Repairing Infrastructures

The Maintenance of Materiality and Power

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4 From Versailles to Armageddon: Building and Maintaining the Infrastructural State

Introduction: An Infrastructure for Nuclear Armageddon

During the twentieth century, the United States detonated more than one thousand nuclear weapons. Aside of course from the two bombs exploded over Hiroshima and Nagasaki, each of these weapons was exploded to test and refine designs developed over decades of work in the post–World War II era by US weapons designers, engineers, and technicians. Testing nuclear devices not only allowed weapons designers to check the results of their models, but also sent a very public message to other countries about the nation's atomic capabilities. In this way, the mushroom cloud demonstrated the organizational and technical capacity of a vast and secret weapons infrastructure. Behind the hundreds of tests stood a weapons complex of research, administrative, and manufacturing work, comprising sites across the country to design, test, and create the bombs. Los Alamos, New Mexico, where the first atomic bombs were designed and built, is the best known of these locations, but the nuclear weapons complex also included uranium and plutonium enrichment facilities at Oak Ridge, Tennessee, and Hanford, Washington, respectively, and other major research, production, and testing sites spread throughout the country. All of this is to emphasize that the systems for producing nuclear weapons might not be the first example of an infrastructure that jumps to one's mind, but producing a reliable bomb—one that appeared as a credible threat to geopolitical rivals—required a massive system of coordinated material, technical, and organizational resources. In turn, the complex provided employment, prestige, and stability for many thousands of US scientists, engineers, technicians, and administrators.[1]

There is nothing subtle about detonating an atomic bomb. Even underground testing sends a distinct seismic message through the ground that other countries can detect and register. During the Cold War, nations including the United States, the Soviet Union, the United Kingdom, France, and China demonstrated their capabilities and joined the group of global nuclear powers through testing; more recently, India, Pakistan, and North Korea have used testing to signal their arrival in this system of power and the terror of nuclear Armageddon. Testing was considered an essential element of nuclear deterrence, where exploding a bomb was meant to, according to one weapons designer, "scare small children" through the specter of nuclear war.[2]

The Cold War system of nuclear weapons design and production was thrown into uncertainty after 1996, when countries around the world signed the international Comprehensive Test Ban Treaty, forbidding the testing of nuclear weapons. In the United States, as in other nuclear weapons states, this left many thousands of employees unsure of their futures and the prospects for their work in the nuclear weapons complex. It also opened up new questions about how to position nuclear weapons as a credible deterrent in the absence of the routine demonstration of their capabilities through testing. Within the complex, scientists and administrators sought new methods for securing the reliability of the existing stockpile of US nuclear weapons, the expertise of weapons scientists, and the future of the complex itself.

How would weapons scientists, military brass, and politicians continue to convey the threat of a US nuclear arsenal without testing and, at the same time, preserve the far-flung infrastructure of the complex? This question—about the fate of the US nuclear weapons complex and its search for legitimation at the end of the twentieth century—helps us see the scale and the stakes for this chapter, where we explore the role of infrastructural repair at the level of nation-states and the geopolitical and economic interests that construct and maintain national and international structures of power. Repair on this scale involves work on physical structures and systems, the kind of materially based repair required to dig a canal or fix a bridge, but it also takes us into realms where the repair of symbolic and discursive systems goes hand-in-hand with the maintenance of materiality. Who controls and benefits from infrastructures and the economic, political, and symbolic resources that may flow from them? In many ways, these

questions and the stories we use to explore them are a direct continuation of our discussion of systemic repair featured in chapter 3; seeing the way that infrastructures span nations and connect the globe will also help lead into our analysis of global infrastructures in chapter 5.

To get from the systemic to the global, however, it is critical to see just how important the building of infrastructures has been for political states of all kinds, from early urban settlements to colonial empires and contemporary nation-states. In this chapter, we focus mainly on the latter two forms of state formation, covering roughly from the period of empire building and colonization by Western powers in the seventeenth century to the era of nations and nationalism that typify the world's political structure today. Infrastructures form a key source of power for states in this period, where material systems for controlling land, populations, and resources reinforce the power of the state and serve as sources of authority and legitimation for a range of persons through the policies and resources supported by infrastructures. Specific interest groups may benefit or be marginalized through the design of infrastructures and how they are repaired, especially via the economic, political, or cultural capital that rulers, bureaucrats, commercial interests, military leaders, and engineers and other experts accrue through infrastructures. Once those investments and benefits are in place, literally built in to the sociotechnical character of infrastructures, repair becomes a matter of personal and class interest for the elites who develop and control infrastructures, meaning that those who benefit from them are more likely to favor an approach to infrastructural repair that maintains those interests.

This *repair as maintenance* may act on the concrete, steel, and other material elements of infrastructures, but also through ideology and identity, the kinds of cultural meanings that we invest in these systems. We pay special attention to the interplay of materiality and discourse here, analyzing cases that show both how expertise is constructed through infrastructures and the struggles that politicians, scientists, engineers, and others face when infrastructures are challenged and disrupted. For example, in the case of the US nuclear weapons complex in the late twentieth and early twenty-first centuries, the material and technical capacity for designing and deploying nuclear weapons was tied to immense economic and political structures, each in turn seen as critical for convincing the rest of the world that the United States had the power to obliterate its geopolitical enemies and rivals.

The loss of testing called several of these interconnected elements into question, thereby initiating a sense of urgency among physicists and engineers, military leaders, and defense hawks; questions about the future of the system threatened not only their jobs but also the legitimacy of the weapons complex. (We return to this case in more detail later in this chapter.)

In sum, to understand how states have developed in the past several centuries of world history, it is important to see how they are *infrastructural states*, that is, political bodies with embedded interests in maintaining structures of material and discursive power.[3] Whereas in chapter 2, we emphasized the role of the human body in sensing the need for repair, here repair is initiated and sponsored by those who gain capital from the structure and durability of the infrastructural state. In this chapter, we use the umbrella term *elite* to refer to the persons and interest groups that benefit most directly from infrastructures and have the strongest incentives to protect them through repair. The administrator overseeing a large nuclear weapons research facility, a politician demonstrating their influence through a showy new building project, and a developer hoping to make a sizable profit from investments in land may not be uniform in terms of their access to and control of the infrastructural state and its levers of power, but each has an outsized role in the creation and maintenance of these systems. As we will see, infrastructures and their repair have had a key role to play in the establishment of our global political order, especially as government, military, and commercial interests developed and maintained infrastructural systems to achieve their goals and consolidate power through sociotechnical means.

While the infrastructural state provides considerable resources and power for an elite who controls and benefits from this system, this does not mean that they wield total and unquestioned control. We also detail some examples where those subject to infrastructural systems resist and rebel against these structures. Infrastructures can be used to divide the haves from the have-nots, supporting an elite at the same time that they disenfranchise those who might have limited access to critical resources like food, water, or energy and the infrastructures that provide those goods. As in the case of the Barrio Logan neighborhood, sometimes disadvantaged communities have an unwelcome infrastructure built right on top of their homes. Those same structures, however, can serve as a means for communities to employ the materiality and symbolic power of infrastructures for their own

ends, potentially wresting their own sources of power from sociotechnical systems.

This means that repair at the scale of states and populations is not always about fixing literally broken infrastructures, though of course that is sometimes the case. Instead, we focus in more depth on the ways that infrastructures are built and maintained to embody systems of power. Who has infrastructural power, how did they get it, and how do they keep it? We investigate three key themes related to the infrastructural state: the importance of land and place for initially creating these structures of power, the rise of expertise and systems of expert knowledge through infrastructures, and the communities and identities that grow in tandem with infrastructures and groups of people on a national scale.

In the course of exploring these three themes, we also trace the role of three key sets of human actors negotiating the design, implementation, and repair of the infrastructural state: elites, experts, and the populations subject to the infrastructures built and maintained by the first two groups. While the boundaries among these three sets of actors are blurry, the general interests and activities of each group help us see how repair at the level of states plays out through the structures, organizations, and identities that are built into infrastructures. Modern elites became "elite" in part through the creation of the infrastructural state, deriving power through systems that helped them control land and other resources. Cultivation of experts and new systems of knowledge and technique were and are a key part of these building projects, and experts themselves can participate in this system of power and privilege through the sponsorship of elites. However, experts' grasp on these resources is contingent on their ability to support the maintenance of infrastructures, meaning that they play a key role in repairing the stability of the infrastructural state in times of change and crisis. When things break down, elites count on experts to serve as their repair workers.

The scope of infrastructures and their connections to the state mean that we are all subject to these structures and have a stake in both their positive and negative impacts. The risks and benefits of infrastructure are not evenly distributed, however. While some populations consistently benefit from building and using infrastructures, others are more vulnerable to the risks and negative impacts they create. The rise of the infrastructural state means that countless humans have been abused, conscripted, marginalized, and

even subject to injury and death via infrastructures; the exercise of power through infrastructures almost always comes with costs that are not equitably borne by the experts and elites, who accrue benefits from them. The very materiality of infrastructures, however, ensures that they may provide potent targets of protest and reappropriation, meaning that the power of elites is never total or unchanging. The struggle among these three groups as they seek to control and repair infrastructures to support often divergent interests is an important theme of this chapter.

Building the Infrastructural State: Turning Land into Systems of Power

Many of the infrastructures that we have described in this book have one thing in common: they are grounded in a specific place, their material form part of a landscape, a community, or even a region. Infrastructures such as bridges, canals, and roads use geographic topography and features to channel the power of nature and achieve human goals, creating sociotechnical systems that become new landscapes in and of themselves.[4] These kinds of infrastructures appeared early in human societies and had an important role in supporting complex political states. In some cases, such as Egyptian irrigation systems and Roman aqueducts, the close historical connection between infrastructure and the rise and fall of state power is well known, and even taught to children in school. Recent studies suggest that infrastructural harnessing of nature is a key part of the history of a much wider range of civilizations around the globe.[5] So although state investment in infrastructures is nothing new, scholars who study the role of infrastructures in supporting modern states emphasize a set of transitions that have taken place over the past several hundred years. They include the rise of capitalist economies and emerging global markets, the colonial ambitions of the West, scientific and technological advances and the widespread exchange of ideas through printed papers and books, and patterns of inequality and racial ideologies that structured and legitimated who had, and did not have, resources and rights.[6] While the roots of capitalism, colonialism, and emerging scientific and racial ideologies may have earlier foundations in major historical changes such as plagues and shifting systems of religious thought,[7] an era of acceleration starting in the seventeenth and eighteenth centuries intensified the growth of the modern infrastructural state, increasingly tying people and materiality together

via sociotechnical systems. These were early steps toward the infrastructural engineering of the earth itself, a topic we discuss in more detail in chapter 5.

The control of territory through infrastructural systems allowed states and state actors to partner with the emerging interests of capital and colonialism, providing a synergy of interests between political and economic elites and spurring the creation of new systems of expert knowledge and practice. In this way, reengineering land through infrastructures created not only the material resources to support the accumulation of capital and power but also a context in which new or sharpened tools, such as censuses, mass media, and collective imaginaries, allowed the state to study and manipulate its human populations, develop new centers of taxation or profit, and generate a sense of allegiance or at least acquiescence to a centralized infrastructural state. While not a complete explanation for how modernity became modernity, the control of land and resources based in earth and water helps us see how the power and resources found in natural systems were transformed into built environments that facilitated the accumulation of social and technical power. In turn, those who benefited from these structures developed new interests in the resources that flowed from them, helping us to see how an approach to repair as maintenance is often favored by elites and experts. In the face of challenges, crises, and even revolutions, repair as maintenance is about protecting power, and this section shows how this approach to repair was effectively built into the landscapes and institutions of the early modern European state.

One way that infrastructures facilitated this set of transformations was via their capacity to control time and space. Space-time compression, a concept developed by geographer David Harvey, highlights the roles of canals, roads, railways, bridges, and ports for opening up new avenues for commerce, military conquest, and the imperial ambitions of states, compressing the distance between any two points on the earth and making time itself subject to sociotechnical control.[8] Infrastructures that reduced the time to move troops, bring goods to market, and share information effectively shrunk the globe, and those who created and controlled these infrastructures reaped the benefits of mastering space and time. But a focus exclusively on how infrastructures enable the movement of people and things misses the important and material ways that the administration of land via infrastructures increasingly became the goal of states in the early modern

period. Controlling territory was a key means of developing new capital through the emerging infrastructures that helped early modern states take control of and harness these resources.

Sociologist Michael Mann, whose multivolume analysis of the sources of social power provides a key resource for understanding the infrastructure-state relationship, emphasizes that infrastructural power is a key goal for political states because they are bounded by a geographic limit, and infrastructures help them achieve "a unified territorial reach."[9] By combining access to the material boundaries of a place with the administrative capacities of modern states (bureaucratic functions such as surveying, taxing, and mapping), Mann argues that political elites wield considerable power:

> [The state's infrastructural] powers are now immense. The state can assess and tax our income and wealth at source, without our consent or that of our neighbours or kin (which states before about 1850 were never able to do); it stores and can recall immediately a massive amount of information about all of us; it can enforce its will within the day almost anywhere in its domains; its influence on the overall economy is enormous; it even directly provides the subsistence of most of us (in state employment, in pensions, in family allowances, etc.). The state penetrates everyday life more than did any historical state. Its infrastructural power has increased enormously.[10]

By compressing time and space and extending their administrative and technical reach, these new capacities of the state allowed rulers to develop the "infrastructural power" that Mann describes, and in the remainder of this section, we treat two scholars' case studies of the early modern infrastructural state. Sociologists Chandra Mukerji and Patrick Carroll demonstrate through historical analysis of the growing infrastructural state in seventeenth-century France and Ireland, respectively, how a growing administrative state, technology, ideology, and competition for land and other resources all came together to fuel what Mukerji terms the "territorial ambitions" of early modern European states. In one of her key works, Mukerji focuses on the creation of the French gardens at Versailles under the direction of Louis XIV and his chief advisor, Jean-Baptiste Colbert, in the latter decades of the seventeenth century; a second book details the construction of France's Canal du Midi in the same period, a 240-kilometer waterway that helped connect France's Atlantic and Mediterranean coastlines, and was considered a marvel of engineering at its construction.[11] While a large-scale canal building project and design of a royal garden

may not seem closely connected at first glance, Mukerji emphasizes that each project supported Louis XIV's attempts to consolidate power centrally through the control of territory both in France (where the state sought to bring provinces under greater centralized control) and out of France (through colonization). State infrastructures demonstrated the power of the monarchy and brought increased bureaucratic and military oversight to sites far from the seat of power, ultimately centralizing state administration and creating the symbolic and material apparatus of the infrastructural state.

Symbolic and material power were embodied in the plan for Versailles, which Mukerji emphasizes was created as a *place*, deliberately engineered to embed assumptions about French political and military power in the land itself. This focus on land and place is important to highlight. Infrastructures such as roads, canals, harbors, and military installations facilitated the movement of people, commercial cargo, and materials of war, but they also remade landscapes and ecologies according to these interests.[12] As Louis XIV sought to compete with European rivals as well as unruly nobles in his own court, Versailles provided the setting to "[speak] obliquely but effectively to French prowess in war."[13] Innovations in irrigation, hydraulics, and other forms of engineering were needed to support the display and spectacle of the gardens at Versailles; in this way, Versailles had a symbolic power founded in the resources marshaled to construct and maintain such a vast garden, but it also generated new knowledge and technologies that hybridized with military engineering such as design of forts and battlements. The geometric layouts and designs of the gardens echoed and influenced military installations, meaning that Versailles served both symbolic and practical uses in the emerging era of regional and global ambitions for empire (see figure 4.1).[14]

Whereas Versailles and its regal collection of opulent chambers, gardens, and fountains signified the centralized power of the infrastructural state, the construction of the Canal du Midi illuminates how the mastery of hydraulic engineering allowed Louis XIV to extend control of the French state into territory far from his palace. Although some of the same engineering knowledge that supported the creation of Versailles was used for the Canal du Midi, Mukerji's history of the project shows how its completion was achieved only through the appropriation of knowledge developed by the rural peasants who had long lived along the rivers and streams

that became the path for the canal. While the canal was deemed a feat of "impossible engineering" due to the demands of channeling water through the Pyrenees, local residents had developed practices and technologies for controlling the flow of water through the mountains and employing it for their own purposes via mills, laundries, and weirs for the retention of water. Mukerji argues that by latching onto the ideas of these "indigenous engineers," many of them women, the canal builders were able to solve many challenges of routing the canal through the mountains while also rendering their contributions invisible.[15] Because the peasants were largely illiterate, their work and knowledge were not recorded in the history of the canal but instead attributed to the genius of the canal's chief builder, Jean-Mathias Riquet, and the glory of Louis XIV.

While Mukerji emphasizes the ways that the canal's construction and use was flawed—sections quickly failed under the challenges of the massive built system—the way that these failures and the contributions of local knowledge were papered over helped to create an aura of impersonal and inevitable governance through the infrastructural power of the state. Like many of our encounters with infrastructures, the canal was far from perfect in its execution and operation, but an emerging modern French state was built in part on the perception that it could administer projects on the scale of the Canal du Midi with rational and powerful techniques of control.[16] Materially, the canal was constructed with the support of indigenous engineering knowledge, which was in turn used to build the symbolic mastery of expert systems and the central state over the harshest landscapes in its domain. The challenges that the state's engineers and administrators faced

Figure 4.1

Images of the Latona and Apollo fountains at Versailles. Mukerji notes: "[The Latona and Apollo fountains] spoke eloquently to the military might and ambitions of the king and state. The central statue of the Latona fountain showed a delicate and beautiful young mother with her children (one of which was Apollo as a baby) surrounded and attacked by quite horrifying figures of angry peasants, frogs, and lizards. . . . It was an image of vulnerability that was balanced in the Apollo fountain by an image of complete and utter adequacy. . . . The counterpoint of the two fountains, contrasting youthful vulnerability and adult potency, provided an interesting comment on the Sun King's [Louis XIV's] coming of age." Quotation from Chandra Mukerji, *Territorial Ambitions and the Gardens of Versailles* (New York: Cambridge University Press, 1997), 68–70. Images by Christopher R. Henke, 2019.

were repaired using local knowledge, providing a foundation for both engineering science and the state's legitimacy and power.

Extending the infrastructural state deep into a landscape facilitated the appropriation of knowledge, as in the case of the Canal du Midi, and at the same time allowed state actors to survey and catalog the material and human capital contained within specific regions. Patrick Carroll describes a similar exercise of state infrastructural power in the case of seventeenth-century Ireland, where William Petty represented the English state and its attempts to domesticate Irish lands and peoples during Oliver Cromwell's invasion in 1649.[17] Carroll details the use of maps, surveys, censuses, and other means of collecting data to understand and ultimately control Ireland as a colonial territory of the growing English empire. The triangulation of these various forms of data created the "political arithmetic," in Petty's terms, to implement systems of taxation and other sources of revenue.[18] The early foundations of modern science's experimental method were being codified by Petty, Robert Boyle, and other members of the English Royal Society during this period, but these methods were not isolated in laboratories or the salons of the elite. Instead, Carroll shows how the scientific revolution was entirely tied up with political and economic revolutions and the colonial ambitions of European powers. Petty himself was granted an estate of more than 200,000 acres of Irish land as a reward for his efforts in securing Ireland for the Crown.[19]

Coercing land and people into subjects of the modern state helped consolidate considerable social and material power for rulers and their advisors like Louis XIV, Jean-Baptiste Colbert, Oliver Cromwell, and William Petty. While their power ebbed and flowed with the political revolutions that rocked Europe and the rest of the world during this period, the process of transforming land and building the infrastructures of the modern state set in place a network of sociotechnical structures for the accumulation of economic, political, and cultural capital—and an incentive to keep this capital flowing. State-of-the-art infrastructures such as canals helped promote commerce through the sixteenth to eighteenth centuries, setting the basis for the capitalist, military, and citizenship models that undergird modern states. Just as rulers and ruling parties came and went, these infrastructures were often supplanted by newer systems (railroads superseding canals, highways diminishing the importance of trains), but each enabled power from diverse sources and defined the interests of a political class that wanted to maintain their access to power and capital through these structures.[20]

The techniques and tools needed to build these infrastructures were innovative and cutting-edge technologies at the time, highlighting the ambition of those who took on projects even in the face of what seemed to be impossible engineering challenges. High risks led to great rewards once these infrastructures were built into the geographic and administrative systems of the emerging modern state; in turn, those structures needed to be maintained and protected once the means were in place to reap the benefits of access to new resources. In effect, elites and their experts were captured by their own investments of power in and from infrastructures, tied to the structures that supported their positions and sources of capital. Elites' interests in repair therefore were and are built in to both the material design of infrastructures and the administration of infrastructures through state agencies, policies, and practices. Both the modern state and the class of economic and political elites who control and benefit from the state have vested interests in these structures, helping us see the impetus for repair as maintenance at this larger scale.

Embedded Interests: Levees and Flood Control in New Orleans = Repair as Maintenance[1]

Historian Peirce Lewis describes the city of New Orleans as "impossible but inevitable," emphasizing the promise of its location at the mouth of the Mississippi River while recognizing the challenges in siting a city in the middle of an enormous floodplain.[2] Given its geographic potential for trade and military defense, New Orleans's location was just too good to pass up, but how to keep it dry? Beginning in the nineteenth century and continuing largely until today, New Orleans has been protected by an extensive levee system that acts as a "jacket" for the Mississippi and the other bodies of water that surround the city. As more and more of the Mississippi was jacketed in levees with ever higher walls, the constrained river actually created higher waters during flood stages and increased the risk of catastrophic flooding due to breached levees. Nevertheless, the levees-only policy was favored by elites, especially landowners and developers who sought to expand settled areas onto land that was once considered swamp.[3]

Once the land was developed, it became difficult to turn back the clock, and the extensive levee system formed a built environment that reflected the economic interests and power structure of New Orleans, creating a sociotechnical structure for future action. This process was illustrated in the extensive flooding along the Mississippi in 1927, when New Orleans was threatened by rising floodwaters along the city's levees. The commissioners of the regional levee boards and top brass in the US Army Corps of Engineers wielded incredible authority in the face of the flood, conscripting an army of disenfranchised

Embedded Interests: Levees and Flood Control in New Orleans = Repair as Maintenance (continued)

labor (many of whom were African Americans working on post-Reconstruction plantations) to shore up the levees.[4] As the floodwaters continued to rise, city elites conspired with the state to dynamite levees south of the city, in St. Bernard Parish, to serve as an outlet for the rising waters and protect the city from flooding. Nearly ten thousand residents of St. Bernard Parish were evacuated, and their homes and livelihoods were destroyed as the parish became an enormous holding reservoir.[5] As an extreme form of repair as maintenance, this strategy kept New Orleans dry, preserving the structure of both the levee system and power relations in the city, but at the cost of destroying St. Bernard Parish.

Fast-forward to the devastating impact of Hurricane Katrina on New Orleans in 2005, and the repair-as-maintenance approach helps us see the perverse way in which the destruction that the hurricane caused was essentially engineered into the built environment of the city and its river.[6] Death and damage due to a strong storm like Hurricane Katrina was widely predicted many years before the events of 2005, yet the inadequate levee system was not upgraded or replaced with a superior system. The impacts of Katrina were disproportionately distributed, and low-income communities of color faced death and displacement in numbers that reflected the inequities of urban spaces in the United States, as well as the more specific infrastructural ecology of New Orleans and its levee system.[7]

1 The case study in this section is derived from Christopher R. Henke, "Situation Normal? Repairing a Risky Ecology," *Social Studies of Science* 37, no. 1 (2007): 135–142.

2 Peirce F. Lewis, *New Orleans: The Making of an Urban Landscape*, 2nd ed. (Santa Fe, NM: Center for American Places, 2003), 19.

3 Ari Kelman, *A River and Its City: The Nature of Landscape in New Orleans* (Berkeley: University of California Press, 2003).

4 John M. Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (New York: Simon & Schuster, 1998), chap. 14.

5 Gay M. Gomez, "Perspective, Power, and Priorities: New Orleans and the Mississippi River Flood of 1927," in *Transforming New Orleans and Its Environs: Centuries of Change*, ed. Craig E. Colten (Pittsburgh: University of Pittsburgh Press, 2000), 109–120; Kelman, *A River and Its City*, chap. 5.

6 William R. Freudenburg, Robert B. Gramling, Shirley Laska, and Kai Erikson, *Catastrophe in the Making: The Engineering of Katrina and the Disasters of Tomorrow* (Washington, DC: Island Press, 2009).

7 Joan Brunkard, Gonza Namulanda, and Raoult Ratard, "Hurricane Katrina Deaths, Louisiana, 2005," *Disaster Medicine and Public Health Preparedness* 2, no. 4 (2008): 215–223; Elizabeth Fussell, Narayan Sastry, and Mark VanLandingham, "Race, Socioeconomic Status, and Return Migration to New Orleans after Hurricane Katrina," *Population and Environment* 31, no. 1–3 (2010): 20–42; Carl Bialik, "We Still Don't Know How Many People Died Because of Katrina," *FiveThirtyEight* (blog), August 26, 2015, https://fivethirtyeight.com/features/we-still-dont-know-how-many-people-died-because-of-katrina/.

Experts and Governmentality: The Maintainers of State Power

If repair as maintenance is the preferred approach for those who gain capital from established infrastructural systems, that fact begs a question: Who does all this maintenance work? Historians Andy Russell and Lee Vinsel ask us to recognize and appreciate these often behind-the-scenes workers they term "the maintainers"—those who perform "undervalued forms of technological labour"—who support our everyday sociotechnical orders.[21] While we have explored this work in previous chapters, in this section we focus specifically on those maintainers—experts and their systems of knowledge—sponsored by the state to create and maintain infrastructural systems. Experts and infrastructures have a symbiotic relationship in that it is hard to imagine the existence of complex infrastructures without the technical knowledge and skill required to build and repair them. As we saw with the Canal du Midi, ambitious infrastructural projects often require or inspire the creation (or appropriation) of new knowledge systems and even whole new professions, and so the relationship between infrastructures and experts reflects the splintered division of labor in industrialized societies, where jobs are ever more specialized.[22]

In addition, infrastructures are of much interest to the state, so the symbiosis of infrastructures and experts does not occur in a political vacuum. Instead, state interests shape and support the growth of knowledge and expertise connected with infrastructures. In fact, experts are often part of the state apparatus itself, employed in bureaus of land management, engineering, transportation, agriculture, forestry, and many other specialized agencies. The military ambitions of the state also figure critically here, as research and development funds for technological innovations support many experts with duties related to defense structures and systems. However, this sponsorship comes with strings attached, and experts may feel conflicted about their roles in maintaining the infrastructural state.[23] Communities of experts may also be divided by political allegiances and institutional interests, leading to potential tensions within what we might otherwise consider homogeneous groups of engineers, scientists, technicians, and agency administrators. Overall, experts are deeply embedded within the tangled nest of interests and resources assembled through infrastructures, meaning that they have strong (if sometimes conflicting) incentives to maintain and repair those systems. In turn, state and elite interests

support this maintenance and repair because it enables them to continue to benefit from the economic and political capital that accrues through expert control of infrastructures.

Historian and philosopher Michel Foucault's work on the rise of the modern state provides another important set of resources for understanding how infrastructures and systems of expert knowledge coevolved over the past three hundred years. Foucault's perhaps most influential work, *Discipline and Punish: The Birth of the Prison*, is an important touchstone for seeing how these systems not only became embedded within modern institutions of all kinds, but also shifted how we think about human organization and life.[24] As states established the administrative reach described in the prior section, they also increasingly developed tools for shaping the hearts and minds of state subjects. While prisons and systems of punishment might not initially seem important for understanding the connections between infrastructures and experts, Foucault emphasizes the impact of these systems on our methods and discourses of punishment in the modern era and on our everyday thoughts and behaviors.

Foucault begins *Discipline and Punish* with a provocative excerpt describing the execution of a man in 1757 who was sentenced to be drawn and quartered (pulled apart by four horses tied to his various limbs; look it up if you want the literally gory details, but suffice it to say that it is actually a lot of gruesome work to kill someone in this way). Foucault contrasts this method of punishment with an example from just eighty years later, in the early nineteenth century, where incarcerated prisoners are "disciplined" through a highly regimented series of activities, including moral education, labor, and even recreation, all carefully planned to reform criminals and transform them into new people. By emphasizing this contrast between a brutally public punishment *on* the body and a carefully planned discipline *of* the body by penal experts, Foucault highlights the transformation of how states consider and treat their subjects in modernity.

Infrastructures play an important part in Foucault's story, including especially the "panoptic," or all-seeing, structure of modern prisons and other infrastructures of surveillance. Prisons are designed so that guards and wardens can monitor their charges at all times. Continual surveillance, Foucault argues, was and is intended to get into our heads, making not just prisoners but all members of modern states internalize a set of values

and practices that lead them to self-discipline. By continually monitoring our own motivations and desires, we can adopt a form of self-control that Foucault argues is, ironically, a more total (and perhaps more tragic) form of discipline than the public spectacle of punishment through torture more common before 1800. In effect, we maintain our own actions through this process of internalizing and acting on assumptions about what it means to behave as a modern member of civilized society. While prisons and other material structures are still important mechanisms where the state can control the bodies of its subjects, repairing the mind, Foucault argues, is ultimately the most effective and invasive approach.

The growth of knowledge systems, especially in human sciences such as psychology and economics, is also central to this shift, as experts developed new techniques and technologies to administer the disciplinary state and were increasingly employed as the bureaucratic maintenance force that did its routine work.[25] *Governmentality* is the term Foucault uses to describe the set of practices and structures that typify the modern state. He defines the state not so much in terms of a power structure—who rules whom—but rather through the mechanisms by which governing is actually done on people's bodies and in their minds. Governmentality includes actual material structures such as panoptic viewing stations and record-keeping systems, as well as the discourses that legitimate these practices, leading to a more subtle but all-encompassing form of power than the direct control of earlier ages.[26]

Foucault helps connect the examples of canals and censuses we described in the previous section, where infrastructures helped states extend their material reach into new territories, with subsequent use of infrastructures to mold citizens and their sense of identity and obligations to the state. For example, Stalin's equivalent of the Canal du Midi, the White Sea–Baltic Canal, connecting the Siberian coast on the northern reaches of the Soviet Union to the Baltic states in the southeast, employed forced prison labor to build the 227-kilometer canal in just two years, between 1931 and 1933. While construction of the canal itself was a key goal of the project, the effort was also meant to support the Stalinist principle of *perekovka*, or reforging, to "mold criminal prisoners into dedicated believers and practitioners of Soviet ideology."[27] In this way, the project was meant to build a sense of nationalist identity and obligation. Among the many experts employed

to build the canal, a Writers Brigade of 120 journalists and other authors toured the canal, interviewed the prison laborers, and wrote accounts of the canal "advocat[ing] and applaud[ing] the remaking of Russian society into a Soviet Stalinist society."[28]

Many thousands of workers died in the process of completing the canal, pointing to the limits of the state and its infrastructures to shape the minds of citizens without also policing their bodies, sometimes in brutal ways. Foucault also emphasizes that the subjects of state and expert control do not obey these systems unthinkingly. In fact, he argues, resistance is an embedded feature of power: wherever power is exercised, resistance in some form will be there too.

Transantiago: A Case Study on the Limits of Expert Power

Sebastián Ureta's study of the Transantiago public transit system in Santiago, Chile, explores the impact on commuters when a new and intentionally transformative transit model was introduced to the city in 2007.[1] Ureta uses Foucault's work as a lens to understand how everyday subway riders were treated as *scripts*, or idealized constructions of malleable and polite transit users. While Transantiago was meant to be among the most efficiently planned and executed public transit models of the new century, taking advantage of the newest technologies and planning techniques, the reality of a flood of new users, overcrowded trains, and major delays forced Transantiago's planners to implement a number of policies and practices meant to reorient and "normalize" the commuters' ways of engaging with the system. Signs posted throughout the subway tunnels exhorted riders to be considerate toward each other, security guards were posted on each platform to police behavior, and at peak times of commuter traffic, riders were forced to wait in place before moving to or from train platforms until the system could catch up with demand.[2] While these efforts at repairing users' relationship to and engagement with Transantiago helped salvage the system, Ureta also points to the limits of these disciplinary practices and the larger limitations on experts' and policymakers' attempts to repair the relationship between commuters and the idealized vision of Transantiago.[3]

Ureta's case study helps us see how Foucault's ideas can illuminate the power of discourses when implemented in specific infrastructural contexts, but also the limits of these same techniques. Indeed, just as Foucault emphasizes the subtle but deep way that expert discourses shape our thoughts and actions, he also emphasizes the limits to these systems of power, especially through resistance.[4] When guards must be placed on each platform to enforce

ideals of discipline, the limited power of internalized discourses is highlighted, demonstrating the ongoing tensions and struggles over infrastructural repair.

1 Sebastián Ureta, "Waiting for the Barbarians: Disciplinary Devices on Metro de Santiago," *Organization* 20, no. 4 (2013): 596–614; Sebastián Ureta, "Normalizing Transantiago: On the Challenges (and Limits) of Repairing Infrastructures," *Social Studies of Science* 44, no. 3 (2014): 368–392; Sebastián Ureta, *Assembling Policy: Transantiago, Human Devices, and the Dream of a World-Class Society* (Cambridge, MA: MIT Press, 2015).

2 Ureta, "Waiting for the Barbarians," 604–610.

3 Ureta, "Normalizing Transantiago."

4 Brent L. Pickett, "Foucault and the Politics of Resistance," *Polity* 28, no. 4 (1996): 445–466.

A Fragile Power: The Codependency of Experts and the State

While experts can benefit greatly from their place within state structures, gaining the sponsorship needed to develop new knowledge and create incredible works of material, technical, and organizational sophistication, this patronage is not without a set of trade-offs, given the intense interest that politicians, generals, and investors have in the work of experts and their desires for specific outcomes and payoffs. Chandra Mukerji describes experts' situation as "a fragile power," a term that emphasizes the fundamental dependency of experts but also acknowledges their place in a system of considerable resources and influence.[29] Mukerji claims that scientists act as a reserve labor force for the state, ready with support in times when the state may be especially in need of their expertise. The state does not necessarily have a specific use for every piece of research produced by the experts they sponsor, but instead they see the value in being able to tap a reserve of knowledge and technical skill "more consistently relevant to state interests and visible to government agencies."[30] Mukerji's focus on oceanographic science makes the relevance of these scientists' experience and knowledge for military interests especially clear. The US Navy, in particular, funds a lot of ocean scientists and has a strong yet somewhat detached interest in maintaining a civilian corps of researchers who have significant experience living and working at sea. These skills and systems come into play when the Navy needs to find a lost submarine or when a conflict arises.[31]

Similarly, the US Department of Energy funds a great deal of basic research that is not directly tied to energy or nuclear weapons, but helps maintain its ties to a larger research community and allows the state to project an image of scientific competency in line with its status as a military superpower.[32] As noted earlier in this chapter, the US nuclear weapons complex is an enormous set of infrastructures built around the expert knowledge systems needed to develop and maintain the weapons stockpile. With the end of nuclear testing in the 1990s, scientists and administrators sought new methods of both maintaining and developing the scientific basis for weapons design and securing the credibility of the existing US nuclear arsenal. Ultimately, two key strategies emerged to cope with the loss of testing. The Stockpile Stewardship Program, which remains the basis of US nuclear weapons research efforts, sought to preserve existing knowledge about weapons design primarily through development of computer simulations meant to virtually test the weapons stockpile. A later program that was ultimately canceled, the Reliable Replacement Warhead (RRW) instead focused on the creation of a warhead design that would not require testing to develop and would in turn have a very long shelf life as part of the US arsenal.

These programs were meant to maintain the material destructive capacity of the nuclear weapons arsenal, given a context where the complex's stewards were not able to verify and demonstrate the viability of the weapons through testing. But Stockpile Stewardship did little to protect the interests of the workers, technicians, and machinists who actually built nuclear weapons, most of whom lost their jobs with the end of the Cold War. Instead, it focused on repairing the credibility and status of the technical experts at the weapons research laboratories. Laboratory leaders, in particular, argued that the deterrent effect of nuclear weapons was fundamentally based on the credibility of the experts who designed and created the weapons. Sig Hecker, who directed Los Alamos National Laboratory from 1986 to 1997 and was a key figure in the transition of the weapons complex during the shift away from testing, told us in an interview: "It is the labs per se that provide the deterrence, not the bombs. Bombs can be overcome with newer designs or countermeasures, [but] the Russians will never be able to overcome our ability to evolve and develop new technological capabilities."[33] In Hecker's view, the intellectual expertise and technical resources that stood behind the weapons complex were the true deterrent. Though

he is clearly making an argument that supports the interests of the labs and the weapons scientists in the face of a new set of restrictions around testing, he is also thinking through the ways that the work of the weapons complex might be maintained through new missions and a renewed sense of purpose.

In each case, the proposed solutions were meant to repair the credibility of the weapons, as well as the system of scientific expertise behind them. However, the Stockpile Stewardship Program, by arguing for a departure from the design of new weapons and major investment in new computing infrastructures, was resisted by some in the core weapons design community because it was seen as a relatively radical repair of the longstanding discourses and institutions supporting the weapons development process. Although the RRW program might seem on face value to be more transformative, since it championed the development of a new weapons design, discursively and institutionally the program mobilized the kinds of knowledge and skills central to the Cold War design and testing process. This approach appealed to many in the core weapons design community since it seemed to preserve their autonomy and authority within a familiar weapons development regime. These two different ways of framing the technical, cultural, and institutional changes needed to adapt to a radically changed set of political and practical circumstances for work in the weapons complex demonstrate how "repair may serve to reveal hidden differences" among the key stakeholders tied to a complex set of infrastructures.[34] Sponsorship from state and corporate patrons makes experts part of the elite class in their own way, though their status is contingent on shifting demands for knowledge, technology, and repair based on political and economic change.

Infrastructures on Display: Making Nations and Nationalism through Sociotechnical Repair

In the twentieth century, the nation-state became the predominant form of political organization and discourse through the world, and infrastructures continue to be a key part of national strategies for defining legitimacy and power. We have already discussed several examples where sociotechnical systems were and are used to demonstrate the power of the state and develop techniques to materially control and exploit its territories. The era of the

The "Mutual Orientation" of the Internet's Open Culture and Structure

The advent of the nuclear age and the onset of the Cold War in the late 1940s and 1950s created a strategic interest in developing computers and information networks that would allow the US military to monitor nuclear and other activities around the globe. Ideally, these sociotechnical systems would be robust and redundant, able to withstand disruption from attack and sabotage. Thus, many scholars trace the roots of our contemporary internet back to the ramp-up of R&D spending and intensive sociotechnical network development that began during World War II and continued through the Cold War. The open and decentralized—even chaotic—structure of the internet may seem at odds with military interests, ideologies, and organizational approaches. But internet historians such as Paul Edwards argue that the history is more complex and that the structure of systems like the internet actually grew out of the interdisciplinary and relatively nonhierarchical structures of Cold War research organizations like the Manhattan Project and MIT's Radiation Lab.[1] While funding from the state was meant to develop technical capacities, the details and expectations for this work were relatively unstructured, governed by a process of "mutual orientation" where military sponsors, research scientists, and corporate engineers and entrepreneurs shared a common set of political and technological discourses about the aims of US defense research and development.[2] So computers and networking gained their contemporary structure through the organization of knowledge production and technical innovation in the postwar years, not despite it—and now the two of us have the capacity to coauthor this book via Google Docs, watching each other's edits in real time.[3]

Despite the "fragile power" of experts described above, military largesse provided enormous resources for the growth of academic and corporate science during the twentieth century, effectively creating a new class of sociotechnical workers who largely enjoyed lifestyles commensurate with or better than the emerging American middle class.[4] With the advent of internet-based systems of managing and distributing work, however, scholars are increasingly asking questions about the future of this system of expertise. Computer scientist and communication researcher Lilly Irani studies Amazon.com's Mechanical Turk system for distributing "microtasks" to contingent workers around the world—answering surveys, checking the accuracy of web data, and other short tasks compensated by the job, effectively creating an online "market for largely invisible cognitive pieceworkers."[5] In some cases these microtasks might be called a form of repair, where workers are asked to police the content of web advertisements and social media posts.[6] As work is increasingly distributed across the globe, split into ever finer tasks, and compensated with fractional incomes, the human and artificial intelligences that complete this

work may increasingly erode the fragile power of experts and other skilled repair workers. The distribution and diffusion of expertise may also make it harder for states to control these knowledge systems and use them for their own geopolitical ends.

1 Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA: MIT Press, 1996); Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010); Janet Abbate, *Inventing the Internet* (Cambridge, MA: MIT Press, 1999); Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006); Andrew L. Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (Cambridge: Cambridge University Press, 2014).

2 Edwards, *The Closed World*; Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey, and Andrew Feenberg (Cambridge, MA: MIT Press, 2003), 185–225.

3 Russell, *Open Standards and the Digital Age*, provides a somewhat contrary view, detailing competing standards for networking and the relative failure of democratic methods to adopt a common protocol.

4 Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton, NJ: Princeton University Press, 1989).

5 Lilly Irani, "Microworking the Crowd," *Limn*, February 13, 2012, https://limn.it/articles/microworking-the-crowd/; Lilly Irani, "The Cultural Work of Microwork," *New Media and Society* 17, no. 5 (2015): 720–739.

6 Irani, "Microworking the Crowd"; Andrew Russell and Lee Vinsel, "Hail the Maintainers," *Aeon*, 2016, https://aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more.

nation-state continues this trend, where infrastructures are often deliberately made visible in both a grand way to display the power of the state and a more personal way in which feelings and understandings of citizens' place in a political system are expressed through their relationships with infrastructures. The scope of infrastructures and their potential to transform landscapes and lives provides a powerful means to demonstrate the reach of the state and even define the contours of how people think of themselves in terms of national identities and their place within modern technological and cultural lifestyles. Anthropologist Brian Larkin notes, "Roads and railways are not just technical objects then but also operate on the level of fantasy and desire. They encode the dreams of individuals and societies and are

the vehicles whereby those fantasies are transmitted and made emotionally real."[35] Larkin points us toward the ways infrastructures are not just embedded in our landscapes and material environments; they also shape the way we think about ourselves and our place in political structures. In this section, we explore this symbolic power of infrastructures for the state and its citizens in more depth, focusing on two key aspects of how infrastructures shape discourses about social and material structures: through the identities that citizens of modern states develop around their national allegiances and through the efforts of states to make grand statements about their power through infrastructural construction and control. Each of these mechanisms shapes and influences life in modern infrastructural systems and demands various forms of repair from politicians, experts, and everyday citizens.

The first mechanism, nationalist identity, begs the question: What exactly causes anyone in a group of millions to feel like they are somehow the same kind of people as others in their nation? This is the question anthropologist Benedict Anderson tackles in his influential work, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. As the title implies, Anderson argues that nationalism, or the sense of belonging to a specific nation-state, is an affinity that citizens internalize and *imagine* as a strong and even sacred connection to their fellow nationals. Just because it is an imagined community, however, does not mean it is not a strong one. Indeed, as Anderson powerfully notes, many millions of people gave up their lives during conflicts throughout the past two hundred years in the service of nation-states.[36] How does the nation exert such a powerful pull on our sense of identity and allegiance?

Anderson traces the formation of imagined national communities to some of the same structures and practices we described earlier in this chapter, factors that were also critical to the growth of a modern infrastructural state in contexts such as the English colonization of Ireland. Censuses helped to enumerate populations and make them subject to state control and surveillance.[37] The creation of common languages through the rise of printing and shared media such as books and newspapers standardized previously heterogeneous dialects into a national common tongue.[38] National borders, especially in colonial states, were shaped through the administrative apparatus that the colonizers forced onto the outlines of their territorial aims.[39]

Infrastructures play a role in not only creating the data, media, and organizations that structure and support the modern nation-state, but

also, as Larkin notes, shaping the hopes and dreams of citizens. To this we add that infrastructures can be part of our nightmares too, as in the case of the nuclear weapons complex and its capacity for global destruction. Anthropologist Joseph Masco argues that nuclear weapons were the signature technology through which Americans were willing to think through the ultimate national sacrifice during the twentieth century: "The nuclear complex remains a particularly potent national project, informing one way in which citizens imagine both their collective lives and deaths. The unthinkability of the nuclear age has from this vantage point been perhaps *the* American nation-building project since World War II."[40] The United States tested hundreds of bombs, built thousands more, spent trillions of dollars, and sold the narrative that we needed them for the security of ourselves and our nation. Nuclear weapons demonstrate the incredible scope of infrastructures for supporting national ambitions and nationalist identities.

In addition, and at a more local level, everyday encounters with roads, bridges, and other infrastructures that represent our national affiliations continually reinforce these connections and provide a daily reaffirmation of nationalist identities. Anthropologist Michael Billig describes these everyday encounters with symbols of national identity as "banal nationalism," such as when a citizen walks past a flag hanging from a government office building.[41] In this view, nationalism is not an exceptional outburst of patriotism but instead an ongoing identity in need of maintenance, continually flagged through the signs and symbols we encounter each day, including our interactions with the infrastructural state. Banal nationalism represents a way that infrastructures can themselves repair collective identities and provide an often subtle yet pervasive means by which "a nation must be put to daily use" through its infrastructures.[42]

With that said, we also have to emphasize the limits of nationalism and its power to legitimate infrastructural projects. Some feel the pull of nationalism more strongly than others, and some actively resist nationalist projects centered in infrastructures; the antinuclear power and weapons movements are good examples of ideologies and organizations counter to the broader sense of a shared national identity.[43] And some people and groups, marginalized through their race, ethnicity, religion, or other forms of difference, are simply left out of the collective stories that undergird nationalism.

A Tale of Two Canals: Infrastructures, Nationalism, and Decolonization

National interests and identities that are built into infrastructures can be a site for conflicting ideologies. Anthropologist Ashley Carse's study of the construction of the Panama Canal emphasizes the interests that the US state had in its construction during the late nineteenth- and early twentieth-century period of American imperial expansion through the Western Hemisphere. When Panama asserted its independence from Colombia in 1903, US warships were present to ensure the security of the fledgling state and stake a literal land claim to the canal site. As the Panamanian state sought to assert control over the canal, however, it increasingly framed American control of the waterway as an assault on its national sovereignty.[1]

Benedict Anderson notes that the colonial powers effectively taught the colonized how to think through and enact their own nationalist identities: "For the paradox of imperial official nationalism was that it inevitably brought what were increasingly thought of and written about as European 'national histories' into the consciousnesses of the colonized."[2] One after another, colonized peoples used nationalism to promote their own interests and attempt to wrest control of infrastructures away from the imperial powers. For example, when Egyptian president Abdel Nasser nationalized the Suez Canal in 1956, Israeli, French, and British forces invaded Egypt and attempted to reestablish control of the waterway, with the British especially fearful of losing strategic access to this shipping lane. Egypt maintained control of the Suez Canal, signaling for many the relative decline in power of the once global British Empire.[3] Similarly, Panama and the United States signed a treaty in 1977, in which the United States promised to cede control of the Panama Canal to Panama, which was effected on December 31, 1999.

1 Ashley Carse, *Beyond the Big Ditch: Politics, Ecology, and Infrastructure at the Panama Canal* (Cambridge, MA: MIT Press, 2014), 45–47.

2 Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1983), 120.

3 David M. McCourt, *Britain and World Power since 1945: Constructing a Nation's Role in International Politics* (Ann Arbor: University of Michigan Press, 2015), chap. 2.

The second broad mechanism we treat in this section centers on nations' infrastructural demonstrations that are meant to be anything but banal. Anthropologist James Scott, in *Seeing Like a State*, provides several examples of how states use building projects and infrastructural demonstrations as sociotechnical symbols of their power and prestige.[44] Scott emphasizes that many of these projects employed expert systems of knowledge that

valorized theoretical and political ideals over systems of knowledge in place in local communities. Whereas the French engineers in Mukerji's history of the Canal du Midi appropriated local knowledge systems to solve engineering challenges, Scott notes a disjuncture between national ideology and local knowledge, often layered with class- and race-based prejudices, where experts overlook the needs of local and indigenous communities and dismiss their potential contributions. Scott discusses the case of the city of Brasília, founded in 1960 to replace Rio de Janeiro as the new capital of Brazil.[45] Brasília was built as a planned city according to the ideals of twentieth-century architects such as Le Corbusier and Oscar Niemeyer. Le Corbusier, in particular, abhorred the tangle of streets, alleyways, and communal spaces that typified older cities, such as London and Paris, as they grew organically over centuries. Brasília, by contrast, was designed on a grid structure and was meant to resemble an aircraft when viewed from above—a technology associated with modern ideals of clean lines and the highest technological sophistication.

The daily rhythms of residential life and work in Brasília were subordinate to the modern aesthetic, and Scott emphasizes that plans for the city "made not the slightest concession to the desires, history, and practices of its residents."[46] This top-down approach to infrastructural development is all too common as an expression of state power, yet we must also acknowledge how people and communities use infrastructures in creative and resistant ways to repair their own relationships and interests with respect to these omnipresent structures. Scott describes these everyday tools of resistance as the "weapons of the weak," where those subject to systems of power use passive and hidden forms of protest as a response to the state.[47] In the case of Brasília, historian Larissa Pires's work on the class, gender, and racial politics of the city demonstrates the limits of centralized planning for ordering urban spaces and their populations. Pires notes that the city's planners initially hoped that the migrant laborers who built the city would find other places to live upon its completion, but ultimately experts and elites had to relent and incorporate spaces for working-class settlers in Brasília (though only after a series of violent conflicts, including a massacre at a city labor camp in 1959).[48] The materiality of a city, however rationally planned, makes it hard to fully control according to the designs of politicians and planners, as Pires notes:

> The fact that thousands of workers refused to return to their hometowns after finishing their initial construction assignments and, instead, fought for the right to reside in, and around, the city they had built shows how Brazil's state-controlled urban plans ultimately failed to control for the power of spontaneous urbanization. While architects, engineers, and technocrats planned the new city, its migrant population ultimately shaped its functions and dynamics; in other words, this demonstrates that experts can try to design a city from above, but it will be claimed from below.[49]

Specific components of city infrastructures can also be a key site for protest and resistance, as emphasized in the work of anthropologist Antina von Schnitzler, who writes on the role of infrastructures in postapartheid South Africa.[50] Von Schnitzler focuses on the implementation of utility meters as a means of regulating and commodifying water use in the transition to a postapartheid democracy. During the apartheid regime, many disenfranchised residents did not pay their rent and utility bills as form of protest against the state, limiting its ability to generate revenue. The continued use of nonpayment as a form of protest prompted the new regime to implement prepaid meters that would shut off utilities, especially water supplies, if residents did not pay in advance for service. In turn, residents sought ways to bypass or even destroy and remove the meters, along with demonstrations and other more visible forms of protest.

These two cases highlight the potential for infrastructures to serve as both mechanisms for state and elite influence over populations and resources for contesting power relations and structures. In both of these cases, as in the case of Barrio Logan and the Coronado Bridge, acts of resistance modified and appropriated elements of infrastructure from below, in defiance of the visions of the systems' original architects. In the South African case, this culminated in a protracted back-and-forth repair struggle between infrastructure owners and users, in which each side ultimately used physical modifications to infrastructure to try to limit the actions of the other. In cases like these, infrastructures' sociomateriality provides the ground for both repression and resistance, and repair becomes an explicitly political act.

Conclusion: Neoliberal Approaches to Infrastructural Repair in Twenty-First-Century Modernity

Although there is not a linear path from the gardens of Versailles that Louis XIV built in the late seventeenth century to the tools of Armageddon

developed by the nuclear nation-states in the twentieth century, in this chapter we have emphasized a set of processes and stakeholders that were key factors in building the infrastructural state over the past three hundred years. State power has been a central theme, and states and state elites gain power through infrastructural systems in diverse ways, including through the economic capital derived from transportation networks, energy generation, real estate speculation, food production, and all the ways that land, water, and other environmental services can be tapped and commodified through infrastructures. Canals, roads, communications networks, and weapons systems also allow states to extend their administrative and military reach across large territories, controlling vast spaces and populaces. More subtly, though incredibly powerfully, nationalism and other internalized belief systems shape citizens' perspectives on their place in history, space, and everyday practices, meaning that states and other elite actors have the tools to set both the material and cultural frames for our lives.

Add this all up, and we have incredibly complex and pervasive sociotechnical systems that now stretch across the globe and give states enormous infrastructural power.[51] Elites did not do this work on their own, and in this chapter, we have also highlighted the work of experts and expert systems of knowledge that grew in tandem with the infrastructural state. In some cases, experts are elites in their own right; in others, they do not have formal credentials or state sponsorship, but instead have hard-won experiential knowledge of local settings that might be appropriated for state use or serve as tools for resistance to state interests. The very fact that infrastructures are embedded in our everyday lives means that they often serve as a site of contestation between elites, experts, and those who may be disenfranchised or subject to oppression and violence through these systems. Those struggles may be fought through the materiality of infrastructures via repair, such as when a water user in South Africa hacks the meter measuring their water use. Typically those material methods of resistance go hand-in-hand with discursive practices that seek to reframe infrastructural systems and shift the focus of repair from the maintenance that elites typically favor toward a more transformative vision.

As we prepare to consider more fully the global scale of infrastructural repair in the next chapter, we conclude here by discussing the continued role of infrastructures in shaping the political structures of modern nation-states. Scholars dispute the terms and concepts to understand where we

stand in terms of our current relationship to modernity, with some arguing that we have never really been modern, that we are in a period of reflexive modernity, or that we reside now in postmodernity. In terms of the role of infrastructures, however, one thing is clear: we live in a world with an incredible number of these systems, entangled in every possible way with our material and political lives, at scales from local to global.[52] As more infrastructures are embedded within state systems and practices and older ones need to be repaired and replaced, we face critical questions about the state's role in supporting infrastructural systems—namely, who is responsible for building and maintaining all these infrastructures, and who pays? A fuller discussion of these questions requires backing up to the mid-twentieth century and tracing ideologies of state support for infrastructural development through the past several decades.

In the aftermath of the Great Depression and through the first two decades after World War II, the prevailing economic philosophy for industrialized nations was Keynesianism, named for the ideas of John Maynard Keynes, a British economist. By keeping unemployment and inflation low, economic growth steady, and limiting the duration of recessions, all through centralized economic planning and intervention, Keynesian economists and bankers advocated that central banks take a strong and active role in directly controlling their national economies. Infrastructures played a key part in the Keynesian approach, especially during hard economic downturns, where nations were advised to borrow money and use it to create jobs and stimulate the economy, typically through building public works such as roads, bridges, and dams. In this way, the continued building of the infrastructural state played a key role in the economic structure of modern nations in the twentieth century. By promising and promoting infrastructural projects, states attempted to both directly stimulate economic growth and lay the groundwork for future economic development through improved transportation networks, increased energy production, new communication lines, and other structures that facilitated economic exchange. In addition, after World War II, infrastructural repair was seen as critical for restoring the shattered communities and economies of postwar nations.[53]

The Keynesian approach generally held sway until the 1970s, when political unrest, oil shocks, and runaway interest and inflation rates challenged the toolbox that Keynesian bankers and economists used to influence and

maintain the economy. *Neoliberalism* is the term that scholars and policymakers use to define the global economic and political order since roughly 1970. It is an ideology that favors individual rights and freedoms, a limited role for the state, and the valorization of free markets. Neoliberalism is often set in contrast to the Keynesian approach, though it would be wrong to put them entirely at odds, especially given that nations in the twenty-first century still use many of the same Keynesian tools for manipulating economic trends. However, beginning in the late 1970s, under political leaders such as Margaret Thatcher in the United Kingdom and Ronald Reagan in the United States, a generation of economists trained to favor a neoliberal approach took control of central banks and global institutions such as the International Monetary Fund and the World Bank. The neoliberals advocated a smaller role for the state in the economy and called for reduced taxation rates, increased privatization of government-controlled industries, and attacks on union power in these industries—such as Reagan's standoff with US air traffic controllers and Thatcher's confrontation with coal miners in the United Kingdom, both in the early 1980s. In these conflicts, discourses about fairness, freedom, and control were informed by competing visions of the role of the state for infrastructures and their role in employment and labor power. Neoliberals argued that infrastructure would be more efficient and nimbler if taken away from the bureaucratic control of the state. Those who favored a more protectionist approach to industries such as the transportation and energy sectors targeted by Reagan and Thatcher suspected (and continue to suspect) a money and power grab for public resources by elite interests.[54]

Now, after several decades under the neoliberal policy regime, scholars are tracing the impacts of this approach on the infrastructural state, including especially the impacts of privatization and declining attention to infrastructural maintenance and repair. The case of postapartheid South Africa is one example of how private utility providers commodify materials essential for life, especially water, that states might well be expected to provide as a right of citizenship for their residents.[55] The infrastructural state even shapes our relationships at the most personal levels. Anthropologist Elana Shever traces the privatization of the formerly state-controlled oil industry in Argentina, noting that shifting resources from public to private not only has widespread macroeconomic and social effects but also affects the individuals and families whose lives are entangled with infrastructural

systems, often over the course of generations.[56] When Argentina privatized its state-owned energy industry, managers and workers on the ground frequently conceptualized these changes in terms of familial relationships—personifying the company and its workers through kinship ties such as that between parents and children. When infrastructures are privatized, the impacts are felt at each scale that we treat in the chapters of this book, from this local and personal level of family ties, all the way to global perceptions about the stability (or not) of the infrastructural state. Workers sold a conception of state and corporate entities as family have to reframe and repair their understanding of the place of these entities in their lives; as globalization shifts jobs and corporate headquarters around the world, workers in many locations face this same challenge.

In the next chapter, we discuss this global scale of repair in more detail, but as a closing point here, it is useful to consider how infrastructural states were built on resources that will not be available in the same ways in coming decades and what that suggests for the stability of states. Anthropologists Timothy Mitchell and Dominic Boyer point to the importance of energy—itself an infrastructural product—in the creation of broader national infrastructures during the Keynesian and neoliberal eras, emphasizing the key role of petroleum in literally fueling growth in the decades following World War II.[57] As neoliberal reductions in public support of infrastructures take hold, however, Boyer notes that the "legacy of 'public infrastructure' has become rather threadbare, capturing a general sense of evaporating futurity in the medium of corroded pipes and broken concrete."[58] As we understand more and more about the coming impacts of climate change, Boyer's reference to the future of infrastructures raises questions about how and whether the existing nexus of infrastructure and energy use (especially via oil and gas) will continue to be a viable model in an age of rapidly changing climate. When enough people begin to see infrastructures as unreliable, risky, and in need of repair beyond our capacities, we engage in a collective form of "broken world thinking" that may ultimately call into question the legitimacy of the infrastructural state to repair itself.[59]