of contemporary formulations that situate the city as a particular problem of government, I work in the chapters that follow to shed light on how the city-as-complex-system came to be – how it was built through technical efforts to intervene in and model it. I probe how three unique postwar initiatives – a project to model the Bay as a natural system, a program to simulate the dynamics of the real estate market, and the construction of an interactive museum and exhibition space – worked to both render urban life legible as a complex totality of interconnected processes and redefine the city as problem to govern. Through a detailed engagement with historical records and commentary pertaining to the modeling initiatives outlined above as well as municipal planning proposals, technical reports, government documents, and popular media sources, I trace the particular effects of three specific governmental initiatives. Each chapter casts distinct light on three particular themes: first, how notions regarding "organized complexity" and the management of whole systems informed the construction and use of urban models; second, how, in turn, these distinct modeling projects not only generated new bodies of knowledge about the city but presupposed its physical transformation; and, finally, how the conceptual and material transformation produced by modeling technologies and techniques shaped the way the city was – and continues to be – approached as a problem of government in the Bay Area and beyond.

[32] Peter J. Taylor, "Technocratic Optimism, H.T. Odum, and the Partial Transformation of Ecological Metaphor after World War II," *Journal of the History of Biology* 21: 2 (Summer 1988) p. 215.

Chapter 2:

Modeling the System



Figure 4: The Bay Model during construction. **Source:** *Construction Illustrated*.

> *The Bay is inextricably woven into each resident's sense of place, culture, and community; it is a dynamic and interconnected system whose value is crucial to the region's environmental, economic, and social prosperity.*[1]
>
> -Bay Conservation and Development Commission

> *A "problem-space," in my usage, is meant first of all to demarcate a discursive context, a context of language. But it is more than a cognitively intelligible arrangement of concepts, ideas, images, meanings, and so on – though it is certainly this. It is a context for argument and, therefore, one of* intervention.[2]
>
> -David Scott

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[1] *The San Francisco Bay Plan*. (Sacramento: San Francisco Bay Conservation and Development Commission, 1969).

[2] David Scott, *Conscripts of Modernity: The Tragedy of Colonial Enlightenment* (Durham and London: Duke University Press, 2004) p. 4.

My rental sputters across the bridge. I am nervous. Earthquakes *have* to happen *some* time. Tsunamis. Pancake collapses. Tires blow. Eminent death just below in the cold bay water among the sharks and detritus and tankers. But I make it and hit the gas up the hill. Ahead lie San Quentin Prison and the splendor of San Pablo Bay. Behind, the city's picturesque skyline framed like an ad in some tourist magazine.

I check the rearview mirror and gag. Damn it, the boosters are right. It's too beautiful. Sunlit sky and golden hills and sparkling water. A vast pastel expanse. I drive through a lush green landscape of strip malls, fast-food chains, and multi-million dollar homes. The lanes are packed with racing cars and trucks and buses. Flicking past on my right, eco-modernist houseboats bob along the shoreline of Richardson Bay. A shiny new electric car leaves me in the dust.

Shorebirds greet me upon arrival. My eyes drawn from the first to their feathers, their seemingly dainty legs, their long necks and beaks. *Breathe*. Salt and plant matter and mud. The wind picks up. This feels like a long way from thirty minutes ago, I think. I've heard that wetlands provide a kind of environmental service, that they are productive, like an ecological machine. But is this a bank? I turn back from the bay. My foot sinks into the wet earth.

A Concrete Abstraction

In 1959, the urban planner and theorist Mel Scott published the first comprehensive historical study of the San Francisco Bay Area as a unified metropolis. Throughout *The San Francisco Bay Area: A Metropolis in Perspective*, Scott documented the various physical and social developments that shaped the region during the nineteenth and early twentieth centuries while paying special attention to the efforts of politicians, business leaders, and planners to set up metropolitan forms of government and regulation. Though administratively an amalgamation of separate counties and municipalities, Scott argued, the metropolitan Bay Area was best understood – and acted upon – as a single entity consisting of distinct yet interconnected locales and concerns. An advocate for regional modernism and a planning practitioner himself, Scott insisted that his book, at heart, was an attempt to "disseminate knowledge" about a common area-wide "heritage" and thus foster public sentiment in favor of "regional fealty."[3]

In the preface to the first edition of the book, Scott emphasized that it was of the utmost importance for the San Francisco Bay Area to achieve a unity of purpose as "a

[3] Mel Scott, *The San Francisco Bay Area: A Metropolis in Perspective* (Berkeley and Los Angeles: University of California Press, 1959) viii.

galaxy of interdependent communities." The perils and pressures of postwar urban growth, he urged, required the formation of a broad political consensus that extended beyond the narrow interests of neighboring municipalities. Scott suggested that such a "vision" for metropolitan solidarity had long been a trait of "the most perceptive residents of the Bay cities and counties." Yet, despite this fact, he lamented the observation that "this conception of the area as a single entity has never been assimilated by the whole population of the area." In other words, the "vision of the few" had yet to become "the goal of the many." Throughout the first edition's preface, Scott gestured toward the need to build a single "civic" identity at the metropolitan scale – a collective sense of belonging that would transcend those political boundaries that stunted responsible growth and wellbeing. Not once – other than references to the bay as a necessary geographical unifier – did questions of nature or environment serve as focal points in the preface to the first edition. For Scott, the essence of the Bay Area – in 1959 – lay in its spatial character as a totality of nested administrative units.[4]

Twenty-six years later, in the preface to the second edition, Scott marveled at how much had changed since the book's initial publication. The most important of these, to his mind, was the emergence of regional agencies of metropolitan government and the establishment of a cohesive metropolitan identity among the general public. "I should like to think," he wrote, "that in the past two and a half decades the number of residents who are capable of thinking regionally has tellingly increased." Specifically, he indicated that in "such matters as the control of air and water pollution, transportation, the preservation of San Francisco Bay, and the long-term assurance of adequate water supplies, people more and more are obliged to take an area-wide view."[5] Underwriting Scott's updated narrative of the emergence of a regional civic community was a wholly new – if seemingly un-remarkable – description of the Bay Area as a highly complex and interconnected socio-natural system.[6] From the perspective of 1985, he could posit that his book was "a pioneer effort…to delineate the emergence of an interdependent, closely linked metropolitan complex extending into the several valleys whose waterways drain into the bay."[7] Not just a totality of administrative units, in this iteration, the metropolitan area was framed as a single mechanism of ecological feedbacks.

The very character of Scott's object of analysis, then, underwent something of a transformation between the publication of the first and second editions of *The San Francisco Bay Area.* While the imperative to federate the different communities surrounding the bay remained consistent across Scott's two prefaces, his description of the essential nature of the metropolitan region shifted from a relatively static

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[4] Ibid, vii-ix.

[5] Mel Scott, *The San Francisco Bay Area: A Metropolis in Perspective* (Berkeley and Los Angeles: University of California Press, 1985) x.

[6] A number of scholars interested in urban politics in the Bay Area and the rise of environmentalism in the United States have pointed out that a profound change in popular ways of seeing the urban environment took place during the postwar years. See: Hal Rothman, *The New Urban Park: Golden Gate National Recreation Area and Civic Environmentalism* (Lawrence: University Press of Kansas, 2004); Richard Walker, *The Country in the City: The Greening of the San Francisco Bay Area* (Seattle: University of Washington Press, 2008); Philip Dreyfus, *Our Better Nature: Environment and the Making of San Francisco* (Norman: University of Oklahoma Press, 2009).

[7] Mel Scott, *The San Francisco Bay Area: A Metropolis in Perspective* (Berkeley and Los Angeles: University of California Press, 1985) ix.

"geographical entity" to a dynamic "estuarial system…generally recognized as constituting the San Francisco Bay Area."[8] In a striking departure from his original formulation of the metropolis, Scott argued a quarter century later that what drew the disparate communities of the Bay Area together politically as well as materially was nature itself: the *nature* of cities as complex socio-natural *systems*. Though Scott was concerned specifically with the Bay Area, the shifting conception of the character of the metropolis – as a "problem-space" of government – that his two prefaces together highlight took hold much more broadly in the discourses and practices of urban planning, design, and government.[9] Whereas urban authorities and experts before World War II focused on securing "order" and "progress" in the city as a physical form by intervening in the built environment to mold moral subjects, contemporary planners and policy makers increasingly aim to guide the economic and socio-ecological "performance" of the city as a system of processes by promoting the conditions under which the dense interaction of human capital might flourish.[10]

Today, policy makers, planners, and governmental authorities in the Bay Area and beyond largely take the definition of the metropolitan region as a complex socio-ecological system for granted. Such a conception of metropolitan land, air, water, vegetation, and people as intertwined components of an environmental system in need of stewardship and optimization rather than primarily as a stock of resources to be secured and exploited was hardly common at mid-twentieth century. Yet, this socio-natural world was not simply discovered during the years between the publication of the first and second edition of Scott's book. It was neither found nor thought into existence. Instead, it was enacted, performed, and produced through the iterative, recursive, and technical practices of measurement, inscription, simulation, and intervention.[11] It was achieved through efforts to know and manage it. And, as I show, this achievement had distinct effects that continue to animate political life in the metropolitan region today.

In this chapter, I address how the urban region was both re-conceived and re-made as a socio-natural system in the decades after World War II by examining the construction, use, and impact of a single machine: The San Francisco Bay-Delta

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[8] Ibid, ix.

[9] Scott, *Conscripts of Modernity, p.* 4.

[10] For an overview of this historical shift, see Chapter 1. Contemporary formulations about the character of cities as complex systems animate urban discourse and cut across a variety of academic, political, and theoretical affiliations. For a brief but indicative survey, see: Allen Scott and Michael Storper, "The Nature of Cities: The Scope and Limit of Urban Theory," *International Journal of Urban and Regional Research* 39, no. 1 (2015) 1-15; Luis M.A. Bettencourt, "The Kind of Problem a City Is," Santa Fe Institute Working Paper 13-03-008; Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier* (New York: Penguin, 2011); Richard Florida, *The Rise of the Creative Class: How it's Transforming Work, Leisure, Community and Everyday life* (New York: Basic Books, 2002).

[11] An expansive body of scholarly literature examines the performativity of models and the politically constitutive character of technical practices of knowledge production. For example, see: Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Boston: MIT Press, 2013); Lisa Gitelman, ed., *'Raw Data' is an Oxymoron* (Cambridge: MIT Press, 2013); Donald Mackenzie, *An Engine Not a Camera: How Financial Models Shape Markets* (Cambridge: MIT Press, 2008); Peter Galison, "Computer Simulations and the Trading Zone," in Galison and Stump, eds., *The Disunity of Science: Boundaries, Contexts, and Power* (Palo Alto: Stanford University Press, 1996); Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999); Michael Lynch and Steve Woolgar, *Representation in Scientific Practice* (Cambridge: MIT Press, 1990).

Hydraulic Model, a large-scale physical model of the bay-estuary built by the Army Corps of Engineers to simulate tidal conditions and test the feasibility of regional development plans. Composed of hundreds of carefully adjoined 12' by 12' concrete slabs and outfitted upon a vast network of adjustable jacks, the Bay Model continues to occupy a former Bechtel shipbuilding warehouse in the town of Sausalito. At the turn of the millennium, rendered obsolete by advances in numerical modeling and computer simulation, it ceased operating in any official research capacity and was transformed into a visitor's center and public showcase for the Corps. Over the course of its four-decade working life, however, not only did the model serve as an important engineering and scenario planning tool but it also helped constitute the metropolitan world that residents of the Bay Area inhabit today.

The rest of the chapter is organized into three main parts. After tracing divergent accounts of what spurred the modeling impulse in the first section, I explore the construction and use of the Bay Model in the second. I suggest that – in order to be modeled as a system in the first place – the wider landscape of the Bay Area had to be intervened in, worked upon, and remade. In the third section, I probe the model's wider political effects, illustrating how various actors drew upon model studies and the physical model itself to promote new forms of political authority in the region. Finally, I conclude by circling back to the model as it stands today.

Birth of the Model

The San Francisco District of the Army Corps of Engineers continues to maintain the Bay Model as a public attraction. But encountering this seemingly anachronistic artifact of postwar planning today can leave one feeling profoundly disoriented. One expects – at least I initially did – to encounter a view of the whole from above, an analogue version of the digital visualizations that we have come to increasingly consume in daily life. But there are no people in the model, no buildings, no cities, and, with a few exceptions, no obvious points of reference or landmarks. Passing through the Bay Model Visitor Center means confronting a vast terrain of miniature canals and levees, dikes and bridges, rivers and bays, and technical instruments and appurtenances that collectively target the bay-estuary and its watershed as a system to simulate. Above the almost imperceptible ebb and flow of the model's mechanized tide, the occasional whir of electric devices punctures the damp stillness of the air; the smell of treated water – almost metallic in quality – greets one's nostrils upon arrival; and rust steadily creeps along the bottom of the sprawling and distorted test-bed. A landscape to traverse as much as a view to behold, the Bay Model presents the concrete sedimentation of forty years of technical practice.

While the model has been renovated a number of times over the decades in order to render the complex more legible to the public, its current curatorial instantiation as a kind of "educational center" or "water museum" was completed in the mid 1990s.[12] Upon

[12] Author interviews with: Bill Angeloni on 1 September 2015 and 9 March 2016; Nancy Rogers 4 March 2016; Chris Gallagher 18 March 2016. For details on the first efforts to frame the model as a pedagogical

entering the warehouse, visitors are literally guided on a "journey" through a corridor depicting the San Francisco Bay watershed. The hallway leads into a small theater where a noticeably dated orientation video plays on loop. Spectators emerge from the theater to find themselves at the center of the model on a raised platform occupied by a variety of exhibits on the model's history and the accomplishments of the Corps more broadly. Scattered across the floor of the test-bed itself are a variety of framing devices and informational placards on everything from dredging and drainage to military shipbuilding during WWII. Toward the warehouse's exit, awkwardly resting upon pipe grating, sits a Tule reed boat in apparent reference to the Ohlone people indigenous to the bay. The inclusion of the boat, seemingly as an afterthought, contrasts the kind of story the Corps intends to curate at the Bay Model against its role in the history of colonial violence. Rather than the institutional embodiment of a racial and settler colonial state, the Army Corps of Engineers celebrates itself as an environmental steward and authority on ecosystem management.[13]

But why was the Bay Model built in the first place? What conditions underwrote the Corps' efforts to simulate the Bay Area as a hydraulic system? In this section, I sketch out the some of the historical developments that underwrote the birth of the model. I suggest that grasping the constitutive nature of the model requires situating it in the context of broader innovations in postwar engineering and environmental governance. Indeed, the Bay Model emerged as a particular and local instantiation of a much wider and historically novel modeling impulse.

Metropolitan Development and the San Francisco Bay Project

The eventual construction of the Bay Model was undoubtedly informed by competing local development schemes and comprehensive planning proposals in the region. The most prominent, controversial, and subsequently infamous plan in the Bay Area at mid-century by far was the "San Francisco Bay Project," known more colloquially as the Reber Plan.[14] Brainchild of the community theater director and amateur engineer John Reber, the proposal sketched out a system of planned dams and locks that its author and many others believed could solve the region's water problems

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space, see: "Grand Model Puts San Francisco Bay into Action. You Can Now Visit It," *Sunset Magazine* (November 1980) p. 78.

[13] Ashton Wesner; "Contested Sonic Space: Settler Territoriality and Sonographic Visualization at Celilo Falls," *Catalyst: Feminism, Theory, Technoscience 4:2* (October 2018); Mark A. Smith, "Engineering Slavery: The U.S. Army Corps of Engineers and Slavery at Key West," *The Florida Historical Quarterly* 86: 4 (Spring 2008) 498-526. It is worth pointing out here that while the Corps had removed snags and eliminated sandbars in the Mississippi River since 1824, its charge to improve navigation throughout the Mississippi River Valley expanded with the rise of the plantation-based cotton trade, an economy premised on racialized slavery. See, Ben H. Fatherree, *The First 75 Years: History of Hydraulics Engineering at the Waterways Experiment* Station. (Vicksburg, MS: U.S. Army ERDC, 2004) 6.

[14] Virtually all scholars who discuss the Bay Model do so in relation to the Reber Plan: Walker, *The Country in the City*; Dreyfus, *Our Better Nature*; Charles Wollenberg, "The Man Who Helped Save the Bay by Trying to Destroy It," *Boom: A Journal of California* (April 14, 2015). <https://boomcalifornia.com/2015/04/14/the-man-who-helped-save-san-francisco-bay-by-trying-to-destroy-it/> (Last accessed 18 September 2018).

(namely, the residential and agricultural need for a steady supply of fresh water), allow for the creation of valuable new land for real estate development through bay fill, and streamline metropolitan transportation in one fell swoop. From 1929, when he initially formulated the proposal, until his death in 1960, Reber promoted his vision for the Bay Area as though it represented the greatest performance of his directorial career. "What is master planning," he rhetorically asked a journalist in 1950, "but stage managing an area?"[15]

Drawing on observations and contacts he had made putting on plays throughout the state as well as support from figures like former president Herbert Hoover and professional engineers in the area, Reber continuously updated his plan to address evolving transportation, defense, and commercial concerns in the Bay Area. Despite these updates, however, the proposal's main thrust remained the same: the erection of two earth-filled dams, one located just south of the where the Bay Bridge stands today and the other at the location of the Richmond-San Rafael Bridge. The dams were envisioned to both serve as regional transportation corridors and block salt-water intrusion into the north and south portions of the bay, creating, in effect, two large freshwater lakes. In addition, the plan called for a substantial amount of bay fill, which would have transubstantiated acres of marshland and bay waters into lucrative real estate. While the scheme garnered broad support from various agricultural and industrial quarters, engineering consultants, and regional municipal officials, a considerable amount of skepticism and opposition toward the Reber Plan – technical, political, bureaucratic, and commercial – hardened and began to play out in the years after World War II.[16]

Enthusiasm for the Reber Plan reached its zenith around 1949, when Senator Sheridan Downey of California, a proponent of the proposal, convened a subcommittee of the U.S. Senate Committee on Public Works to hold official hearings on its merits. While the majority of those in attendance supported the plan – and while Reber's testimony proved compellingly theatrical – opposition from the likes of the Joint Army-Navy Board on Bay Crossings, the Bureau of Reclamation, and the California State Engineer remained staunch. A year later, Congress appropriated funds for the Army Corps of Engineers to survey the bay with an eye toward development. As part and parcel of this charge, the Corps set about constructing the Bay Model in order to both simulate the effects and test the feasibility of various development proposals and planning interventions, including – but not limited to – the Reber Plan.[17] It took another thirteen years to complete an analysis of the one-time director's scheme. With the release of its *Technical Report on Barriers* in 1963, the Corps suggested that the proposed dams would not ultimately produce fresh water lakes. Moreover, the report indicated that the system of locks and floodgates necessitated by the plan would have both created unnecessary

[15] Frank J. Taylor, "They Want to Rebuild the Bay," *Saturday Evening Post,* November 18, 1950. 32–33.
[16] For example, see: Correspondence, Boxes 6-9. Reber Papers (94-09). Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Region, San Bruno, California (Collection hereafter cited as Reber Papers, RG 77, NARA); Wollenberg, "The Man Who Helped Save the Bay by Trying to Destroy It."
[17] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24. Reber Papers, RG 77, NARA.

security risks and impinged dramatically upon naval and commercial navigation. That is, it simply was not feasible.[18] Reber's plan died once and for all three years after he did.

Contemporary scholars have expressed shock that the Reber Plan was ever taken seriously at all and relief that it was not implemented. One recent commentator, for instance, has suggested that if the proposal came to fruition it would have been the "greatest calamity ever to befall" the Bay Area.[19] Implicit in this assessment, it should be noted, is a celebration of the Army Corps of Engineers' role in securing its ultimate demise. Through objective and technically sophisticated analyses generated by simulations run on the Bay Model, the story goes, the Corps helped save the bay from being dammed.[20] But it's worth pointing out here that – rather than some preposterous and historically anomalous outlier – the Reber Plan actually embodied the outlook and approach of mid-twentieth-century modernist planning. As historian David Long suggests, Reber's proposal to "streamline" the bay might best be understood as a specific iteration of a widespread utilitarian faith in the ability of human reason and technological innovation to secure planning solutions to any number of conceived urban ills.[21] Indeed, Long's point is bolstered by the fact that in Scott's 1959 preface he specifically acknowledged Reber as well as his Berkeley "colleagues in the Department of City and Regional Planning" as among those few with metropolitan "vision."[22]

Hydraulic Modeling at the 'Scale of Nature'

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The story often told about the birth of the Bay Model – the one told at the model itself by the Corps – no doubt offers important insights into its "origins." But it also glosses over the fact that the Bay Model was but one of a set of large-scale hydraulic models built by the Corps over the course of the mid-twentieth century. The outlines of Maryland's Chesapeake Bay Model warehouse, for example, opened in the 1970s before falling into disuse and decay, might be gleaned from satellite images today.[23] Likewise,

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[18] U.S. Army Engineer District San Francisco, *Technical Report on Barriers: A Part of the Comprehensive Survey of San Francisco Bay and Tributaries* (San Francisco: Corps of Engineers, 1963).

[19] Matthew Booker, *Down by the Bay*: *San Francisco's History between the Tides* (Berkeley and Los Angeles: University of California Press, 2013) 219.

[20] Perhaps the most explicit scholarly celebration of the Army Corps of Engineers role in killing the Reber Plan can be found in Weisberg: "The Corps recognized the benefits that the Reber Plan might bring to the area, but it was certain that damming the Bay would have serious, unintended consequences. It recognized that a battle of words would not be helpful in advising regional authorities; it needed hard data. But how could such data be collected without actually building the dams and risking harm to the Bay? Its solution was to build a massive hydraulic scale model of the San Francisco Bay." Weisberg, *Simulation and Similarity,* 1-3.

[21] David Long, "Mistaken Identity: Putting the John Reber Plan for the San Francisco Bay Area into Historical Context," in *American Cities and Towns: Historical Perspectives*, Joseph Rishel, ed. (Pittsburgh: Duquesne University Press, 1992).

[22] Mel Scott, *The San Francisco Bay Area: A Metropolis in Perspective* (Berkeley and Los Angeles: University of California Press, 1959) viii.

[23] Matthew Coolidge and Sarah Simons, eds. *Overlook: Exploring the internal fringes of America with the Center for Land Use Interpretation* (New York: Metropolis Books, 2006) 86-95; Center for Landscape Interpretation, "The Chesapeake Bay Hydraulic Model," *Lay of the Land Newsletter* (Spring 1998).

the ruins of the massive Mississippi Basin Model, itself a feat of engineering that targeted the Mississippi River and its major tributaries, can still be discovered outside of Jackson, Mississippi. These anachronistic behemoths serve as crumbling monuments to the rise of hydraulic modeling and laboratory experimentation in the field environmental engineering more broadly. Up until the 1920s, river and harbor engineering work in the U.S. was largely an empirical process with little credence given to conducting model and simulation experiments.[24] "Most of the Corps," one historian of the institution argues, "was openly skeptical of the value of models and actually feared they posed a threat to traditional engineering practices based on field data and experience."[25] But a growing chorus of high-profile hydraulic engineers insisting on the research benefits of modeling as well as the disastrous Mississippi flood of 1927 pushed Corps' brass to reconsider existing approaches to flood control and unleashed the political impetus to create a hydraulics research laboratory.[26]

In 1929, the Corps established the Waterways Experiment Station (WES) in Vicksburg, Mississippi to assist in flood control, river and harbor navigation, and environmental engineering efforts. The task of founding the WES fell to Lt. Herbert D. Vogel, a 29 year-old hydraulic engineer who had earned a PhD in Germany. With initial political support coming from local interests and the Mississippi River Commission, Vogel got to work designing the facility and overseeing the construction and operation of hydraulic models, most of which reproduced conditions in isolated sections of the Mississippi River watershed. Though the station began under relatively inauspicious circumstances, studies performed there over the first decade significantly "advanced both theoretical and applied hydraulics research."[27] The Flood Control Act of 1936 further pushed the Corps to take on a more comprehensive research and development approach. By the start of World War II, the WES was conducting hydraulics research on behalf of virtually all Army Corps of Engineers districts in the country. In turn, it emerged as both an increasingly influential seat of decision-making and an important site of research and development. Absorbed into the US Army Engineer Research and Development Center in

<http://clui.org/newsletter/spring-1998/chesapeake-bay-hydraulic-model> (Last accessed 20 November 2018).

[24] During the late nineteenth century, European engineers, particularly German ones, began drawing upon Newton's "Principle of Similitude" to study hydraulic processes through what was then seen as a controversial method: the small-scale modeling of actual rivers and harbors. In the early twentieth century, Hubert Engels of the *Technische Hochschule* at Dresden drew upon early efforts to revolutionize hydraulics research. Taken by these "German advances" in the study of hydraulics, American engineers such as John Freeman and Herbert Hoover became staunch proponents of modeling methods and lobbied for the establishment of a national hydraulic laboratory. See, Fatherree, *The First 75 Years,* 5.

[25] Michael Robinson, "Rivers in Miniature: The Mississippi Basin Model," in, ed., Barry Fowle, *Builders and Fighters: US Army Engineers in World War II* (Virginia: Office of History, US Army Corps of Engineers, 1992) 277.

[26] For a history of the rise of hydraulic modeling in the US during the early twentieth century, see Fatherree, *The First 75 Years*, 2-6; For an in-depth examination of the social, economic, and political consequences of the flood of 1927, see John M. Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How it Changed America* (New York: Simon and Schuster, 1997).

[27] Robinson, "Rivers in Miniature," 280.

1999, the WES continues to operate today as the largest civil engineering research complex within the Department of Defense.[28]



Figure 5: Ruins of the Mississippi River Basin Model. **Source:** Author's Photo

The most important and spectacular early project undertaken by WES engineers was the construction of the massive Mississippi Basin Model (MBM). Taking a closer look at the MBM – the Ur-model, if you will, of the Corps' postwar hydraulic modeling program – can help put the San Francisco Bay Model into perspective. A concrete scale model built in phases between 1943 and 1966, the MBM replicated most of the Mississippi River and its major tributaries – an area equal to forty-one percent of the continental U.S. – on over two hundred acres of land in Clinton, Mississippi. The MBM was initially conceived by Major Eugene Reybold, who, while serving as a district

[28] Fatherree, *The First 75 Years*, 2. For a detailed institutional history of the WES produced by the Corps, see: J.B. Tiffany, ed., *History of the Waterways Experiment Station* (Vicksburg, MS: Army Engineer Waterways Experiment Station, 1968).

engineer in Memphis during the 1937 flood, recognized that a model of the entire river valley could aid in a more comprehensive approach to flood control and water management. When Reybold became Chief of Engineers in 1941, he put the model-building process in motion. Once a preliminary study was made and officially approved, the model site was cleared and prepared by German POWs captured in North Africa. WES staff set to work contouring the concrete test-bed, verifying various dimensions of the model-prototype relationship, and outfitting it with necessary appurtenances and automatic instrumentation features.[29]

Flow simulations started being run on parts of the MBM as early as 1949. And in 1952 the tool was put to the test. In April of that year, heavy rains led parts of the Missouri River to crest in Iowa. Local authorities in the downriver towns of Council Bluffs and Omaha, worried that their levees might not hold, contacted the Corps for assistance. In constant communication with surveyors in the field, WES engineers worked on the model day and night to reproduce river conditions and generated a number of simulations that predicted likely future scenarios, including flood stages and potential levee failures. Tests run on the model suggested the location of levees that needed to be raised and fortified; they also indicated which populated areas should be evacuated for precautionary reasons. Information gleaned from model tests was hurriedly relayed to local field workers, who put suggested measures in place.[30] In the end, the prescriptions generated through simulations run on the MBM saved two cities from devastation and prevented an estimated $65 million in property damages.[31]

While the practical mobilization of the MBM proved its worth as a forecasting tool, the model itself simultaneously embodied and promoted a broader paradigmatic shift in technical ways of seeing and managing nature. On the one hand, as the Corps moved away from earlier piecemeal efforts to control individual rivers, the model offered a means by which to pursue a more holistic and systematic approach to inundation. "To understand the Mississippi River Basin as a dynamic system of interconnected waterways," landscape architect Kristi Cheramie has argued, "the Corps needed to develop new, more sophisticated tools." On the other hand, as a comprehensive simulation tool, it played a constitutive role in the emergent character of environmental planning and policy. "The model," Cheramie suggests, "allowed the Mississippi River Basin to become, for the purposes of study, an *object*, a manageable site." And like the San Francisco Bay Model did later, it promoted "a new scale of thinking" and demonstrated "the power of visualizations to shape policy through design."[32] Another historian of the Corps went so far as to call the MBM "the Brooklyn Bridge or Hoover Dam of the hydraulics research field – a preeminent structure of unprecedented scale and complexity that represented a rapid advancement of technological frontiers."[33] Yet, despite such references to its historical importance, the model had a relatively short working life. The Corps completed its basin-wide testing program in 1969 and, with advances in computing and numerical modeling, put the model to use on a case-by-case

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[29] Coolidge and Simons, *Overlook*, 70-77; Tiffany, *History of the Waterways Experiment Station*, 13; Fatherree, *The First 75 Years*, 73-75, 89-95; Robinson, "Rivers in Miniature," 280-292.
[30] *Kristi Dykema Cheramie, "The Scale of Nature: Modeling the Mississippi River," Places Journal (March 2011). https://doi.org/10.22269/110321 (Last accessed 16 Sep 2018).*
[31] Fatherree, *The First 75 Years*, 93.
[32] Cheramie, "The Scale of Nature."
[33] Robinson, "Rivers in Miniature," 277.

basis. In 1993, it turned the facility over to the city of Jackson, leaving the model ultimately to be reclaimed by a Mississippi pine forest [Figure 5].[34]

Both the Mississippi Basin Model and the San Francisco Bay Model were specific instantiations of a broader paradigmatic shift in the Army Corps of Engineers' approach to managing nature. In this section, I have suggested that a number of factors contributed to the Bay Model's ultimate materialization. Particular postwar development and planning schemes in the Bay Area – a variety of proposed infrastructural improvement plans, ongoing military and commercial concerns about navigation in the bay, apprehension over dredging costs, and regional barrier and landfill proposals including but not limited to the Reber Plan – undoubtedly animated the Corps' decision to build and use a concrete scale model. Importantly, however, the very notion itself that a hydraulic model *as such* might prove useful in engaging local concerns grew out of broader historical developments in environmental engineering research and practice. While the Bay Model is the only mid-twentieth-century model actively maintained by the Corps today, it was but one facility among a sprawling network of modeling sites constructed and operated during the postwar era. That is, it was a particular and concrete instantiation of more general and abstract trend in efforts to manage and control nature. Still, it's worth emphasizing here that the *natural system* that the Bay Model sought to replicate – more so than any other of the Corps' modeling targets – had a thoroughly urban character. Indeed, the San Francisco Bay was a decidedly "urbanized estuary."[35] In the following section, I examine the particularity of the Bay Model in greater detail, tracing the way its construction and use set the stage for political events that continue to reverberate today.

The Model and the Bay

Most accounts of the Bay Model – including those offered by the Corps of Engineers and scholars interested in the postwar history of the Bay Area – emphasize what it allowed technical experts to *say* about the San Francisco Bay. Indeed, when the model is described as doing work in the world at all, it is generally done so in a way that stresses how the knowledge it provided stopped something from happening: The Bay Model helped save the bay from the fate of Reber's dams. Drawing on scholarship interested in maps, models, and simulations as much for what they do in the world as for what they say about it, I explore in this section how – rather than merely provide a mirror to an external social and natural urban world – the construction and use of the Bay Model played a constitutive role in building the postwar metropolis.

To put the representational logics animating conventional understandings of the model in perspective, I examine the model's construction, verification, and use below. I account for both the ways in which efforts to model the San Francisco Bay required intervening in the wider landscape as well as how the "outside" environment perpetually intruded (and continues to intrude) upon the model itself. An examination of these twin

[34] Fatherree, *The First 75 Years*, 95.
[35] T. John Conomos, ed., *San Francisco Bay: The Urbanized Estuary* (San Francisco: Pacific Division of the American Association for the Advancement of Science, 1979).

boundary-crossing processes – the iterative material practices of taking back and forth between model and field site – unsettles any neat metaphysical distinction between the Bay Model and the Bay Area. While it isn't hard to deconstruct those dualisms that underwrite modern assumptions about a world cleaved into two realms – an interior realm of representations and an external one of a priori reality – the technical practices that underwrite and help forge such a conceit nonetheless produce powerful effects.[36] I thus conclude this section by probing the ways in which the use of the Bay Model as well as the dissemination of its test results produced the effect of a novel original reality – the bay system – as both the natural scale and object of political preoccupation and administration.

Constructing a Demonstration Site

The public hearings convened by Senator Downey in 1949 stimulated potential interest in a comprehensive study of the Bay. But questions about relative cost and genuine need remained. The following year, a preliminary investigation was authorized in Section 110 of the River and Harbors Act. In conjunction with engineers from the WES, the San Francisco District of the Corps spent the next three years working on a preliminary report that simultaneously outlined various defense and development needs in the region and justified a full-scale survey. "A study model," the San Francisco District Engineer concluded, "is considered essential to the solution of many problems…not otherwise susceptible to analytical solutions."[37] Only simulation, it seemed, could reveal the effects of intervening in complex natural systems. The total cost of the comprehensive survey, which from its conception included everything from population and public health forecasts throughout the region to shoaling and pollutant dispersal patterns in the actual bay, was estimated at $2,500,000. Included in that cost was $500,000 set aside for the hydraulic modeling component of the study.[38] In early 1954, the Board of Engineers in Washington D.C. gave official approval for "a comprehensive study of the San Francisco Bay and Bay Area" and Corps engineers began looking for a suitable site to construct the

[36] This deconstructive move is valuable not simply because it shows the binary frames of material-ideal, original-copy, real-representation themselves to be fundamentally false or distorted – such positions, as strategically and politically viable as they may be under certain conditions, remain cloaked in the modernist logics critics often seek to critique – but because it opens up intellectual space to question the contingent effects of those historical practices that produce and reproduce such divisions within the experience and architecture of the world. See: Tim Mitchell, "The Stage of Modernity," in *Questions of Modernity* (University of Minnesota Press, 2000); Rosalyn Deutsche, "Boys Town," *Environment and Planning D: Society and Space* 9, no. 1 (1991): 5-30; and Michel Foucault, "Two Lectures," in *Power/Knowledge: Selected Interviews and Other Writings, 1972-1977*, ed. Colin Gordon (New York: Pantheon, 1980).

[37] San Francisco District Office, "Army Corps of Engineers Report, Preliminary Bay Study," August 12, 1953. Folder: US Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[38] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

accompanying model.[39] Toward the end of 1955, they settled their sights on a former shipbuilding warehouse at the Corps' "operation base-yard" located in the town of Sausalito.[40]

It was not a given that the model would be built in the Bay Area itself. As discussed earlier in this chapter, most hydraulic research undertaken by the Corps – no matter where practical application might pertain – was performed at the WES. Not only did the station provide a centralized staff of experts and the necessary facilities to conduct modeling operations, it also allowed for the manufacture of specific technical appurtenances on site. Indeed, when the notion that a model might aid in the comprehensive survey of the Bay Area was initially floated, it was assumed that such a facility would be constructed at the WES.[41] Yet, as soon as discussion of a potential model of the bay reached the public, local interests – city and regional business organizations, planning associations, state agencies, and municipal authorities in virtually every community surrounding the bay – clamored for it to be built in the Bay Area.[42] By 1953, it was clear to J.B. Tiffany, director of the WES, and other officials that popular interest in the model demanded it be built locally.[43] Though the cost of building the model onsite would be somewhat higher, Corps brass reasoned, its local presence would prove advantageous in a number of ways: it would "provide greater accessibility to using agencies" and offer engineers "proximity to the prototype." In addition, locating "the model in the San Francisco area would be valuable…in demonstrating to the local public either the effectiveness of proposed works…or the detrimental effects those same proposed works might have on the existing economy."[44] That is, it might serve a pedagogical function as a demonstration site. Tiffany reassigned two members of the WES staff, Haywood Dewey and W.D. Johnson, to the San Francisco District. The former engineer (who had been chief of the Mississippi Basin Model since 1947) was charged with overseeing the overall Bay Study and model operations program; the latter was to guide the construction of the model itself.[45]

With technical personnel assembled and a physical site selected, Corps engineers at the San Francisco District and the WES were almost ready to start construction. But before they could begin to assemble a concrete scale model, they, of course, had to gather as much information regarding the physical characteristics of the actual bay. In this regard, initial efforts centered on compiling previous topographical and hydrographical

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[39] Telegram from John F. Shelley to John Reber, February 26, 1954. Folder: 2/1954. Box 10: Correspondence 7/53-12/54. Reber Papers, RG 77, NARA.

[40] Letter from J.A. Graf to South Pacific Division Engineer, November 23, 1955. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[41] Letter from Owen Stanley to J.B. Tiffany, December 14, 1949. Folder: San Francisco Bay Study, Waterways Experiment Station, 1949-53. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[42] *San Francisco Call Bulletin*, "Lab to test Reber Plan," December 31, 1956. Folder: 12/56. Box 30: Clippings. Reber Papers, RG 77, NARA.

[43] Memoranda, February 23, 1953. Folder: San Francisco Bay Study, Waterways Experiment Station, 1949-1953. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[44] San Francisco District Office, "Army Corps of Engineers Report, Preliminary Bay Study," August 12, 1953. Folder: US Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[45] San Francisco *Call Bulletin*, "Lab to Test Reber Plan," December 31, 1956. Folder: 12/56. Box 30: Clippings. Reber Papers, RG 77, NARA; Fatherree, *The First 75 Years*, 89.

charts produced by the Navy, the U.S. Geological Survey, the Coast Geodetic Survey, and the Army Corps of Engineers itself.[46] The San Francisco District also embarked on an extensive and ongoing aerial reconnaissance mission. In collaboration with a private aerial photographer and over the course of dozens of flight runs, the Corps photographed the bay's entire shoreline at both high and low tides, compiling a detailed and exacting record of the bay from on high [Figure 6].[47] The data gleaned from these charts, surveys, maps, and photographs allowed the Corps to carve out a basic picture of the bay as a three-dimensional feature.



Figure 6: Corps' Aerial Survey Photos. **Source:** SF Bay Topographical Survey, Aerial Photographs, 1955-1968. Chief of Engineers, Civil Works Project Files, RG 77, NARA. NRHS Accession Number 077-99-0.

[46] "Proposed Program for Collection of Field Data," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.
[47] San Francisco Bay Topographical Survey, Aerial Photographs, 1955-1968. Boxes 1-16. Records of the Office of the Chief of Engineers. Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Region, San Bruno, California. NRHS Accession Number 077-99-0

Upon completing its initial survey, the Corps set about constructing the Bay Model between March 1956 and June 1957 at a horizontal scale of 1: 1,000 and a vertical one of 1:100. Originally encompassing a swath of the Pacific Ocean and the entire bay to the confluence of the San Joaquin and Sacramento rivers, the engineering tool was designed to ultimately reproduce an average tidal cycle at a timescale of 14.9 minutes. Working off of a master blueprint, labor crews carefully carved channels, rivers, bays, and other man-made and natural features into hundreds of individual 12' by 12' concrete slabs. These chiseled components of the test-bed were then assembled together on adjustable jacks within the warehouse. With the physical construction of the test bed completed, District engineers installed the essential technical equipment to run simulations on the model, including a primary tide generator, water pumping and drainage systems, flow controllers, tide gages, and velocity meters among other devices (later, other automatic measurement instruments were installed). But the ability to continually adjust the levels of the model's bed via jacks – correcting for general processes of settling and tectonic activity – represented an innovation in hydraulic modeling unique to the Bay Model. Indeed, the outside world that the model intended to replicate continually worked upon its physical condition. Between 1957 and 1963, the test-bed was surveyed and, after being found distorted, re-leveled a dozen times. In 1966, the Corps began building an extension to the model in order to test the U.S. Bureau of Reclamation's controversial plan to divert fresh Delta water to southern California and the agricultural fields of the Central Valley. Subsequent simulations verified that the Peripheral Canal plan – a 'feat' of hydraulic engineering on par with proposals to dam the San Francisco Bay – was a viable possibility.[48]

On June 14, 1957, the Corps hosted an official dedication ceremony at the Bay Model. Organized and promoted by the office of San Francisco Mayor George Christopher as well as other local sponsoring organizations, the pageantry-soaked event was attended by hundreds of dignitaries, including members of Congress from the Bay Area, regional business elites, various municipal authorities, local developers, representatives of organized labor, state officials, military leaders, and figures with an interest in metropolitan planning such as John Reber.[49] Attendees toured the model, listened to descriptions of its capabilities as an engineering tool delivered by Corps staff, and observed a demonstration of tidal simulation. A few weeks prior, engineers had affixed the model's final concrete slab, pumped water into the test-bed for the first time, and allowed journalists to visit the facility in an effort to publicize its completion. The dedication ceremony itself, however, marked the first public opportunity for Army Corps staff to demonstrate how their efforts at "[p]ainstaking accuracy had paid off."[50]

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[48] U.S. Department of the Army, Corps of Engineers, San Francisco District, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model.* (Mountain View, CA: Hydrocomp, 1981).

[49] Letter from J.A. Graf to George Christopher, June 24, 1957; Memo from John D. Sullivan to Mayor Christopher, May 7, 1957. Folder: Bay Model, Reber Plan, 1956-1960. Box: 3. SFH 7, Christopher Papers, San Francisco History Room, San Francisco Public Library.

[50] Harold Gilliam, "The Most Remarkable Acre of Concrete in the World," *San Francisco Chronicle*, June 9, 1957.

'Hot Fish' and the Verification of the 'Model-Prototype' Relationship

The initial construction of the physical model garnered considerable attention. Many early commentators were particularly struck by the size and appearance of the model as something akin to a gigantic relief map. Yet, the model was not built to be a static representation of the region. Instead, it was conceived of as a tool to simulate processes in the bay and test the potential effects of interventions in the bay system. Thus, to be effective as an engineering tool, the model had to be "verified to known prototype conditions."[51] But, in fact, when the Corps began its comprehensive survey, granular data about the hydraulic processes and specific qualities of the actual bay hardly existed. That is, the process of verification required – in the first place – that the Corps undertake the most in-depth technical and scientific study of the bay hitherto pursued. Between 1956 and the publication of its *Technical Report on Barriers* in 1963, the Corps engaged in a series of extensive field studies that generated a comprehensive library of environmental data about the bay and its processes. "You see," Johnson, the engineer in charge of building the model, told a reporter at the start of the project, "we have to find out what's going on in the Bay as it is now before we can determine what will happen if things are changed."[52]

Like the socio-natural world more generally, the San Francisco Bay is an object of potentially infinite complexity. For the purposes of modeling it reliably, the Corps needed to investigate two relatively specific features of the bay. On the one hand, Army engineers wanted to better understand its character as a hydraulic system: tidal dynamics, flow, salinity, and current velocity among other aspects. These phenomena could be investigated and measured directly "in the prototype."[53] On the other hand, the Corps needed to generate reliable information about the movement, dispersal, and circulation of silt and sediments throughout the bay-estuary. Developing a method to do so – with the help of engineers at the University of California, Berkeley and scientists at the Naval Radiological Defense Laboratory in San Francisco – ultimately proved critical to the overall efficacy of the model as an engineering and planning tool. These two ongoing surveys, one concerned with hydraulic conditions and the other with sedimentation, began even before the completion of the physical model and were pursued concurrently with one another. Together, they also illustrate how the construction and use of the Bay Model was more than a matter of merely replicating an already existing natural world. It was an iterative practice of measuring, inscribing, working upon, and intervening in the world beyond the warehoused walls of the model itself.

The comprehensive survey of hydraulic conditions in the bay took place in a series of stages. While initial measurements were made as a part of the Corps' preliminary examination, a full-fledged investigation of bay conditions was inaugurated in earnest in September of 1956. Organized and led by Dewey, head of the Bay Study, a coordinated crew of eighty engineers, scientists, and laborers on fifteen boats spread out

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[51] Eugene M. Huggins and Edward A. Schultz, "The San Francisco Bay and Delta Model," *California Engineer* 51, no. 3 (January 1973) 13.
[52] *San Francisco Call Bulletin*, "Lab to Test Reber Plan," December 31, 1956. Folder: 12/56. Box 30: Clippings. Reber Papers, RG 77, NARA.
[53] Huggins and Schultz, "The San Francisco Bay and Delta Model," 13.

across the bay to survey the action of the "prototype" as a hydraulic system.[54] Over the course of an entire tidal cycle, the technicians measured and documented with extreme precision characteristics of flow, tide, salinity, and the distribution of current velocity. The latter measurement was especially important due to the fact that "reproduction of all details of flow in the model" depended upon the ability to accurately simulate velocity distributions on it.[55] In addition to generating a baseline hydraulic dataset, the Corps team installed both nine "primary current velocity and salinity stations" and a network of twenty-one "tide-gage stations" around the shores of the bay to automatically record the rise and fall of the water surface on a chart.[56] The Corps repeated similar surveying programs in 1958 and 1959 in order to ensure accuracy and garner a sense of seasonal variability.[57]

Not only did the Corps' hydraulic investigations generate information about prototype conditions, those surveys also both sponsored and depended upon the construction of a monitoring and measurement infrastructure – field stations, gage networks, work posts, observation platforms, etc. – throughout the entirety of the actual bay. Indeed, the process of verifying the model to prototype conditions followed the creation of this socio-material and region-wide infrastructural network. As information generated via this wider machine ecology emerged, engineers at the model facility started to make adjustments to the test-bed and related apparatuses.[58] They installed salinity-, evaporation-, and tide-gage stations in the model at the same locations that they were at in the field; fine-tuned the model's tide generator; and adjusted flow inputs and meters. Perhaps the most important adjustment engineers made on the model in an effort to verify it to processes in the prototype had to do with the test-bed's "roughness," a term used by engineers at the model to refer to the vegetation and detritus that affected velocity patterns.[59] Because the relatively smooth concrete floor of the model led to distorted simulations of current velocities, it was necessary for Corps staff to develop a reasonably flexible way to account for all the vicissitudes of the complex organic world. The solution they came up with – hundreds of removable copper tabs affixed to the bed of the

[54] "Appendix 'H,' Hydraulic Model Studies, Volume I – Text and Figures to the Technical Report on San Francisco Bay Barriers," March 1963. Box 2: Comprehensive Survey Reports and Studies Related to Civil Works Projects, 1955-1992. Records of the Office of the Chief of Engineers. Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Division, San Bruno, California.

[55] "Proposed Program for Collection of Field Data," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[56] "Information on San Francisco Bay Model," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA; U.S. Army Corps of Engineers, *San Francisco Bay Model Visitor's Pamphlet*, May 1962. Folder: Army Corps of Engineers – Notices, Permits, Correspondence. Carton: 9. Save San Francisco Bay Association Records. BANC MSS 87/29 c, Bancroft Library, University of California, Berkeley (Collection hereafter cited as SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley).

[57] U.S. Army Corps of Engineers, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model.*

[58] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[59] "Proposed Program for Collection of Field Data," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

model – can be seen at the Visitor's Center today.[60] After years of tacking back and forth between the base-yard in Sausalito and various locations on and around the San Francisco Bay, engaging in iterative practices of prototype measurement and test-bed adjustment, Corps engineers were eventually confident that they could accurately reproduce the general behavior of the bay – as a hydraulic system – on the Bay Model.

As the verification of hydraulic processes unfolded, the Corps took on a second and arguably more complicated study of sediment movement and circulation in the bay. While much of the publicity surrounding the engineers' comprehensive survey focused on what a scale model might say about future development scenarios, the Corps consistently sold its importance to federal appropriations committees on the basis of its potential ability to lower dredging costs.[61] Indeed, one of the primary responsibilities of the Corps of Engineers in the Bay Area was the maintenance of defense and commercial shipping channels as well as marine facilities. The build up of silt, sand, and other sediments at particular locations in the bay led Army Engineers to engage in the near Sisyphean task of perpetual dredging; the Corps dredged some eight million cubic yards of material annually at a cost of two million dollars.[62] In its preliminary report on the feasibility and efficacy of a comprehensive survey, the San Francisco District suggested that – if the engineers could accurately reproduce the existing regimen of sediment circulation and discharge – a model would serve as "a primary tool in the solution of general silting and shoaling problems."[63] Of course, in order to simulate sedimentation patterns with an eye toward developing new cost-saving dredging practices, the Corps had to figure out what those patterns were in the actual bay first.

More than the field-based hydraulic survey, the study of sediment movement in the bay posed serious technical difficulties. It was one thing for the Corps to take measurements of salinity and tide, but a wholly different matter to trace the circulation and settlement of underwater soil, mud, and silt in the bay-estuary. Early on, Dewey and other engineers at the WES toyed with a number of potential ways to do so, including the use of underwater television equipment.[64] But from the very beginning, Bay Study researchers held out hope that the field of nuclear engineering could provide some answers. As the model site was being prepared, Corps staff reached out to scientists at both the Scripps Institution of Oceanography in San Diego and the Oak Ridge Institute of Nuclear Studies in Tennessee to inquire about the possibility of using radioactive isotopes – detectable, gamma-emitting "tracers" that would stick to granular material – to map out

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[60] "Information on San Francisco Bay Model," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[61] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[62] U.S. Army Corps of Engineers, *San Francisco Bay Model Visitor's Pamphlet*, May 1962. Folder: Army Corps of Engineers – Notices, Permits, Correspondence. Carton 9. Save San Francisco Bay Association Records. BANC MSS 87/29, Bancroft Library, University of California, Berkeley.

[63] San Francisco District Office, "Army Corps of Engineers Report, Preliminary Bay Study," August 12, 1953. Folder: US Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[64] Letter from G.P. Reily to Portland District Engineer, October 24, 1955. Folder: San Francisco Bay Study Silt and Salinity, 1952-1956. Box 1. RG 77, Records of the Office of the Chief of Engineers, San Francisco District, Civil Works Project Files, 1949-1965. National Archives, San Bruno, California. (Collection hereafter cited as Chief of Engineers, Civil Works Project Files, RG 77, NARA).

the movement of sediments.[65] At the same time, Dewey met personally with technicians at the Naval Radiological Defense Laboratory in San Francisco to discuss adapting its studies on radioactive contamination in soil to suit the sedimentation survey.[66] Ultimately, the Corps formed a partnership with a group of prominent engineers at the University of California, Berkeley, including Hans Einstein, son of physicist Albert Einstein, with experience researching both sedimentation and radioactive isotopes.[67] This collaboration between the Corps and Berkeley researchers – contractually cemented in the summer of 1956 – lasted for five years and proved critical to the eventual efficacy of the Bay Model as a planning and engineering tool.[68]

Together, the university engineers and the San Francisco District of the Corps embarked on an ongoing research and development project to forge and implement a new method to trace the circulation and discharge of sediments. On the one hand, while providing technical assistance and monetary compensation to the University of California, the Corps' Bay Study division set about sampling bay waters for particulate material and locating especially problematic shoaling locations.[69] Over the course of 1957 and 1958, Army engineers conducted a series of sedimentation surveys throughout the bay, eventually providing Einstein and company with samples for research and experimentation.[70] On the other hand, the university researchers were charged with developing a viable radioactive isotope in laboratory conditions, one that would fix firmly upon bay sediments and emit just enough radiation to be useful in the field. After conducting numerous lab and flume studies, the Berkeley engineers decided upon using a particular isotope, gold-198, a "gamma-emitter" with a half-life of nearly three days for use "in the field."[71] In addition, they labored to design and construct a detector capable of tracing and recording the radioactive isotopes as they moved in tandem with silt and mud through the bay. Within a few years, not only had researchers at the university developed a viable radioisotope, they also constructed a necessary "underwater scintillation" device to track the "gamma-emitter" as it circulated throughout bay waters.[72] With these technological innovations in tow, the Corps proceeded with its sedimentation survey.

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[65] Letter from J.A. Graf to W.C. Pollard, July 1956. Folder: San Francisco Bay Study, Silt and Salinity; Letter from Roger Revelle to J.E. Deignan, April 23, 1956. Folder San Francisco Bay Study, University of California, 1954-1961; Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[66] Letter from J.A. Graf to Commanding Officer, U.S. Naval Radiological Defense Laboratory, April 30, 1956. Folder: San Francisco Bay Study Silt and Salinity, 1952-1956. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[67] Letter from Hans Einstein to J.E. Deignan, June 15, 1956. Folder: San Francisco Bay Study, University of California, 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[68] Letter from J.A. Graf to Robert Sproul, August 16, 1956. Folder: San Francisco Bay Study, Silt and Salinity, 1952-1956. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[69] Letter from J.A. Graf to N.W. Snyder, April 27, 1956. Folder: San Francisco Bay Study, Silt and Salinity, 1952-1956. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[70] Letter from J.E. Deignan to Hans Einstein, December 4, 1957; J.E. Deignan to Hans Einstein, September 1957. Folder: San Francisco Bay Study, University of California 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA; "Engineers Test Bay for Silting," *San Francisco Chronicle,* February 14, 1958. Folder: 11/1957. Box 31. Reber Papers, RG 77, NARA.

[71] Letter from Ray Krone to John Harnett, May 5, 1958. Folder: San Francisco Bay Study, University of California 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[72] Letter from Ray Krone to San Francisco District Engineer, April 1961. Folder: San Francisco Bay Study, University of California 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

As the development of a practical method for sedimentation mapping came to fruition, the Corps chose a location near Mare Island in the northern portion of the bay-estuary to unleash its first round of tracers. But not before a number of interested parties expressed concern over the potential effects of introducing radioactive material into the bay. "The difficulty with the use of radioactive tracers," suggested Roger Revelle, Director of the Scripps Institution, "is, of course, the small margin between detectibility [sic] on the one hand and hazard to human beings on the other." Moreover, because marine animals "concentrate radioactivity," he worried that the Corps' tracing efforts might lead to "some 'hot' fish in the market stalls on Fisherman's Wharf."[73] Likewise, when the California State agencies got wind of the proposed project, officials responded in kind. "As the addition of such materials may have an effect on the living organisms of the bay," spokesperson W.T. Shannon wrote to Dewey, "the Department of Fish and Game is concerned with the use of radioactive isotopes within the waters of this state."[74] To address these and other anxieties, Dewey and the university researchers held a meeting regarding the isotope study with all interested state and federal agencies at Berkeley in June of 1958.[75] Previously skeptical officials acquiesced and a few weeks later the Bay Study division, accompanied by university engineers and members of the WES staff, introduced isotopes into the bay for the first time.[76] Over the course of the following days, survey crews carefully tracked and recorded the movement and settlement of radioactive sediment. This first experiment in the field was followed up with a number of additional tracer surveys throughout various parts of the bay between September of 1959 and August of 1960.[77]

All told, these radioactive tracer surveys generated substantial information about the character, action, and behavior of sediments and soils in the estuarine environment. And, as was the case with the hydraulic survey, once the Corps knew what was going on in "the prototype," it could work to reproduce those conditions in the model with an eye toward testing "remedial measures," namely, alternative dredging practices and locations that might engender lower costs.[78] That is, the radioactive tracer studies enabled Corps technicians to ensure that processes replicated in the model would correspond, albeit narrowly, to the sedimentation regime as observed in the bay. Perhaps the most important model-prototype verification procedure undertaken in this regard was the development of a suitable stand-in for the actual silt, sand, mud, and granular debris moving around in the water. After analyses of the density, weight, and transport characteristics of various

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[73] Letter from Roger Revelle to J.E. Deignan, April 23, 1956. Folder San Francisco Bay Study, University of California, 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.
[74] Letter from W.T. Shannon to H.G. Dewey, June 17, 1957. Folder: San Francisco Bay Study, Fish and Wildlife, 1956-1958. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.
[75] Letter from John Harnett to the Director of the California Department of Fish and Game, May 20, 1958. Folder: San Francisco Bay Study, Fish and Wildlife, 1956-1958. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.
[76] Hans Einstein et al., "Silt Transportation Studies," December 30, 1958. Folder San Francisco Bay Study, University of California, 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.
[77] Letter from Ray Krone to San Francisco District Engineer, August 26, 1960. Folder San Francisco Bay Study, University of California, 1954-1961. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.
[78] U.S. Army Corps of Engineers, *San Francisco Bay Model Visitor's Pamphlet*, May 1962. Folder: Army Corps of Engineers – Notices, Permits, Correspondence. Carton 9. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.

sediment substitutes, Corps scientists decided upon gilsonite – a "lightweight, bituminous material mined in Utah" – as an appropriate, "qualitative" stand-in for use in the model.[79] As far as the circulation patterns of dispersal, settlement, and discharge were concerned, model engineers adjusted roughness, intake, and other hydraulic features on the test-bed in an iterative effort to reproduce prototype conditions in the model as accurately as possible.[80] With the verification of sedimentation processes in the model completed, the Corps was able to begin testing future development interventions in those realms like dredging, barrier construction, landfill, and marsh reclamation among others.

While the hydraulic and sedimentation surveys underwrote the Corps' efforts to verify the model to prototype conditions, they also produced new understandings about the Bay Area as a system of flows and processes. It is worth emphasizing here how the "nuclear-industrial complex" remade both nature and frameworks for thinking about the socio-natural world more broadly during the postwar era.[81] As Valerie Kuletz has emphasized, the very concept of the ecosystem – a concept that continues to gird popular understandings about nature – developed in tandem with nuclear science and engineering. That is, the emergence of ecological systems science, most notably in the work of Howard and Eugene Odum, depended on the deployment and tracking of radioactive material in both laboratory conditions and ecological systems – ponds, coral reefs, farms – themselves.[82] The Corps' sedimentation survey of the bay can be seen as an extension of these research concerns and practices. But unlike the "systems" traced by the Odum brothers, the Corps took the infrastructural and ecological centerpiece of a major metropolitan area as its object of study. It mobilized radioactivity to trace the nature of the urban region itself as a complex system.

Using the Model, Simulating the Bay

As work crews labored to put the finishing touches on the physical model in early 1957, the Chief Engineer of the San Francisco District invited various representatives of organized labor in the Bay Area to tour the facility and learn about the ways in which tests run on the model might influence regional growth. George Johns, Secretary of the San Francisco Labor Council, was astonished by the model's size, scope, and forecasting potential. "Obviously," he reported back to the Labor Council's membership, "such a working model of the San Francisco Bay will of necessity be a major governing factor in planning the future development of this area."[83] Johns was also particularly impressed by

[79] "Proposed Program for Collection of Field Data," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.
[80] H.G. Dewey, "Model-Prototype Studies of the San Francisco Bay," n.d. Folder: U.S. Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.
[81] Jake Kosek, *Understories: The Political Life of Forests in Northern New Mexico* (Durham and London: Duke University Press, 2006) 264.
[82] Valerie Kuletz, *The Tainted Desert: Environmental and Social Ruin in the American West* (New York: Routledge, 1998) 256-265. See also, Frank Golley, *A History of the Ecosystem Concept in Ecology: More than the Sum of the Parts* (New Haven: Yale University Press, 1996).
[83] *Official Bulletin of the San Francisco Labor Council*, vol. 8 no. 1 (January 1957). Folder: San Francisco Labor Council, 1957-1958. Box 23: Publications – Government and Other. Reber Papers, RG 77, NARA.

the range of development questions that model tests could lend perspective on: "Not only future bridges or other crossings, navigational aids, projects of vast scope such as the Reber plan, rapid transit, changes in present bridges, and other programs involving the Bay itself, but industrial development and regional planning generally will be 'checked out' by means of the Bay Model."[84] Over the entire course of its operation, the Bay Model did indeed serve as a means to "check out" a variety of defense and development scenarios. Yet, as initial processes of verification began to conclude, the Corps developed a relatively circumspect testing agenda yoked to the original justification for a comprehensive survey of the Bay Area.

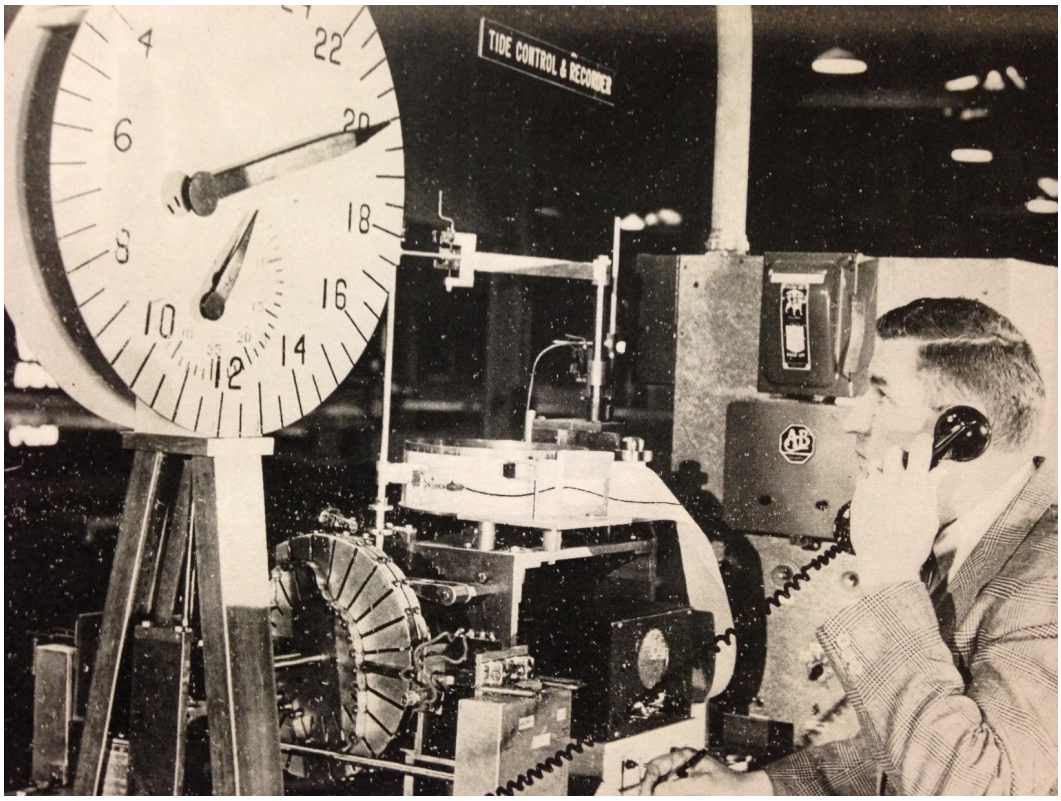


Figure 7: The tide generator at the Bay Model. **Source**: USACE, *Technical Report on Barriers*, 1963.

Perhaps unsurprisingly, the initial simulation program undertaken by the Corps at the model concentrated on two principle areas of concern: first, the effects of potential barrier, land reclamation, and development projects on bay hydraulic conditions and, second, how those projects might affect shoaling and sedimentation problems throughout the region.[85] These twin concerns were taken up in turn. From late 1958 through the

[84] *Official Bulletin of the San Francisco Labor Council*, vol. 8 no. 4 (February 1957). Folder: San Francisco Labor Council, 1957-1958. Box 23: Publications – Government and Other. Reber Papers, RG 77, NARA.
[85] "Appendix 'H,' Hydraulic Model Studies, Volume I – Text and Figures to the Technical Report on San Francisco Bay Barriers," March 1963. Box 2: Comprehensive Survey Reports and Studies Related to Civil Works Projects, 1955-1992. Records of the Office of the Chief of Engineers. Record Group 77, San

summer of 1961, an orchestra of model technicians pursued dozens of simulations designed to evaluate the impact of land reclamation, barrier, and development projects on flood control efforts, hydraulic and salinity conditions, and the bay's tidal prism [Figure 7].[86] On the heels of those tests, engineers at the Bay Model devoted several months to examining the impact and feasibility of Reber's plan to create freshwater lakes through the erection of salt-water barriers. Though the Corps tested numerous other barrier proposals in addition to the ones advocated by Reber, model results indicated that his plan would not only not produce its intended benefits but might also lead to negative, unanticipated consequences.[87] Upon completing the various hydraulic tests, Army engineers moved on to examine sedimentation patterns in the bay under various conditions. Between 1961 and December of 1963, the Corps studied a variety of shoaling and silting outcomes, paying special attention to dredging scenarios in and around the Oakland harbor as well as the Oakland-Alameda and Mare Island Strait navigation channels.[88] All in all, the initial five-year testing program run on the Bay Model produced thousands of pages of technical information about flows and processes in the bay – as it was and as it might be.

In addition to probing the effects of barrier construction and land reclamation on hydraulic conditions and sedimentation, the Corps took on another pair of tests – requested, respectively, by the U.S. Public Health Service and the Maritime Administration – examining the dispersion of pollution and waste in the bay. While the U.S.P.H.S. was concerned with water quality, the capacity of the bay-estuary to satisfactorily "flush" pollutants from the system, and the negative health effects of urbanization more generally, the Maritime Administration wanted the Corps to explore the potential results of a bio-chemical attack unleashed on the Bay Area through some sort of clandestine operation.[89] Both types of inquiry required that Bay Model technicians develop a way to simulate the dispersal of waste and pollutants given known parameters. From August 1959 until December 1960, engineers experimented with different types of dye and debris in the model, eventually reproducing a number of scenarios concerning public health and potential defense vulnerabilities.[90] Not only did the Corps posit that the Bay Area was susceptible to a military attack via the release of toxic agents in the bay, it

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Francisco District, National Archives and Records Administration – Pacific Division, San Bruno, California.

[86] U.S. Army Corps of Engineers, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model.*

[87] U.S. Army Engineer District San Francisco, *Technical Report on Barriers: A Part of the Comprehensive Survey of San Francisco Bay and Tributaries* (San Francisco: Corps of Engineers, 1963) xx; U.S. Army Corps of Engineers, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model*; Weisberg, *Simulation and Similarity,* 1-3.

[88] U.S. Army Corps of Engineers, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model.*

[89] San Francisco Bay Model Report, January 16, 1961. Folder: S.F. Bay Model Reports, 1958-1961. Box 2. Chief of Engineers, Civil Works Project Files, RG 77, NARA; *San Francisco Examiner*, "Bay Tests to Decide A-Danger," December 5, 1960.

[90] "Appendix 'H,' Hydraulic Model Studies, Volume I – Text and Figures to the Technical Report on San Francisco Bay Barriers," March 1963. Box 2: Comprehensive Survey Reports and Studies Related to Civil Works Projects, 1955-1992. Records of the Office of the Chief of Engineers. Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Division, San Bruno, California; U.S. Army Corps of Engineers, *Users Guide for the San Francisco Bay-Delta Tidal Hydraulic Model.*

also concluded that pollution and waste in bay waters – concentrating particularly in the South Bay – posed a severe and ongoing hazard.

By 1963, San Francisco District staff started preparations to release the highly anticipated first round of comprehensive study findings. In addition to its survey and simulation results, the Corps partnered with the Department of Commerce to produce a study of population growth in the Bay Area as well an "economic analysis" of present and future development patterns.[91] Moreover, despite the extremely specific and technical nature of the studies run on the Bay Model, the Corps worked to present its overall findings in a way that emphasized seven broad social, infrastructural, and environmental problems that needed to be addressed in a systematic capacity over the following decades. The issues of deep draft navigation and flood control called for a coordinated effort among municipal, state, and federal agencies; population increase would only exacerbate existing problems such as pollution, traffic congestion, and diminishing access to water supply and recreational space; and the ongoing reclamation of marsh, tide, and submerged lands around the bay would continue to produce changes in tidal height, thereby compounding all of the highlighted problem areas. The implementation of a bay barrier plan along the lines proposed by Reber and other parties, the engineers stressed, would not provide a viable, long-term solution in any of these arenas.[92]

The publication of the Army Engineers' *Technical Report on Barriers* garnered considerable attention among municipal officials and the general public alike. Over the course of nearly three hundred pages and numerous technical appendixes, the Corps laid out the major environmental and socio-economic issues confronting "the common weal of the 9-county Bay Area," forecasted various problematic trends, and offered a detailed account of the effects of various barrier plans on the bay.[93] A major takeaway from the report was the fact that – given the region's character as an interconnected socio-natural system – no simple technical fix would alleviate the environmental problems caused by rapid urbanization. But another persistent argument emerged from the text: the need for the establishment of a governing authority at the scale of the metropolitan region. Actually, the Corps had long suggested the desirability of establishing "a regional supervisory body" in the Bay Area for the purpose of environmental governance and management.[94] Yet, it was the dissemination of the Corps' formulation of the bay as single, interconnected system – and its demonstration as such to both policy makers and the public at the Bay Model – that put "the problem of establishing…some form of multi-purpose regional metropolitan government" on the political agenda.[95]

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[91] Letter from J.A. Gtaf to John Judge, May 10, 1957; Louis Peltier to H.G. Dewey, April 15, 1958. Folder: San Francisco Bay Study, Department of Commerce. Box 23: Publications – Government and Other. Reber Papers, RG 77, NARA.

[92] Army Engineer District, San Francisco, "Draft Report of Survey for San Francisco Bay and Tributaries, California," October 1966. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

[93] U.S. Army Engineer District San Francisco, *Technical Report on Barriers: A Part of the Comprehensive Survey of San Francisco Bay and Tributaries* (San Francisco: Corps of Engineers, 1963) 39.

[94] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.

[95] Army Engineer District, San Francisco, "Draft Report of Survey for San Francisco Bay and Tributaries, California," October 1966. Box 1. Chief of Engineers, Civil Works Project Files, RG 77, NARA.

The World a Model Makes

As an engineering and planning tool, the Bay Model produced a number of effects that continue to animate political life the Bay Area. Most notably, it constituted the bay-delta system as an object of sustained inquiry and fixed the region as an appropriate scale of environmental management and administration. As early as 1967, Eugene Huggins and Edward Schultz of the San Francisco Army Engineer District pointed to the model as a primary means by which such realignments were achieved. On the one hand, they argued that simulations run on the model produced "the finest and most comprehensive library of data on the action and environment of the Bay in existence" and provided "the foundation for almost all regional planning, by practically all agencies, in the Bay Area." By offering a framework with which to probe the impact of individual projects on the bay-estuary and delta as a whole, the model, in their view, girded a broader scientific and popular shift in conceptions of the San Francisco Bay as an interconnected ecological system. Indeed, the model might be said to have served as one mechanism by which contemporary ecological sensibilities in the Bay Area were installed. Tellingly, data about the bay-delta system generated on the physical model, programmed into computers, continues to inform contemporary modeling exercises. On the other hand, in highlighting the intertwined fate of different Bay Area communities at the scale of nature, Huggins and Schultz suggested that the information produced on the model (as well as the model itself as an educational prop) proved to be a "major stimulant" in the formation of new forms of authority.[96]



Figure 8: The Bay Model in its current incarnation as an "educational center." **Source:** Author's Photo.

[96] Eugene M. Huggins and Edward A. Schultz, "The San Francisco Bay in a Warehouse," *Journal of the IEST* 10, no. 5 (1967).

The following section examines the effects of the Bay Model on environmental thought and governance in the Bay Area [Figure 8]. I begin by highlighting the various organizations – professional and popular alike – that had held longstanding interest in the establishment of some form of metropolitan government in the region. Despite conflicting viewpoints on a variety of issues concerning development, each group drew upon model studies to advance their respective planning and political agendas and collectively sponsored a shift in popular imaginations. Yet, because of what the model rendered invisible as much as what it made clear, this shift precluded ways of understanding the urban environment that centered on classed and raced inequalities. There are no people in the model, no communities, no power dynamics or social relationships. Yet, it is worth pondering how decisions made about development and governance with the help of simulation studies undoubtedly had uneven social impacts. Next, I move on discuss the tangible results, in terms of policy and planning, that these groups were able to achieve wielding a vision of the bay constituted in part through the Corps' modeling program: namely, the creation of the Bay Area's first regional authority in the form of the Bay Development and Conservation Commission and its Bay Plan of 1969. Finally, I conclude by describing how these institutional arrangements – girded by the simulation of the bay as an interconnected natural system – led to the valuation of environmental processes in ways that animate political discourse today.

The Few and the Many

The model studies offered three distinct yet intersecting groups interested in politics at the metropolitan scale with material to argue for the formation of a new governing authority. The first of these groups – undoubtedly made up of those "few" with a "regional view" celebrated by Mel Scott – was composed of modernist planners, political scientists, architects, and landscape architects at the University of California, Berkeley. Indeed, both the College of Environmental Design as well as the Institute of Governmental Studies at Berkeley had long been home to rather close-knit community of intellectuals and professionals who worked not just as professors at the university but in municipal planning departments and architectural firms throughout the Bay Area. As far back as the late 1930s, drawing inspiration and support from the likes of Lewis Mumford, Catherine Bauer, and William Wurster, city planners and regionalists such as Francis Violich and T.J. Kent – both of whom would later take turns as Chair of the Department of City Planning – organized the Telesis group, a visionary organization that advocated for progressive regional planning in the area.[97] By the 1950s and 1960s, these regionalists were fully ensconced in the Bay Area's institutional and professional milieu.

Perhaps no other figure among these modernist planners played a more central role in drawing upon the view of the metropolis forged at the Bay Model to advocate for a governing authority at the regional scale than Scott himself. He had long been interested in the comprehensive survey undertaken by the Corps of Engineers, visiting the

[97] Peter Albert Allen, "A Space for Living: Region and Nature in the San Francisco Bay Area, 1939-1969," PhD Dissertation in the Department of Architecture, University of California, Berkeley (Fall 2009).

model multiple times and requesting information about the studies from the San Francisco District.[98] But in 1959, after completing his book on the Bay Area, Scott took up a research position at Berkeley's Institute of Governmental Studies that ultimately underwrote his subtly shifting view that the nature of the bay as an environmental system provided the basis for regional planning and governance.[99] Scott went to work preparing a report for the Institute on development trends in the Bay Area with an eye toward the pitfalls of bay fill. Published in 1963, *The Future of the San Francisco Bay* offered a portrait of the bay as a "total unit" of social and natural processes rather than a mere collection of individual parcels of private and municipal property. Citing the Army Corps of Engineers' model studies and *Technical Report on Barriers*, Scott urged the creation of a "Bay Conservation and Development Commission" to guide the growth of the metropolitan region in a holistic way.[100] The piece received widespread interest and, as I'll discuss below, Scott's call for a new commission would ultimately be acted upon.

Besides the city and regional planning community in and around Berkeley, a second group of elites drew on the Corps' model studies as inspiration to act upon long-held desires to establish a regional governing body. The Bay Area Council (BAC) – a corporate organization formed after World War II to coordinate the transition from wartime to peacetime metropolitan economy – saw the necessity of a greater authority. Yet, as a booster organization with a fundamental interest in corporate growth, the BAC was mainly concerned with maintaining and expanding industrial infrastructure; its membership was concerned that an autonomous metropolitan government might usurp the authority of landowners and local municipalities. In an attempt to preempt the regional impulse, the BAC sponsored the formation of the Association of Bay Area Governments (ABAG), a "voluntary association" with no legislative power as an alternative to what some of the Institute for Governmental Studies members wanted.[101] Nonetheless, inspired by the Corps' simulation studies of sedimentation in shipping channels, both the BAC and ABAG actively lobbied for funds to keep the Bay Model running.[102] For the Bay Area's business elite, it seemed, a reasonable form of regional authority would be limited to overseeing bay-related concerns like dredging harbors and ports, planning commercial and infrastructural improvements, and managing environmental and public health problems.

While professional and business elites had long advocated for "a regional view" on behalf of commercial development and urban expansion, it took an activist organization, the Save San Francisco Bay Association or Save the Bay, to install a regional sensibility among "the many." Founded and led by a cohort of politically astute and socially connected environmental activists from Berkeley – Kay Kerr, Sylvia

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[98] Mel Scott, "A Progress Report on a Study of the Future of the San Francisco Bay," October 10, 1962. Carton 9: Folder 26. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[99] T.J. Kent, Jr, "Professor and Political Activist: A Career in City and Regional Planning in the San Francisco Bay Area," an oral history conducted in 1981-1982 by Malca Chall, in *Statewide and Regional Land-Use Planning in California, 1950-1980 Project, Volume II*, Regional Oral History Office, The Bancroft Library, University of California, Berkeley, 1983.
[100] Mel Scott, *The Future of the San Francisco Bay* (Berkeley: Institute of Governmental Studies, University of California, 1963) 102.
[101] Joel Thibert, *Governing Urban Regions through Collaboration.* (Surrey: Ashgate, 2015) 105-115.
[102] The Association of Bay Area Governments, *The Emergence of a Regional Concept, 1910-1970.* (Berkeley: ABAG, 1970) 3.

McLaughlin, and Esther Gulick – Save the Bay was largely worried about indiscriminant filling and development. In 1961, after encountering maps produced by the Corps that showed future projections of bay reclamation, the cohort invited a number of conservationists to a meeting to consider a course of action. Soon thereafter, Save the Bay embarked on an area-wide publicity campaign concerning the fate of the bay as natural feature and agitated against a variety of development campaigns. The group captured the public's imagination and put the question of environmental management at the regional scale on the rhetorical map as never before.[103] "With surprising rapidity," the geographer Richard Walker argues, "the movement to save the bay became a mass political uprising." Subject of a vast number of articles, books, documentaries, and radio programs, the organization grew at an astonishing rate with membership quickly numbering into the thousands. "Nothing was more essential to the foundation of the Bay Area's green culture," Walker suggests. "It all goes through Save the Bay."[104]

Though Corps' maps might have stimulated the formation of Save the Bay, the Bay Model – the physical structure as well as those technical understandings about the bay generated on it – provided the grounds upon which the organization made political bids. Indeed, despite the fact that many accounts of postwar environmentalism pit the Corps against anti-development activists, Save the Bay simultaneously fostered and drew upon a relationship with the Army Engineers from its beginning. Tellingly, at one of the organization's first meetings in 1961, Eugene Huggins, public liaison officer at the Bay Model, presented members with information regarding both model simulation studies and the Corps' role in granting bay-development permits.[105] In fact, Save the Bay maintained an ongoing correspondence with Huggins and the San Francisco District, honing in on the Corp's characterization of the region as an interconnected system and gaining inside information about planned development projects.[106]

In some respects, the model – as a scientific tool with which to generate "facts" about the "bay system" – became a terrain of struggle between developers and environmentalists, serving as a basis for interpretation and a site for the generation of political ammunition. "Now that the bay model exists," William Mott, one-time president of Save the Bay, wrote to District Chief Robert Allen, "decisions can be made based on facts, which should be made public."[107] And as data generated on the model continued to inflect attempts to shape the course of metropolitan growth and narratives about the character of the region, so too did the physical space of the facility serve as a constitutive grounds for Save the Bay; the organization held a number of annual membership meetings at the warehouse in Sausalito, generating much "enthusiasm" among members about the metropolitan scene presented in gigantic miniature.[108] But the Bay Model also

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[103] Harold Gilliam, *Between the Devil and the Deep Blue Bay: The Struggle to Save San Francisco Bay.* (San Francisco: Chronicle Books, 1969).
[104] Walker, *The Country in the City,* 115.
[105] Letter from Kay Kerr to Eugene Huggins, November 1961. Carton 9: Folder 5. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[106] Letter from Kay Kerr to Eugene Huggins, January 11, 1963; Kay Kerr to John Morrison, February 20, 1963. Carton 9: Folder 5. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[107] Letter from William Mott to Col. Robert Allen, February 28, 1965. Carton 2: Folder 19. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[108] Membership Newsletter, January 15, 1965. Carton 2: Folder 19. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.

literally constituted the space of concern taken up by Save the Bay and other interested parties, providing a stage upon which to advocate for a particular governing regime premised on the popular understanding of the nature of the Bay Metropolis: "The model," Kerr wrote Congressman Philip Burton on behalf of appropriating funds for the facility's continued support in the 1970s, "has been of primary importance in educating the public to the need to protect this significant, vulnerable, and irreplaceable natural resource."[109] In other words, the importance of the model to movements like Save the Bay can be gleaned from the fact that ultimately the organization wanted not just to 'Save the Bay' but to 'Save the Bay Model' as well.

The model offered the material and conceptual scaffolding upon which the disparate groups described above could pursue their governance objectives. But it also foreclosed other political outlooks, agendas, and frameworks for action. Indeed, the racial and class character of the Save the Bay activists – to say nothing of the Corps technicians, professional planners, and business elites with whom they associated – says something not just about the whiteness of postwar environmentalism in the Bay Area but about the political nature of the Bay Model itself. The model was conceived, built, and deployed to simulate flows and processes at a regional scale with an eye toward dredging and development, not the violence of pollution or hunger in segregated urban neighborhoods. It rendered invisible, for example, what Nathan Hare, head of the country's first ethnic studies department at San Francisco State, termed "Black Ecology," or the environmental interests of black and brown people in postwar American cities.[110] The model constructed a view from on high that precluded other ways of seeing, knowing, and addressing the socio-natural world, a political effect just as important as that which it allowed by rendering visible.

The Commission and the Plan

A central aim of regional modernists and environmentalists in the Bay Area was the creation of a metropolitan agency of governance. Between 1963 and 1969, they forged political alliances, battled an array of development interests, and embarked on a legislative campaign to protect the bay from ongoing degradation. To be sure, the process of establishing the San Francisco Bay Conservation and Development Commission (BCDC), the first truly metropolitan governing body in the region, was an over-determined one involving a plethora of individuals, interests, and political maneuvers. Nonetheless, the Bay Model and model studies – mobilized by the groups discussed above – laid the discursive and conceptual groundwork for the formation of legislation centered on environmental regulation and management. The formulation of the very nature of the San Francisco Bay Area generated on the Bay Model provided a condition of possibility for the formation of the BCDC as a novel type of regional authority. The story of efforts to save the bay, culminating with the BCDC and its Bay Plan, has been

[109] Letter from Kay Kerr to Congressman Burton, May 1, 1975. Carton 8: Folder 28. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[110] Nathan Hare, "Black Ecology," *The Black Scholar* 1, no. 6 (April 1970) 2.

told many times.[111] In what follows, I offer a brief historical outline of this political and legislative achievement.

The seeds of a permanent regional governing body were sewn with the somewhat inauspicious establishment of the Bay Conservation Study Commission (BCSC) in 1964. One of founders of Save the Bay, Kay Kerr, drawing on her network of elite contacts, convinced State Assembly member Nicholas Petris, himself an environmentalist, to introduce some sort of conservation legislation. When his bill failed, Kerr turned to a seemingly unlikely ally, State Senator Eugene McAteer, an old-guard politician not associated with environmental concerns. McAteer had clout with the governor and both houses of the legislature and took up the issue with gusto. According to Joe Bodovitz, the first Executive Director of the BCDC, the State Senator was an instrumental force in establishing a regulatory framework for governing bay development.[112] In an attempt to outflank developer opposition in the legislature, McAteer worked to secure "a little money for a study" and establish the nine-member Bay Study Commission.[113] The BCSC itself held a dozen hearings over the course of four months with an eye towards formulating a "comprehensive and enforceable plan for the conservation of the waters of the bay and the development of its shoreline."[114] It is worth noting here that a number of the early Bay Study Commission hearings were indeed held at the Bay Model, which literally served as the stage upon which political interventions and regulations could be contested.

In 1965, the McAteer-Petris Act, a co-sponsored bill that grew out of recommendations made by the Bay Study Commission, passed through the California legislature. The McAteer-Petris Act established the BCDC on a temporary, four-year basis and charged the new agency with developing a regulatory framework for environmental oversight and metropolitan growth. It also placed a *de facto* moratorium on bay fill and immediately halted a number of shoreline development projects.[115] In fact, the BCDC became a battleground for groups like Save the Bay, regional planners, corporate members of the BAC, and private development interests to struggle over the character of future permitting processes as well as the fate of the bay writ large. In an oral history conducted two decades after the initial birth of the BCDC, Bodovitz suggested that an important aspect of the agency was its composition: federal, state, and local officials all took a seat at the table in an effort to forge permitting guidelines that would provide a balance between the public good broadly defined in terms of communal health and recreational access and the rights of private property and land developers who could argue for the wider benefits of their respective projects. In his view, the strength and efficacy of the BCDC – unlike ABAG and other governance regional organizations –

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[111] Rice Odell, *The Saving of San Francisco Bay: A Report on Citizen Action and Regional Thinking* (Washington, D.C.: The Conservation Foundation, 1972); Gilliam, *Between the Devil and the Deep Blue Bay*; Walker, *Country in the City*, 114-116; Thibert, *Governing Urban Regions through Collaboration*, 110-122.

[112] Joseph E. Bodovitz, "Management and Policy Directions," an Oral History Conducted in 1984 by Malca Chall, *The San Francisco Bay Conservation and Development Commission, 1964-1973*, Regional Oral History Office, The Bancroft Library, University of California, Berkeley, 1986.

[113] Odell, *The Saving of San Francisco Bay,* 20.

[114] Odell, *The Saving of San Francisco Bay,* 23; Thibert, *Governing Urban Regions through Collaboration*, 112.

[115] Walker, *Country in the City*, 115.

resided precisely in its character as an agency able to reconcile multiple interests within a mixed rubric of conservation *and* development.[116] With this in mind, it's perhaps worth pointing out here that – by law – the Army Corps of Engineers, as both hitherto the only practical adjudicating authority in terms of bay development and the primary source of technical information about the operation of bay as a hydraulic system, was required to have representation on the commission.

Over the course of three years, the BCDC worked to develop an area-wide plan to simultaneously guide metropolitan growth and ensure the preservation of the bay. In an effort to do so, the commission heard from a variety of experts and produced a number of reports on everything from the different features of the bay as a natural resource to problems of bay-fill and development. According to Odell, as the BCDC formulated a comprehensive plan, it was guided by three distinct precepts: that the use of the bay should be premised on "substantial public benefit," that future development should involve minimal filling, and that "a single-purpose agency" should be formed with the power to regulate the "entire bay and shore as a unit."[117] In unprecedented and sweeping fashion, the San Francisco Bay Plan provided a regional approach to environmental regulation and metropolitan development that took public access and bay conservation as its fundamental principles.[118] The Bay Plan passed through the legislature and was signed into law by Governor Ronald Reagan in 1969, making the BCDC a permanent governing authority. Indeed, the BCDC continues to operate today as a regional regulatory agency, working "to protect and enhance San Francisco Bay and to encourage the Bay's responsible and productive use for this and future generations."[119]

For the journalist and environmentalist Harold Gilliam, the Bay Plan was "a Magna Carta for the bay – a declaration of the bay's right to live."[120] Moreover, in making the BCDC permanent, it represented the culmination of the various efforts undertaken by regional planners, policy advocates, and environmental activists to forge a governing authority at the metropolitan scale. It is indeed telling that questions of environment – the nature of the region as an interconnected system – offered the terrain upon which such a governing body was ultimately forged. Drawing in part on the hydraulic, sedimentation, salinity, and evaporation studies conducted by the Corps of Engineers on the Bay Model, the "few" were able to impart their vision for a greater regional authority to the "many" and gain legislative support for the BCDC. The Bay Model, it should be said, did not automatically lead to the establishment of a metropolitan governing body. But, in generating understandings about the bay as interconnected socio-natural system, it did help lay the conceptual and material groundwork necessary for its eventual emergence.

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[116] Bodovitz, "Management and Policy Directions," 7.
[117] Odell, *The Saving of San Francisco Bay,* 67.
[118] San Francisco Bay Conservation and Development Commission, *The San Francisco Bay Plan*. (Sacramento: San Francisco Bay Conservation and Development Commission, 1969). The Bay Plan can be viewed on the BCDC's website: <http://www.bcdc.ca.gov/plans/sfbay_plan.html> (Last accessed 20 November 2018).
[119] San Francisco Bay Conservation and Development Commission website: <http://www.bcdc.ca.gov/> (Last accessed 20 November 2018).
[120] Odell, *The Saving of San Francisco Bay,* 65.

Economizing the System

In a 1973 essay (and 1974 rejoinder to criticisms) that the geographer Morgan Robertson claims "must be considered an ur-text of political ecology," Richard Walker argued that competing measures and definitions of the *value* of wetlands not only proved a recurrent theme in political ecology but contributed to an ongoing ambiguity over and mystification of the character of ecological processes in scientific and environmentalist circles.[121] This insight points to the fact that contests over the valuation of the San Francisco Bay accompanied efforts to model and regulate it. Indeed, throughout the campaign to Save the Bay and constitute the BCDC – processes that had the effect of fixing the socio-natural region as an object of sustained governmental concern – the value of the bay as an interconnected system serving various purposes and ends emerged as a rallying cry for preservationists, conservationists, ecologists, and developers alike.

A contested, slippery, and normatively deployed term, "value" lay at the heart of debates over both the character of the bay and the formation of some kind of regional oversight authority. To be sure, from the start of the Army Corps of Engineers' efforts to model the bay and simulate its processes through the establishment of the BCDC to that agency's continued efforts at environmental governance, the value of the bay in terms of its importance and commercial worth as private property and infrastructure remained of central concern. Still, in public discourse, notions about the health, recreational, aesthetic, and commercial values of the bay were met by novel ideas about the ecological and biological productivity of so-called natural services. The economy of the bay as an interconnected set of socio-natural flows and processes emerged as the animating framework for political actors in the Bay Area to address. And while this "economy" (itself a term used under different conventional pretexts) was often mobilized strategically in activist and governmental circles to check rampant development and the reclamation of submerged lands, it also provided a conceptual frame through which current market-based forms of environmental governance continue to be pursued today. I explore below the ways in which value has been – and continues to be – assigned to the bay in terms of its defined character as: property and infrastructure, a productive biological and estuarial system, and a set of ecosystem services amenable to economization and, potentially, marketization.[122] The staging and performance of the bay system at the Bay Model as well as the dissemination of simulation results no doubt shaped constructions of value that inflected approaches to governing to the bay.

At least since the imperialist annexation of Alta California by the United States following the Mexican-American War, the value of the bay – perhaps unsurprisingly – had been framed in economic terms as property and commercial infrastructure. "Legally

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[121] Richard A. Walker, "Wetlands Preservation and Management on Chesapeake Bay: The Role of Science in Natural Resource Policy," *Coastal Management* 1, no. 1 (1973) 75-101; Richard A. Walker, "Wetlands Preservation and Management: A Rejoinder – Economics, Science and Beyond," *Coastal Management* 1, no. 2 (1974) 227-233; Morgan Robertson, "Measurement and Alienation: Making a world of Ecosystem Services," *Transaction of the Institute of British Geographers* 37, no. 3 (2012) 386-401. Quote, 390.

[122] On use- versus exchange-value, see: Karl Marx, *Capital: A Critique of Political Economy, Volume One*, trans. Ben Fowkes (London: Penguin Books, 1990) Chapter 1. On economization, see: Koray Caliskan and Michel Callon, "Economization, Part I," *Economy and Society* 38 no. 3 (2009) 369-398 and Wendy Brown, *Undoing the Demos: Neoliberalism's Stealth Revolution.* (New York: Zone Books, 2015) 31.

speaking," Mel Scott suggested in his 1963 report, "the bay is a very large amount of real estate, or rather the tidelands along its shores and the drowned valleys beneath its waters have long been treated as real estate in countless statutes and thousands of conveyances."[123] Indeed, the piecemeal (and sometimes wholesale) development of tidelands along the bay's shoreline led to the organization of activist groups like Save the Bay and ultimately the formation of the BCDC. In their political efforts to contest the authority of the bay's sole valuation as private property, environmental activists and regional planners – through the creation of a governing body to regulate development – were able to at least partially transform the "Divided Bay" into a kind of "watery commons."[124]

Nevertheless, a related notion regarding the value of the bay as the infrastructural facilitator of capital accumulation continued to inform approaches to governing the region. That is, emphasis on the importance of the bay as a means of transportation girding industrial production, commercial expansion, and metropolitan wellbeing persisted throughout the postwar decades. Even earlier than Reber's initial scheme to dam the bay, the bay's character as a commercial transportation corridor emerged as a central planning concern.[125] From the very beginning of the Corps effort to build a model and simulate tidal and sedimentation patterns in the bay, for instance, a major concern was making sure that port capacity and deep-draft shipping channels in the bay were up to par on behalf of commercial needs.[126] A decade and a half after the Army Engineers released its preliminary survey findings, in a report to the BCDC, Colonel Frank Boerger of the Corps reiterated similar and longstanding concerns over "waterborne commerce" and its relationship "to industry and economic growth" in the Bay Area. He urged BCDC members and the public to support efforts to "accommodate larger sized cargo ships" traveling into the Bay Area via dredging and port development proposals or else risk the dislocation of "industry."[127] The commission, of course, acquiesced. Calling into question the value of the bay as commercial infrastructure, it seems, was – and no doubt continues to be – simply out of bounds.

Still, working with and through the BCDC over the course of its initial interim status, regionalists and environmental activists successfully countered the strictly utilitarian valuation of the bay as property and infrastructure. Indeed, by the 1970s, a new age of "environmental values" had dawned. Not simply a bundle of real estate parcels or a watery freeway for the transportation of industrial goods, the San Francisco Bay, according to the BCDC's manifesto, was "an irreplaceable gift of nature" which provided "great opportunities for recreation," offered "scenic enjoyment," and "in countless other ways" helped "to enrich man's life."[128] In pushing for bay policies that would produce

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[123] Scott, *The Future of the San Francisco Bay,* 1.
[124] Ibid; Walker, *Country in the City*, 111.
[125] San Francisco District Office, "Army Corps of Engineers Report, Preliminary Bay Study," August 12, 1953. Folder: US Army Corps of Engineers, 1953-1960. Box 24: Publications – Government and Other. Reber Papers, RG 77, NARA.
[126] Colonel John Harnett, "The San Francisco Bay Study and Future Developments," March 7, 1958. Folder: U.S. Army Corps of Engineers, 1953-1960. Box: 24: Publications – Government and Other. Reber Papers, RG 77, NARA.
[127] "Remarks by Colonel Frank C. Boerger before the Bay Conservation and Development Commission, December 5, 1968," Carton 9: Folder 6. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[128] San Francisco Bay Conservation and Development Commission, *The San Francisco Bay Plan.*

the "greatest public benefit," groups like Save the Bay didn't eschew older economic valuations altogether.[129] Instead, they sought to incorporate other normative assessments within a characterization of the bay as "a natural resource of scenic, recreational, ad economic value."[130] Their efforts paid off in the form of an enforceable area-wide plan and the establishment of an environmental governing agency at the regional scale. As the historian Philip Dreyfus suggests, the BCDC's attention to questions of aesthetic beauty, pollution and public health, recreational access, and the protection of non-human species "was a far cry from the narrowly economic utilitarianism of the preceding decades."[131]

In addition to promulgating the aesthetic and recreational values of the bay, activists and BCDC members alike forged an assessment of it as a source of value itself. That is, they highlighted the "productivity" of the bay-estuary as a complex and interconnected system of ecological processes and natural services. As a fertile cradle of biological and ecological diversity, the San Francisco Bay and Estuary had long been recognized as a rich site for a variety of resources: minerals, estuarine fish, shellfish, and waterfowl among others.[132] But over the course of the 1960s and 1970s, another version of the bay's ecological productivity emerged. More than just resources, the bay-estuary, as a system of flows and processes, produced environmental services. Wetlands and tidal flow flushed pollution, for example, while bay waters moderated climate and air quality. The natural environment itself thus became the solution to problems plaguing urban society. In 1971, William Siri, one-time president of Save the Bay, provided a glimpse of how this formulation of productivity could be folded into other assessments of the bay's value. "The bay is a natural resource of great economic value as a body of water," he wrote in a letter to General Clark of the Corps, "of tremendous ecologic significance as a source of oxygen and as an equalizing element to preserve the climate; of open space used to dilute the air pollutants from a congested population and industrial area; and as an aesthetic treasure enjoyed by those who live in the Bay Area as well as the thousands who visit annually."[133] Two years prior, the Bay Plan codified into law the notion that the bay "moderates climate," "combats air pollution," and works to "flush wastes" among other services.[134] By drawing on scientific studies in ecology and biology as well as notions of the bay-estuary as a complex natural system, those planners, policy makers, and environmental activists working through the BCDC brought the productivity of the bay as a set of services rather than simply a hearth of resources into view.

It is not without irony, then, that a conception of the estuarine environment taken up during the postwar years by environmentalists seeking to check the hegemony of utilitarian economic values has come to serve today as a framework for ongoing market valuations of the bay. But that is precisely the case. By the 1990s, mitigation banking, or the creation of markets in "offset" credits (through the establishment of so-called mitigation "banks" such as marshlands and forests in other locales) to compensate for the

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[129] Sylvia McLaughlin to Robert Allen, December 9, 1964. Carton 9: Folder 3. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[130] Membership Newsletter, May 25, 1965. Carton 2: Folder 19. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[131] Dreyfus, *Our Better Nature*, 175.
[132] Scott, *The Future of San Francisco Bay*, 41-52; Walker, *The Country in the City*, 110-114.
[133] William Siri to General Clark, 1971. Carton 2: Folder 25. SSFBA Records, BANC MSS 87/29, Bancroft Library, Berkeley.
[134] San Francisco Bay Conservation and Development Commission, *The San Francisco Bay Plan.*

detrimental effects of development projects on "ecosystem services," emerged as a mechanism of environmental management and governance.[135] In 2002, the BCDC adopted particular "compensatory mitigation" practices and valuations as acceptable regulatory techniques. "Mitigation banks," the commission proclaimed,

> may be established by individuals who anticipate needing to mitigate for future impacts, or by third parties who develop banks as a commercial venture to sell credits to permittees needing to provide compensatory mitigation. Among other benefits, mitigation banks provide the unique opportunity to address the cumulative effects of small fill projects that are too small to be mitigated individually. Provided mechanisms are in place to assure success, mitigation banking can provide a timely, convenient, cost effective and ecologically successful mitigation option.[136]

That is, according to the BCDC, the quantitative economic valuation of qualitative ecological processes in the bay-estuary offers a means by which to secure and potentially optimize the ecological services that characterize the Bay Area as a socio-natural system. As an article linked to on the BCDC website from *Forbes* claims, "the success of this [mitigation banking] model in wetlands restoration is a prime example of the role government policy can play in catalyzing private capital markets to meet environmental and social challenges. With government funding becoming more constrained, and limited philanthropic capital available, private capital is key to large-scale environmental protection and restoration."[137] Here, finance capital provides a key mechanism to secure the optimization of the Bay Metropolis as a system of natural services. In 1963, Mel Scott asked (and answered) a politically powerful, albeit rhetorical, question: "Who owns the bay?" Today, following Scott's lead, it might be apt to pose an updated set of questions: How is the bay economically valued as a system of ecological services? Who gets to determine those values and to what end? And, perhaps most fittingly given the discussion above, is it worth it?

Neither the modeling of the bay as an interconnected natural system nor formulations about the bay's ecological productivity inevitably led to its economic valuation as a set of "ecosystem services." In the 1980s, as market rationalities started to infiltrate the halls and laboratories of environmental governance and science, novel technical practices of measuring, defining, and marketing "nature" as bundles of service and financial commodities began to underwrite "a transformation of the social world through creation of value-bearing abstractions of physical processes."[138] Yet, this social transformation did not occur in an historical vacuum. And that's the point. The ongoing project to model the bay – along with the dissemination of understandings about its character as a "complex estuarine system" generated on the model – constituted the stage

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[135] Morgan Robertson, "The Neoliberalization of Ecosystem Services: Wetland Mitigation Banking and Problems in Environmental Governance," *Geoforum* 35 (2004) 361-373.
[136] San Francisco Bay Conservation and Development Commission, *The San Francisco Bay Plan,* Mitigation, Section H. <http://www.bcdc.ca.gov/plans/sfbay_plan#35> (last accessed 20 November 2018).
[137] Logan Yonavjak, "How Private Capital is Restoring U.S. Wetlands," *Forbes*, April 24, 2014.
[138] Robertson, *Measurement and Alienation*, 387.

upon which market metrics and mechanisms eventually took hold.[139] The Bay Model, in other words, helped to construct the conceptual and material grounds that we stand on in the Bay Area today.

The Angel of History at Richardson Bay



Figure 9: Debris collection dock at the Corps' operation base yard in Sausalito. **Source:** Author's Photo.

In this chapter, I traced the historical emergence and formation of the Bay Area as a contemporary "problem-space" of government. To do so, I explored the construction and impact of a single engineering and planning tool: The Army Corps of Engineers' San Francisco Bay-Delta Hydraulic Model. In the first section, I situated the impulse to build the Bay Model in the first place within the context of both local planning and development conditions and broader conceptual and technical innovations in hydraulic modeling. In the second section, I tracked the construction, material verification, and technical use of the model as a simulation tool between the early 1950s and the Corps' publication of study findings in 1963. Rather than an act of merely re-presenting an already existing feature of the metropolitan world, I suggested, modeling the bay required material and iterative practices of measurement, inscription, and intervention – including

[139] U.S. Army Corps of Engineers, San Francisco District, *San Francisco Bay-Delta Tidal Hydraulic Model User's Manual* (Washington, D.C.: Government Printing Office, 1993).

the establishment of a technical infrastructure and the release of radioactive isotopes – that collectively worked upon and remade that world. Moreover, the publication and dissemination of data generated through simulation studies run on the model produced a widespread understanding about the character of the bay as an interconnected system of flows and processes. In the third section, I examined the way in which this technical understanding was taken up by regional planners, business elites, and environmental activists to make bids in the popular and political spheres. A conceptualization of the bay as a complex natural system underwrote successful efforts to forge the Bay Area's first truly regional authoritative body of government. Yet, in tandem with emergent notions regarding the productivity of ecological processes, it also offered a stage for market-based valuations of the bay as a set of ecosystem services to proliferate. In the end, I have argued that the socio-natural world we inhabit in the Bay Area was achieved in part through techno-political efforts to know, model, and govern it.

In conclusion, let us reflect on the Bay Model as it stands today. Despite the new layers of paint, the framing devices, and the addition of an observation deck designed to render the structure legible, visiting the model can still leave one feeling overwhelmed. It is not uncommon to spot marauding bands of children and their adult counterparts hurry past exhibits on natural history and WWII-era shipbuilding only to lose themselves within the abstract maze of concrete bays and sculpted channels. While the model's size, shape, and distorted scale combine to produce a sense of disorientation, its character as a relic or technological artifact of some bygone era bolsters this impression. It's almost as though the model – a mere stone's throw from the global epicenter of 'disruptive innovation' – got swept up in the storm of "progress" and dumped on shores of Richardson Bay in Sausalito.[140] The un-timeliness of the model is hard to escape. After all, upon stepping out of the warehouse, one of the first things to confront visitors is a heaping mountain of wreckage. The Corps continues to run its "floating debris hazard collection" operations out of the Sausalito Base Yard, and it regularly deploys patrols to search for driftwood, sunken vessels, and rotting piers that might hinder navigation. Around ninety tons of detritus is pulled from the bay each month and loaded onto a dock in front of the Bay Model [Figure 9]. There it sits, waiting to be trucked offsite for disposal. For the San Francisco District of the Army Corps of Engineers, progress literally entails the piling up of debris.

[140] This refers to Walter Benjamin's invocation of the Klee painting "Angelus Novus" in his "Theses on the Philosophy of History": "This is how one pictures the angel of history. His face is turned toward the past. Where we perceive a chain of events, he sees one single catastrophe which keeps piling wreckage upon wreckage and hurls it in front of his feet. The angel would like to stay, awaken the dead, and make whole what has been smashed. But a storm is blowing from Paradise; it has got caught in his wings with such violence that the angel can no longer close them. This storm irresistibly propels him into the future to which his back is turned, while the pile of debris before him grows skyward. This storm is what we call progress." In Walter Benjamin, *Illuminations: Essays and Reflections*, trans. Harry Zohn (New York: Schocken Books, 1969) 257-258.

Chapter 3:

Simulating Renewal



Figure 10: A demolished block along Geary Boulevard in San Francisco, Western Addition's A-2 Redevelopment Zone. **Source:** Found SF.

> *We do not live in cybernetic societies, but in societies that are increasingly understood and governed by means of a kind of cybernetic style of thought.*[1]
>
> -Thomas Osborne and Nikolas Rose

> *The notion that government needs to be more entrepreneurial is not new. But what* is *new is the arrival of technologies that will make this transition easier than at any time in history.*[2]
>
> -Gavin Newsom and Lisa Dickey

[1] Thomas Osborne and Nikolas Rose, "Governing Cities: Notes on the Spatialisation of Virtue," *Environment and Planning D: Society and Space* 17:7 (1999) p. 750.
[2] Gavin Newsom and Lisa Dickey, *Citizenville: How to Take the Town Square Digital and Reinvent Government* (New York: Penguin, 2013) p. xxii.

The train runs late. And so do I. Hurrying past a station busker who I've seen a hundred mornings over, I check the time on my phone. Three minutes. Thirteen. Thirty. New messages. I fumble through my wallet and find the transit card tucked behind a credit card next to a folded up piece of paper. I tag into the system.

Gallop, plop, gallop. Gallop down the stairs.

The conductor says go. I smell the morning showers and all of last night's piss on the floor. A throng of workers, draped in linen and polyester and denim and wool, hurtle through space while swiping phone screens. I glance up from mine and survey the walls of the train.

Degrees for working adults! You're exceptional, right?

At the other end, I take my place among the wave as it spills out of the car and onto the platform. Alone together, we make our way to the exit. We surge with other waves and pass posted advertisements. MBAs on a budget! Part time gigs! Drone delivery services! One in the distance catches my eye.

If you are
struggling emotionally
or thinking of suicide
call

1-800-273-TALK

Free and confidential

Governing Cities as Systems of Information

In a 1968 speech given before an audience at the Smithsonian Institution, then Vice President Hubert Humphrey argued for the need to bring specific technical innovations to the government of metropolitan life in the United States.[3] "The techniques that are going to put a man on the Moon," Humphrey argued, "are going to be exactly the techniques that we are going to need to clean up our cities." His appeal to apply space-age technologies and military forms of analysis to "urban problems" continued in no

[3] A version of this chapter has been published as: John W Elrick, "Simulating Renewal: Postwar Technopolitics and Technological Urbanism," *Environment and Planning D: Society and Space* (2020).

uncertain terms: "[T]he management techniques that are involved, the coordination of government and business, of scientist and engineer…the systems analysis that we have used in our space and aeronautics program – this is the approach that the modern city of America is going to need if it's going to become a livable social institution."[4] By the time Humphrey offered his remarks, a faith in the ability of wartime command-and-control technologies and techniques to help alleviate those social, political, and economic "ills" associated with urban life had hardened among city planners, governmental officials, and urban administrators.

Today, some fifty years later, the mobilization of computational techniques and infrastructures to facilitate the governing of cities continues to captivate urban professionals, entrepreneurs, and officials alike. In recent years, a growing preoccupation over the intertwined effects of global urbanization and climate change has spurred both the development of a "new science of cities" in academic circles and the deployment of "ubiquitous computing technologies" on the ground to better understand and manage cities as complex systems amenable to optimization.[5] Within this context, the figure of the "resilient" and "smart" city has emerged in development and policy discourse as a solution to any number of socio-ecological problems at a variety of scales.[6] A slew of initiatives – animated by the techno-libertarian ideology of Silicon Valley – have been proposed across the United States and beyond. Alphabet (Google's parent company), Cisco (the largest hardware manufacturer in the Bay Area), IBM (one of the oldest and most politically connected information technology corporations in the U.S.), and other tech businesses, along with municipal agencies and "good government" groups, continue to promote the vision of a fully networked city, one complete with real-time data sensors, unlimited broadband capacity, interactive media facades, and driverless cars. At root, such an urban vision is premised on a singular question: "What if the people who build circuits and social networks could build cities, too?" For some entrepreneurial designers and programmers – supported by their allies in municipal departments of planning and economic development – the promise of "new places, designed from scratch and freed from broken policies," seem to provide the ultimate answer.[7]

While specific smart city initiatives have been critiqued as utopian schemes or strategies to attract corporate investment, other investigations have shown how the techniques and technologies girding smart urbanism promote particular forms of calculation and normative types of behavior.[8] Whether city-wide development projects

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[4] Agatha Hughes and Thomas Hughes, eds., *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After* (MIT Press, 2000) p. 16.

[5] Michael Batty, *The New Science of Cities* (MIT Press, 2013); Anthony Townsend, "Cities of Data: Examining the New Urban Science," *Public Culture* 27:2 76 (2015) pp. 201-212; Stephen Graham, "Software-sorted Geographies," *Progress in Human Geography* 29:5 (2005) pp. 562-580; Rob Kitchin and Martin Dodge, *Code/Space: Software and Everyday Life* (MIT Press, 2011); Shannon Mattern, "Interfacing Urban Intelligence," *Code and the City* (London: Routledge, 2016) pp. 49-60;

[6] Jeremy Walker and Melinda Cooper, "Genealogies of Resilience: From Systems Ecology to the Political Economy of Crisis Adaptation," *Security Dialogue* 42:2 (2011) pp. 143-160; Adam Greenfield, *Against the Smart City (The City is Here for You to Use)* (Amazon Digital Services, 2013).

[7] Emily Badger, "Tech Envisions the Ultimate Start-Up: An Entire City," *New York Times*, February 24, 2018.

[8] Orit Halpern, Jesse LeCavalier, Nerea Calvillo, and Wolfgang Pietsch, "Test-bed Urbanism," *Public Culture* 25:2 (2013) pp. 272-306; Alan Wiig, "IBM's Smart City as Techno-utopian Policy Mobility," *City* 19:2-3 (2015) pp. 258-273; Francisco Klauser, "Through Foucault to a Political Geography of Mediation in

envisioned by tech behemoths or street-level "civic innovation" experiments driven by individual entrepreneurs in conjunction with municipal agencies, such initiatives no doubt cast light on the ideological predilections of the planning profession as well as the accumulation strategies of information technology companies. But they also point to a related yet fundamentally distinct phenomenon: the emergence of a historically novel mode of urban government – understood as a governing rationality or framework for conduct – premised on binding virtually all forms of subjectivity and activity to market logics.[9] This is the phenomenon that I intend to interrogate – through an exploration of its historical preconditions – in this chapter.

Two interrelated planks support his governmental stage: On the one hand, contemporary approaches to urban governance broadly draw upon a fundamental characterization of cities as adaptive systems of information signals and socio-ecological processes. On the other, processes of information feedback are understood to serve as the primary mechanisms regulating the behavior of the system. One recent attempt to reduce carbon emissions in San Francisco via environmental sensors and real-time data feeds, for instance, is that city dwellers will encounter themselves represented on the street as units of emission within a totality of emissions and respond accordingly to optimize the "metabolism" of the city as a whole.[10] Though offering a paradigmatic example of the way in which environments of information feedback have been constructed to regulate conduct, this prototype is by no means the only one. From utility meters and transportation apps to "smart" monitoring instruments and interactive media displays, technical infrastructures and devices – bound up with normative notions regarding market entrepreneurialism and "disruptive innovation" – have become novel sites of governance.[11]

When did this formulation of the city as a system of communication and surveillance emerge? How did it take hold in governmental and policy circles as an object to manage? And what political insights for the present might an excavation of its historical formation offer? This chapter works to trace the emergence and dissemination of the concept of the city as a complex, stochastic system of information feedback to practical efforts by planners and technical consultants in the decades following World War II. During the 1950s and early 1960s, urban experts attempted to respond to the

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the Information Age," *Geographica Helvetica* 68:2 (2013) pp. 95-104; Jennifer Gabrys, "Programming Environments: Environmentality and Citizen Sensing in the Smart City," *Environment and Planning D: Society and Space* 32:1 (2014) pp. 30-48; Reinhold Martin, *The Urban Apparatus: Mediapolitics and the City* (Minneapolis: University of Minnesota Press, 2016).

[9] On the market logics that imbue this framework of urban rule, particularly the imperative to constitute urban subjects as bits of human capital under the rubric of "civic innovation" in the Bay Area, see Chapter 4 of this dissertation.

[10] John Elrick, "Visionary Politics: Technologies of Government in the Capital of Innovation," *Society and Natural Resources* 30:7 (2017) pp. 860-876; Kriston Capps, "Letter from San Francisco: A Living Innovation Zone by Gehl Architects and Exploratorium," *Architect: The Journal of the American Institute of Architects.* March 8, 2014.

[11] Shannon Mattern, "Mission Control: A History of the Urban Dashboard," *Places Journal* (March 2015); Anthony Townsend, *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia* (New York: WW Norton, 2013); Lisa Gitelman, ed., *"Raw Data" is an Oxymoron* (MIT Press, 2013). On the way in which technologies of information feedback animated governmental visions beyond the imperial and capitalist context of the United States, see: Eden Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile* (MIT Press, 2011).

cumulative social, political, and economic effects of both local and federal housing policies and real estate practices, long premised on the racist and racializing discourses of white supremacy, by imbibing analytical techniques and computational technologies originally developed for the military. In so doing, I suggest, they helped forge the grounds upon which contemporary modes of urban government rest.

To make this broader argument, I focus on an early effort to simulate the housing market. The Community Renewal Program (CRP), an experimental project established by the federal government in response to the piece-meal character of urban renewal efforts as well as the socio-political unrest and rebellion that accompanied them, sought to promote comprehensive urban planning and development in cities across the country. If municipal governments were willing to imbibe the precepts of this new approach to governmental forecasting and redevelopment, CRP administrators advertised, the precursor to the Department of Housing and Urban Development (HUD) would offer matching grants to help fund the technical and bureaucratic aspects of a new renewal project.[12] In San Francisco, the first city along with Pittsburgh, Pennsylvania to apply to the program, Community Renewal Programming involved the establishment of institutional partnerships among municipal planners, administrators, and consultants in an effort to build a mathematical simulation model capable of iteratively predicting the impact of potential renewal interventions. Throughout the first half of the 1960s, the city's planning department, in concert with technicians from the Arthur D. Little, Inc. engineering consultation firm, attempted to develop a computer database and run urban renewal simulations premised on dozens of socio-economic variables and dynamic scenarios of supply and demand.[13] Though the CRP ultimately failed to provide an ongoing tool with which to guide questions of governance in San Francisco – stymied by a lack of computing power, uncertain standards regarding quality-of-life measures, and, ultimately, inadequate access to information about the state of socio-economic behavior in the city – it nonetheless had long-lasting effects. The most important of which, according to one official retrospective, was how the program introduced ways of seeing "the safety and happiness of the people who live in cities" as dependent not just on "physical structures" but on "the performance of economic and social systems as a whole."[14]

The rest of this chapter is organized into three main parts. In the first section, I situate the federal impulse to create the Community Renewal Program within the historical context of both the raced and classed excesses of twentieth-century housing policy as well as the development of military technologies and techniques of control. Then, in the second, I explore in detail the efforts of municipal planners and operations researchers in San Francisco to devise and build the simulation model as a governmental

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[12] For an important and influential account of the history and politics of suburbanization, see: Kenneth Jackson, *Crabgrass Frontier: The Suburbanization of the United States* (Oxford University Press, 1985).
[13] Jennifer Light, *From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America* (Johns Hopkins University Press, 2003); Garry Brewer, *Politicians, Bureaucrats, and the Consultant: A Critique of Urban Problem Solving* (New York: Basic Books, 1973); Andreas Faludi, ed., *A Reader in Planning Theory* (New York: Pergamon, 1973); Robert Lilienfeld, *The Rise of Systems Theory: An Ideological Analysis* (New York: John Wiley and Sons, 1978).
[14] *Design Requirements for the Data and Systems Support Essential to an Urban Blight Systems Analysis: A Report* (Los Angeles, CA: Community Analysis Bureau, 1970). Quoted in Light*, From Warfare to Welfare*, p. 57.

tool. In the third section, I trace how expert appraisals of the model's deficiencies actually served to cement the characterization of the city as a system of market signals. To conclude, I highlight the ways in which the techniques associated with contemporary modes of urban governance in places like the Bay Area address the difficulties identified by those initial supporters of the CRP's simulation efforts, though in updated terms and toward different ends.

Renewal: Race, Real Estate, and the Machinery of War

In this section, I put the Community Renewal Program as well as the attendant rise of computer simulation as a viable tool of urban planning into historical context. In doing so, I argue that two broad historical dynamics underwrote the turn towards forecasting as a means of government. First, I sketch out how new technical approaches to the administration of cities grew out of a heightened concern over the socio-political effects of racist New Deal housing policies and urban redevelopment projects initiated by the federal government in the postwar years. This is well-trod territory in the academic literature on U.S. cities. Less emphasized, however, is the way in which such policies and projects were historically enabled in part by the introduction of race, as a quantifiable category, into technical forms of economic valuation through earlier market practices and the formation of land economics as an academic discipline. That is, the re-articulation of race and real estate during the early twentieth century – in the realms of market practice, academic discourse, and governmental policy – forged the historical context within which novel models of urban governance emerged. Second, I suggest that wartime efforts to develop military technologies and techniques also sponsored novel ways of seeing and governing cities as complex socio-technological situations. As growing social and political strife continued to erupt in U.S. cities during the 1950s and 1960s, local and federal officials turned to computational technologies and cybernetic frames of analysis developed by defense intellectuals and operations researchers to address what was increasingly being discussed as problems of National Defense: "blight" and the urban population itself.

As an effort to sponsor economic development in US cities, the CRP was established at the height of the federal government's now-infamous support for urban renewal during the 1950s and 1960s. Postwar processes of suburbanization, coupled with a declining tax-base in central cities and the socio-economic effects of so-called urban decay, led a variegated cohort of federal officials, local administrators, and real estate interests to push for the wholesale rebuilding of entire neighborhoods in an effort to induce capital investment and raise property values at the urban core.[15] Across the country, a plethora of municipal agencies and booster coalitions established local

[15] For an explicit discussion of uneven development as the product of economic logics within the domain of urban real estate, see: Neil Smith, *Uneven Development: Nature, Capital, and the Production of Space* (University of Georgia Press, 2010). A more historically nuanced and geographically specific account of uneven metropolitan development as a set of political dynamics – especially in terms of the racial character of housing in the San Francisco Bay Area – can be gleaned from Robert Self, *American Babylon: Race and the Struggle for Postwar Oakland* (Princeton University Press, 2005).

redevelopment agencies under the auspices of the Housing Act of 1949.[16] Particular redevelopment projects were legally required to address "blight," a loaded term mobilized in a variety of ways by agencies and boosters to justify governmental intervention in urban space. By and large, individual renewal projects across U.S. cities were pursued to remove and remake working-class neighborhoods and communities of color. Indeed, under the autocratic leadership of M. Justin Herman, the Redevelopment Agency in San Francisco embarked on a series of initiatives to do just that: the Golden Gateway project razed a long-standing produce market on the Embarcadero; the South of Market project transformed an area largely composed of Single Room Occupancy hotels and gay leather bars; and, in the Fillmore/Western Addition, then home to mostly African American and Japanese residents, the agency targeted two huge swaths for redevelopment.[17] The raced and classed character of those renewal-related displacements scarred the city and its future in fundamental ways.

In the Bay Area and beyond, socio-physical conditions in the city – as well as the postwar notion that top-down deployments of what Martin Anderson termed the "federal bulldozer" might alleviate that condition – were neither inevitable nor natural.[18] Instead, they were produced over the previous half century through a combination of explicitly racialized market practices, the attendant rise of an empirical science of real estate economics, and the eventual uptake of those analytical frames within federal housing policy circles during the New Deal and postwar years. No doubt, in a country founded in part on class power, white supremacy, and racialized slavery, discourses and practices premised on intersecting hierarchies of race, gender, and class have shaped social and physical landscapes in urban space from the nation's very beginnings.[19] Still, at least in reference to the federal renewal program unleashed in the 1950s, a set of distinct historical precursors can be traced to particular developments in the early twentieth century. Moreover, while these particular historical developments unfolded in cities across the nation, Chicago, as a nineteenth-century archetype of urban modernity in an

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[16] Alexander Von Hoffman, "A Study in Contradictions: The Origins and Legacy of the Housing Act of 1949," *Housing Policy Debate* 11:2 (2000) pp. 299-326.

[17] Chester Hartman and Sarah Carnochan, *City for Sale: The Transformation of San Francisco* (University of California Press, 2002); John Mollenkopf, *The Contested City* (Princeton University Press, 1983); Rachel Brahinsky, "'Hush Puppies,' Communalist Politics, and Demolition Governance: The Rise and Fall of the Black Fillmore," in Chris Carlsson, ed., *Ten Years that Shook the City: San Francisco, 1968-1978* (San Francisco: City Lights Books, 2011).

[18] Martin Anderson, *The Federal Bulldozer: A Critical Analysis of Urban Renewal, 1949-1962* (MIT Press, 1964). The influential mathematician and systems scientist Thomas Schelling, a graduate of both UC Berkeley and Harvard, formulated a widely referenced model that purported to prove that racial segregation in the postwar housing market was not the product of racism but rather the natural sorting out of racial communities. That is, he suggested that his model, supposedly devised on a napkin during a flight he took to Boston from Oakland, showed how spatial inequalities along the lines of race were natural and cumulative effects of individual preferences rather than the outcome of institutional racism. For the model itself, see Thomas Schelling, "Dynamic Models of Segregation," *Journal of Mathematical Sociology* 1:2 (1971) pp. 143-186.

[19] Ira Berlin, *Many Thousands Gone: The First Two Centuries of Slavery in North America* (Harvard University Press, 2009); Eva Sheppard Wolf, *Race and Liberty in the New Nation: Emancipation in Virginia from the Revolution to Nat Turner's Rebellion* (Louisiana State University Press, 2006); Anne McClintock, "'No Longer a Future Heaven': Gender, Race, and Nationalism," *Cultural Politics* 11 (1997) pp. 89-112; Simone Browne, *Dark Matters: On the Surveillance of Blackness* (Duke University Press, 2015).

expanding and industrializing America, emerges as a geographically, politically, and intellectually crucial point of departure from which to trace the "origins" of federal housing policy as it became institutionalized after World War II.[20] To understand the social conditions and governmental approaches underwriting urban redevelopment and the Community Renewal Program in San Francisco, it is necessary to map the trajectory of the modern American metropolis as a collection of socially differentiated market practices, intellectual discourses, and policy responses to the vagaries of urbanization.

The socio-technical seeds of urban renewal as a postwar project of governmental intervention began to be sown at the turn of the century, during the Jim Crow era, when black people resisted white supremacist violence *en masse* by migrating from southern enclaves to northern and western cities.[21] Upon encountering a burgeoning urban modernity in industrializing American places, black residents experienced both entrenched racism and *de facto* forms of racial segregation premised on nefarious market practices. Blockbusting, a market strategy of preying upon "white fears and black aspirations" to make a killing, proved to be a particularly potent force in producing racial segregation.[22] Real estate agents and speculators would encourage and sometimes even sponsor black families to move into a predominantly white neighborhood; they then warned surrounding white households that property values would tank because of the presence of their new neighbors before offering to buy them out with increasingly low offers; the agents flipped newly acquired homes, selling them to black families at inflated prices and setting off new rounds of fear among white property holders of declining values. Over the course of a few years if not months, entire neighborhoods would segregate along racial lines. As these processes unfolded, white homeowners organized "neighborhood improvement clubs" across the city to agitate for legal segregation as a regulatory means to protect property values as a "public" good. In something like a positive – albeit vicious – feedback loop, perceptions of property devaluation among large-scale property owners led to disinvestment in nonwhite communities and thus spurred further stages of devaluation.[23] The introduction of race into forms of economic valuation through real estate practices like blockbusting proved devastatingly central to the future of life within American cities.

While industrial cities across the country witnessed the hardening of residential segregation along racial lines during the first few decades of the twentieth century, perhaps no other city exemplified that process as boldly and violently as Chicago. Indeed, for the analytical purposes of this section, that city served as an important hearth for the emergence of the urban-based social sciences – a development, needless to say, that

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[20] William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991); Miriam Levine, Sophie Forgan, Martina Hessler, Robert Kargon, and Morris Low, *Urban Modernity: Cultural Innovation in the Second Industrial Revolution* (MIT Press, 2010).

[21] C. Vann Woodward, *The Strange Career of Jim Crow* (Oxford University Press, 2002 [1955]); Allan H. Spear, *Black Chicago: The Making of a Negro Ghetto, 1890-1920* (Chicago: The University of Chicago Press, 1967).

[22] Margaret Garb, "Drawing the 'Color Line': Race and Real Estate in Early Twentieth-Century Chicago," *Journal of Urban History* 32:5 (July 2006) p. 778.

[23] Ibid; Spear, *Black Chicago,* pp. 20-26; Sherry Lamb Schirmer, *A City Divided: The Racial Landscape of Kansas City, 1900-1960* (Columbia: University of Missouri Press, 2002) p. 42-43; William M. Tuttle, *Race Riot: Chicago in the Red Summer of 1919* (New York: Athenaeum, 1985); James R. Grossman, *Land of Hope: Chicago, Black Southerners, and the Great Migration* (Chicago: The University of Chicago Press, 1989).

reverberated beyond Chicago itself. Just as the city provided a field upon which the so-called Chicago School of urban sociology drew its inspiration, so too did it offer a 'laboratory' within which to pursue 'empirical' studies of real estate processes at the community scale in the burgeoning field of land economics.[24] A group of influential economists and reform advocates, headed by Richard T. Ely of the Institute for Research in Land Economics and Public Utilities at the University of Wisconsin and later Northwestern University, conducted a plethora of community studies in Chicago over the course of the teens and twenties in an effort to devise policy solutions to "objective" conditions in the housing market. In effect, these economists wanted to increase American homeownership rates by encouraging banks to provide a greater number of home loans; to do so, they sought to identify ways institutions might lower the risk – or perceived risk – of losing money on residential mortgages by changing assessment conventions from being primarily attuned to the individual dwelling to the condition of the surrounding area. And, as I've suggested, in urban places like Chicago during the 1920s, location had everything to do with the equation of race and value. "Though clearly not advocating racial determinants in commercial lending policies," the historian Margaret Garb has convincingly argued, "the economists' recommendations exacerbated residential segregation and added new barriers to home ownership among African Americans."[25] These academic studies and discourses about property valuation generated in the hyper-segregated city of Chicago during the first few decades of the twentieth century would indeed come to animate urban renewal in places like San Francisco.

Novel assessments of risk and value – informed by the racial politics of real estate and forged in the urban 'laboratory' of Chicago – became codified in postwar federal housing policies. In turn, those policies underwrote the fundamental remaking of American metropolises after World War II.[26] Most notably, the selective credit programs devised by the Federal Housing Administration (FHA) in the 1930s that created the modern mortgage market drew explicitly on the analytical framework generated through community studies in Chicago. In an effort to sponsor greater homeownership (and, in effect, mass suburbanization), the FHA worked to insure home loans granted by private financial institutions and in the process standardized the long-term, low-interest mortgage. While FHA policies secured the resources of suburbia and thus helped a huge number of ordinary Americans become homeowners – because the administration's underwriting guidelines were explicitly premised on racialized formulations of risk – its benefits went almost exclusively to white people.

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[24] During the early teens and twenties, social scientists and researchers at the University of Chicago forged a social scientific model for urban studies – the "Chicago School" – that continues to offer both a language and an orientation to academics and urban professionals. For a taste, see: Robert Park and Ernest Burgess, *The City: Suggestions for Investigation of Human Behavior in the Urban Environment* (Chicago: The University of Chicago Press, 1925 [1967]) and Louis Wirth, "Urbanism as a Way of Life," *American Journal of Sociology* 44:1 (1938): pp. 1-24.

[25] Garb, "Drawing the 'Color Line,'" p. 783.

[26] Jackson, *Crabgrass Frontier*; Richard Walker, "A Theory of Suburbanization: Capitalism and the Construction of Urban Space in the United States," in Michael Dear and Allan Scott, eds., *Urbanization and Urban Planning in Capitalist Society* (New York: Methuen, 1981).

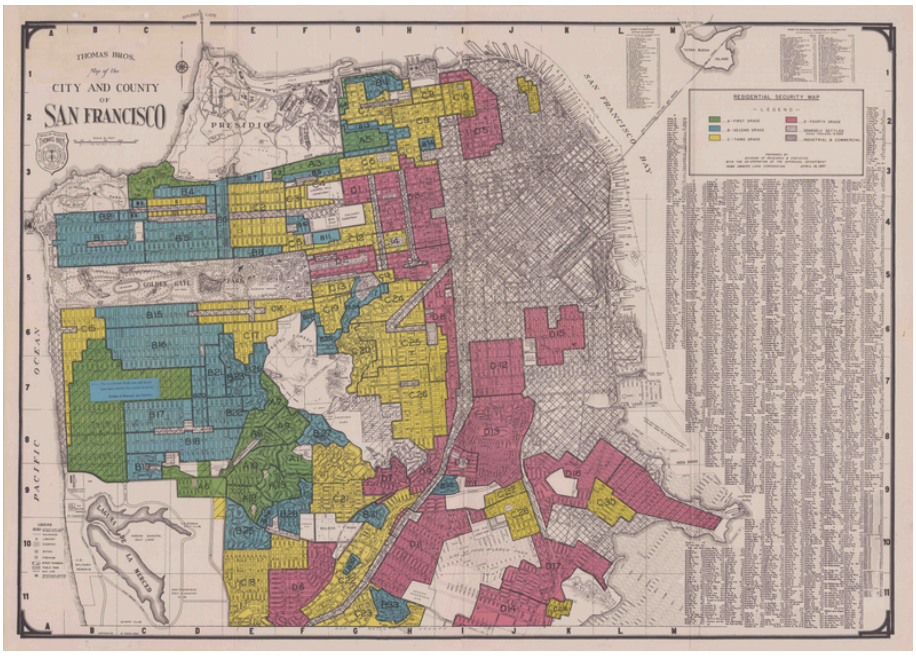


Figure 11: A 1937 "residential security map" of San Francisco produced by the Home Owners' Loan Corporation. **Source:** The Anti-Eviction Mapping Project.

Lending guidelines, innocuously etched into the now infamous redlining maps made by the Home Owners' Loan Corporation, dictated investment along racial lines [Figure 11]. Likewise, the Veterans Administration's mortgage guarantee program, enacted after the war to support the housing needs of returning troops, systematically discriminated by race.[27] By the late 1950s and early 1960s, the net effect of these governmental policies and market practices was a distinctly raced and classed form of uneven development – the spatial and material manifestation of social inequality – at the metropolitan scale.

The Community Renewal Program emerged as a mode of governmental intervention at the same time that local and federal officials enthusiastically supported top-down efforts at urban renewal. Yet, it represented something of a departure in the way authorities sought to address the problem of uneven development through particular renewal plans. On the one hand, the notorious efforts of planning and redevelopment authorities under the rubric of urban renewal focused on specific interventions in the built environment – the physical removal of so-called blighted features in the landscape (like buildings and people) in the interest of attracting capital and raising local property values in central cities. Robert Moses, the "master builder" and head of public works in postwar New York, offered what has since become considered a quintessential expression of the attitude of urban authorities in the age of redevelopment: "[W]hen you operate in an

[27] David Freund, "Marketing the Free Market: State Intervention and the Politics of Prosperity in Metropolitan America," in Kevin Kruse and Thomas Sugrue, eds., *The New Suburban History* (University of Chicago Press, 2006). David Freund, *Colored Property: State Policy and Racial Politics in Suburban America* (University of Chicago Press, 2010); Ira Katznelson, *When Affirmative Action was White: An Untold History of Racial Inequality in Twentieth-Century America* (New York: W.W. Norton, 2005).

overbuilt metropolis, you have to hack your way with a meat ax."[28] The CRP, on the other hand, was created in response to the social dislocations produced by early renewal projects as well as the perceived limitations of the piece-meal character of 'meat ax' redevelopment policy. Premised on "using certain sophisticated techniques developed in other fields, such as mathematical simulation models," the CRP – according to one of the program's leaders in San Francisco – was developed to simultaneously enable a more comprehensive approach to planning, incorporate various social factors into the renewal decision-making process, and "to test the likely consequences of alternative public actions."[29] That is, opposed to the vision of planning officials like Moses, CRP administrators imbibed a conception of the city as a set of social and economic processes, a dynamic system of discernable data points that could be simulated via the development of informational databases and the proper deployment of computational technologies. In this view, any number of potential cause-and-effect renewal scenarios could be screened – and their efficacy judged – in advance. Moreover, such analytical forecasts might allow urban managers to influence the behaviors of residents and market actors. Ultimately, the hopes of such an approach rested upon the notion that cities were interconnected systems that could be modeled and thus governed as such.

Rather than some kind of straightforward problem calling for the "meat ax," the city – for postwar planning advocates and experts who saw social metrics and market dynamics as central to urban renewal – increasingly came to be seen a complex situation that required innovative means and methods of intervention. Indeed, while the political history of race and real estate described in the paragraphs above laid the groundwork upon which the CRP emerged in federal policy, technical developments forged in the wartime laboratories of defense research provided both its technological basis and analytical rationale. That is, the techniques and technologies originally formulated by defense intellectuals in the realm of weapons manufacture were taken up after World War II to address uneven metropolitan development.[30]

Perhaps the most important figure in bringing the technologies of twentieth-century warfare to the government of cities was the MIT mathematics professor and "father of cybernetics" Norbert Weiner.[31] As early as 1950, in a *Life Magazine* article entitled "How U.S. Cities Can Prepare for Atomic War," Weiner implied that – in order to facilitate urban dispersal in case of a targeted nuclear attack – it was necessary to rethink the basic outlines of the nature of cities themselves. "A city is primarily a communications center," he argued, "serving the same purpose as a nerve center in the body."[32] The similarity between the transportation of 'signals' in/among human beings and the material transportation of goods and messages, here, was more than merely analogous: it was the basis for building a supposedly better, less congested, and safer urban world, especially in light of the conflicts embroiling both postwar American cities

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[28] Quoted in Robert Caro, *The Power Broker: Robert Moses and the Fall of New York* (New York: Alfred A. Knopf, 1974) p. 849.
[29] Ira M. Robinson, "Beyond the Middle-Range Planning Bridge," in Faludi, *A Reader in Planning Theory,* p. 172.
[30] Light offers a compelling account of this historical development, but also see: Paul Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (MIT Press, 1997).
[31] Light, *From Warfare to Welfare*, p. 35.
[32] Norbert Wiener, "How U.S. Cities Can Prepare for Atomic War: MIT Professors Suggest a Bold Plan to Prevent Panic and Limit Destruction," *Life Magazine* 29:25 (1950) p. 85.

and the globe more broadly. As a problem of management, defense, and renewal, the figure of the American city – in this view – needed to be redefined as a more-than-human network of transportation and communication.

The conception of the city as a problem of communication animating both Weiner's piece in *Life Magazine* and, later, the CRP's effort to foster development in places like San Francisco fundamentally drew upon the emerging language of cybernetics. During World War II, Wiener – along with many of his academic colleagues – was enlisted by the military to work on developing range finders for antiaircraft guns. Within the context of pursuing weapons research at the Radiation Laboratory at MIT, Wiener and fellow researchers began to formulate a novel scientific approach to the predictive and regulatory mechanism of information feedback in systems of communication among humans, machines, and organizations – a transdisciplinary science of systems as it were. As Weiner came to succinctly claim, cybernetics offered a path toward "the scientific study of control and communication in the animal and the machine."[33] And his emphasis on control – not so much as in outright coercion but in the sense of influencing or guiding behaviors and outcomes – was an important indicator of the political implications of cybernetics. In what might be considered his definitive statement on the topic, *The Human Use of Human Beings*, Weiner outlined his specific rationale behind coining "cybernetics" to describe this new science of systems. "Until recently," he offered, "there was no existing word for this complex of ideas, and in order to embrace the whole field by a single term, I felt constrained to invent one. Hence 'Cybernetics,' which I derived from the Greek word *kubernētēs*, or 'steersman,' the same Greek word from which we eventually derive our word 'governor.'"[34] Indeed, at root, cybernetics appeared to offer an analytical aid to the project of governing, whether the object-system in question was an airplane cockpit or an entire metropolis divided along the lines of race and class among other social categories. From its very inception in wartime research laboratories through its eventual dissemination across academic and managerial fields, then, the promise of cybernetics resided in its potential to bolster the ability to govern various socio-technical scenarios at a variety of scales.

Though initially forged by defense intellectuals and technicians within the context of the military research complex during World War II, the emergent science of cybernetics – as a philosophy concerned with the character and regulation of socio-technical systems – rapidly garnered interest in the life and social sciences, the design and planning fields, and across a spectrum of managerial, engineering, and administrative professions. In one line of flight, the early formulation and dissemination of cybernetic thinking across a variety of academic circles – in the disciplines of anthropology, electrical engineering, design, and mathematics among others – can be traced specifically to a number of conferences hosted by the Josiah Macy, Jr. Foundation over the course of the 1940s and 1950s. The so-called Macy conferences brought together a coterie of eminent academics, from the anthropologists Margaret Mead and Gregory Bateson to the mathematicians Claude Shannon and John von Neumann, to further develop a regulatory

[33] Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and Machine* (MIT Press, 1965).
[34] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston: Houghton Mifflin, 1954) p. 15.

science of systems capable of addressing the problems confronting a post-atomic world.[35] As academics and theorists continued to probe the principles of cybernetics, operations research and industrial consultant firms such as the RAND Corporation and Arthur D. Little, Inc. sought to put those principles into management practice by reconstituting them under the heading of "systems analysis." A faith in the ability of mathematical innovations and computer simulation to solve any number of large-scale social problems – including the problem of the city – animated the rise of systems analysis in the postwar years.[36]

Within the context of ongoing processes of uneven metropolitan development and the attendant rise of both social movements and urban rebellions responding to the racialized effects of those processes, cybernetics and systems analysis seemed to offer urban planners and administrators a conception of the city as a system amenable to control as well as the tools necessary for intervention.[37] "By 1966," Jennifer Light recounts, "Richard Meier and Richard Duke would write in the *Journal of the American Institute of Planners* that the urban professions were experiencing a 'revolution' in theory and practice, with computers at the center of this transformation."[38] Indeed, those techniques and technologies originally developed to target military enemies in the combat zones of World War II were ultimately taken up by local and federal administrators to target the city and the behavior of the urban population itself.[39] In this section, I have examined the historical context out of which experimental efforts to mobilize simulation on behalf of urban renewal sprang. On the one hand, a history of racist market practices and housing policies produced urban conditions that postwar officials and managers sought to address through projects of urban renewal. On the other hand, the military-inspired development of cybernetics as a mode of thinking and method of control led those officials and managers to adopt a computational, systems-based approach to governmental intervention in American cities. In the following section, I examine a federally supported albeit experimental project to build and wield a computer simulation model on behalf of urban management and renewal in San Francisco.

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[35] On the Macy Conferences, see: Steven Heims, *The Cybernetics Group* (MIT Press, 1991). For an examination of the way in which cybernetics influenced government and the media landscape after World War II, see: Fred Turner, *The Democratic Surround: Multi-Media and American Liberalism from World War II to the Psychedelic Sixties* (University of Chicago Press, 2013). Cybernetic principles also came to animate the field of biology and the neurosciences: Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (University of Chicago Press, 1999).

[36] David Hounshell, "The Medium is the Message, or How Context Matters: The RAND Corporation Builds an Economics of Innovation, 1946-1962," in Hughes and Hughes, *Systems, Experts, and Computers.* For a kaleidoscopic take on the role of cybernetics and innovations in computing on the design professions during this era, see: *Orit Halpern, Beautiful Data: A History of Vision and Reason since 1945* (Duke University Press, 2014).

[37] For an insightful take on the civil rights movement and the varied tactics and strategies of black resistance in postwar America, see: Manning Marable*, Race, Reform, and Rebellion: The Second Reconstruction in Black America, 1945-1990* (University Press of Mississippi, 1991).

[38] Light, *From Warfare to Welfare*, p. 37; Richard Meier and Richard Duke, "Gaming Simulation for Urban Planning," *JAIP* 32:1 (1966) pp. 3-17.

[39] In *From Warfare to Welfare*, Jennifer Light provides a comprehensive historical account of the transposition of military techniques and technologies to urban planning and government.

Simulation: Community Renewal Programming

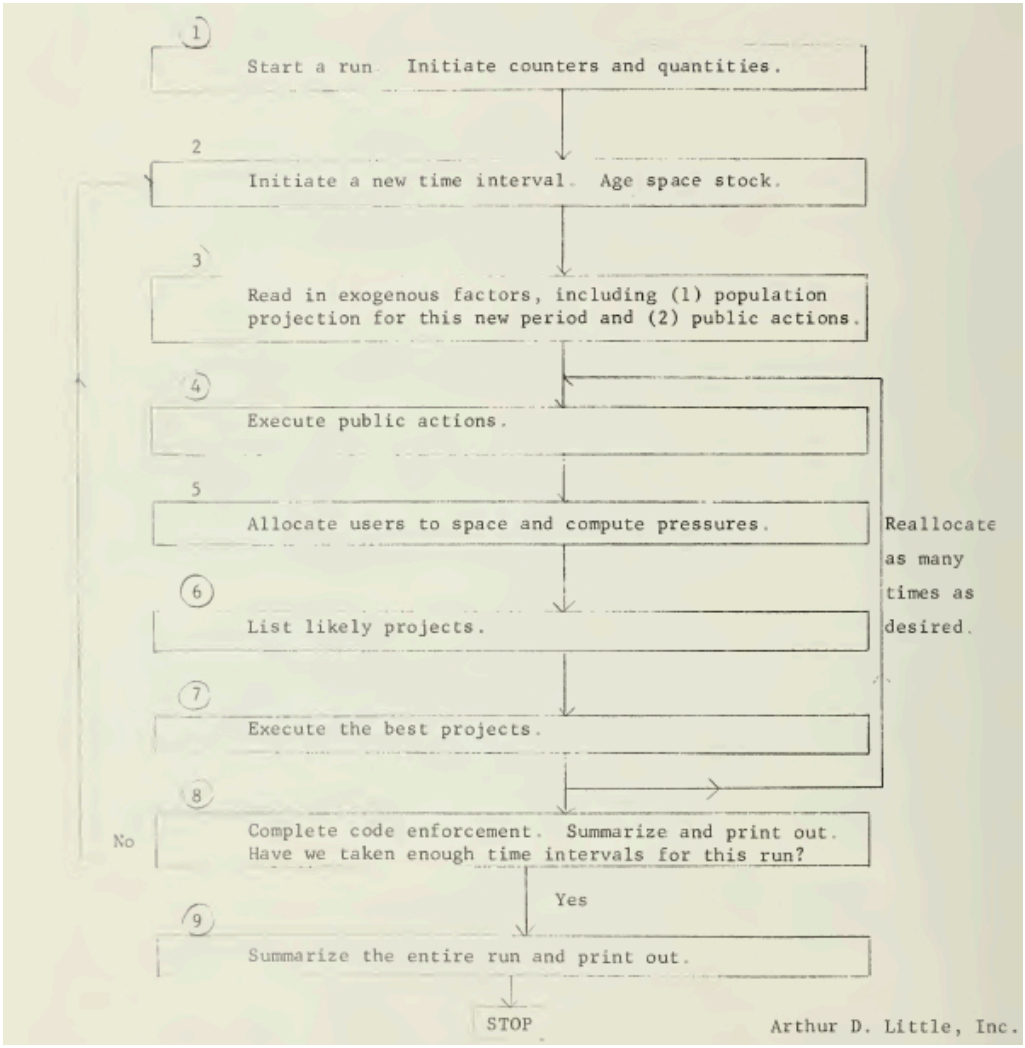


Figure 12: An abbreviated flow chart, San Francisco's Community Renewal Program simulation model. **Source:** Arthur D. Little, Inc., *Technical Paper #8, San Francisco Community Renewal Program.*

I turn in this section to specific efforts to build a simulation model capable of forecasting the effects of interventions within the real estate market of San Francisco. With an explicit desire to alleviate the 'unintended consequences' of governmental interference into private markets in land and housing – such as the social devastation and political reaction wrought by the "federal bulldozer" – planners and technical consultants in the city drew upon a 1959 amendment to the Housing Act of 1949 that provided funding for the creation of experimental Community Renewal Programs at the local level. While hundreds of cities would eventually establish similar programs, two cities in particular – Pittsburgh and San Francisco – were the first to apply for federal grants through the Housing and Home Financing Agency. "In a few cities," the project head in

San Francisco wrote in 1973, "the CRP has been recognized for what it is; a major new approach to urban renewal and a radical departure for the city planning." Rather than a framework for unleashing bulldozers on behalf of piecemeal redevelopment plans, that is, the CRP was envisioned as a means to offer local government officials a broad and authoritative set of guidelines with which to pursue urban planning and renewal in a comprehensive vein. Moreover, central to the process of institutionalizing this novel postwar approach to the redevelopment of U.S. cities was "the stimulus for a new wave of innovations in the urban renewal process."[40] Just as Chicago had served as a laboratory for the formation of land economics and urban studies in the earlier part of the century, cities like San Francisco were seen to offer a kind of experimental field within which a possible new science and method of urban government could be forged after World War II.

In San Francisco, the formation of the CRP – and the ongoing attempt by experts associated with that burgeoning institution to build a computer model on behalf of scenario planning – involved a complex series of negotiations and relationships among federal policy administrators, local public officials, industrial consultant firms, and private operations researchers and planners. It also highlighted battles between and among municipal agencies at the time. After all, the planning department, rather than the hitherto all-powerful Redevelopment Agency, contracted with the federal government to conceive of, develop, and control the city's CRP; previous renewal projects in the city – piecemeal in character, as discussed above, and premised on the wholesale remaking of entire swathes of the urban environment – had been dictated by M. Justin Herman's agency. But in October of 1962, having previously applied for federal funds, the planning department received over a million dollars for the establishment of a CRP. This gave it political sway in the realm of municipal decision-making. At the same time, planners had been looking to acquire a shiny new electronic data processing system; and the department contracted with an industrial engineering consultancy firm, Arthur D. Little, Inc. (ADL), to develop a computational system for the city on behalf of the program.[41] By late 1963, the CRP's entire bureaucratic and political arrangement in San Francisco had been configured: operations researchers from ADL set up shop in conjunction with members of the planning department; a citizens advisory committee was established to ensure popular participation; and a technical advisory board consisting of eminent experts in the planning and design fields was formed.[42] With the organizational contours of the city's CRP under wraps, the administrative work of analysis and renewal proceeded in turn.

Before ADL officially contracted with San Francisco's planning department to work on behalf of community renewal, it relentlessly sold the city on the idea of a simulation model. Headquartered in Cambridge, Massachusetts, the firm had a smaller

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[40] Robinson, "Beyond the Middle-Range Planning Bridge," p. 172. For a discussion of the way in which cybernetic thinking informed the development of the CRP on an intellectual and policy level, see: Light, *From Warfare to Welfare*, pp. 55-68 and Philip Morse, ed., *Operations Research for Public Systems* (MIT Press, 1967).

[41] Brewer, *Politicians, Bureaucrats, and the Consultant,* pp. 114-120.

[42] For accounts of the San Francisco CRP's citizen advisory board, see: Box 3: Folders 17-19, John F. "Jack" Shelley Papers. San Francisco History Room 10, San Francisco Public Library. It's worth pointing out here that there was little public "participation" in the decision to draw upon computer simulation as a planning tool.

regional office in the Bay Area – but a contract with San Francisco to work on developing techniques for the CRP promised to significantly expand its presence in California. It pitched the city on its ability to solve socio-political problems via computational means with perhaps overly exaggerated confidence. "The system concept," the firm argued in a prospectus presented to the city, "utilizing a mathematical model adapted to electronic computers, offers the most promising method of dealing with the complexities involved."[43] In turn, a general enthusiasm for computers as tools for planning and government, despite a lack of technical experience or know-how among municipal officials, engulfed the administrative quarters of city hall. As one member of the planning department later reflected on the decision to use computational techniques: "We just got swept away."[44] When ink on the consultancy contract dried, the construction of a simulation model – built by ADL operations researchers with the input of a few city planners – emerged as the central component of the CRP.

The rationale behind using a model as a governing tool rested upon both the conception of the city as a system of market signals and socio-economic processes as well as a faith in the ability of computational techniques to successfully represent and reenact those processes. In theory, technicians could program a variety of "inputs" – the condition of the housing stock, the class and racial character of different neighborhoods, the valuation of past and present residential properties, and the likely behavior of market actors among others – into a computer in order to simulate dynamic relations of supply (housing) and demand (households). That is, programmers held that they could accurately model the working of the residential real estate market in the city over a variety of time scales. With market conditions and processes captured and mathematically expressed, the thinking went, it would be possible to introduce specific planning scenarios or forms of governmental intervention into the equation and thus judge their impacts. Checking the potential effects of various "public actions" [Figure 12] on this idealized market via a computer model appeared to offer municipal officials plausible deniability in the case that some sort of political controversy erupted surrounding municipal interference in market processes. Likewise, simulation modeling also seemed to provide an opportunity for administrators to take stock of the way in which individual and collective behaviors could be accounted for and potentially even influenced. An ADL project researcher in San Francisco suggested as much in a 1966 case study. "*Good planning,*" the spokesperson argued,

> *requires the ability to predict the results of different actions or programs and to choose the best from among them. These actions and their results can be simulated in an electronic computer, in a comprehensive, time-saving, pioneering planning technique developed and proved as part of the San Francisco Community Renewal Program* (italics in original).[45]

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[43] Arthur D. Little, Inc, *San Francisco Community Renewal Program – Purpose, Scope, and Methodology*, (San Francisco: Arthur D. Little, Inc., 1963), p. 21. Hereafter cited as ADL, *SFCRP Prospectus.*
[44] Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 105.
[45] Arthur D. Little, Inc, *Community Renewal Programming: A San Francisco Case Study* (New York: Frederick A. Praeger, 1966) p. 191. Hereafter cited as ADL, *Community Renewal Programming*.

Computational techniques of simulation, in other words, made sense under a relatively novel rubric of urban government premised on guiding and managing processes rather than dictating and imposing forms.[46] In turn, this sensibility was premised on a specific understanding of the character of the city itself. Melvin Webber, a professor of planning at U.C. Berkeley and confidant of Ira Robinson, the CRP's lead in San Francisco, summed up the way in which these conceptions and techniques informed leading-edge approaches to planning. If the city was a "form of action," he suggested, then a "master plan" shouldn't be "a fixed and static document" but a dynamic program that might account for changes over time and mitigate those unintended consequences of governmental planning and management.[47] This, it should be noted, was an historically novel and politically consequential way of re-imagining the city as a problem to attend to and address.

The initial work of actually building a simulation model on behalf of the CRP consisted of two fundamental tasks: developing the model's parameters, on the one hand, and collecting and configuring the adequate data on the other. Before pursuing either, however, project leader Robinson assembled the modeling team. A handful of city planners, eleven ADL staff members, five technical consultants, and fifteen on-call advisors eventually constituted its ranks. Though the initial prospectus presented to the city held out hope for a comprehensive model encompassing a region-wide approach to social and economic planning, the scale of the project was reduced early on to focus on the land market in San Francisco alone.[48] Rather than explicitly incorporate social or housing theory the program, the engineers and planners in charge of developing the program premised their work almost exclusively on orthodox economics. From the beginning, the model was premised on the normative notion that markets were fundamentally self-regulating systems of supply and demand. To simulate this system, ADL researchers based the model on a two-year time horizon and worked to define the various "inputs" presented by the existing "housing stock" and "households" of the city

[46] This move away from the top-down imposition of form toward the management of flows or processes as an explicit planning rubric can be traced back to the work of Benton MacKaye, Lewis Mumford, and other members of the Regional Planning Association of America as well as their colleagues who took on regional development and planning projects during the New Deal. See, especially, Benton MacKaye, *The New Exploration: A Philosophy of Regional Planning* (Urbana: The University of Illinois Press, 1990 [1928]). It's worth noting here that MacKaye and Mumford were deeply influenced by philosophical thinkers in the realm of planning like Ebenezer Howard and Patrick Geddes. See, Ebenezer Howard, *Garden Cities of To-morrow: A Peaceful Path to Real Reform* (London: Swan Sonnenschein, 1902) and Patrick Geddes, *Cities in Evolution: An Introduction to the Town Planning Movement and the Study of Civics* (London: Williams and Norgate, 1915). Historian Marc Weiss has shown how the collectivist and utopian impulses of earlier "Garden City" models were later taken up and stripped of their reform character to underwrite market-driven suburbanization in the United States: Marc Weiss, "Developing and Financing the 'Garden Metropolis': Urban Planning and Housing Policy in Twentieth-Century America," *Planning Perspective* 5:3 (1990): 307-319. Thanks to Peter Ekman for his insights and the latter reference.

[47] Webber was an important CRP interlocutor and an intellectual advocate of systems analysis in the field of city planning more generally. Quoted in Light, *From Warfare to Welfare*, p. 49; Leland Swanson and Glenn Johnson, eds., *The Cybernetic Approach to Urban Analysis* (Los Angeles: University of Southern California Graduate Program in City and Regional Program, 1964) p. 9.

[48] ADL, *SFCRP Prospectus*, p. 21; Arthur D. Little, Inc., *San Francisco Community Renewal Program: Simulation Model for Renewal Programming* (San Francisco: Arthur D. Little, Inc., 1964). Hereafter cited as ADL, *Simulation Model for Renewal Modeling.*

as a whole.[49] They identified 106 distinct neighborhoods in the city and aggregated the population (households) into 114 categories along the lines of four "attributes": "type" (age), "color" (race, understood as a proxy for economic valuation), "size" (the number of people in various housing units), and "income" (class). With the object of intervention supposedly replicated, ADL staff decided to build three distinct kinds of public activity into the program: direct intervention into the market through purchases, sales, and site improvements; implicit intervention through changes in rents, taxes, and subsidies; and interventions designed to shape the market environment such as changes in zoning regulations and ordinances. A nine-step flow chart was finally developed to direct the program by which supply and demand were to interact.[50] By the end of 1964, the parameters of the CRP simulation model had been worked out on paper – or, as a matter of fact, in a computer.

With the technical parameters worked out, CRP members ran a simplified formula using hypothetical data in December of 1964. The following month, Robinson and his team of planners and operation researchers decided in earnest to develop a complex version of the model using verifiable data about housing in the city. That, of course, required access to adequate information.[51] The planning department had some information about the real estate market in the city and even produced a study projecting population growth through 1990.[52] But because the model depended delicately on demographic data and well-executed forecasts, the group set about surveying all available information resources produced by the city. ADL representatives not only reached out to the Assessor's Office for fine-grained demographic data but to the Board of Education as well. For unstated reasons, both declined to cooperate. Though project researchers undertook a number of additional data surveys and special studies to supplement verifiable informational sources produced by governmental agencies, the simulation model that they engineered ultimately relied upon demographic data collected for the 1960 census.[53] In relation to the categories and attributes aggregated by modelers during the construction of the model, the federal census – especially its focus on the racial and class character of the population – appeared to offer modelers the essential data points with which to simulate the market dynamics of supply and demand within San Francisco.

After constructing the technical parameters of the model, deciding upon the program's order of processing, and identifying and configuring the necessary units of information required for a simulation of the urban housing market, ADL project leaders fulfilled their contract by delivering a simulation model on behalf of the CRP to the city. Early on in the project's development, an ADL spokesperson outlined to the CRP staff precisely what the firm intended to deliver. "The objective," the employee wrote, "is to deliver a workable model to the city of San Francisco on the 31st of July and to also develop and deliver a technical paper which characterizes and describes the model in

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[49] Arthur D. Little, Inc., *San Francisco Community Renewal Program: Report on Organization and Administration for Renewal* (San Francisco: Arthur D. Little, Inc., 1963).
[50] Brewer, *Politicians, Bureaucrats, and the Consultant*, pp. 116-117; ADL, *Community Renewal Programming,* pp. 191-201.
[51] Robinson, "Beyond the Middle-Range Planning Bridge," pp. 176-181.
[52] San Francisco Department of City Planning, *Population Projection for San Francisco, 1960-1990* (April 1960).
[53] ADL, *Community Renewal Programming*, pp. 187-202; Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 116-117

terms of what it will and will not do."[54] The modeling crew fulfilled both objectives, first presenting the simulation model to city officials in June of 1965. That demonstration was run on an IBM 7040/7014 computer over the course of two and a half hours. ADL also produced an official report entitled "Technical Paper #8" that offered the clearest public description of the model and its capacities according to the consultancy firm.[55] By the end of 1965, ADL gave the model over to the planning department and exited the CRP as an active participant.[56] Nonetheless, the simulation model constructed in San Francisco – as well as the other experimental one built on behalf of the CRP in Pittsburgh – garnered considerable public commentary and attention among practitioners who had worked on behalf of the CRP as well as academics, planning professionals, and advocates of electronic computation alike as a means of urban government.[57] In no uncertain terms, the turn to computer simulation through the CRP offered – no matter how experimental, incomplete, or inadequate – a governing tool that captured the hearts and minds of innumerable public figures with an interest in urban politics.

The CRP continued to pursue efforts at social and economic renewal well beyond the creation of a simulation model in San Francisco as well as in hundreds of other cities across the United States. But it was the program's effort at technical innovation in realm of simulation modeling that circulated throughout the planning and public administration fields more broadly. When ADL fulfilled their contracted obligations, the planning department took up the original model and continued to work on an updated version. Yet, there remained questions about both the viability and usefulness of the tool as originally delivered. In the following section, I explore some of the political and technical responses to the CRP simulation model from residents, planners, and, indeed, systems analysts themselves. Though experts critiqued design and organizational elements of the model produced through the renewal project, I suggest that their negative appraisals of it as well as the specific reasons why it was seen as flawed actually served to reinforce the basic presupposition that the fundamental character of cities was rooted in their nature as systems of informational flows amenable to management and optimization. Such a presupposition, I argue throughout this dissertation, continues to inform techno-utopian and market-based forms of political rationality taking hold in cities today.

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[54] Quoted in Brewer, *Politicians, Bureaucrats, and the Consultant*, pp. 116-117; ADL, *Community Renewal Programming,* p. 150.

[55] Arthur D. Little, Inc., *Technical Paper #8, San Francisco Community Renewal Program* (San Francisco: Arthur D. Little, Inc., 1966).

[56] A final report was handed over in the summer of 1965: Arthur D. Little, Inc., *San Francisco Community Renewal Program: Analysis, Goals, Long-Range Policies and Program* (San Francisco: Arthur D. Little, Inc., 1965).

[57] Participants and planners wrote a flurry of professional and academic articles on the heels of the CRP modeling programs in both San Francisco and Pittsburgh. On the San Francisco CRP model, see: John Dyckman, "The Scientific World of City Planners," *American Behavioral Scientist* 6 (February 1964); Ira M. Robinson, Harry B. Wolfe, and Robert L. Barringer, "A Simulation Model for Renewal Programming," *Journal of the American Institute of Planners* 31 (May 1965) pp. 126-134; Harry B. Wolfe and Martin L. Ernst, "Simulation Models and Urban Planning," in Philip Morse, ed., *Operations Research for Public Systems* (MIT Press, 1967); John P. Crecine, "Computer Simulation in Urban Research," *Public Administration Review* 28 (January and February 1968): pp. 72-73.

Appraisals: Critiquing the Model, Affirming the System

While official accounts of the Community Renewal Programming initiative produced by ADL staff characterized efforts to build a simulation model as successful if incomplete, planners and administrators soon encountered the original model's deficiencies – its erratic behavior and unreliable "outputs." The planning department ran the program less than twenty times before realizing that the model outlined in "Technical Paper #8" needed further development, a particularly bitter pill to swallow because of the amount of resources that went into its initial construction. When asked what the city got out of the CRP's modeling project, one representative of the department responded, "about 3¢ on the dollar."[58] As a useful and practical forecasting tool, the CRP model was panned, in short, as a failure. Perhaps it was a failed experiment, but – as I show in this section – it was a productive one.[59] After briefly discussing the way in which the CRP was viewed in certain communities with suspicion as an iterative tool of redevelopment, I focus on a specific critique of the actual CRP model levied most forcefully by a RAND systems analyst and academic researcher. Though urban experts determined that the CRP model came up short as a viable governing tool and criticized it along technical and bureaucratic lines, their appraisals of it not only *affirmed the characterization* of cities as informational systems of market signals but *confirmed in principle* the ability to model them as such given an appropriate infrastructure of data capture and collection.

Experts in the fields of urban planning and systems analysis were not, of course, the only ones to hold suspicions about either the viability of the San Francisco CRP model or its function as a governmental tool. After all, the CRP project, as discussed earlier, was entrenched within postwar efforts to rebuild and remake metropolitan space in the name of renewal. The raced and classed character of those efforts, representing historical continuity rather than departure, animated collective political responses in segregated and marginalized neighborhoods. Though outright physical violence and coercion – both extra-legal and state-sanctioned – absolutely informed the experiences of people of color throughout the Bay Area, the socio-economic effects of more subtle and technical forms of political intervention in black and brown communities became more and more apparent during the postwar era.[60] Indeed, critical takes on the socio-political implications of market and planning technologies such as redlining maps (and by extension renewal simulation programs) emerged most forcefully in the social spaces of non-white migrant communities. "The south is not half as bad as San Francisco," a young

[58] Quoted in Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 168.

[59] My discussion of the model as a productive failure draws in some ways upon Latour's exploration of the failure to implement a personal rapid transit system in Paris: Bruno Latour, *Aramis, or The Love of Technology* (Harvard University Press, 1996).

[60] There are countless examples of resistance to racist policies and politics in the Bay Area by working-class communities of color during and after World War II. For a very truncated set of examples, see: Javier Arbona, "After the Blast: Building and Unbuilding Memories of Port Chicago" (PhD Dissertation, Department of Geography, University of California, Berkeley 2013); Marilynn Johnson, *The Second Gold Rush: Oakland and the East Bay in World War II* (Berkeley: University of California Press, 1994); Donna Murch, *Living for the City: Migration, Education, and the Rise of the Black Panther Party in Oakland, California* (Chapel Hill: University of North Carolina Press, 2010); Rachel Brahinsky, "The Making and Unmaking of Southeast San Francisco" (PhD Dissertation, Department of Geography, University of California, Berkeley, 2012).

black resident told James Baldwin at the beginning of *Take This Hammer*, a film chronicling the author's visit to the city in 1963. "I'll tell you about San Francisco. The white man, he's not taking advantage of you out in public like they do down in Birmingham. But he's killing you with that felt and the paper…."[61] Likewise, the role of computers and automation as economic and governmental tools of racial and class exploitation and oppression – despite being presented as scientific and therefore neutral – was later taken up explicitly by intellectuals in the Bay Area's black revolutionary circles. "In a highly mechanized economy," Eldridge Cleaver of the Black Panther Party argued a few years after the CRP concluded, "it cannot be said that the fantastically high productivity is the product solely of the Working Class. Machines and computers are not members of the Working Class, although some spokesmen for the Working Class…seem to think like machines and computers."[62] In these sentiments and others, the technical sensibilities underwriting governmental aspirations like renewal programming (to say nothing of the policing applications of computational tools) were implicated as political technologies that served an elitist and racist status quo.

No doubt, suspicions surrounding urban renewal led to critical vernacular assessments of the CRP and its attendant dependency on technical means of assessment. But perhaps the most explicit and detailed critique of the CRP's experimental modeling initiative came from within the expert halls of systems analysis itself. Garry Brewer, a researcher at the RAND Corporation and future Professor at the Yale School of Management, undertook a detailed examination of the CRP in both San Francisco and Pittsburgh.[63] Simultaneously interested in the theoretical and practical dimensions of complex governmental decision-making – with a distinct enthusiasm for computer simulation – Brewer gained unprecedented access to members of the San Francisco's planning department and interviewed employees with intimate knowledge of the modeling project. In his resulting study, *Politicians, Bureaucrats, and the Consultant: A Critique of Urban Problem Solving*, Brewer outlined the administrative, political, conceptual, and technical dimensions of the CRP in meticulous detail. As an employee at RAND, he also took a particular interest in the way in which the ADL consultancy firm pursued a contract with the city to build a simulation model as well as the bureaucratic context within which such decisions were made. Technical care, Brewer suggested in regard to San Francisco's CRP, lost out to political expediency and the desire to find a "quick fix" to complex urban problems.[64]

In appraising the Community Renewal Program in San Francisco, Brewer – subsequently cited by a bevy of urban experts interested in computation and the policy sciences – came to the conclusion that the model was ultimately a failure as a forecasting tool because it didn't sufficiently capture the reality of those social processes and market

[61] Richard O. Moore, director, *Take this Hammer* (San Francisco: KQED Television, 1963).
[62] Eldridge Cleaver, *On the Ideology of the Black Panther Party, Part I* (Ministry of Information: Black Panther Party, 1970) p. 9.
[63] Brewer earned an undergraduate degree from the University of California, Berkeley in 1963, right when San Francisco initiated talks with ADL to construct a simulation model on behalf of the CRP, before pursuing an MS degree at San Diego State and then a PhD at Yale. In addition to working for RAND, he held professorships at the University of Michigan, U.C. Berkeley, and Yale.
[64] Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 150.

signals that constituted cities as complex objects of management.[65] That is, in his view and that of other urban experts and technicians, the usefulness of the model as a decision-making mechanism proved insufficient not because it embodied a fundamental conceptual or programmatic flaw but because of a dearth of necessary, up-to-date demographic information. "Data deficiencies," Brewer concluded, "plagued this project from start to finish."[66] While technicians ultimately did build a model simulating market processes, he argued, its usefulness as a practical tool was hindered by the fact that reliable and programmable units of information about those processes proved insufficient: "If one does not have sufficient good, reliable data, and if the prospects for developing the data are not particularly encouraging, why constitute a data-dependent model at an extremely fine level of detail?"[67] Rather than question the presupposition that the city was fundamentally characterized as a complex informational system, Brewer pointed to the fact that early difficulties finding appropriate data sources should have given CRP modelers pause in the first place. "Perhaps we should admit," Brewer addressed his fellow systems analysts in conclusion, "that we 'don't know' very much about the complexity of urban decision. We don't. That admission, earnestly made, might facilitate some honest and possibly productive 'groping around.'"[68] To adequately simulate a complex socio-technical system like a city, he suggested, it was necessary to develop a complex infrastructure of data collection – to 'grope around' for effective techniques to visualize the flow of market and social processes.

Though Brewer critiqued the CRP's simulation project as shortsighted, premised on political expediency, and ultimately inadequate because of a dearth of viable data, his appraisal also upheld the notion that cities were essentially systems of market signals capable of being modeled as such. With Brewer leading the pack of "systems men" willing to take on the practical failures of their discipline, a number of technical observers weighed in on the need to develop more sophisticated methods of capturing data about the urban scene and encoding that data within computer programs for the purposes of better government.[69] In *The Rise of Systems Theory: An Ideological Analysis,* Robert Lilienfeld – a contemporary of Brewer – pointed to this moment of self-reflection among the disciples of systems analysis as central in cementing a view of the world that only bolstered the governmental predilections of systems technicians.[70] While systems analysts might have criticized the political and bureaucratic jockeying among city

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[65] Hundreds of urban policy and management scholars have cited Brewer's study in the four-plus decades since its initial publication. Two books – one published in 1975 and the other in 2013 – provide a sense of its reach and ongoing relevance: Martin Shubik, *Games for Society, Business, and War* (Elsevier, 1975) and Batty, *The New Science of Cities*. It's also worth pointing out here that Brewer's critique of the model drew on the representational logics discussed in the previous chapter. The problem, he surmised, did not reside either in the fundamental assertion of the nature of the city as a market-based system of information signals or in the attempt to model it as such. Instead, for Brewer, the problem resided in the fact that the necessary information about that system was neither available nor sufficiently developed. See: Chapter 2 of this dissertation, especially footnote 34.

[66] Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 163.

[67] Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 146.

[68] Brewer, *Politicians, Bureaucrats, and the Consultant*, p. 233.

[69] Robert Lilienfeld, *The Rise of Systems Theory: An Ideological Analysis* (New York: John Wiley, 1978) p. 128.

[70] For his discussion of Brewer's appraisal of the CRP, see: Lilienfeld, *The Rise of Systems Theory*, pp. 128-130.

administrations and consultancy firms in attempting to build simulation models on behalf of the CRP, in levying those critiques they only confirmed the 'reality' of the systematic processes they sought to 'represent' through the development of data sources and computing. That is, in the words of Jennifer Light, "the lasting significance of this episode in the history of American cities cannot be measured by the direct effects and successes or failures of systems analysis and computing in the Community Renewal Program."[71] Instead, simulation initiatives in this moment rendered up a distinct managerial view of the urban world and initiated an ongoing faith in computational techniques and technologies as tools with which to govern U.S. cities.

Renewal Simulation and Civic Innovation

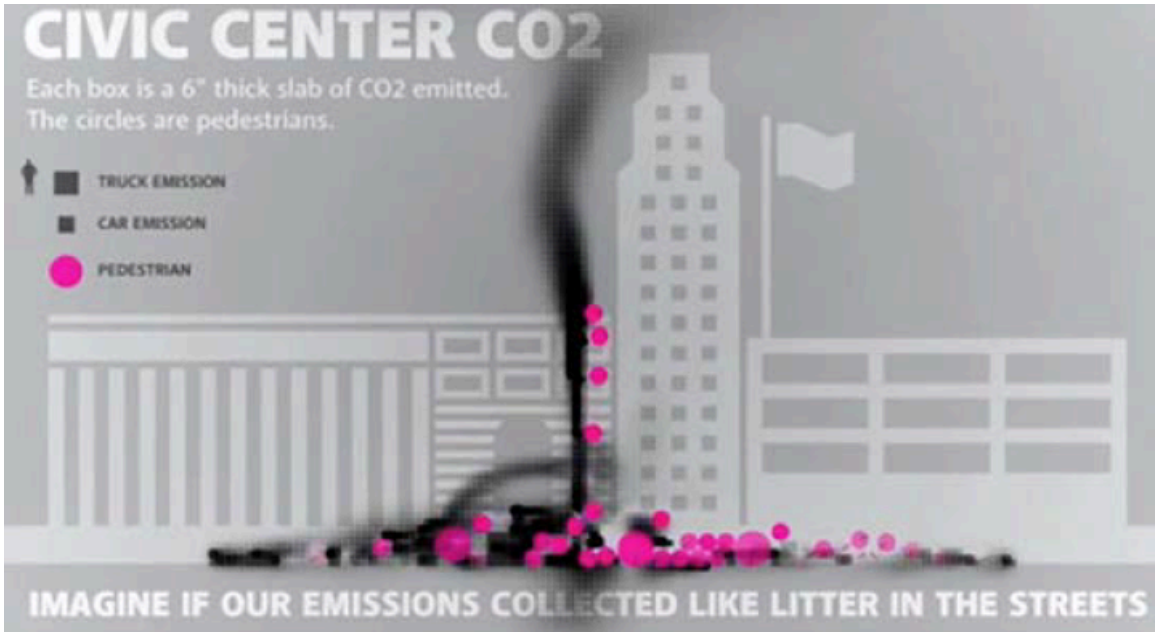


Figure 13: Still from a visualization prototyped at the Urban Data Canvas Challenge in San Francisco equating Google bus protestors to automobiles as sources of carbon dioxide emission. **Source:** Gray Area Foundation for the Arts.

I began this chapter by posing a set of questions regarding the present landscape of urban government in San Francisco: When did the formulation of the city as an informational system of market signals emerge? How did it take hold in governmental and policy circles as an object to manage? And what are the political stakes of posing such inquiries in the first place? These questions sprang from observations about governmental efforts – often described as "smart" or "resilient" and premised on the deployment of remote-sensing and interactive technologies – in the San Francisco Bay Area today, the contemporary hearth of market-based technological innovation. The

[71] Light, *From Warfare to Welfare*, p. 91.

project of so-called civic innovation, an emergent framework of urban management premised on directing the behavior of city residents via processes of information feedback and the establishment of technological infrastructures, represents the fruition of those postwar governmental dreams conjured in the name of cybernetics and systems analysis.[72]

In a recent prototypical example of civic innovation in San Francisco, for instance, the Urban Data Canvas [Figure 13] simultaneously embodied those governmental logics formulated during the postwar years and enrolled distinct technical innovations that seemed to possibly address the informational adequacies identified in critical appraisals of the Community Renewal Programming initiative. With environmental sensors and real-time data displays, the thinking went, all sorts of problems – from the effects of climate change and pollution to urban poverty and conflicts over the forces of gentrification – might somehow be alleviated via technical fixes. That is, when political protestors of private tech buses saw themselves represented as collective units of carbon emission, they would respond accordingly not as protestors but as responsible actors in a liberal milieu.[73] If only political conflicts, civic innovation adherents seem to lament, could be eliminated by technical solutions.

The technological and conceptual grounds upon which current governmental projects in cities like San Francisco continue to unfold formed in earnest after World War II when urban planning and policy professionals turned to scenario planning and computational techniques. In order to explore such historical formations, this chapter examined the history of the Community Renewal Program as an early experiment in mobilizing computer simulations as a mechanism of urban governance. While the CRP's initial foray into modeling housing markets and forecasting the effects of governmental interventions in urban space ultimately fell short of intended results, expert appraisals of that failing only served to embolden normative approaches to the city as a problem of management. Crucially, the conception of the city as a system of market signals that underwrote the CRP as well as a faith in the capability of simulating those processes were never fundamentally questioned. Instead, the lack of sufficient data representing socio-physical conditions and market behaviors, in addition to administrative and bureaucratic excesses, was implicated as the cause of the program's downfall. With the appearance and development of remote environmental sensors, real-time data feeds, high-speed wireless networks, and infrastructures of digital surveillance, all the barriers that got in the way of the efficacy of the CRP simulation program appear from a certain perspective to have collapsed. But, of course, politics and political conflict can never be transcended. Nonetheless, the desire to do so via technical means continues to animate and shape urban politics – and social life – in metropolitan regions like the Bay Area today.

As barriers to the flow and feedback of something called information increasingly diminish thanks to market-driven technological innovations and the commercial dissemination of technical devices, the governmental potential of systems analysis and

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[72] For an explicit discussion of civic innovation as a mode of governmental reason, see the following chapter, especially the introductory section. See also, John Elrick and Will Payne, "Model City: Rule of Innovation," in Robbie Herbst, ed., *New New Games* (San Francisco: Southern Exposure, 2016) pp. 10-11.
[73] For discussions of the Google bus protests see, Rebecca Solnit, "Get Off the Bus," *London Review of Books*, 36:4 (2014) pp. 34-35 and John Elrick, "Visionary Politics: Technologies of Government in the Capital of Innovation," *Society and Natural Resources* 30:7 (2017) pp. 860-876.

simulation forecasting – seemingly freed from the data-access limitations faced by technical practitioners of the postwar decades – have burst onto the stage once again. Now, however, in light of postwar failures, the monitoring and capture of real-time data within the landscapes of everyday life has become a fundamental managerial pursuit. Those practices, moreover, are generally pursued in an effort to subsume the subjectivity and activity of urban subjects within a rubric of decision making premised not just on market logics but on the imperative of technological engagement and proficiency. In the next chapter, I examine how the history of that imperative as well as the figure of "human capital" upon which it depended was forged under the shadow of Hiroshima and in the unsuspecting halls of a celebrated museum of interactive science education.

Chapter 4:

Staging Interactivity

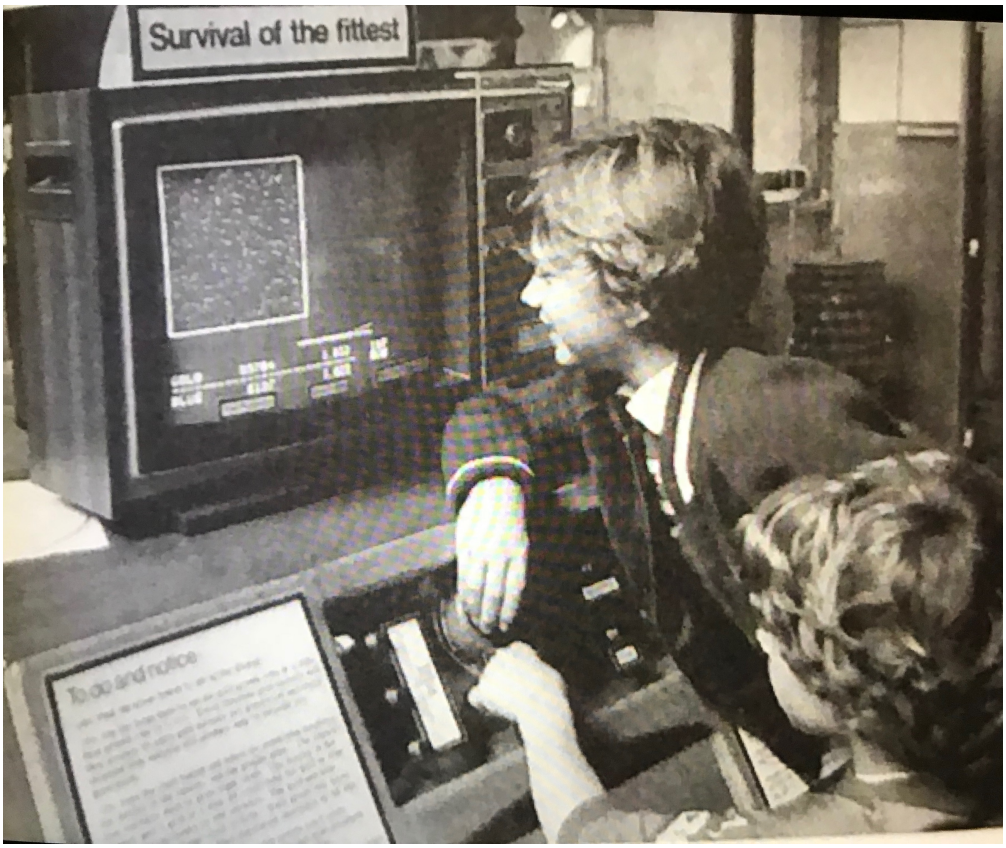


Figure 14: An interactive exhibit at the Exploratorium. **Source:** Hein, *The Exploratorium*.

> *In the past, monuments were made of bronze. In the future, monuments will be made of code. They will continue to instill civic values, but they will use different strategies than the bronze monuments.*[1]
>
> -Project Coordinator, Living Innovation Zone

> *The origin always precedes the fall. It comes before the body, before the world and time. It is associated with the gods and its story is always sung as theonogy. But historical beginnings are always lowly.*[2]
>
> -Michel Foucault

[1] Greg Niemeyer, "Urban Data Canvas Hackathon, Morning Presentation," *Gray Area Foundation for the Arts*, February 22, 2014. < https://www.youtube.com/watch?v=gm0BvpJDasY> (Last accessed July 19, 2019).
[2] Michel Foucault, "Nietzsche, Genealogy, History," *The Foucault Reader*, ed., Paul Rabinow (New York: Pantheon, 1984) p. 79.

The sidewalks of Market Street vibrate and clack. Shoppers saunter by department store windows. Tourists take turns boarding cable cars. Street performers bang drums and bark invitations. Women and men in office attire and aprons and uniforms scramble through the midday rush. A nearby construction crew hammers away.

I walk past the train station before running smack dab into some sort of public installation. A pair of giant concrete dishes face opposite each other dozens of feet apart. Two strangers seated within them appear to be holding an impossibly intimate conversation amidst the bustle and roar of the street. To the side, a bench affixed with musical appurtenances invites those passing by to take a seat and play.

I've read about this intervention before. It is one of a series of interactive science and technology exhibits, described by the Mayor's Office of Civic Innovation as "Monuments to Human Capital," planned for public installation in the city. Sponsored by a coalition of public and private entities, staff members of the Exploratorium – the city's famed interactive science and technology museum – built this particular exhibit. In fact, it was originally on display inside the museum.

I watch a person push a grocery cart full of belongings…folded cardboard, blankets, empty bottles and cans…past the musical bench. A security guard at a nearby coffee shop looks on. Two young people, a couple, perhaps, or maybe fellow employees at a tech firm in the area, wait to take their turn to play on the bench. Somewhere down the street, a police siren erupts.

The Capital of Innovation: Monuments as Political Technologies

In 2013, a crop of interactive public installations began to sprout up on the sidewalks of downtown San Francisco. A musical bench invited pedestrians to sit down and tinker around on their own or with others. An exhibit of giant parabolic dishes – plucked directly from the Exploratorium, the city's science and technology museum – encouraged intimate conversations amidst the roar of the street. And a prototyped visual display of real-time environmental data held out the promise that city dwellers might 'see' themselves as units of carbon emission and thus comport themselves in

environmentally efficient ways. Dubbed "Living Innovation Zones" or "monuments to human capital," the interactive design environments were but one dimension of a broader programmatic effort undertaken by the Mayor's Office of Civic Innovation to "embed startup DNA" into the very fabric of everyday urban life. In addition to the Living Innovation Zone initiative, "civic innovation" advocates in San Francisco have recently established an Entrepreneurship-in-Residence at City Hall, hosted a litany of hackathons and other events that promote the enterprising use of public data, and built a slew of public-private partnerships with the hope of bringing technology industry solutions to a wide variety of urban problems – political, socioeconomic, and environmental alike.[3] Though rather humble at first sight – dwarfed in scale and scope by other market-oriented projects of technological urbanism such as Sidewalk Labs' smart city plan for Toronto – these exhibits nonetheless express in concrete detail contemporary concerns among urban administrators over the innovative capacity and behavior of city dwellers as well as the socio-ecological performance of urban systems.[4]

Cities are on the map today as never before. A growing concern over the increasingly urban character of life on earth has swept across global development and policy-making circles. As the world's population continues to shift from rural to primarily urban settings, a heightened emphasis on the character of the city as the site of socio-economic dynamism and potential political strife has taken hold in the halls of both the academy and institutional power writ large.[5] Likewise, as the effects of climate change intensify and appear to correlate with burgeoning processes of global urbanization, the object of the city itself has emerged as a central lens through which administrators, social scientists, a subsection of environmental activists, and policy wonks alike contemplate and seek to curtail environmental crises produced under the watch of modern industrial capitalism with all its attendant technological and social imperatives.[6] In addition to nitrogen, oxygen, carbon dioxide, and particulate matter of suspicious origin, the air we breathe today, so to speak, is infused with existential questions concerning sustainability, resilience, and urbanity itself. Whether at the scale of global policy discourse or local municipal administration, the figure of the city is increasingly an object of intense political concern.

This preoccupation has been met by a redoubled effort among urban scholars, designers, entrepreneurs, and planners to plumb the depths of the urban question and – with the help of novel computational methods and technologies – forge a "new science of

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[3] San Francisco Mayor's Office of Civic Innovation website. <https://www.innovation.sfgov.org/> (accessed August 1, 2019); Luke Fretwell, "New SF Effort Will Embed Startup DNA into Government," *Govfresh*, Oct. 2, 2013. <https://govfresh.com/2013/10/san-franciscos-entrepreneurship-residence-program/> (accessed August 1, 2019).

[4] Sidewalk Labs is Alphabet Inc.'s "urban innovation" organization. For its Toronto plan, see: <https://www.sidewalktoronto.ca/> (accessed August 1, 2019).

[5] United Nations, *World Urbanization Prospects: The 2011 Revision* (New York, 2012); UN-HABITAT, *State of the World's Cities, 2012/2013* (New York, 2013); World Bank, *World Development Report, 2009: Reshaping Economic Geography* (Washington, 2009); Rockefeller Foundation, *The 2013 Annual Report* (New York, 2013).

[6] Bruce Braun, "A New Urban Dispositif?" *Environment and Planning D: Society and Space* 32 (2014) pp. 49-64; Bruce Braun and Sarah Wakefield, "Governing the Resilient City," *Environment and Planning D: Society and Space* 32 (2014) pp. 4-11; Harriet Bulkeley, *Cities and Climate Change* (New York: Routledge, 2013).

cities."[7] While contemporary developments in the social scientific field of urban analysis continue to underwrite a variety of corporate governance initiatives under the alternative headings of "smart," "sustainable," and "resilient" city programs, perhaps the most far-reaching effect of these technical efforts to know the city resides precisely in the way that object has become defined. In contemporary urban theory and planning discourse, the city is posited as a "complex system" of land uses and social, technological, and ecological processes embedded within a global field of competition; the normative function of this city is to drive economic growth by facilitating dense interactions of human capital; and its defining feature is a capacity to evolve within a decision-making arena governed by market mechanisms. This characterization of the kind of problem a city poses remains consistent across a wide array of disciplinary backgrounds and ideological outlooks.[8]

Technological innovation has become something of a governing principle in American cities. A variety of strategies – from the establishment of corporate tax incentives and workforce retraining programs to urban redesign and revitalization schemes – have been pursued to both secure the competitive advantage of individual cities and render the public realm into the site of potential innovation. At root, these initiatives share a singular goal: they aim to instill in city dwellers the value of investing in one's self as human capital. As opposed to the classical liberal capitalist subject of the free worker who sells his or her labor power on the market as a commodity, the figure of human capital—popularized by Gary Becker of the Chicago School—denotes a self-investing subject who perpetually seeks to enhance his or her value and attract investors across all spheres of life, including those not previously qualified in economic terms.[9] Michel Feher suggests that human capital designates a "type of subjectivity" that is "simultaneously presupposed and targeted by neoliberal policies."[10] If attending to the conditions of market innovation frames the purpose of urban government today, then fostering an urban public capable of innovative behavior is an increasingly central governmental goal.

If calling forth city dwellers as human capital increasingly signals the ends of urban governance, then the deployment of interactive technological environments has come to serve as its means. In San Francisco, advocates of civic innovation have concentrated their efforts over the past decade on transforming the landscape of the city into a kind of open-air workshop where the sparks of interaction among units of human capital are thought to be the stuff of value. Central to this transformation has been the

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[7] Michael Batty, *The New Science of Cities* (Cambridge: MIT Press, 2013); Anthony Townsend, "Cities of Data: Examining the New Urban Science," *Public Culture* 27: 2 (2015) 201-212; Shannon Mattern, "Interfacing Urban Intelligence," *Places Journal* (April 2014).

[8] For an indicative survey, see: Allen Scott and Michael Storper, "The Nature of Cities: The Scope and Limit of Urban Theory," *International Journal of Urban and Regional Research* 39: 1 (2015) 1-15; Luis M.A. Bettencourt, "The Kind of Problem a City Is," Santa Fe Institute Working Paper 13-03-008; Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier* (New York: Penguin, 2011); Richard Florida, *The Rise of the Creative Class: How it's Transforming Work, Leisure, Community and Everyday life* (New York: Basic Books, 2002).

[9] Michel Foucault, *The Birth of Biopolitics*: *Lectures at the Collège de France, 1978-1979* (New York: Picador, 2008) pp. 215-233; Wendy Brown, *Undoing the Demos: Neoliberalism's Stealth Revolution* (New York: Zone Books, 2015) pp. 30-42.

[10] Michel Feher, "Self-Appreciation; or, The Aspirations of Human Capital," *Public Culture* 21 (2009) p. 23.

construction and public installation of Living Innovation Zones. And it's no accident that the first implemented design was taken straight from the floors of the Exploratorium, a novel interactive museum of science and technology in San Francisco [Figure 4.2]. Essentially, these installations are technical exhibit spaces designed to encourage people to engage in technological ways of seeing and interacting. Whether through the construction of real time data displays or the installation of street-level pedagogical exhibits, governmental projects in cities like San Francisco increasingly enroll sociotechnical forms of interactivity to impress upon city dwellers the importance of acquiring new skills, habits, relations, and types of literacy. Technological interactivity – a normative form of behavior linked to the figure of human capital and the ideal of self-investment in market practices – has been built into the grounds of the city as a means of urban government.



Figure 15: Unveiling of the first "Living Innovation Zone." **Source:** City of San Francisco.

When did these interactive technological environments emerge as pedagogical stages for the production of urban subjects? How did they become infused with the logic of market innovation? And how can thinking about them as contingent historical creations help us shed light on the present conditions of urban political life? I work in this chapter to answer to these questions by tracing the history the Exploratorium, one of the first and most influential interactive museums of science and technology. Founded by the physicist and educator Frank Oppenheimer in 1968, the museum provided a model for a new form of public pedagogy. Rather than emphasize measured observation and expert instruction like conventional science museums, Oppenheimer's model encouraged visitors to pursue hands on experimentation and direct interaction with exhibits and technical artifacts: oscillators, optical displays, pendulums, and organs among many others. Organized around the theme of human perception, the museum's sole injunction

was 'to play!' This approach to science education reflected Oppenheimer's view that the museum was first and foremost a profoundly "political institution." He believed that in an era when nearly all aspects of life were influenced by scientific and technological developments, it was of vital importance that citizens not only have a voice in technical matters but that they understand both the scientific principles underlying the natural world and the technological means by which those principles could be ascertained. Traditional science education – whether in the museums or the rote instruction of school classrooms – failed to do the latter. Technological society demanded interactive citizens, but interactive behavior itself had to be modeled.

Neither the creation of the Exploratorium nor Oppenheimer's role in its founding were inevitable. Indeed, a variety of historical and political events and processes converged to form the terrain upon which it could be imagined and built. After exploring two particularly important dimensions of that convergence in the following section – the unleashing of the atom bomb on Hiroshima and Nagasaki and the anticommunist crusades of McCarthyism – I sketch out Oppenheimer's vision for the museum as a political institution in greater detail. A participatory science and technology museum, he believed, provided a model for interactivity as a creative and politically valuable, indeed essential, form of behavior. I then proceed to track how that model was taken up nationally and internationally as well as how it became infused with the logic of market innovation and mobilized as means of urban rule in San Francisco. What had been conceived and constructed as a model to promote the growth of a creative and politically engaged citizenry in a technological era – the interactive technological environment – was later transformed and taken up as a means to call forth urban subjects as human capital in the city conceived as a socio-ecological system amenable to optimization.

The Bomb and the Blacklist

If, as a writer for the American Society of Landscape Architects suggested, one of the goals of the project to install interactive exhibits in public space was to render the urban landscape as such into a kind of museum where urban residents would "see and feel innovation at every corner over the course of a day," then it is worth taking stock of the conditions under which such a science and technology museum emerged in the first place.[11] The history of the Exploratorium is obviously bound up with the personal experiences of its founder, Frank Oppenheimer.[12] But it was the way in which two broader historical phenomena – the development and use of the atom bomb and the anticommunism of the Cold War – converged to shape Oppenheimer's life and outlook that ultimately led him to build a novel type of pedagogical center. A desire to make amends for his role in building a weapon capable of mass devastation and death,

[11] Jared Green, "San Francisco Wants You to See and Feel Innovation," *The Dirt: Uniting the Built and Natural Environments*, April 2, 2014. http://dirt.asla.org/2014/04/02/san-francisco-wants-you-to-see-and-feel-innovation/ (last accessed January, 2017).

[12] In addition to Oppenheimer's personal papers, the account of his life that I offer here draws upon a biography of the physicist written by his colleague and interlocutor: K.C. Cole*, Something Incredibly Wonderful Happens: Frank Oppenheimer and the World he Made Up* (Boston: Houghton Mifflin Harcourt, 2009).

combined with the fact that he was blacklisted from university physics for his political affiliations during Cold War, pushed Oppenheimer to conceive of and build an alternative space to pursue both science and politics.

Oppenheimer was a highly skilled particle physicist and the brother of J. Robert Oppenheimer, director of the Manhattan Project, the United States' effort to develop an atomic weapon during World War II. In the years before the war, the brothers had achieved considerable professional success in the field of physics: J. Robert took on a dual professorship at both the University of California, Berkeley and Cal Tech as Frank earned his PhD at the latter before taking a research position at Stanford. Concerned about the rise and spread of fascism, they both jumped at the chance to participate in the war effort. While Robert took over the Manhattan project, Frank helped build particle accelerators and oversaw safety procedures at the test site. Together, they watched the Trinity test explosion outside of Los Alamos with a combination of purpose, awe, and horror. The brothers saw it as their duty to humanity – conceived of in abstract and universal terms – to develop a weapon that could thwart the onslaught of militaristic aggression.[13]

But when the US dropped bombs on the civilian populations of Hiroshima and Nagasaki – a political decision made within the racialized and historical context of white supremacist policy-making in the US – the Oppenheimers struggled with the fact that they had played a part in developing weapons capable of destroying that humanity which they had hoped to save. Indeed, in their own ways, Robert and Frank spent the rest of their lives trying to come to terms with their respective wartime roles as "father" and "uncle" of the bomb. Before his death, Frank suggested that everything he had done in his life after the war – including establishing the Exploratorium – was a response to the part he played in developing the bomb.[14] While the power of the atom bomb to wipe out large swathes of humanity in a single blow informed Oppenheimer's trajectory as the founder of a museum, that trajectory was also shaped by the way in which McCarthyism and anti-communism limited his professional opportunities after the war.

In 1937, Oppenheimer joined the Communist Party and took up the alias Frank Folsom. Though his ideological commitment to the party eventually waned, it nonetheless offered an attractive platform from which to fight for social justice. Indeed, it took the lead in organizing against poverty and racism at home and fascism abroad, struggles that Oppenheimer actively embraced.[15] By the end of the decade, however, on the heels of Franco's victory in Spain and the signing of the Molotov-Ribbentrop pact between the Soviet Union and Hitler's Germany, he became disillusioned with party

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[13] Letter to Palmer Hoyt, September 23, 1961. Carton 1: Folder 33, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

[14] Cole, *Something Incredibly Wonderful Happens,* 281. A number of works – manuscripts, documentary films, and even an opera – have explored the role J. Robert Oppenheimer played in developing the first atom bomb as well as his response to its unleashing. For a scattershot sampling of these pieces, see, respectively, Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Alfred K. Knopf, 2005); *The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb,* directed by Jon Else (Santa Monica, CA: Pyramid Home Video, 1981); and *Doctor Atomic*, by John Adams with libretto by Peter Sellars, San Francisco Opera (San Francisco, October 1, 2005).

[15] See, for example, his discussion about "the class nature" of fascist society and the progressive role of the Communist Party both domestically and abroad: Unaddressed letter written in Pasadena and dated October, 1937. Carton 1: Folder 30, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

politics. While he quit the party for good in 1940, he continued to engage in progressive politics throughout the postwar years, including efforts to rescind military control over atomic weapon projects in favor of a more democratic system of decision-making.[16]

The FBI had investigated Oppenheimer's political affiliations even before the war started but it ceased surveillance operations during wartime. As anti-Soviet paranoia took hold in postwar America, anyone suspected of having communist leanings – and especially those scientists, like Oppenheimer, who had worked on the bomb to defeat fascism – became targets of suspicion. Agents began to trail him again at war's end when, following a brief stint as a researcher Berkeley, he was offered a permanent position at the University of Minnesota studying high-altitude cosmic rays. Apparently, someone within the FBI leaked information from Oppenheimer's file to the *Washington Times-Herald*, which ran a story in 1947 alleging that the brother of J. Robert Oppenheimer not only had communist sympathies but also was a party member and potential spy.[17] Oppenheimer publicly denied that any of it was true. When university administrators told him to produce a public statement testifying to as much, he obliged, writing that he had never been a member of the party. This lie would come back to haunt him. In 1949, the House Un-American Activities Committee (HUAC) summoned him to testify. Once in front of the committee, he divulged the fact that he had actually been a party member. In turn, he was fired from the University of Minnesota. His life would forever be altered.[18]

When Oppenheimer testified before HUAC, he copped to his own history but refused to provide any information about other individuals. That is, he refused to "name names." Such a refusal garnered not only ire from the committee but put him on a collision course with J. Edgar Hoover's FBI. He continued to seek a position in university physics, following up with a number of colleagues who had indicated he might fill in openings. But, time and time again, those positions would vanish before his eyes.[19] FBI agents continued to hound him as well as potential employers, indicating to him that he needed to cooperate if he wanted to continue his academic career. Oppenheimer remained firm in his refusal to name names. After receiving a number of offers to speak and work abroad, Oppenheimer attempted to renew his passport and his career internationally.[20] But his passport renewal was denied.[21] In effect, he was blacklisted from university physics.

Devastated by his banishment from the profession, Oppenheimer went into exile in the mountains of Colorado. He would remain there – and away from university physics – until the late 1950s. Having earlier purchased land outside of the town of Pagosa

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[16] "Atom Bomb-Nightmare Weapon: Scientist Tells CIO it Must Be Controlled," *Labor Herald*, Sec. 2, Pg. 1, December 14, 1945.

[17] "U.S. Atom Scientist's Brother Exposed as Communist Who Worked on A-Bomb," *Washington Times-Herald*, July 12, 1947.

[18] In a letter to the chair of the physics department at the University of Colorado, Oppenheimer offered an "outline of the relevant events" in his personal history. Letter to Mr. Brittin, No Date. Carton 1: Folder 50, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

[19] Letter from Arthur H. Snell, December 16, 1958; Letter from Wolfgang Panofsky, January 13, 1959. Carton 1: Folder 23, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

[20] Letter to Professor Woxen, October 11, 1947. Carton 1: Folder 32, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

[21] Letters from the Department of State to Frank Oppenheimer, August 6, 1947 and March 30, 1950. Carton 1: Folder 23, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

Springs, he tried his hand at cattle ranching and began teaching basic science classes at the local high school. He later described teaching high school science as the most challenging work he had ever attempted and he spent countless hours developing hands-on experiments and course work designed to inspire enthusiasm in his students. In hindsight, these years proved crucial in pushing him to consider the merits of interactive science education. After nearly a decade in Pagosa Springs, Oppenheimer moved to Boulder with the hope of reentering the academy. In 1959, he secured employment as a research associate at the University of Colorado and two years later was hired on as a professor.[22]

While Oppenheimer was happy to be back within the milieu of academic physics, he was disheartened by the state of the university. Students, he found, were interested more in the possibility of making money than in the joy of learning; his colleagues appeared to care more about receiving credit for discoveries than actually making them; and teaching conventions centered upon rote instruction and memorization. Within such an environment, the pedagogical philosophies he had acquired in the mountains continued to inform his work and his interest in teaching. Along with a colleague, he built a new physics laboratory at the university, which he named the "Library of Experiments" and included eighty experimental prototypes offering lessons on everything from radioactive decay to the Doppler effect.[23] In many ways, the new laboratory was very much like a participatory museum.

In 1965, Oppenheimer received a Guggenheim fellowship to pursue research at University College in London.[24] His interest in alternative forms of science education led him to explore a number of museums and educational centers throughout Europe. Three institutions, in particular, impressed him a great deal and would inform his later efforts to develop a new type of institution. At the Palais de la Decouverte in Paris, various models were deployed to demonstrate scientific concepts and high school students were employed to explain the principles on display. The South Kensington Museum of Science and Art struck Oppenheimer as an example of the way in which educational centers could emphasize the creative nature of learning. And the Deutsches Museum in Munich not only demonstrated natural laws but also illustrated how they could be applied in the service of industry. Upon his return to the United States, he began to widely discuss and write about the importance of public science museums as corollaries to public schools.[25]

Oppenheimer soon committed himself to creating what had yet to exist: an alternative space for science and interactive science education. The only question left was where to build it. San Francisco emerged as a compelling option. Both Oppenheimer and his wife, Jackie, had friends and colleagues in the area. Moreover, Frank had a number of professional connections and supporters at Berkeley and Stanford. When they took a trip to the city to feel out possibilities for a new museum, they learned that the newly refurbished Palace of Fine Arts – a grand hall designed by Bernard Maybeck for the

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[22] Cole, *Something Wonderful Happens*, pp. 101-143.
[23] "The Library of Experiments at the University of Colorado," 1964. Carton 5: Folder 14, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.
[24] Guggenheim Fellowship, 1965. Carton 7: Folder 10, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.
[25] Letter to Zack, January 6, 1967. Carton 1: Folder 39, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley; Frank Oppenheimer, "The Role of Science Museums." In *Museums and Education*, ed. Eric Larrabee (Washington D.C.: Smithsonian Institution Press, 1968) pp. 167-178.

Panama Pacific International Exhibition in 1915 – was available for lease. Through contacts at the San Francisco *Chronicle*, the city's biggest newspaper, Oppenheimer met with the Mayor, the Board of Supervisors, and the chamber of commerce to pitch the idea of housing a new type of museum in the building. After Oppenheimer formed a nonprofit and a board of trustees for the museum, the city awarded the Exploratorium a dollar-a-year lease. In August of 1969, the doors of the Palace of Fine Arts creaked open without fanfare. A sign hung above the door read, "Here is Being Created the Exploratorium / A Community Museum Dedicated to Awareness."[26]

A Model Museum

A cacophonous scene greeted visitors to the Exploratorium during its first few months. A series of exhibits originally organized by Jasia Reichardt for a show at London's Institute for Contemporary Art entitled *Cybernetic Serendipity* were scattered throughout the Palace of Fine Art's cavernous space: walls of computers buzzed and beeped, some beckoning observers to turn their dials and punch their buttons; flashing lights, swinging pendulums, and computer-generated graphics provided a smorgasbord of movement and image; and sound-sensing robots reacted to the inputs offered by visitors-turned-participants. Algorithmically programmed machines lay at the heart of the museum's festivities. But, unlike conventional science and technology centers, visitor interaction with those machines – indeed, the very the principle of interactivity – proved to be its *raison d'être.*[27]

The interactive technological environment that visitors encountered in the fall of 1969 was an early material and spatial expression of pedagogical ideas and philosophies developed by Oppenheimer over the previous decades. An essay written by Oppenheimer in 1967 and published in 1968 entitled "A Rationale for a Science Museum" offered a succinct blueprint for what would become the Exploratorium. In it, he emphasized that because science had come to "shape the nature of our society" in all encompassing ways, there was "an increasing need to develop public understanding" of it. Indeed, the ongoing application of scientific concepts to "industrial processes" ensured that every dimension of human life – from the clothes we wear and the buildings we dwell in to the food we eat and the medicine we consume – was touched by science and technology.[28] Moreover, in an era of potential nuclear war, Oppenheimer suggested, it was necessary for the survival of democratic practices and societies more broadly that citizens endeavor to understand the nature and application of scientific principles.

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[26] Cole, *Something Wonderful Happens*, pp. 147-157. Quote, p. 157; Frank Oppenheimer to the Board of Directors of the Palace of Arts and Science Foundation, December 4, 1968 and August 21, 1969. Carton 2: Folder 1, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley; Mayor Joseph Alioto to Donald McLaughlin, April 17, 1969. Carton 4: Folder 1, Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley; Status Report, Palace of Arts and Science, August 25, 1969. Carton 2: Folder 2, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[27] Status Report, Palace of Arts and Science, November 1, 1969. Carton 1: Folder 1, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley; *San Francisco Chronicle*, October 16, 1969.

[28] Frank Oppenheimer, "A Rationale for a Science Museum," *Curator* 11 (November 1968) p. 206.

Yet, despite the centrality of science and technology to everyday life, Oppenheimer pointed to what he saw as an ever-widening gap in understanding between practitioners and the general public. Indeed, he gestured toward the increasing prevalence of outright hostility toward scientific and technological developments, a general pessimism he might have understood given his response to Hiroshima and Nagasaki but nonetheless did not share. "The phenomena of basic science which have become the raw material of invention are not easily accessible by the direct and unaided observation of nature," he wrote. "Yet, they are natural phenomena which have, for one segment of society, become as intriguing and as beautiful as a butterfly or a flower." For Oppenheimer, this condition of social disparity suggested a need to "bridge the gap between experts and laymen."[29]

Oppenheimer acknowledged the important intent of public schools and traditional museums of science and natural history to induce a general understanding of scientific principles. In fact, he saw a well-funded and appropriately staffed public school system as integral to social wellbeing. Yet, when it came to educating the public on science and technology, he argued that public schools and most museums were "at a disadvantage because they lack props." That is, those institutions weren't able to sufficiently mobilize the technologies and mediating aids required for non-experts to observe the "basic phenomena of science." In "A Rationale for a Science Museum," Oppenheimer argued that efforts to successfully educate the public about science "require apparatus which people can see and handle and which display phenomena which people can turn on and off and vary at will. Explaining science and technology without props can resemble an attempt to tell what it is like to swim without ever letting a person near the water."[30]

The solution to the problem of public science pedagogy, according to Oppenheimer, hinged upon the construction of interactive environments in which people could "learn to swim" in the waters of a technological society. "There is a growing need," he wrote in his manifesto, "for an environment in which people can become familiar with the details of science and technology and begin to gain some understanding by controlling and watching the behavior of laboratory apparatus and machinery; such a place can arouse the latent curiosity and can provide at least partial answers."[31] In addition to eliciting behaviors and outlooks necessary for technological citizenship, Oppenheimer suggested that the "laboratory atmospheres of such an 'exploratorium' could then be supplemented with historical displays showing the development of both science and technology and its roots in the past."[32] The eventual and ongoing production of the actually existing museum would bear a striking resemblance to the one outlined in Oppenheimer's essay. The production of urban residents capable of engaging with the technological basis of postwar life did indeed seem to hinge upon the production of an interactive pedagogical space.

From the very start, Oppenheimer envisioned the Exploratorium to be above all a political institution. He made this explicit in an interview with the filmmaker Jon Else: "The Manhattan Project had a political motivation as well as a technical one. And so does

[29] Oppenheimer, "A Rationale," p. 206.
[30] Oppenheimer, "A Rationale," p. 206.
[31] Oppenheimer, "A Rationale," p. 206.
[32] Oppenheimer, "A Rationale," pp. 206-207

the Exploratorium."[33] Disheartened by public skepticism toward science and technology and what he perceived as a general turning away from what he deemed a "rational" pursuit of knowledge about the natural world during the postwar years, he hoped to encourage renewed curiosity in people by providing the conditions under which they could explore scientific principles on their own rather than be lectured about them by experts. "The whole point of the Exploratorium," Oppenheimer once stated, "is to make it possible for people to believe they can understand the world around them. I think a lot of people have given up trying to comprehend things, and when they give up with the physical world, they give up with the social and political world as well. If we give up trying to understand things, I think we'll all be sunk."[34]

At the heart of the Exploratorium's character as a political institution lay its message of active engagement. Visitors were encouraged to engage with the exhibits and demonstrations, to make their own observations, to follow their own interests rather than some script, and to play with the technologies on display. That is, they were to be participants in the process of learning rather than mere observers of artifacts. Of course, Oppenheimer and his staff were the ones who decided which kinds of principles, demonstrations, and paths of discovery could be chosen. Nonetheless, the form of empowerment that girded the museum's political goals depended upon – indeed, demanded – that visitors embrace technological interactivity as a form of behavior.[35] As I will show in the next section, this type of empowerment – and the interactive environments that enable it – would later be taken up and transformed into a means of urban government not imagined by Oppenheimer and his interlocutors.

It was an important moment – a crucial step forward towards realizing Oppenheimer's vision of a new kind of participatory science and technology museum – when the doors of the Exploratorium swung open on October 11, 1969. Not only was it the day of the first public unveiling of the *Cybernetic Serendipity* exhibition on the West Coast of the United States,[36] it was also the first event publicly advertised by the Exploratorium, the museum's grand opening as it were. Indeed, for all intents and purposes, the exhibition served as the new institution's statement of purpose.[37] While *Cybernetic Serendipity* featured a variety of cybernetic devices demonstrating mechanisms of feedback – technologies and processes considered to be of significant pedagogical import – it also embodied two principles, one philosophical and the other organizational, that the Exploratorium would continue to grow around.[38]

The first component of *Cybernetic Serendipity* that simultaneously reflected the mission of the Exploratorium and helped materialize that mission was its aesthetic

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[33]Interview by Jon Else, Carton 7: Folder 31, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley; Also quoted in Cole, *Something Wonderful Happens*, p. 234

[34] Hilde Hein, *The Exploratorium: The Museum as Laboratory* (Washington D.C.: The Smithsonian Institution Press, 1990) p. xv.

[35] While the ideal of interactive democratic empowerment can be found across virtually all of Oppenheimer's writings on the museum, later scholars suggested explicitly that it lay at the heart of the institution: Hein, *The Exploratorium,* xiv; Barry, *Political Machines,* 135; Cole, *Something Incredibly Wonderful Happens.*

[36] The exhibition traveled from London to the Corcoran Annex in Washington, D.C. before being commissioned by the Exploratorium. See, Status Report, Palace of Arts and Science, November 1, 1969. Carton 1: Folder 1, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[37] Hein, *The Exploratorium*, pp. 23-44.

[38] Jasia Reichardt, *Cybernetic Serendipity: The Computer and the Arts* (Praeger, 1969).

dimension – the fact that, as a public exhibition, it unabashedly sought to bring science and technology into the realm of the arts. While the different exhibits making up *Cybernetic Serendipity* emphasized various ways in which electronic and computer technologies could be taken up in the service of cultural production, the exhibition as a whole explored the relationship between random systems employed by artists and the goal-oriented ones devised by engineers.[39] In his rationale for the museum, Oppenheimer had previously emphasized that it needed to "have an aesthetic appeal as well as a pedagogical purpose," reflecting an underlying belief in the unity of art and science as creative processes of human understanding.[40] The Exploratorium invited local artists – including members of the newly formed West Coast chapter of Experiments in Art and Technology (EAT) – to display their work at the same time as the Cybernetic Serendipity exhibition. Beyond featuring artistic exhibits and eventually establishing an artist-in-residency program, the museum established itself as an important meeting and exhibit space for counter cultural artists and technologists in the Bay Area.[41]

The second aspect of *Cybernetic Serendipity* that served to materialize the philosophy of the Exploratorium had to do with the museum's thematic organization and was linked to the goal of interactivity. The exhibition was able to showcase the relationship between artistic and scientific modes of understanding through its emphasis on human perception and technological interaction. The first exhibits secured by the museum were either donated or salvaged – including an accelerator from Stanford, optical displays on imaging from Lockheed, and a cloud chamber from NASA – but none of them explicitly invoked human perception as a theme.[42] Oppenheimer knew it would take time to fill up the museum space with exhibits, and explicitly embraced an "opportunistic" stance toward acquiring and building the various "trees" that would make up his "woods of natural phenomena."[43] But, in his blueprint for the Exploratorium, he sketched out a potential organizational scheme for the museum that would introduce "the various areas of science and technology with sections dealing with the psychology of perception and the artistry associated with the various areas of perception."[44] This "possible form of organization" included sections on hearing and sound, vision and light, taste and smell, touch (including heat and cold as well as roughness), and a final section on control and feedback. Building experimental exhibits around this theme, Oppenheimer suggested, would enable visitors to engage not only with the scientific principles and concepts underlying natural phenomena and the biological and physiological dimensions of human sense perception but would also necessarily introduce to visitors the various technologies and mediating devices required to observe natural phenomena in the first place.[45]

The *Cybernetic Serendipity* exhibit remained at the Exploratorium for the next two years, drawing considerable notice from critics and the Bay Area public alike. Several pieces of the original exhibition, such as the "Pendulum Harmonograph"

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[39] Hein, *The Exploratorium*, p. 34.
[40] Oppenheimer, "A Rationale," p. 207.
[41] Hein, *The Exploratorium*, p. 40.
[42] Status Report, The Palace of Arts and Science, November 1, 1969. Carton 2: Folder 1, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.
[43] Cole, *Something Incredibly Wonderful Happens*, p. 16.
[44] Oppenheimer, "A Rationale," p. 207.
[45] Oppenheimer, "A Rationale," pp. 207-209.

(renamed the "Drawing Board"), which demonstrated pattern formation, remained at museum on permanent display. Over the years that followed, the Exploratorium continued to both build and acquire a plethora of experimental exhibits – optical displays and light refractors, oscillators, touch-sensitive plant aquariums, a "shadow box," a catenary arch made out of wooden blocks, and even an electronics laboratory – many of which centered upon the theme of human perception outlined in "A Rationale for a Science Museum." If there were a single component of the Exploratorium that remained constant throughout the museum's development, it would have to be the open workshop. As the place where new exhibits were built and old ones repaired, the workshop figured as central as any other exhibit in embodying the philosophy and purpose of the Exploratorium. Oppenheimer argued that everything in the museum had to be transparent, clarifying, and fundamentally honest rather than merely clever, obfuscating, or mystical, including the business of building and maintaining exhibits.[46] Moreover, because he believed that the public needed to approach and interact with exhibits in a way similar to how a scientist approaches phenomena in the natural world or the laboratory, he argued that the "laboratory apparatus" should be at the center of the participatory science and technology museum.[47]

Though the Exploratorium started off in a rather inauspicious manner, it soon began to garner considerable public attention as well as notoriety in scientific and pedagogical circles as both the birthplace of interactive science and technology education and a model for other museums to emulate. While colleagues and friends of Oppenheimer such as the physicists Luis Alvarez and Wolfgang Panofsky as well as the famed architect and designer Buckminster Fuller voiced their admiration for the museum and pledged their support, funding agencies, museum associations, and educators in San Francisco and the beyond began to take note of the pedagogical innovations on display at the Exploratorium.[48] It also began to attract attention from abroad; an early delegation from the People's Republic of China declared the Exploratorium a prime example of what a "People's Museum" could be.[49] By the time of Oppenheimer's death in 1985, the museum was widely recognized as a prime example of how the principle of interactivity might be mobilized on behalf of public science and technology education. Spin-offs of the Exploratorium sprouted up in Beijing, Paris, Rio de Janeiro, Budapest, Seoul, and Bombay among other countries throughout the 1970s and 1980s. The director of the New York Hall of Science called the Exploratorium one of the most influential museums in the world.[50] If the Exploratorium provided a kind of model with which pedagogical institutions sought to elicit interactive forms of behavior from the public, the diffusion of that model has since shaped science and technology education around the world.

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[46] This included – somewhat paradoxically considering his desire to attain the Cybernetic Serendipity exhibition – a suspicion of computers and chips more generally as obfuscating rather than clarifying pedagogical devices. See Cole, *Something Incredibly Wonderful Happens*, p. 155.

[47] Oppenheimer, "A Rationale," p. 209.

[48] See Frank Oppenheimer, Correspondence, Incoming Letters. Carton 4: Folders 1-28, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley and Correspondence, Incoming Letters. Carton 1: Folders 1-28, Frank Oppenheimer papers BANC MSS 98/136 c, Bancroft Library, Berkeley.

[49] Frank J. Oppenheimer and Karen C. Cole, "The Exploratorium: A Participatory Museum," *Prospects,* vol. IV, No. 1 (Spring 1974) pp. 21-34.

[50] Cole, *Something Incredibly Wonderful Happens*, p. 302.

An Infusion of Market Logics

In contemporary urban planning and policy debate, the city is posited as a complex system of agglomerated land uses and social, technological, and ecological processes embedded within a global network of cities; the normative function of this city is to drive economic growth by facilitating dense interactions of human capital; and its defining feature is a capacity to evolve within a decision-making arena governed by market mechanisms.[51] Rather than pursue regulations or the redistribution of social wealth, urban government within this framework is relegated to the role of promoting the conditions for market innovation and competition. And a fundamental precondition for market innovation is the existence of an urban population willing and able to engage in innovative behavior. Whereas the wellbeing of contemporary cities in "advanced industrial economies" is measured in terms of the population's possession and acquisition of scientific and intellectual capital, strategies of urban government have come to increasingly hinge upon maintaining and growing that capital. In other words, the ends of urban government today center more and more upon the production of urban subjects who simultaneously understand themselves to be and act as self-investing units of human capital.

In San Francisco, design interventions in the built environment – including the construction and public installation of interactive science and technology exhibits – have emerged as a means by which advocates of "civic innovation" work to encourage the formation of self-managing and self-investing subjects. That is, the model of public science and technology pedagogy offered by the Exploratorium has been taken up on behalf of governmental projects promoting market-based modes of urban rule. How did an experiment in participatory science and technology education morph into a means for neoliberal government? How did the pedagogical environment constructed by Oppenheimer as a place of discovery in which people could engage in the process of scientific understanding – an interactive space designed to change the way people see and live in the political and physical world – become a tool to render urban subjects into human capital?

To answer these questions, I explore in this section a set of distinct yet interrelated factors that contributed to both the way in which the model offered by the Exploratorium was taken up and transformed. But before doing so it is worth considering how the principle that girded the political potential of Oppenheimer's model – interactivity – also helped constitute the terrain upon which a novel framework for government would eventually take hold. "Interactivity," according to Andrew Barry, "is more than a particular technological form. It provides what Deleuze calls a diagram for organizing the relations between objects and persons. Today, interactivity has come to be a dominant model of how objects can be used to produce subjects. In an interactive model, subjects are not disciplined, they are *allowed*."[52] Rather than the ordered spaces characteristic of the deployment of disciplinary power, the birth of the interactive technological environment signals the emergence of a novel strategy of power – a mode

[51] This general formulation animates urban discourse and cuts across a variety of academic, political, and theoretical affiliations. See Chapter 1 of this dissertation for an overview.
[52] Barry, *Political Machines*, 129.

of government that attends to the conditions under which urban subjects might allow themselves to be persuaded of the benefits of certain forms of behavior and types of self-investment.

Interestingly, Oppenheimer's thoughts on "the role of science in the domain of human relations" suggested the necessity of a similar shift in the domain of science education. The problem, as he saw it, was the way in which scientists themselves had conceived of and communicated the place and character of science in society. Popular understanding of science had come to center on the capacity of scientific and technological inventions to predict and control things in the world. "People," Oppenheimer mused, "not wanting to be predicted and controlled, react by rejecting both the social and the physical sciences." But he suggested that the true beauty of science hinged not on prediction and control but on the capacity to understand the world – to answer the question: why? To convince someone of something requires, at root, that you persuade she or he of its veracity. Thus, Oppenheimer argued stringently that science and science education should center upon persuasion rather than coercion. [53] I cannot help myself from pointing out that a formulation maps on to the historical emergence of biopolitical power in suggestive fashion.

The political effects of interactivity can be ascertained by focusing on the contrast between the logics animating contemporary museums and the earlier public function assigned to them. The modern museum emerged in the nineteenth century as a place where the successes of the imperial state could be displayed and justified, a monument of artifacts, so to speak, celebrating European conquest and racial superiority.[54] But it was also envisioned as liberal space within which middle- and working-class subjects could participate in their own cultural and moral improvement. According to Tony Bennett, the museum served as a tool to help govern a bourgeois public "by providing it with the resources and contexts in which it might become self-educating and self-regulating."[55] It was a place to see and be seen. Through ordering techniques of display and visibility, the nineteenth-century museum encouraged the formation of self-governing liberal subjects.

By the turn of the century, earlier notions about culture as a means of moral uplift had given way, at least in part, to a conception of culture as a consumer good. Traditional museums were seen as paternalistic, stodgy, dominated by the concerns of curators, and ultimately too dependent on government subsidy. In light of declining government funding for social services and the arts as well as a general dwindling of public subsidy more generally, the argument that museums needed to be more competitive and run like business enterprises emerged as a rallying cry for administrators. "The battlefield will be the marketplace," director of the London Science Museum Neil Cossons suggested, "and the casualties will be those museums that fail to adapt."[56] Accompanying this debate over the institutional character of the museum was a growing insistence that the economic health of polities more broadly – cities, countries, regions – would in the future depend on the intellectual and scientific capital of their populations.

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[53] Frank Oppenheimer, "Science and the Ethics of Coercion," No date. Carton 2; Folder 23, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.
[54] See, Timothy Mitchell, *Colonizing Egypt* (Berkeley: University of California Press, 1991).
[55] Tony Bennett, *The Birth of the Museum: History, Theory, Politics* (Routledge, 1995) p. 40.
[56] Barry, *Political Machines*, 134

Within this shifting context, the principle of interactivity played a dual role. On the one hand, it offered museums a tool with which to economize their relationship to visitors as well as industry. In a business climate where competition over visitors determined continued institutional prosperity, a product that offered playful engagement and individual consumer choice proved attractive. The form of democratic empowerment originally envisioned by Oppenheimer as a key political consequence of interactive education became yoked to market logics. In practice, political empowerment became synonymous with the empowerment of consumers. On the other hand, interactivity offered a partial solution to the problem of government by providing a means to encourage the self-management of visitors. The interactive technological environment served as a milieu in which visitors, through their bodily and material engagement with exhibits and technical devices, made phenomena and scientific principles visible to themselves and in the process learned the value of acquiring and developing technical capacities, habits, and forms of literacy. Self-experimentation promised a means with which to instill in urban subjects the importance of self-investment – and secure the economic wellbeing of the collective whole in a technological era of market competition. While the model of interactivity put into practice at the Exploratorium provided fertile ground for the cultivation and dissemination of market-based political rationalities, as an institution, the museum itself underwent a profound transformation over the years.

Throughout the first decade of its existence, the Exploratorium was kept afloat thanks to the efforts of Oppenheimer, who sold the idea of an interactive science and technology museum and secured funding for it on an ad-hoc basis. After winning a start-up grant from the San Francisco Foundation in 1969, he worked to obtain financial resources from governmental agencies and philanthropic organizations and solicited donations from wealthy residents and corporations. While his initial attempts to win grants from large funding organizations failed because the museum was not a credential-granting outfit, Oppenheimer was soon able to secure governmental and foundation funds for the museum by emphasizing its teacher training and workshop apprentice programs. In the late 1970s, the museum hired a development director in order to formulate and pursue an aggressive fundraising plan. Nonetheless, lacking any permanent form of public subsidy, the first ten years of the Exploratorium's life proved somewhat precarious and financially uncertain.[57]

During these early years, the Exploratorium simultaneously promoted and reflected a growing governmental preoccupation over public understandings of science and technology. On one hand, it shook up the way large funding organizations awarded research grants. When the National Science Foundation (NSF) rejected Oppenheimer's initial application for educational research funds, for example, it did so because prior standards dictated that funding go to "certifying" institutions. But it was subsequently impressed with the museum's rationale as well as its emphasis on public engagement with science and technology. In 1971, the NSF awarded a grant to the Exploratorium as an educational research institution, marking a break in its prior resistance to funding public science museums. On the other hand, the museum reflected a broader trend in the United States to impress upon the public the need to understand and engage with science and technology. In the years after the NSF awarded the Exploratorium funding, for instance, the U.S. Department of Health, Education, and Welfare created a new agency

[57] Hein, *The Exploratorium*, pp. 171-197; Cole, *Something Incredibly Wonderful Happens*.

called the Institute of Museum Services to promote public interest in what is referred to today as the STEM (Science, Technology, Engineering, ad Math) fields.[58] By the dawn of the 1980s, the Exploratorium – and a growing number of offshoots – financially depended upon grants from governmental agencies at the federal, state, and municipal levels.

While corporate and individual donations had been a part of the Exploratorium's financial survival strategy from the very beginning, two political phenomena – the passage of Proposition 13 in California and the onset of what Jamie Peck has termed "rollback neoliberalism" under the Reagan administration – injected corporate interests into the heart of the museum.[59] An amendment to the California State Constitution enacted in 1978 by means of the initiative process, Proposition 13 drastically decreased property taxes in the state and restricted the amount of annual increases. By targeting the mechanism by which the social redistribution of wealth had been increasingly pursued in postwar California, Proposition 13 effectually limited the state's ability to fund social and educational programs.[60] Moreover, Ronald Reagan rode the wave of the "taxpayer revolt" into the White House two years later. The new regime began to slash government funding for all sorts of agencies, including the NSF, which had been an important source of support for the Exploratorium.[61] Funds from federal agencies dropped from 39 percent of the museum's income in 1979 to a mere 6 percent in 1983. State support also dropped to 6 percent of the museum's income that year.[62] Pressure to keep operations afloat in lieu of government support continued to mount, and the Exploratorium – in competition with other arts and educational institutions – turned to what appeared to be its only financial option: presenting itself as a sound moral and business investment to corporate donors.[63]

Despite the fact that the Exploratorium's survival increasingly depended on corporate and individual gifts, Oppenheimer refused to entertain the notion that the museum itself should be run like a business – drawing the ire of the institution's business-savvy board of directors. One of the museum's founding principles, for example, was that it should free and open to everyone; Oppenheimer refused to charge an admission fee even during the museum's lean early years. As pressure to secure long-term financing for the museum increased after the passage of Proposition 13, Oppenheimer and the museum's development director, Virginia Rubin, looked to build an endowment that would ensure the Exploratorium's future stability. They found a willing partner in the Columbia Foundation, which pledged what would amount to $10 million over ten years if the museum could raise $750,000 over the next four. Another condition, however, was that the museum undergo an audit by a professional evaluator,

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[58] Karen A. Rader and Victoria E. M. Cain, *Life on Display: Revolutionizing U.S. Museums of Science and Natural History in the Twentieth Century* (University of Chicago Press, 2014): n. 34, p. 370.
[59] Jamie Peck, *Constructions of Neoliberal Reason* (Oxford University Press, 2010).
[60] R. Jeffery Lustig, ed., *Remaking California: Reclaiming the Public Good* (Berkeley: Heyday Books, 2010).
[61] Daniel A. Smith, "Howard Jarvis, Populist Entrepreneur: Reevaluating the Causes of Proposition 13," *Social Science History* 23: 2 (Summer, 1999) pp. 173-210; David Harvey, *A Brief History of Neoliberalism* (Oxford University Press, 2007).
[62] Hein, *The Exploratorium*.
[63] But not just any corporate donors. The Chair of the Board of Directors, F. Van Kasper, explicitly called for the museum to reach out to "companies in the South Bay," i.e. Silicon Valley, for sponsorship: Minutes of the Board Meeting, January 10, 1984. Box 1: Folder 3, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

whose critical assessment led to a more active role in the management of the museum by the board of directors.[64] And what the board of directors wanted was a business model. In 1983, in a cruel twist of fate, the board sought to remove Frank from his position as lead administrator, arguing that the day-to-day manager of the museum should have a keen head for business.[65] By the time of Oppenheimer's death in 1985, the Exploratorium charged admission and was increasingly run like profit-seeking enterprise.[66]

Through the latter half of the 1980s and 1990s, with the emergence of the Internet and Silicon Valley's cyber-libertarian fever dream, a new corporate culture began to take hold over the museum. Companies such as IBM, Apple, Cisco, Lockheed Martin, and Microsoft pumped money into the organization in exchange for subtle forms of influence (through public persuasion) and public visibility (through dollars).[67] Ongoing tensions over layoffs and the character of the museum among long time staff members, an increasingly stratified class of managers, and a new business-minded board of directors – tensions rooted in the transformation of the museum into a profit-seeking enterprise – resulted in a protracted unionization battle.[68] The new director, Goery Delacote, a French physicist who had started a museum similar to the Exploratorium in Paris a few years earlier, suggested that a union was not the creative response worthy of the museum.[69] Nonetheless, staff members overwhelmingly voted in favor of joining a local of the SEIU.[70] Throughout the 1990s, the gap between the staff on the one hand and management and board of directors widened.

"Nobody but Frank could have built the Exploratorium. But Frank couldn't get hired to run the Exploratorium today," one-time director Van Kasper later surmised. "He couldn't get hired to run *any* museum today."[71] In some ways, the history of the Exploratorium provides a lens into how the retreat from the postwar welfare state effected social and educational institutions. Ironically, the museum that Frank Oppenheimer conceived of as an antidote to nefarious business and political practices had become a tool with which administrators and corporate interests could work to persuade visitors to respond to market reality by engaging in innovative behavior. Perhaps it's no wonder that advocates of civic innovation today want to render the urban landscape itself into a version of interactive science and technology museum.

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[64] Cole, *Something Incredibly Wonderful Happens*; Hein, *The Exploratorium.*

[65] Minutes of the Board Meeting, 1983, Box 1: Folder 2, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[66] Financial Statement and Auditors' Report, The Exploratorium, May 31, 1985 (With Comparative Totals for 1984), Box 1: Folder 3; Minutes of the Board Meeting, January 10, 1985, Box 1: Folder 3, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[67] The embrace of the Exploratorium among technology corporations was expressed perhaps most impressively in 1984 when the museum teamed up with IBM to organize the "Seeing the Light" exhibit in New York. See "Seeing the Light" Pamphlet, Carton 36: Folder 46, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[68] Joseph G. Ansel, Jr., "The Unionization of the Exploratorium." In *Institutional Trauma: Major Changes in Museums and its Effect on Staff,* ed. Elaine Heumann Gurian (Washington D.C.: American Association of Museums, 1995).

[69] Memorandum to all employees from Goery Delacote, 1990, Carton 9: Folder 45, Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[70] Memorandum from Goery Delacote to Exploratorium Staff, December 6, 1991. Carton 9: Folder 45. Exploratorium Records. BANC MSS 87/184, Bancroft Library, Berkeley.

[71] Quoted in Cole, *Something Incredibly Wonderful Happens*, 291.

Staging the City as a Laboratory for Innovation



Figure 16: A view of the city from the museum's observatory. **Source:** Author's Photo.

In 2013, the Exploratorium moved out of the Palace of Fine Arts and into a spectacular new $220 million home on the downtown waterfront. In addition to a 330,000-square foot exhibition hall, the new structure – erected on a pair of retrofitted piers – included a swanky restaurant, a gift shop, and an impressive observatory overlooking the bay. As what *Time Magazine* referred to as "A Bigger, Better Playground for the Mind," the new building – and the museum's new location – also embodied something of the transformation that the institution had had gone through since its birth.[72] After all, the museum had become a darling of the city's political and entrepreneurial classes, promoted as a premier tourist attraction by municipal authorities and coddled like a stepchild of the Bay Area's tech-centric business community. Corporate sponsors, including computer- and bio- technology companies such as Autodesk, Intel, Salesforce, and Genentech among others, figured prominently in the museum as well as its promotional literature; matching gifts from Apple, Adobe Systems, Google, Hewlett-Packard, and IBM helped sustain the museum and its move. While

[72] Harry McCracken, "San Francisco's New Exploratorium: A Bigger, Better Playground for the Mind," *Time.* April 17, 2013. <http://techland.time.com/2013/04/17/san-franciscos-new-exploratorium-a-bigger-better-playground-for-the-mind/> (last accessed November 10, 2017).

private contributions made up 33.4 percent of the museum's revenue during the first year at its new location, over 56 percent of its annual revenue was earned income.[73] The glass-ensconced new building – jutting out over the sparkling waters of the San Francisco Bay near Fisherman's Wharf and other tourist destinations – seemed to mark the museum's coming of age as both a civic institution and a business enterprise.[74]

Not long after the museum moved to its new location, I paid it a visit. It did not disappoint. The size and scope of the place, combined with the atmosphere created by hundreds of frolicking children, parents, teenagers, and millennials, was impressive. I perused the exhibits, tinkered with gadgets, and watched other visitors explore the space's various nooks and crannies. I made sure to stop by the open workshop located at the center of the building. An exhibit designer appeared to be working on some wiring. While the majority of the 600-plus experimental exhibits scattered throughout the building were transported from the Palace of Fine Arts, the showpiece of the new museum, the only part of the structure built from scratch, was the Fisher Bay Observatory. I had to check it out.

As I made my way up the stairs to the viewing platform, I got an eerie sense of being whisked away from the practical exhibits on the ground floor to some supposedly loftier place of understanding. Upon entering the observatory, I and other visitors were invited to take part in "Visualizing the Bay," a seemingly effortless feat considering the floor-to-ceiling windows that framed panoramas of both the San Francisco Bay and the city's skyline. Indeed, standing on the observation deck inside what amounts to a giant glass cube, I couldn't help but feel impressed by the imposing world outside. Juxtaposed against the exterior environment – and corresponding to it with remarkable accuracy – were a number of carefully crafted and positioned simulations of that outside world. The winds and the tides, as well as the trade routes of international commerce filtering through the Golden Gate, were literally on display – and on the same digital map at that. Not only did these maps and models help visitors locate and see particular features of the world before them – from the composition of soil and the pattern of water currents to historical property developments and commercial shipping routes – they also affirmed the veracity of the observers' own perspective.

In addition to providing a platform from which to take in the grandeur of both the bay and the city, the observatory also staged the course of history in the metropolis. An impressive catalogue of historical materials – from nineteenth-century cadastral maps and topographical surveys to twentieth-century aerial photographs to contemporary satellite images – was rendered up for display within its glass walls. Significantly, the movement of "human history" in the Bay Area, taking off with the arrival of U.S. military surveyors, engineers, and merchants, was presented as one of natural progression in the realms of knowledge and wellbeing. The colonial artifacts so carefully arranged for public view, it struck me, were produced by armed white settlers who likely embraced a version of the scientific rationality that Oppenheimer so feared was in decline. In retrospect, there was one thing out of place. Against the wall of the observatory, perhaps moved to the side by

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[73] Annual Report, Exploratorium, 2014. < https://www.exploratorium.edu/annual-report-2014/#> (last accessed November 10, 2017).

[74] Edward Rothstein, "An Emphasis on Newton's Laws (and a Little Less Lawlessness: The New Exploratorium Opens in San Francisco," *New York Times*. April 16, 2013. < http://www.nytimes.com/2013/04/17/arts/design/the-new-exploratorium-opens-in-san-francisco.html>

a staff member, stood an apparatus marked "Digital Footprints." The accompanying label suggested that the device offered up a digital image of "twenty four hours of data from the people." It took me several moments of anticipation – several seconds of staring into the void of a black box – before I realized that the apparatus was not plugged in and that no data stream would greet my eager eyes.

Walking towards the museum's exit, I couldn't help but scoff at myself. Transfixed by an unplugged machine! But a comment Oppenheimer once made popped into my mind: "Technology, including the technology of chips, is insidious. It can carry us where we do not want to go if we follow mindlessly."[75] I thought about the irony of having such an experience at the Exploratorium. While Oppenheimer was anything but anti-technological in outlook, he nonetheless remained suspicious of computers as pedagogical tools, fearing that they obscured scientific and technical processes as much as they elucidated them. Nonetheless, the museum's earliest supporters, people such as William Hewlett of Hewlett-Packard, were movers-and-shakers in the computer industry and early exhibits, such as *Cybernetic Serendipity*, *Pong*, and *Survival of the Fittest*, featured human-computer interaction. I puzzled over this seeming paradox as I began making my way toward Market Street.

I passed tourists and accountants; homeless encampments and WiFi cafes; startup employees and panhandlers. I walked through the financial district and the newly "revitalized" Mid-Market corridor. I saw tech "incubators," entrepreneurship centers, Google buses, and Twitter's shiny new headquarters. I also saw makeshift shelters tucked down alley ways, men and women digging through trash cans in search of recyclables, groups of young people hanging out in sheltered pockets of public space, and recurring police patrols. I basked in a privately owned public park and observed people congregating around laptops throughout the city's so-called innovation district. But, considering my excursion to the Exploratorium earlier that day, nothing struck me more than running into one of its exhibits – labeled a "Living Innovation Zone" or "monument to human capital" – on the sidewalk. The model of interactivity birthed at the museum, taken up by advocates of a market-based form of urban government premised on innovation, was being deployed in the urban landscape *writ large*. That is, the model offered a means with which to render the *city as such* into a kind of laboratory where urban subjects could comport themselves as self-investing units of human capital.

If San Francisco is in some ways already a "playground for those with minds" then the price of admission is increasingly steep. Indeed, the past decade has witnessed staggering levels of tenant displacement due to eviction and foreclosure; hyper-gentrification continues to push out longtime city dwellers; and the market-rate development boom that accompanied Tech Boom 2.0 put tremendous pressure on working- and middle-class residents. Moreover, despite – or perhaps because of – these ongoing processes of displacement, San Francisco has become a site of intense social disparity and economic inequality. The mode of urban government enacted through the model of the interactive technological exhibit not only naturalizes this inequality by eschewing both uneven relations of power and histories of accumulation but also actively promotes it. After all, competition among human capitals, like market competition more generally, necessarily entails the production of winners and losers. Such a governing

[75] Frank Oppenheimer, "Chips and Choices," No date. Carton 2: Folder 10, Frank Oppenheimer Papers. Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, Berkeley.

framework promotes the kind of city, like San Francisco, where it is not uncommon to witness a self-driving car parallel park next to a tent city set up on the sidewalk. The future, to paraphrase science fiction author William Gibson, has already arrived in the Bay Area. It's just unevenly distributed.

Conclusion:

Back to the Present



Figure 17: A window. **Source:** Author.

Put the city up; tear the city down;
put it up again; let us find a city.[1]
-Carl Sandburg

What's outside the window?[2]
-Roberto Bolaño

[1] Carl Sandburg, "The Windy City," *Slabs of the Sunburnt West* (New York: Harcourt, 1922) p. 12.
[2] Roberto Bolaño, *The Savage Detectives*, trans., Natasha Wimmer (New York: Picador, 2007 [1998]) p. 648.

> I adore and despise this city. Did I fall for it under some sort of nostalgic embrace? A desire to be a part of a world that came before me and perhaps never existed? For Emma Goldman and Harry Bridges? For Huey P. and Felicia Elizondo? For Pigpen and BOMKAUF and the Beats? Or for a future it once promised? The possibilities that accompany unlit alleyways and the glorious morning light.
>
> *Google Google*
>
> My disdain is less uncertain. It resides in the obnoxious overlap of smug prosperity and utter desperation. In the broken bottles tangled up in soiled hospital gowns. In the construction cranes that creak above holey socks and street tents. In the memories of trauma that interrupt good-time howls on a Tuesday afternoon. The eyes of the okay-for-now peering into the hands of the not-so-much.
>
> *Apps Apps*
>
> This city rises into ruin and collapses at your feet. Teenage fist-fighters and octogenarian musicians rest on stoops. Evangelical preachers and earnest junkies holler and whistle and yawn. Software engineers and nannies seek sanctuary in the shade of storefront awnings and relief in coffee shop bathrooms. Don't drivers and lawyers and janitors and care workers all eat and shit and grieve and sigh? Let's find a city.

Points of Departure

The city of contemporary urban planning practice and policy discourse – an interconnected system of ecological, social, and technological processes amenable to optimization rather than a static physical form – came into being in earnest after World War II. In the preceding chapters, I worked to show how postwar administrators in the Bay Area reconceived and remade the metropolis as such through technical ways of knowing, modeling, and managing it. Collectively, these chapters have attempted to highlight the important if under-appreciated role of the San Francisco Bay Area as a postwar hearth for urban planning and design innovations. Indeed, as a test-bed for the application of military-inspired modeling techniques and technologies to urban problems, the Bay Area also served as a launching pad for the rise of systems analysis and simulation practices as guides for governmental decision-making in cities across the world. Though determined by many processes and events, the present position of the Bay Area as an epicenter of the global information technology industry surely owes much to its postwar formation and trajectory as a complex adaptive system. The past is not dead.

Today, the San Francisco Bay Area is heralded as a model city for others to emulate. Municipal officials and governing administrators within the region routinely reference Jane Jacobs's call to understand cities as problems of organized complexity in order to validate policy platforms that turn away from redistribution as a means to address social problems and towards the technical and entrepreneurial solutions that characterize "innovative government." That is, the near-hegemonic conception of cities as complex systems agreeable to performance evaluation and improvement serves as a means by which market metrics continue to colonize nearly every aspect of collective life. Initially constructed with military tools in reaction to government-sponsored projects of urban renewal, the formulation of cities as systems now naturalizes inequality and renders any vision of collective urban life – ecological, social, or technological – not premised on the economic logics of the market untenable. While historically produced, this condition was not inevitable.

If one potential aim of the genealogical project is to render *that-which-is* into *that-which-need-not-be*, then it is worth alluding here at least briefly to the ways in which this dissertation speaks to a set of pressing contemporary political concerns. A renewed exuberance for modeling cities from scratch, fueled by technical innovations as well as the perceived managerial and market potential of technological urban infrastructures, has recently taken hold in the boardrooms of Silicon Valley and the imaginations of professional administrators. Sidewalk Labs, for example, an arm of Alphabet, Google's parent company, is currently working toward assembling a totally networked neighborhood in Toronto along just those lines. The next few years will no doubt witness an avalanche of similar market-oriented hallucinations. Indeed, municipal governments and information technology companies alike seem to be increasingly swept up in the technocratic dream of a brave new urban world freed from political contestation, in the dream of urban systems governed by discrete and discernable processes and guided by supposedly neutral designers, engineers, technical consultants. But, as this dissertation has attempted to show, cities like the San Francisco Bay Area have long been surveyed and modeled and simulated and molded. Far from being neutral, those engagements have had distinct and far-reaching material and political consequences. They've shaped the urban stage of debate and recourse and subjectivity. And the particular dimensions of that stage pose an equally specific set of questions: Is the market the best model with which to combat climate change and impeding ecological catastrophe? Do we want our cities and communities to be built and run as computers? Toward what ends? Should grade-schoolers and grandparents and laid-off service workers see and comport and invest in themselves primarily as financial portfolios or as people enmeshed in a web of social relations? The future is upon us.

Over the course of writing these pages, the political terrain in the United States and across the globe more broadly has shifted in urgent and distressing ways. The open and hostile resurgence of white supremacy, the callous embrace of xenophobic nationalism, and the increasingly violent effects of fossil capitalism all frame the present political moment. By offering a genealogical account of the city of contemporary technopolitical practice and discourse that calls into question the very terms of its construction – by showing the present city to be historically constructed and thus amenable to reconstruction – I hope to have contributed in some small way to prying

open a space within which to imagine and work towards a more just urban future. Let us build a city.

References

Books, Articles, Websites, and Other Sources

Allen, Peter. "A Space for Living: Region and Nature in the San Francisco Bay Area, 1939-1969." PhD Dissertation in the Department of Architecture, University of California, Berkeley, 2009.

Althusser, Louis. "Contradiction and Overdetermination." *For Marx*. New York: Penguin Press, 1969.

American Planning Association. *100 Essential Books of Planning*, 2009. <https://www.planning.org/library/greatbooks/> (Last accessed July 15, 2020).

Anderson, Martin. *The Federal Bulldozer: A Critical Analysis of Urban Renewal, 1949-1962.* Cambridge, MA: MIT Press, 1964.

Ansel, Jr, Joseph. "The Unionization of the Exploratorium." In *Institutional Trauma: Major Changes in Museums and its Effect on Staff,* ed. Elaine Heumann Gurian. Washington D.C.: American Association of Museums, 1995.

Anti-Eviction Mapping Project. <http://www.antievictionmap.com/> (Last accessed July 15, 2020).

Arbona, Javier. "After the Blast: Building and Unbuilding Memories of Port Chicago." PhD Dissertation in the Department of Geography, University of California, Berkeley, 2013.

Arthur D. Little, Inc. *San Francisco Community Renewal Program: Purpose, Scope, and Methodology.* San Francisco: Arthur D. Little, Inc., 1963.

-------- *San Francisco Community Renewal Program: Report on Organization and Administration for Renewal.* San Francisco: Arthur D. Little, Inc., 1963.

-------- *San Francisco Community Renewal Program: Simulation Model for Renewal Programming.* San Francisco: Arthur D. Little, Inc., 1964.

-------- *San Francisco Community Renewal Program: Analysis, Goals, Long-Range Policies and Program.* San Francisco: Arthur D. Little, Inc., 1965.

-------- *Community Renewal Programming: A San Francisco Case Study.* New York: Frederick A. Praeger, 1966.

-------- *Technical Paper #8, San Francisco Community Renewal Program*. San Francisco: Arthur D. Little, Inc., 1966.

Association of Bay Area Governments, *The Emergence of a Regional Concept, 1910-1970.* Berkeley: ABAG, 1970.

"Atom Bomb-Nightmare Weapon: Scientist Tells CIO it Must Be Controlled," *Labor Herald*, December 14, 1945. Sec. 2, p. 1.

Badger, Emily. "Tech Envisions the Ultimate Start-Up: An Entire City." *New York Times*, February 24, 2018.

Barry, Andrew. *Political Machines: Governing a Technological Society.* London: Athlone Press, 2001.

Barry, John. *Rising Tide: The Great Mississippi Flood of 1927 and How it Changed America*. New York: Simon and Schuster, 1997.

Batty, Michael. *The New Science of Cities*. Cambridge, MA: MIT Press, 2013.

Benjamin, Ruha. *People's Science: Bodies and Rights on the Stem Cell Frontier.* Stanford University Press, 2013.

Benjamin, Walter. *Illuminations: Essays and Reflections*, trans. Harry Zohn. New York: Schocken Books, 1969.
Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Duke University Press, 2010.
Bennett, Tony. *The Birth of the Museum: History, Theory, Politics*. New York: Routledge, 1995.
Berlin, Ira. *Many Thousands Gone: The First Two Centuries of Slavery in North America.* Harvard University Press, 2009.
Berube, Alan. "All Cities Are Not Created Unequal." *Brookings Institution*, February 20, 2014.
Bettencourt, Luis. *The Kind of Problem a City Is*. Santa Fe Institute Working Paper 13-03-008, no date.
Better Market Street. *One Street: Streetlife*, no date. <http://bettermarketstreetsf.org/> (Last accessed June 15, 2016).
Bird, Kai and Martin J. Sherwin. *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer.* New York: Alfred K. Knopf, 2005.
Bodovitz, Joseph. "Management and Policy Directions." In *The San Francisco Bay Conservation and Development Commission, 1964-1973*. Interview by Malca Chall. Regional Oral History Office, The Bancroft Library. University of California, Berkeley, 1986.
Bolaño, Roberto. *The Savage Detectives*, trans., Natasha Wimmer. New York: Picador, 2007.
Booker, Matthew. *Down by the Bay*: *San Francisco's History between the Tides*. Berkeley: University of California Press, 2013.
Bowker, Geoffrey and Susan Leigh Star. *Sorting Things Out: Classification and its Consequences*. Cambridge, MA: MIT Press, 1999.
Brahinsky, Rachel. "Hush Puppies," Communalist Politics, and Demolition Governance: The Rise and Fall of the Black Fillmore. In Chris Carlsson, ed. *Ten Years that Shook the City: San Francisco, 1968-1978*. San Francisco: City Lights Books, 2011.
--------"The Making and Unmaking of Southeast San Francisco." PhD Dissertation in the Department of Geography, University of California, Berkeley, 2012.
Braun, Bruce. "A New Urban Dispositif?" *Environment and Planning D: Society and Space* 32 (2014) pp. 49-64.
Braun, Bruce and Noel Castree, eds. *Remaking Reality: Nature at the Millennium.* New York: Routledge, 1998.
Braun, Bruce and Sarah Wakefield. "Governing the Resilient City." *Environment and Planning D: Society and Space* 32 (2014) pp. 4-11.
Brewer, Garry. *Politicians, Bureaucrats, and the Consultant: A Critique of Urban Problem Solving*. New York: Basic Books, 1973.
Brown, Wendy. *Politics Out of History*. Princeton University Press, 2001
--------*Undoing the Demos: Neoliberalism's Stealth Revolution.* New York: Zone Books, 2015.
--------*In the Ruins of Neoliberalism: The Rise of Antidemocratic Politics in the West.* New York: Columbia University Press, 2019.
Browne, Simone. *Dark Matters: On the Surveillance of Blackness.* Durham, NC: Duke

University Press, 2015.
Bulkeley, Harriet. *Cities and Climate Change.* New York: Routledge, 2013.
Bumpus, Adam. "The Matter of Carbon: Understanding the Materiality of tCO2e in Carbon Offsets." *Antipode* 43: 3 (2011) pp. 612-638.
Burnham, Daniel and Edward Bennett. *Plan of Chicago*. Commercial Club of Chicago, 1908.
Butler, Judith. *Bodies that Matter: On the Discursive Limits of Sex.* New York: Routledge, 1993.
Caliskan, Koray and Michel Callon. "Economization, Part I." *Economy and Society* 38: 3 (2009) pp. 369-398.
Callon, Michel., ed. *The Laws of the Markets*. Oxford: Blackwell, 1998.
Canellakis, Krista, Paul Chassan, and Cassie Hoeprich. *Living Innovation Zones*. No date. <http://www.sf-planning.org/> (Last accessed June 15, 2016).
Capps, Kriston. "Letter from San Francisco: A Living Innovation Zone by Gehl Architects and Exploratorium." *Architect: The Journal of the American Institute of Architects.* March 8, 2014.
Caro, Robert. *The Power Broker: Robert Moses and the Fall of New York*. New York: Alfred A. Knopf, 1974.
Center for Landscape Interpretation. "The Chesapeake Bay Hydraulic Model," *Lay of the Land Newsletter* (Spring 1998). <http://clui.org/newsletter/spring-1998/chesapeake-bay-hydraulic-model> (Last accessed 20 November 2018).
Cheramie, Kristi Dykema. "The Scale of Nature: Modeling the Mississippi River." Places Journal, 2011. <https://doi.org/10.22269/110321> (Last accessed September 16, 2018).
Chesbrough, Henry. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press, 2003.
City and County of San Francisco, Office of the Mayor. *Mayor Lee Highlights Three Years of Continuing Revitalization*. March 14, 2014. <http://www.sfmayor.org/index.aspx?recordid=545&page=846> (Last accessed June 15, 2016).
Cleaver, Eldridge. *On the Ideology of the Black Panther Party, Part I*. San Francisco: Ministry of Information, Black Panther Party, 1970.
Cole, KC. *Something Incredibly Wonderful Happens: Frank Oppenheimer and the World He Made Up*. Boston: Houghton Mifflin Harcourt, 2009.
Conomos, T. John, ed. *San Francisco Bay: The Urbanized Estuary*. San Francisco: Pacific Division of the American Association for the Advancement of Science, 1979.
Coolidge, Matthew and Sarah Simons, eds. *Overlook: Exploring the internal fringes of America with the Center for Land Use Interpretation*. New York: Metropolis Books, 2006.
Corbyn, Zoe. "Is San Francisco Losing its Soul?" *The Guardian*, February 23, 2014.
Crecine, John. "Computer Simulation in Urban Research." *Public Administration Review* 28:1 (1968) pp. 66-77.
Cronon, William. *Nature's Metropolis: Chicago and the Great West*. New York: WW Norton, 1991.
Davis, Mike. "Who Will Build the Ark?" *New Left Review* 61 (2010) pp. 29-46.

Deutsche, Rosalyn. "Boys Town." *Environment and Planning D: Society and Space* 9: 1 (1991) pp. 5-30.
Dreyfus, Philip. *Our Better Nature: Environment and the Making of San Francisco*. Norman, OK: University of Oklahoma Press, 2009.
Dyckman, John. "The Scientific World of City Planners." *American Behavioral Scientist* 6: 6 (1964) pp. 40-44.
Edmondson, Scott. "Innovation in the Northern Section: San Francisco Takes the Leading Edge." *Northern News: A Publication of the Northern Section of the California Chapter of APA*. November 2012.
Edwards, Paul. *The Closed World: Computers and the Politics of Discourse in Cold War America*. Cambridge, MA: MIT Press, 1997.
---------*A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. MIT Press, 2010.
Elden, Stuart. *Mapping the Present*: *Heidegger, Foucault, and the Project of a Spatial History*. New York: Continuum, 2001.
Elrick, John. "Visionary Politics: Technologies of Government in the Capital of Innovation." *Society and Natural Resources* 30: 2 (2017) pp. 860-876.
-------- "Simulating Renewal: Postwar Technopolitics and Technological Urbanism." *Environment and Planning D: Society and Space* (2020).
Elrick, John and Will Payne. "Model City: Rule of Innovation.' In R Herbst, ed. *New New Games*. San Francisco: Southern Exposure, 2016.
Else, Jon, dir. *The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb.* Santa Monica, CA: Pyramid Home Video, 1981.
Exploratorium, *Annual Report*. San Francisco: Exploratorium, 2014. <https://www.exploratorium.edu/annual-report-2014/#> (Last accessed November 10, 2017).
Faludi, Andreas, ed. *A Reader in Planning Theory*. New York: Pergamon, 1973.
Fatherree, Ben. *The First 75 Years: History of Hydraulics Engineering at the Waterways Experiment* Station. Vicksburg, MS: U.S. Army ERDC, 2004.
Federal Housing Administration, *A Handbook on Urban Redevelopment for Cities in the United States.* Washington, DC, 1941.
Feher, Michel. "Self-Appreciation; or, The Aspirations of Human Capital." *Public Culture* 21 (2009) pp. 21-41.
--------*Rated Agency: Investee Politics in a Speculative Age. T*rans. Gregory Elliot. New York: Zone Books, 2018.
Florida, Richard. *The Rise of the Creative Class: How it's Transforming Work, Leisure, Community and Everyday life*. New York: Basic Books, 2002.
--------"Why San Francisco May Be the New Silicon Valley." *CityLab,* August 5, 2013. <http://www.citylab.com/work/2013/08/why-san-francisco-may-be-new-silicon-valley/6295/> (Last accessed June 15, 2016).
--------"America's Leading Metros for Venture Capital." *CityLab,* June 17, 2013. <http://www.citylab.com/work/2013/06/americas-top-metros-venture-capital/3284/> (Last accessed June 16, 2016).
Foucault, Michel. *Power/Knowledge: Selected Interviews and Other Writings, 1972-1977*, ed., Colin Gordon. New York: Pantheon, 1980.
--------"Nietzsche, Genealogy, and History." In *The Foucault Reader*, ed.,

Paul Rabinow. New York: Pantheon, 1984.
--------*Security, Territory, Population: Lectures at the Collège de France, 1977-1978*. New York: Picador, 2007.
--------*The Birth of Biopolitics*: *Lectures at the Collège de France, 1978-1979*. New York: Picador, 2008.
Franks, Hunter. "Innovating the Physical World." *SF Mayor's Office of Civic Innovation,* 2012. <http://innovatesf.com/mayor-lee-announces-living-innovation-zones/> (Last accessed June 15, 2016).
--------"The Civic Innovation Ecosystem Blooms in 2012." *SF Mayor's Office of Civic Innovation*. http://innovatesf.com/civic-innovation-2012/ (Last accessed June 16, 2016).
Fretwell, Luke. "New SF effort will embed startup DNA into government." *govfresh*, October 2, 2013. <http://www.govfresh.com/2013/10/san-franciscos-entrepreneurship-residence-program/> (Last accessed June 15, 2016).
Freund, David. "Marketing the Free Market: State Intervention and the Politics of Prosperity in Metropolitan America." In Kevin Kruse and Thomas Sugrue, eds., *The New Suburban History*. Chicago: University of Chicago Press, 2006.
-------- *Colored Property: State Policy and Racial Politics in Suburban America*. Chicago: University of Chicago Press, 2010.
Gabrys, Jennifer. "Programming Environments: Environmentality and Citizen Sensing in the Smart City." *Environment and Planning D: Society and Space* 32: 1 (2014) pp. 30-48.
Galison, Peter. "Computer Simulations and the Trading Zone." In *The Disunity of Science: Boundaries, Context, and Power.* Stanford: Stanford University Press, 1996.
Gandy, Matthew. "Rethinking Urban Metabolism." *City: Analysis of Urban Trends, Culture, Theory, Policy, Action* 8: 3 (2004) pp. 363-379.
Garb, Margaret. "Drawing the "Color Line": Race and Real Estate in Early Twentieth-Century Chicago." *Journal of Urban History* 32: 5 (2006) pp. 773-787.
Geddes, Patrick. *Cities in Evolution: An Introduction to the Town Planning Movement and the Study of Civics*. London: Williams and Norgate, 1915.
Gilliam, Harold. "The Most Remarkable Acre of Concrete in the World," *San Francisco Chronicle*, June 9, 1957.
--------*Between the Devil and the Deep Blue Bay: The Struggle to Save San Francisco Bay.* San Francisco: Chronicle Books, 1969.
Glaeser, Edward. *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier.* New York: Penguin, 2011.
Golley, Frank. *A History of the Ecosystem Concept in Ecology: More Than the Sum of the Parts.* New Haven: Yale University Press, 1996.
Graham, Stephen. "Software-sorted Geographies. *Progress in Human Geography* 29: 5 (2005) pp. 562-580.
Gray Area Foundation for the Arts. *Urban Data Canvas Hackathon Morning Presentation*, 2014. <https://www.youtube.com/watch?v=gm0BvpJDasY> (Last accessed June 15, 2016).
--------*Urban Data Canvas Hackathon*. No Date. <http://grayarea.org/event/urban-data-canvas-hackathon/> (Last accessed June 16,

2016).
--------*Data Canvas*. No date. <http://grayarea.org/initiative/data-canvas/> (Last accessed June 16, 2016).
Green, Jared. "San Francisco Wants You to See and Feel Innovation," *The Dirt: Uniting the Built and Natural Environments*, April 2, 2014. <http://dirt.asla.org/2014/04/02/san-francisco-wants-you-to-see-and-feel-innovation/> (last accessed January 15, 2017).
Grossman, James. *Land of Hope: Chicago, Black Southerners, and the Great Migration*. Chicago: The University of Chicago Press, 1989.
Gitelman, Lisa, ed. *"Raw Data" is an Oxymoron.* Cambridge, MA: MIT Press, 2013.
Green, Jared. "San Francisco Wants You to See and Feel Innovation." *The Dirt: Uniting the Built and Natural Environments*. American Society of Landscape Architects, 2014. <http://dirt.asla.org/2014/04/02/san-francisco-wants-you-to-see-and-feel-innovation/> (Last accessed June 16, 2016).
Greenfield, Adam. *Against the Smart City (The City is Here for You to Use).* Amazon Digital Services, 2013.
Grossman, James. *Land of Hope: Chicago, Black Southerners, and the Great Migration*. Chicago: The University of Chicago Press, 1989.
Hall, Peter. *Cities of Tomorrow: An Intellectual History of Urban Planning and Design Since 1880.* Oxford: Blackwell, 2014.
Hall, Stuart. "The Problem with Ideology: Marxism without Guarantees," *Journal of Communication Inquiry* 10: 2 (1986) pp. 28-44.
Halpern, Orit. *Beautiful Data: A History of Vision and Reason since 1945*. Durham, NC: Duke University Press, 2014.
Halpern, Orit, Jesse LeCavalier, Nerea Calvillo, and Wolfgang Pietsch. "Test-bed Urbanism." *Public Culture* 25:2 (2013) pp. 272-306.
Haraway, Donna. *Simians, Cyborgs, and Women: The Reinvention of Nature.* New York: Routledge, 1998.
--------"The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others." Grossberg and Treichler, eds., *Cultural Studies.* New York: Routledge, 1992.
Hare, Nathan. "Black Ecology." *The Black Scholar* 1: 6 (1970) pp. 2-8.
Hartman, Chester and Sarah Carnochan. *City for Sale: The Transformation of San Francisco.* Berkeley: University of California Press, 2002.
Harvey, David. "From Managerialism to Entrepreneurialism: The Transformation in Urban Governance in Late Capitalism." *Geografiska Annaler,* 71:1 (1989) pp. 3-17.
--------*A Brief History of Neoliberalism*. Oxford University Press, 2007
Hayles, Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago: University of Chicago Press, 1990.
Heims, Steve. *The Cybernetics Group.* Cambridge, MA: MIT Press, 1991.
Hein, Hilde. *The Exploratorium: The Museum as Laboratory*. Washington D.C.: The Smithsonian Institution Press, 1990.
Heynen, Nik, Maria Kaika, and Erik Swyngedouw, eds. *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism.* New York: Routledge, 2006.
Honegger, Fanny. "Hacking Urban Data." *Swissnex San Francisco.* March 12, 2014.

http://www.swissnexsanfrancisco.org/media/latest-news/hackingurbandata/ (Last accessed June 16, 2016).
Hounshell, David. "The Medium is the Message, or How Context Matters: The RAND Corporation Builds an Economics of Innovation, 1946-1962." In Agatha Hughes and Thomas Hughes, eds., *Systems, Experts, and Computers,* 2000.
Howard, Ebenezer. *Garden Cities of To-morrow: A Peaceful Path to Real Reform.* London: Swan Sonnenschein, 1902.
Huggins, Eugene and Edward Schultz. "San Francisco Bay in a Warehouse." *Journal of the IEST* 10: 5 (1967) pp. 9-16.
--------"The San Francisco Bay and Delta Model." *California Engineer* 51: 3 (January 1973).
Hughes, Agatha and Thomas Hughes, eds. *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*. Cambridge, MA: MIT Press, 2000.
Jabareen, Yosef. "Planning the Resilient City." *Cities: The International Journal of Urban Policy and Planning* 31 (2013) pp. 220-229.
Jackson, Kenneth. *Crabgrass Frontier: The Suburbanization of the United States*. Oxford University Press, 1985.
Jacobs, Jane. *The Death and Life of Great American Cities*. New York: Penguin, 1964.
Johnson, Marilynn. *The Second Gold Rush: Oakland and the East Bay in World War II.* Berkeley: University of California Press, 1994.
Katz, Bruce and Julie Wagner. *The Rise of Innovation Districts: A New Geography of Innovation in America.* Brookings Institution, 2014.
Katznelson, Ira. *When Affirmative Action was White: An Untold History of Racial Inequality in Twentieth-Century America*. New York: WW Norton, 2005.
Kent Jr, TJ. "Professor and Political Activist: A Career in City and Regional Planning in the San Francisco Bay Area." In *Statewide and Regional Land-Use Planning in California, 1950-1980 Project, Volume II*. Interview by Malca Chall. Regional Oral History Office, The Bancroft Library. University of California, Berkeley, 1983.
Kitchin, Rob and Martin. Dodge. *Code/Space: Software and Everyday Life.* Cambridge, MA: MIT Press, 2011.
Klauser, Francisco. "Through Foucault to a Political Geography of Mediation in the Information Age." *Geographica Helvetica* 68: 2 (2013) pp 95-104.
Knight, Heather. "Swept off Mid-Market, SF's Homeless Cluster Nearby." *SFGate,* January 11, 2014. <http://www.sfgate.com/bayarea/article/Swept-off-Mid-Market-S-F-s-homeless-cluster-5135078.php> (Last accessed July 15, 2020).
Kosek, Jake. *Understories: The Political Life of Forests in Northern New Mexico*. Durham: Duke University Press, 2006.
Kuletz, Valerie. *The Tainted Desert: Environmental and Social Ruin in the American West.* New York: Routledge, 1998.
Laclau, Ernesto and Chantal Mouffe. *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics.* Verso, 1985.
Landstrom, Catharina and Sarah J. Whatmore, "Virtually Expert: Modes of Environmental Computer Simulation Modeling." *Science in Context* 27: 4 (2014) pp. 579-603.

Lamb, J.O. “S.F. Opens Door to Public Tech Incubator Expecting No Return.” San Francisco *Examiner*, May 18, 2014.
Latour, Bruno. *We Have Never Been Modern.* Harvard University Press, 1993.
-------- *Aramis, or The Love of Technology.* Harvard University Press, 1996.
--------*Pandora’s Hope: Essays on the Reality of Science Studies*. Harvard University Press, 1999.
Laurence, Peter. *Becoming Jane Jacobs*. University of Pennsylvania Press, 2016.
Le Corbusier, *The Radiant City*. London: Faber and Faber, 1967 [1933].
Lee, Ed. “San Francisco Action Plan.” *U.S. Conference of Mayors: Technology Innovation Task Force, Open Government Innovation Partnership*, 2013.
Levine, Miriam, Sophie Forgan, Martina Hessler, Robert Kargon, and Morris Low. *Urban Modernity: Cultural Innovation in the Second Industrial Revolution*. Cambridge, MA: MIT Press, 2010.
Light, Jennifer. *From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America.* Baltimore: Johns Hopkins University Press, 2003.
Lilienfeld, Robert. *The Rise of Systems Theory: An Ideological Analysis.* New York: John Wiley and Sons, 1978.
Long, David. “Mistaken Identity: Putting the John Reber Plan for the San Francisco Bay Area into Historical Context.” In *American Cities and Towns: Historical Perspectives*, Joseph Rishel, eds. Pittsburgh: Duquesne University Press, 1992.
Lustig, R. Jeffery, ed. *Remaking California: Reclaiming the Public Good*. Berkeley: Heyday Books, 2010.
Lynch, Kevin. *The Image of the City*. Cambridge, MA: MIT Press, 1960.
Lynch, Michael and Steve Woolgar. *Representation in Scientific Practice*. Cambridge, MA: MIT Press, 1990.
MacKaye, Benton. *The New Exploration: A Philosophy of Regional Planning.* Urbana: The University of Illinois Press, 1990 [1928].
MacKenzie, Donald. *An Engine, Not a Camera: How Financial Models Shape Markets*. Cambridge, MA: MIT Press, 2008.
--------“Making Things the Same: Gases, Emission Rights and the Politics of Carbon Markets.” *Accounting, Organizations and Society* 34: 3 (2009) pp. 440-455.
Marable, Manning. *Race, Reform, and Rebellion: The Second Reconstruction in Black America, 1945-1990*. University Press of Mississippi, 1991.
Martin, Reinhold. *The Urban Apparatus: Mediapolitics and the City*. Minneapolis: University of Minnesota Press, 2016.
Marx, Karl. *Capital: A Critique of Political Economy, Volume One,* trans. Ben Fowkes. London: Penguin, 1990 [1867].
Mattern, Shannon. “Mission Control: A History of the Urban Dashboard.” *Places Journal* March 2015.
Mattern, Shannon. “Interfacing Urban Intelligence.” *Code and the City*. London: Routledge, 2016.
McClintock, Anne. “’No Longer a Future Heaven: Gender, Race, and Nationalism.” *Cultural Politics* 11 (1997) pp. 89-112.
McCracken, Harry. “San Francisco’s New Exploratorium: A Bigger, Better Playground for the Mind.” *Time.* April 17, 2013. <http://techland.time.com/2013/04/17/san-

franciscos-new-exploratorium-a-bigger-better-playground-for-the-mind/> (Last accessed November 10, 2017).
McLean, Heather. "Digging into the Creative City: A Feminist Critique." *Antipode* 46: 3 (2014) pp. 669-690.
Medina, Eden. *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile.* Cambridge, MA: MIT Press, 2011.
Meier, Richard and Richard Duke. "Gaming Simulation for Urban Planning." *JAIP* 32:1 (1966) pp. 3-17.
Meijer, Albert and Manuel Pedro Rodriguez Bolivar. "Governing the Smart City: A Review of the Literature on Smart Urban Governance." *International Review of Administrative Sciences* 82: 2 (2015) pp. 1-17.
Mitchell, Timothy. *Colonising Egypt.* Berkeley: University of California Press, 1991.
-------- "The Limits to the State: Beyond Statist Approaches and Their Critics." *American Political Science Review* 85: 1 (1991) pp. 77-96.
--------"The Stage of Modernity." In *Questions of Modernity*. Minneapolis: University of Minnesota Press, 2000.
--------*Rule of Experts: Egypt, Techno-Politics, Modernity.* Berkeley: University of California Press, 2002.
--------"The Work of Economics: How a Discipline Makes its World." *European Journal of Sociology,* 46: 2 (2005) pp. 297-320.
Mollenkopf, John. *The Contested City.* Princeton, NJ: Princeton University Press, 1983.
Moore, Richard, dir. *Take this Hammer*. San Francisco: KQED Television, 1963.
Morrison, Toni. *Playing in the Dark: Whiteness and the Literary Imagination*. Harvard University Press, 1992.
Morse, Philip, ed. *Operations Research for Public Systems*. Cambridge, MA: MIT Press, 1967.
Moskowitz, Peter. *How to Kill a City: Gentrification, Inequality, and the Fight for the Neighborhood.* Hachette, 2017.
Moten, Fred. *The Little Edges.* Wesleyan University Press, 2015.
Mumford, Lewis. "Regions – To Live In," *The Survey* 54 (1925) pp. 151-152.
Murch, Donna. *Living for the City: Migration, Education, and the Rise of the Black Panther Party in Oakland, California*. Chapel Hill, NC: University of North Carolina Press, 2010.
Nath, Jay. "Reimagining Government in a Digital Age." *National Civic Review* 100: 3 (2011) pp. 19-23.
Newsom, Gavin and Lisa Dickey. *Citizenville: How to Take the Town Square Digital and Reinvent Government.* New York: Penguin, 2013.
Nietzsche, Friedrich. *On the Genealogy of Morals*, trans. Walter Kaufmann and R.J. Hollingdale. New York: Vintage, 1969.
Odell, Rice. *The Saving of San Francisco Bay: A Report on Citizen Action and Regional Thinking*. Washington, D.C.: The Conservation Foundation, 1972.
Oppenheimer, Frank. "The Role of Science Museums." In *Museums and Education*, ed. Eric Larrabee. Washington D.C.: Smithsonian Institution Press, 1968.
--------"A Rationale for a Science Museum," *Curator* 11: 3 (1968) pp. 206-209.
Oppenheimer, Frank and Karen Cole, "The Exploratorium: A Participatory Museum." *Prospects* 4: 1 (1974) pp. 21-34.

O'Reilly, Tim. Government as a Platform. *Innovations: Technology, Governance Globalization* 6: 1 (2011) pp. 13-40.
Osborne, Thomas and Nikolas Rose. "Governing Cities: Notes on the Spatialisation of Virtue." *Environment and Planning D: Society and Space* 17 (1999) pp. 737-760.
Park, Robert and Ernest Burgess. *The City: Suggestions for Investigation of Human Behavior in the Urban Environment*. Chicago: The University of Chicago Press, 1967 [1925].
Peck, Jamie. "Struggling with the Creative Class." *International Journal of Urban and Regional Research* 29: 4 (2005) pp. 740-770.
--------*Constructions of Neoliberal* Reason. Oxford University Press, 2010.
Persia and Daddie$ Pla$tik. *Google Google Apps Apps.*
Rader, Karen and Victoria Cain. *Life on Display: Revolutionizing U.S. Museums of Science and Natural History in the Twentieth Century*. Chicago: University of Chicago Press, 2014.
Reichardt, Jasia. *Cybernetic Serendipity: The Computer and the Arts.* New York: Praeger, 1969. <https://www.youtube.com/watch?v=5xyqbc7SQ4w&has_verified=1> (Last accessed July 1, 2020)
Robertson, Morgan. "The Neoliberalization of Ecosystem Services: Wetland Mitigation Banking and Problems in Environmental Governance," *Geoforum* 35 (2004) pp. 361-373.
--------"Measurement and Alienation: Making a world of Ecosystem Services." *Transaction of the Institute of British Geographers* 37: 3 (2012) pp. 386-401.
Robinson, Ira. "Beyond the Middle-Range Planning Bridge." In A Faludi, ed. *A Reader in Planning Theory.* New York: Pergamon, 1973.
Robinson, Ira, Harry Wolfe, and Robert Barringer. "A Simulation Model for Renewal Programming." *Journal of the American Institute of Planners* 31: 2 (1965) pp. 126-134.
Robinson, Michael. "Rivers in Miniature: The Mississippi Basin Model." In Barry Fowle, ed. *Builders and Fighters: US Army Engineers in World War II*. Virginia: Office of History, US Army Corps of Engineers, 1992.
Rockefeller Foundation, *The 2013 Annual Report.* New York, 2013.
Rothman, Hal. *The New Urban Park: Golden Gate National Recreation Area and Civic Environmentalism*. Lawrence, KS: University Press of Kansas, 2004. Rothstein,
Edward. "An Emphasis on Newton's Laws (and a Little Less Lawlessness: The New Exploratorium Opens in San Francisco," *New York Times.* April 16, 2013.
Rothstein, Richard. *The Color of Law: A Forgotten History of How Our Government Segregated America*. New York: Liveright, 2017.
San Francisco Bay Conservation and Development Commission. *The San Francisco Bay Plan*. Sacramento: San Francisco Bay Conservation and Development Commission, 1969.
--------*The San Francisco Bay Plan,* Mitigation, Section H. <http://www.bcdc.ca.gov/plans/sfbay_plan#35> (Last accessed 20 November 2018).
San Francisco Department of City Planning. *Population Projection for San*

Francisco, 1960-1990. San Francisco, CA: April 1960.
San Francisco Department of City Planning. *Strategies to Address Greenhouse Gas Emissions: Greenhouse Gas Reduction Strategy.* San Francisco: Department of City Planning, 2010.
San Francisco Department of City Planning. *Central Corridor Plan Area Project Description. S*an Francisco: Department of City Planning, 2011.
San Francisco Mayor's Office of Civic Innovation. *A Startup Called Government: Our First Year in Retrospect.* San Francisco: InnovateSF, 2013.
San Francisco Office of Economic and Workforce Development. *Central Market Economic Strategy Draft,* 2011. <http://www.sfgsa.org/index.aspx?page=5482> (Last accessed on June 16, 2016).
San Francisco Planning and Urban Research, "SPUR's Agenda for Change," *The Urbanist*. March 12, 2014.
Sandburg, Carl. "The Windy City." In *Slabs of the Sunburnt West.* New York: Harcourt, 1922.
Saxenian, AnnaLee. *Regional Advantage.* Cambridge, MA: Harvard University Press, 1996.
--------"The Silicon Valley Model: Economic Dynamism, Social Exclusion." In Manuel Castells and Pekka Himanen, eds., *Reconceptualizing Development in the Global Information Age.* Oxford University Press, 2014.
Schelling, Thomas. "Dynamic Models of Segregation." *Journal of Mathematical Sociology* 1: 2 (1971) pp. 143-186.
Schirmer, Sherry Lamb. *A City Divided: The Racial Landscape of Kansas City, 1900-1960.* Columbia, Mo: University of Missouri Press, 2002.
Scott, Allen and Michael Storper. "The Nature of Cities: The Scope and Limit of Urban Theory." *International Journal of Urban and Regional Research* 39: 1 (2015) pp. 1-15.
Scott, David. *Conscripts of Modernity: The Tragedy of Colonial Enlightenment*. Durham: Duke University Press, 2004.
Scott, Mel. *The San Francisco Bay Area: A Metropolis in Perspective*. Berkeley: University of California Press, 1959.
--------*The Future of the San Francisco Bay.* Berkeley: Institute of Governmental Studies, University of California, 1963.
--------*American City Planning Since 1890*. Berkeley: University of California Press, 1969.
--------*The San Francisco Bay Area: A Metropolis in Perspective*. Berkeley: University of California Press, 1985.
Self, Robert. *American Babylon: Race and the Struggle for Postwar Oakland.* Princeton, NJ: Princeton University Press, 2005.
Shubik, Martin. *Games for Society, Business, and War*. London: Elsevier, 1975.
Sidewalk Labs. *Sidewalk Toronto* website. <https://www.sidewalktoronto.ca/> (Last accessed August 1, 2019).
Smith, Daniel. "Howard Jarvis, Populist Entrepreneur: Reevaluating the Causes of Proposition 13." *Social Science History* 23: 2 (1999) pp. 173-210.
Smith, Mark. "Engineering Slavery: The U.S. Army Corps of Engineers and Slavery at Key West." *The Florida Historical Quarterly* 86: 4 (2008) pp. 498-526.

Smith, Neil. *Uneven Development: Nature, Capital, and the Production of Space.* University of Georgia Press, 1984.
Solnit, Rebecca. "Get Off the Bus." *London Review of Books* 36: 4 (2014) pp. 34-35.
Spear, Allan. *Black Chicago: The Making of a Negro Ghetto, 1890-1920*. Chicago: The University of Chicago Press, 1967.
Stehlin, John. "The Post-Industrial 'Shop Floor': Emerging Forms of Gentrification in San Francisco's Innovation Economy." *Antipode* 48: 2 (2015) pp. 474-493.
Stein, Samuel. *Capital City: Gentrification and the Real Estate State.* Verso, 2019.
Stengers, Isabelle. "Opening Pandora's Box?" In Bruce Braun, Sarah Whatmore, and Isabelle Stengers, eds., *Political Matter: Technoscience, Democracy, and Public Life*. University of Minnesota Press, 2010.
Swanson, Leland and Glenn Johnson, eds. *The Cybernetic Approach to Urban Analysis*. Los Angeles: University of Southern California Graduate Program in City and Regional Program, 1964.
Taylor, Frank. "They Want to Rebuild the Bay." *Saturday Evening Post,* November 18, 1950.
Taylor, Peter. "Technocratic Optimism, HT Odum, and the Partial Transformation of Ecological Metaphor after World War II," *Journal of the History of Biology* 21: 2 (1988) pp. 213-244.
Thibert, Joel. *Governing Urban Regions through Collaboration.* Surrey: Ashgate, 2015.
Townsend, Anthony. *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia.* New York: WW Norton, 2013.
--------"Cities of Data: Examining the New Urban Science." *Public Culture* 27: 2 (2015) pp. 201-212.
Tureli, Ipek. "Modeling Citizenship in Turkey's Miniature Park." *Traditional Dwellings and Settlements Review* 17: 2 (2006) pp. 55-69.
Turner, Fred. *The Democratic Surround: Multi-Media and American Liberalism from World War II to the Psychedelic Sixties*. Chicago: University of Chicago Press, 2013.
Tuttle, William. *Race Riot: Chicago in the Red Summer of 1919*. New York: Athenaeum, 1985.
UN-HABITAT. *State of the World's Cities, 2012/2013*. New York, 2013.
United Nations. *World Urbanization Prospects: The 2011 Revision*. New York: United Nations, 2012.
Urban Displacement Project. <http://www.urbandisplacement.org/map/sf> (Last accessed November 6, 2017).
U.S. Army Corps of Engineers, San Francisco District, *San Francisco Bay-Delta Tidal Hydraulic Model User's Manual.* Washington, D.C.: Government Printing Office, 1993.
U.S. Army Engineer District San Francisco, *Technical Report on Barriers: A Part of the Comprehensive Survey of San Francisco Bay and Tributaries.* San Francisco: Corps of Engineers, 1963.
"U.S. Atom Scientist's Brother Exposed as Communist Who Worked on A-Bomb." *Washington Times-Herald*, July 12, 1947.
U.S. Department of the Army, Corps of Engineers, San Francisco District. *Users Guide*

for the San Francisco Bay-Delta Tidal Hydraulic Model. Mountain View, CA: Hydrocomp, 1981.
Von Hoffman, Alexander. "A Study in Contradictions: The Origins and Legacy of the Housing Act of 1949." *Housing Policy Debate* 11: 2 (2000) pp. 299-326.
Walker, Jeremy and Melinda Cooper. "Genealogies of Resilience: From Systems Ecology to the Political Economy of Crisis Adaptation." *Security Dialogue* 42: 2 (2011) pp. 143-160.
Walker, Richard. "Wetlands Preservation and Management on Chesapeake Bay: The Role of Science in Natural Resource Policy." *Coastal Management* 1: 1 (1973) pp. 75-101.
--------"A Theory of Suburbanization: Capitalism and the Construction of Urban Space in the United States." In Michael Dear and Allen Scott, eds., *Urbanization and Urban Planning in Capitalist Society*. New York: Methuen, 1981.
--------The Boom and the Bombshell: The New Economy Bubble and the San Francisco Bay Area. In G. Vertova ed., *The Changing Economic Geography of Globalization.* London: Routledge, 2006.
--------*The Country in the City: The Greening of the San Francisco Bay Area*. Seattle: University of Washington Press, 2008.
--------*Pictures of a Gone City: Tech and the Dark Side of Prosperity in the San Francisco Bay Area*. Oakland, CA: PM Press, 2018.
Weaver, Warren. "A Quarter Century in the Natural Sciences." *Annual Report of the Rockefeller Foundation.* New York: The Rockefeller Foundation, 1958.
Weisberg, Michael. *Simulation and Similarity: Using Models to Understand the World.* Oxford University Press, 2013.
Weiss, Marc. "Developing and Financing the 'Garden Metropolis': Urban Planning and Housing Policy in Twentieth-Century America." *Planning Perspective* 5:3 (1990) pp. 307-319.
Wesner, Ashton. "Contested Sonic Space: Settler Territoriality and Sonographic Visualization at Celilo Falls." *Catalyst: Feminism, Theory, Technoscience 4:2* (2018) pp. 1-32.
Wiener, Norbert. "How U.S. Cities Can Prepare for Atomic War: MIT Professors Suggest a Bold Plan to Prevent Panic and Limit Destruction." *Life Magazine* 29: 2 (1950) pp. 764-777.
-------- *The Human Use of Human Beings: Cybernetics and Society*. Boston: Houghton Mifflin, 1954.
-------- *Cybernetics: Or Control and Communication in the Animal and Machine.* Cambridge, MA: MIT Press, 1965.
Wiig, Alan. "IBM's Smart City as Techno-utopian Policy Mobility." *City* 19: 2-3 (2015) pp. 258-273.
Wirth, Louis. "Urbanism as a Way of Life," *American Journal of Sociology* 44:1 (1938) pp. 1-24.
Wolf, Eva Sheppard. *Race and Liberty in the New Nation: Emancipation in Virginia from the Revolution to Nat Turner's Rebellion*. Louisiana State University Press, 2006.
Wolfe, Harry and Martin Ernst. "Simulation Models and Urban Planning." In Philip Morse, ed. *Operations Research for Public Systems*. Cambridge, MA: MIT Press,

1967.
Wollenberg, Charles. “The Man Who Helped Save the Bay by Trying to Destroy It.” *Boom: A Journal of California* (April 14, 2015). <https://boomcalifornia.com/2015/04/14/the-man-who-helped-save-san-francisco-bay-by-trying-to-destroy-it/> (Last accessed 18 September 2018).
Woodward, Comer Vann, *The Strange Career of Jim Crow*. Oxford University Press, 2002 [1955].
World Bank. *World Development Report, 2009: Reshaping Economic Geography*. Washington, DC, 2009.
Yonavjak, Logan. “How Private Capital is Restoring U.S. Wetlands.” *Forbes*, April 24, 2014.

Archival Materials and Manuscript Collections

Exploratorium Records. BANC MSS 87/184, Bancroft Library, University of California, Berkeley.

Frank Oppenheimer Papers. BANC MSS 98/136, Bancroft Library, University of California, Berkeley.

George Christopher Papers, San Francisco History Room 7, San Francisco Public Library.

John F. “Jack” Shelley Papers. San Francisco History Room 10, San Francisco Public Library.

John Reber Papers (94-09). Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Region, San Bruno, California.

Records of the Office of the Chief of Engineers. Record Group 77, San Francisco District, National Archives and Records Administration – Pacific Region, San Bruno, California.

Save San Francisco Bay Association Records. BANC MSS 87/29 c, Bancroft Library, University of California, Berkeley.