LIFELINES OF OUR SOCIETY

A Global History of Infrastructure

Dirk Van Laak

foreword by Paul N. Edwards, translated by Erik Butler

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A GLOBAL HISTORY OF INFRASTRUCTURE

DIRK VAN LAAK

FOREWORD BY PAUL N. EDWARDS

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FOREWORD

Paul N. Edwards

Sometime around 2020, the sum of all human-made things on earth attained the staggering mass of 1.2 trillion tons, exceeding that of the entire biosphere. All the more jaw-dropping is the speed of this dubious achievement: 120 years earlier, at the dawn of the twentieth century, human-made mass was just 3.5 billion tons.[1] Meanwhile, by 2020 humanity's total energy consumption, including solar energy converted in crops and forestry as well as fossil fuels, nuclear energy, and renewables, reached some twenty-seven terawatts—nearly one-third of the ninety terawatts of biochemical energy produced in the biosphere by photosynthesis.[2]

Much of this energy-hungry, unimaginably colossal construction consists of infrastructure. Roads. Railways and subways. Ports, airports, and spaceports. Container ships and oil tankers. Trucks. Pipelines. Mines, oilfields, and refineries. Electric grids, hydroelectric dams, and power plants. Skyscrapers. Hospitals. Industrial agriculture and monoculture forestry. Communication cables, data centers, and Internet hubs. Sewers, reservoirs, and municipal water pipes. And millions upon millions of other objects, devices, and systems built by human beings.

This extraordinary book is about the heavy weight of infrastructure: not its mass per se, but the histories and stories of its growth, its human purposes, its governance (or lack thereof), and the enormous inertia it can acquire. Infrastructure is built to last, and much of it endures longer

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than a human lifetime, longer than most governments and corporations. The infrastructures of modernity represent a kind of second nature. They set the background conditions of life for generations born into them, who are committed (willingly, knowingly, or not) to their ongoing repair and maintenance. Path dependence—the "inertia of the installed base"—rules.[3] Infrastructure, including its human components, resists change unless it offers clear advantages for many or profits for a few.

The Roman Empire famously built roads throughout Europe and the Mediterranean basin, many of them still in use today. The ancient Chinese had their Great Wall, for a time the only human structure visible from space. Unlike these constructions, designed mainly for ruling elites and their armies, modern infrastructures typically have broader public purposes. *Public works*, a common phrase of the nineteenth and early twentieth centuries, defines the initial period of van Laak's study, when governments first took on provision of fundamental systems and services such as roads, sewers, and canals. This was also the period of the first and second Industrial Revolutions, powered by steam and fueled by coal, whose transport from mines to "coketowns," factories, and cities shaped the outline of canals and railways across England, Europe, and the United States. With the advent of the telegraph, communication cables followed those routes. These later became main highways for cars and trucks, linking "motowns" such as Detroit and Los Angeles. Today, Internet backbone lines trace those same paths, first laid down many decades earlier.[4] Open to most, but not all, infrastructures with public purpose underlie the daily lives of billions.

This is not one story, but many, a myriad of ventures by governments, corporations, and multinationals. In every case, infrastructure confronted tensions between public purposes and private profit, symbolic and practical value, initial investment and long-term maintenance, open systems and security against human threats and natural disasters. Although the main threads of his story come from Europe and the United States, van Laak does not neglect to canvass the colonial empires that supplied much of the material and energy for Western infrastructure—often facilitated by extractivist systems, such as railways, built in the colonies by native peoples under duress, with mainly negative consequences for their bodies, cultures, and lifeways. Not only in the colonies but also in Europe and the United States, those enrolled in infrastructure projects often labored under adverse conditions ranging from dangerous and poorly paid to

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conscription, forced labor, and slavery. Countless miners, railway workers, bridge builders, and others sacrificed lives, limbs, and health in service of public infrastructure, and such unheralded sacrifices continue to this day. Yet infrastructures also improved the quality of life for vast numbers of people (including most readers of this book), in terms of mobility, communication, health, longevity, and standard of living.

To tell these stories, van Laak weaves together an astonishing quantity and variety of historical scholarship from the last several decades, along with numerous sources in multiple languages. Yet this is no dry, academic tome; the writing in van Laak's tour de force is brisk, lively, and entertaining. The book brims with stories and examples. It eschews the drab, tedious language of the academic literature review, yet nearly every sentence has a footnote for those seeking deeper understanding. As scholarship, this book is generous and comprehensive; as a reading experience, the book invites wonder, engagement, and reflection.

During the Cold War, many feared that a US-Soviet nuclear exchange might "bomb us back to the Stone Age." With all the easily accessible minerals and fossil fuels mined out, went this line of thought, humanity would never get out of it again. Today, it's not just ores and fuels; we are even running out of sand for concrete and glass production. Yet merely to survive the coming centuries of climate change—a direct consequence of fossil-fueled infrastructure—whole new infrastructures are needed. Resilience is today's new watchword, revising the taken-for-granted infrastructural tolerances of a bygone age when temperature, weather, and sea levels could be presumed stable; forests, fish, and other resources seemed inexhaustible; and buried raw materials lay waiting for discovery. One can seriously wonder whether re-infrastructuring the world for genuine sustainability is even remotely plausible.

In his final chapter, van Laak examines the condition of infrastructure users today, who often confront (and desire) impersonal digital interfaces requiring little or no human interaction. Even more strangely, such interaction as does occur happens with tech support workers on the other side of the planet who cannot themselves access the systems and services they support. Viewing modern history through van Laak's lens of infrastructure restores a large measure of humanity and a depth of understanding to this increasingly anonymous world. I wish you, reader, the same deep satisfaction this book has brought to me.

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PREFACE TO THE ENGLISH-LANGUAGE EDITION

Since this book's initial publication, in 2018, events have offered many occasions to reflect on infrastructures and their history:

- In the spring of 2021, the container ship *Ever Given* was stuck in the Suez Canal for six days. This unintentional blockade triggered a traffic jam in the global transport system, driving home just how much international commercial logistics depend on the smooth operation of many parts. In broader perspective, the insight was hardly new: shortly after opening in 1869, the Suez Canal quickly became the "aorta of the British Empire."
- The same year, in the wake of the COVID-19 pandemic, the US government inaugurated the largest infrastructural program since the New Deal. But, as had been the case for decades, policy makers disagreed about how, exactly, to understand the scope of projects. Does *infrastructure* refer only to transportation routes, or does the term include social and cultural initiatives?
- Russian aggression in Ukraine in early 2022 demonstrated, once again, the key importance of seizing and destroying infrastructure in modern warfare. Airports, bridges, energy supply systems, and lines of digital communication all provided targets. Civilian arrangements and institutions become critical infrastructures in times of trouble: they make society as a whole vulnerable to blackmail and represent Achilles' heels of states.

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Today, there is more talk than ever of infrastructure, which has come to mean the very foundations of life in society. The ubiquity of the term attests to just how much collective well-being relies on planning, concessions, and the availability of resources, technology, and services. Our day-to-day activities presuppose that various offerings and options will be available. Such provisions, however, are precarious and always at risk of being interrupted or vanishing. Accordingly, interest groups are constantly calling for infrastructures to be maintained and, indeed, expanded. The slightest disturbance in the artificial environment they have created—which now counts as normal—activates unconscious fears.

The idea for this book was hatched about ten years ago. At the time, there was no way to foresee the infrastructural turn in the humanities and social sciences, which, in the last few years, has been booming. *Infrastructure* is used to group all manner of cultural processes and developments. To a great extent, the lack of a clear definition is what makes it so appealing; a broad margin exists for relatively free and loose associations by critics and commentators.

Infrastructures promise to open up spaces and save time. Levels of development and the number of facilities and services inspire a sense of being either modern and up-to-date or backward and stuck in the past. Connection to infrastructures represents a decisive criterion for quality of life. Being excluded from them is reckoned a catastrophe. For all that, increased reliance also brings inherent ambiguities to light. Although infrastructures make possible the expansion of horizons and the circulation of goods both material and immaterial, the same conditions can be exploited to exercise social control and restrict access to vital resources.[1]

When discussion concerns infrastructures, participants usually have the future in mind, specifically prospects for maintaining or improving the common weal. The operative rhetoric tends to suggest that such provisions have always existed. In historical perspective, however, it is clear that technological developments and political measures emerged over time and now are interwoven to such an extent that the whole is difficult to survey. Over the last two hundred years, we will see, the material and organizational arrangements of transport, communication, supply, and disposal have shaped the rhythms and patterns of life itself.

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Infrastructures serve to divide and distribute labor, whether performed by human or machine, and they draw on resources that are available only in limited quantity. They make it possible for many people to participate in social and political decision-making and to enjoy relative prosperity and luxury. They create opportunities. By the same token, however, they give rise to dependency and debt. Moreover, infrastructures represent potential liabilities in ecological terms; disrepair indicates the fragility of social conditions on the whole. In this respect, infrastructures and their history record the seismic shifts of the Anthropocene.[2]

This study explores the subterranean social relations that are built into services and institutions.[3] Accordingly, the account offered of schemes of development, their architects, and the people who use them often stands at odds with standard histories. Only in part does the matter concern geographic borders or the particularities of national cultures. In fact, I argue, infrastructures are the concrete basis for colonization and globalization.[4] They collapse and reorganize space and synchronize and standardize time.[5]

The point is not to define infrastructures once and for all or to explain them in light of any single theory. Nor does this book consider their impact in terms of a privileged category—say, power, economics, or social dynamics. Instead, the goal is to examine infrastructures as parts of a history that has been shaped not by exceptional individuals so much as by the interplay of varied forces and interests. The merit of such an approach has been made clear, in recent years, by numerous case studies with a specific focus and well-defined field of investigation.[6]

The following pages also take up the formative effect on the people who use infrastructures, once they are up and running, observed by researchers time and again. Travelers, for example, adapt to timetables and fee schedules, and they make certain codes of expected conduct their own. In other words, infrastructures are not just a matter of technology, engineering, and organization but also include lived, day-to-day practices.[7] Such processes receive due attention here.

Infrastructures fundamentally concern expectations of the present and the future. They keep things flowing. They exist in a positive sense to the extent they are used—that is, inasmuch as they have a history. Although

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a concept of Western origin, infrastructure represents a global phenomenon; therefore, examples in this book come from all over the world. Detailed empirical studies are now being conducted almost everywhere. The history of infrastructure is an established discipline. In 1999, the sociologist Susan Leigh Star self-depreciatingly remarked that looking at infrastructures means studying “boring things.”[8] The intervening decades have proved the very opposite.

Dirk van Laak, August 2022

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The thought and reflections that inform this book evolved over the course of many years. I owe the idea of writing a cultural and historical analysis of infrastructures in everyday life to my teacher and adviser Lutz Niethammer. In the early 1990s, the topic represented new and almost exotic terrain; since then, it has come to stand at the center of historical and cultural studies. It was my good fortune that the Volkswagen Foundation looked with favor on my proposal to draw up a balance sheet of research to date; I am extremely grateful to the foundation for the Opus Magnum grant, which enabled me to escape academic routine for a year. Colleagues at Giessen and the administration of the Justus Liebig University also supported my efforts. In particular, criticism and comments offered by Benjamin Brendel, Jürgen Dinkel, Sabine Dworog, Denise Eisenbeiser, Tanja Hommen, Jeannette van Laak, and Kai Nowak helped craft a much better and more readable text. Thanks for further improvements are due to Maria Paula Diogo, Axel Dossmann, Alexander Eckermann, Nikola Medenwald, and Johan Schot. Participants at colloquia in Berlin, Copenhagen, Erlangen, Frankfurt am Main, Heidelberg, Munich, Regensburg, and Zurich offered valuable feedback. I am happy to share credit; of course, responsibility for any shortcomings is mine alone.

Dirk van Laak, Leipzig, January 2018

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INTRODUCTION: AS LONG AS IT KEEPS WORKING . . .

It's a familiar sight: people constantly checking their smartphones. At social gatherings and on roadways, at the movies or during sporting events, it seems these devices are never set aside, much less turned off. People today are chronically online, and that's evidently how they like it. But their faces often reflect the stress of being overwhelmed.

The smartphone grants the power to survey, log into, and swipe away the whole world. It symbolizes everything that intellectual enlightenment, industrial revolution, and political liberalism have achieved since the eighteenth century: independence from assigned social space and station, access to global streams of data, and membership in a global community. The smartphone has become the remote control of a networked society and has given rise to comprehensive customer choice, up-to-date and informed citizenship, and free and self-determined personhood.

At the same time, the system behind this device makes people dependent on networked technologies and everything they offer. By requiring us to communicate and make decisions incessantly, the smartphone epitomizes more than two centuries of developments in a field that, somewhat blandly, is called *infrastructure*.

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BEYOND EVERYDAY LIFE

When still a student, I listened in on a conversation between scholars visiting from the German Democratic Republic. One detail has really stuck in my mind: the East Germans, who were in the West for the first time, did not marvel at the consumer offerings. They were ready for that. What astonished them was the seamlessness with which West German *infrastructures* operated. Not long afterward, the GDR collapsed. I largely failed to register what had happened, even though I was studying the history of municipal utilities. My research on long-term structures such as railway lines, power cables, and water supply had distracted me from political events of the day. In retrospect, I recognize a hidden logic at work in my oblivion.

Attention to infrastructures reveals any number of paradoxes. This clumsy word suggests that matters are better left to the experts. Provisions for communications, travel, the delivery of goods, and waste removal free us from worrying about where the electricity or water that we use comes from or how people and commodities get from one place to another. Yet infrastructures constitute a constant object of discussion and debate. Who should build and maintain them? How are they to be protected? And why are they all in such bad shape? Only when they stop working—as occurred in the GDR—does the suspicion arise that operations might not be as straightforward as they appear.

Why do most people pay so little mind to what affects their day-to-day lives? What makes the *conditio sine qua non* of every modern society[1] seem so profane and trifling? Even though the health and wealth of a given society are reflected by its infrastructure, the category itself has come to connote a shortcoming—so much so that the historian Paul Edwards and colleagues have referred to it as an “all-encompassing solution and an omnipresent problem, indispensable yet unsatisfactory, always already there yet always an unfinished work in progress.”[2]

It’s deemed proof positive of backwardness when telephone lines are not working or running water is not available. Infrastructures promise better and more comfortable living conditions. They require constantly connecting with new, more efficient ways of managing transport, communication, and energy. As a rule, advocates couch matters in terms of practical necessity—alongside utopian promises of a brighter future.

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This book does not propose a systematic, comprehensive overview of the economic, political, and legal dimensions of infrastructure—much less its technological aspects—even though these factors all play a role. Instead, it sets out to show that the growth of infrastructure networks has not been steady and has varied in keeping with time and place. The task is to situate and examine infrastructures historically—in particular, their influence on (post)modern culture, everyday life, and cultural practices. To do so requires a shift of perspective away from what normally counts as history. It also means taking a step back from the easy conscience of the welfare state—the calm outlook that infrastructures tend to promote.[3]

Members of my generation, who grew up during the 1960s and achieved political consciousness during the 1970s, expected that infrastructural provisions would continue to expand and improve. Today, however, it seems that infrastructure has come to represent a problem. Wealthy countries

0.1 Artistic renderings of energy and traffic flows are rare. Gustav Wunderwald's 1927 depiction of a Spandau underpass exemplifies the style of New Objectivity (*Neue Sachlichkeit*). The painter died of water poisoning in 1945. © akg-images

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face the challenge of setting up new systems (at the moment, digital ones) while maintaining, or sometimes reducing, existing ones. Elsewhere, the task is to provide a minimum of utilities, waste disposal, and arrangements for communication and transportation, or simply to attain a level similar to what has long existed in richer lands. In the main, talk of development for the last 150 to 200 years has revolved around better or worse infrastructures.

By the same token, infrastructures have become the way to measure so-called modernity—that is, levels of connectedness to a global economy and society. Infrastructures set the standard. It would seem there can never be enough of them: someone else always has it better and enjoys the benefits of more comprehensive networks, faster travel, and fuller access to information.

Since the eighteenth century, infrastructures have brought human communities up to date, integrating groups of people with others in spatial, social, and cultural terms and offering members new possibilities for living their lives. Yet infrastructures exercise control, instill conformity, and shape conduct in ways that are not always welcome. Order and good government are assessed in terms of the scope and performance of infrastructures; indeed, these terms are often used as synonyms. The consequence is an environment where routines are observed intuitively and a kind of second, artificial nature predominates. It is impossible to overestimate the importance of the infrastructural model of modernity in defining culture. Regimes of supply, disposal, communication, transportation, and energy guide the habits and behavior of those who employ them. Thus, they constitute an autonomous and independent factor in recent developments; their complexity and impact represent a real marvel.

Nowhere are human designs and technology tied so closely to everyday life as in the realm of infrastructure, which, more and more often, finds mention as a matter of course alongside the weather or stock market. Instead of just alerting people to traffic jams, the media offers reports on overall trends—say, the mounting flow of vehicles from day to day and the implications of this development. It's essential to stay on top of construction, strikes, interruptions in production or delivery, and anything else that might require a change of routine. Instances of dysfunction occasion debate about who is responsible for arranging and financing it all,

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as well as ways to prevent similar inconveniences. Infrastructural matters have long since left the niche sector of nostalgic railroad enthusiasts and stamp collectors; they now stand front and center in discussions ranging from getting to work on time to setting national and international policy.

It is plain that we are growing increasingly aware how much we depend on infrastructures. It is just as clear that our ability to understand how they work is falling behind. The ready availability of anonymous services has compounded our sense of vulnerability, and digital technology has increased real and perceived dependencies. Presumably, the process will continue for the foreseeable future. The vital importance of infrastructures looms into view when they stop working smoothly, fall into a state of disrepair, are hobbled by strikes or attacks, or when prices rise. A low smartphone battery is all it takes for many people to start getting nervous.

The greater attention being paid to infrastructures points to something else, too. Evidently, the expansion of networks of circulation has peaked.[4] This may seem surprising in light of many developing countries working hard to establish infrastructural systems in the first place. No one would deny them the right—indeed, the need—to do so. Everyone should be invested in providing as many people as possible with clean water and hygienic conditions. That said, examining such provisions and their transformations over time, in the nineteenth and twentieth centuries, reveals how much their expansion presumes continuous economic growth, free markets, and the domination of nature. These axioms of industrialized Western societies are being called into question for good reason.

One of the main questions addressed in this book is how infrastructures have changed everyday life by forging new routines, standards of conduct, and expectations. Emphasis is placed, then, on transformations of what, at a given period of history, has counted as normal. One feature of infrastructural development has long been—and will continue to be—that it relieves us of thinking too much about the past, present, and future. Infrastructures are supposed to spare us the day-to-day difficulties of securing material existence, open room for creative pursuits, and enable people to broaden their horizons. They bring about *flows* that we join as need arises—by turning a tap, boarding a train, or logging onto the Internet. Infrastructure as a whole might be defined as everything stable that enables human beings, goods, and ideas to circulate. Accordingly,

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our focus is on these flows' material dimension: tracks, roadways, pipes, and other conduits down or through which things pass.

Our subject does not include heroic visionaries, epochal shifts, or festive anniversaries. It concerns what the architectural historian Siegfried Giedion calls "anonymous history."[5] Infrastructural planners orient themselves on ordinary human beings and recurring needs in the modern world. From the outset, then, we should note that the infrastructural networks surrounding us did not result from a coherent program so much as they emerged in response to different, and competing, interests. They represent the material substrate of social constellations, the crystallized state of conditions at a given moment. Such arrangements, however, are constantly being negotiated and modified. By foregrounding continuity, which lies below the threshold of ordinary awareness, we see the degree to which infrastructures are subject to change over time.

The account offered here treats secular processes of the modern age. No limits have been placed on extension in space, but in temporal terms our discussion bears mainly on the last two hundred years. Nor does this study claim to be exhaustive. Vantage points and examples have a subjective tint; alternating between illustrative cases and global assessments, the material intersects with other fields of inquiry at every turn. This review of events from the eighteenth century to the present aims to disclose and incorporate a new register of meaning. To date, histories written on a grand scale have hardly treated infrastructure, even though it represents a phenomenon independent from industrialization and urbanization, the emergence of bureaucracy, and the rise of the welfare state. In part I, the first three chapters, which discuss the most essential phases of development in the nineteenth and twentieth centuries, rectify this omission and identify the principal features of processes that have occurred everywhere else in the world at different times and places.

Analysis occurs on urban and national, European and North Atlantic, and global levels; each of these registers contains elements of the others. Restricting the discussion to a specific region or example would fail to do justice to the expansive nature of infrastructures, which open new worlds in a literal sense. If a western European, North Atlantic perspective predominates, it is because more research exists in this area. Even so, the

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big picture is planetary; by definition, infrastructure promotes circulation and growth worldwide.

Since the 1970s, the classical period of building material networks has faded away in so-called developed countries; the era of universal access to standardized services offered by a monopolistic provider is drawing to a close.[6] But elsewhere the modern infrastructure ideal is only starting to gather speed. Chapters in part II concentrate more systematically on discussions of infrastructure that have come to the fore in the last two hundred years: organization, financing, visibility, symbolic value, evolution, decline, and vulnerability—as well as the expectations placed on users and operators. Finally, the most salient issues in contemporary debate are taken up alongside visions of the future.

Our conclusions can be only provisional. In this regard, the book mirrors infrastructures themselves: it represents a formation dependent on the conditions of the moment.[7] Whatever infrastructures provide is developed but ultimately depurposed; at some point, it becomes obsolete. Everything we consider normal and self-evident is subject to rapid change. Infrastructures represent the precondition for networked activity on a global scale that determines the course of everyday life; yet at times they threaten to fall apart. When I first took up the matter in 1989, the scope of the next transformation—the digital revolution—could scarcely be foreseen. It is important to be ready for a new turn of events; a look at what has happened to date can help us anticipate coming developments.

WHERE TO BEGIN?

On March 1, 1952, the *Frankfurter Allgemeine Zeitung* reported that a “bizarre word” had surfaced at a NATO (North Atlantic Treaty Organization) conference in Lisbon; although “baffling to German ears,” technical specialists, government agencies, and organs of the press eagerly adopted it. In keeping with editorial standards, the reputable publication took care to set the offending term apart in special type, recommending, moreover, “always translate the expression *infrastructure* into German.” After all, the article continued, nothing encourages thoughtlessness so much as the “promiscuous use of incomprehensible words.”[8]

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The ambiguity of the term later drove parties allergic to jargon to despair. Their ranks included Bernard S. Katz. In a 1989 column, the advertising executive remarked that *infrastructure* had become inescapable—it was just too tempting for people who thought that obscure language hinted at importance to pass up.[9]

Some twenty-five years later, according to the journalist Till Briegleb, infrastructure had "dissolved into an all-purpose metaphor for just about any kind of system."[10] Indeed, for some time now, it has enjoyed one boom after another in broader and broader contexts, providing a synonym for conditions required not just for technological changes but also for social or cultural processes of any kind.[11] *Infrastructure* shines with the glow of necessity. Presumably, and for all its clumsiness, it owes its prominence to counting as a concept, writ large. This notion, we will see, emerged in western Europe and the United States over the course of the nineteenth century, took on greater dimensions in the twentieth, and finally came into its own in the 1950s and 1960s.[12] Now, it dominates the entire globe—even if, as we will also see, not everyone is happy about it.

In recent decades, more and more voices have been calling for infrastructure to be viewed in historical perspective. Using the lens of social psychology, Harald Welzer notes how it shapes ways of thinking: "Institutional infrastructures regulate growth; the material ones manifest it, and mental infrastructures translate it into lifeworlds, equipping the inhabitants of growth societies with the associated biographies and notions of self."[13] The practical course he recommends—abandoning the idea of perpetual growth—is one of the most radical interpretations to have been proposed.

But couldn't it be said that the concept applies to the ancient and medieval worlds? How else could one describe the wells, streets, canals, city walls, granaries, and arsenals of premodern times? Indeed, since the nineteenth century, the Roman Empire has provided the standard reference point for how government established networks of supply, transportation, and communication. Rome gave posterity the first paved highway between regions, the Via Appia (312 BC); aqueducts as far away as southern France; and the *limites*, or border system, in German territories. Time and again, scholars have drawn attention to the elaborate system providing Rome with water and the impressive Cloaca Maxima, which disposed of waste, in addition to Rome's street design and efficient postal system.

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Officials traveling along the *cursus publicus* benefited from a highly developed logistical system that included relay and rest stations, teams of draft animals, and replacement vehicles.[14]

To this day, knowing about these institutions forms an integral part of the cultural repertoire of the educated classes in Europe. *Opera publica* was a phrase in ancient Rome; in modern languages it became *obras públicas*, *réseaux publics*, *public works*, and *öffentliche Arbeiten*. Now that Europe has come to be just one global province among others, the field of reference includes great achievements elsewhere, not as familiar as Europe's but imposing a belated modesty on them: the canal networks of ancient China; Japanese roadways; irrigation systems in Egypt, India, and Central America; and the Silk Road, for example.[15]

To be sure, the term *infrastructure* can be applied to all the preceding. Still, I prefer to restrict its use to developments over the last two centuries. Our operative definition does not depend on a particular set of technologies, all of which had forerunners of one kind or another. Rather, it concerns the circulation of commodities, people, and ideas, as well as efforts to provide services to, and enable communication among, all citizens. Such goals arose in tandem with the Enlightenment, political revolution in the United States and France, industrialization, and the ascent of a liberal economic order and mass society.

Earlier projects of building roads, exchanging information, and providing welfare services fall outside the scope of inquiry because we are concerned with systems on which the majority of a given population relies from day to day. Infrastructures are not just available; they are actively used. This definition allows us to compare different epochs and regions while acknowledging the particularity of arrangements in a given time and place.

Where should we start, then? There are several options. The classic academic approach would begin with ideas and tie them to pioneers, pathbreakers, and prophets. In that case, we would have to take up early modern utopian schemes for creating harmonious and just societies that meet the needs of all people. For the most part, such visions of a stable future without material need or social marginalization evoke a somewhat boring land of milk and honey.

Alternatively, we could emphasize practical politics. This would mean starting with the emergence of the modern state, policies of mercantilism

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and cameralism, and plans for developing clearly defined territories. In *The Wealth of Nations* (1776), Adam Smith, the father of modern economics, assigned the "sovereign or commonwealth" the duty

> of erecting and maintaining those public institutions and those public works, which, though they may be in the highest degree advantageous to a great society, are, however, of such a nature that the profit could never repay the expense to any individual or small number of individuals, and which it therefore cannot be expected that any individual or small number of individuals should erect or maintain.[16]

On the basis of observations along these lines, generations of political scientists have made such "works" their business; in Germany, the term *öffentliche Anstalten* was used for the first time just two years after Smith's book was published.[17]

Then again, we could take for the point of departure the occasion when the mentality shifted: the notion—formulated in the eighteenth century at the latest—that progress and civilizational advances are the dividends paid by circulation, the free movement of human beings, goods, and ideas.[18] In this framework, sedentary ways of life closed off from interaction with other groups were regarded as backwardness, a condition to be overcome. Conversely, the web, or network, became a positive image for human communities enjoying the benefits of both centralization and decentralization.[19] The picture implies conflicts between infrastructures, which are expansive by nature, and economic realms sealed off by national borders—the problem of the "isolated state" examined by Johann von Thünen (1826). Since then, disagreement has prevailed between those who argue along protectionist lines and those advocating free trade; to this day, infrastructures are set up or curtailed in keeping with decision-makers' preference one way or the other.

Another starting point could be changes from an environmental perspective. The use of fossil fuels for industrial machinery represented a more intensive exploitation of natural resources to meet human needs. Greater activity of this kind had been long anticipated, but means for doing so were limited.[20] Well before the dawn of the machine age, measures were taken to make nature more calculable—for example, dams and levees in marshlands and coastal regions.[21] Johann Wolfgang von Goethe made a point of including such developments at the end of the second

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part of *Faust*; the effectiveness of machinery suggested that natural conditions could be changed at will.

We could also begin with human needs, first and foremost the wish for material security and comfort. In this case, it would be impossible to go back too far. That said, the amenities provided by the forerunners of today's infrastructures were enjoyed by a vanishingly small number of people. As a rule, a given service—say, the opportunity to communicate readily—was the privilege of the nobility or an elite and performed by specialized personnel. It was not until the nineteenth century that broader segments of the population enjoyed the same benefits.

Our history of infrastructures could also focus on material provisions for transport and communication. If so, the fourteenth-century shift from the "time of cathedrals" to the faster tempo of trade described by the historian Jacques Le Goff would represent a starting point.[22] Alternatively, we could look at streets, conveyances, and postal relays from the sixteenth century on; relevant institutions would include optical telegraphs already long in use. This framework would highlight tensions between military and civilian infrastructures, the often-improvised defensive arrangements made in times of crisis and long-term provisions under conditions of peace.

Yet another option would be to place the story of great men front and center. This approach is common in accounts of technological advances, especially among writers belonging to the fields in question. Often with a defiant undertone, they point to heroes whose contributions to general well-being have not been paid due respect. Indeed, it is difficult to overestimate the impact of work by the likes of George Stephenson, Isambard Kingdom Brunel, Heinrich von Stephan, Thomas Alva Edison, or Nikola Tesla. These individuals have had encomiastic volumes written about their lives and inspired many enthusiastic amateurs; the length and scope of their Wikipedia entries are no accident.

Were we to expand the view beyond individual pioneers, the emergence of classes of professionals and cultures of expertise represents a major index: military and civil engineers, planners and administrators, bankers and entrepreneurs, inventors and developers, construction and mining concerns, and political officials at all levels. But with few exceptions, infrastructures are not linked with the names of the parties who

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designed and set them up. They almost always have come into being through complex, cumulative networking and coordination efforts.

In sum, the most advisable course is to view infrastructure as the result of negotiation and compromise.[23] The topic stands at the heart of social existence, and many disciplines have made important contributions. History tends to factor into the discussion in the negative—when disorganization or obsolescence prevails because institutions simply grew (instead of being planned from the ground up). Indeed, the sphere of infrastructure disavows history—and politics, for that matter—because it claims to serve the common good; the pretense of impartiality is a defining characteristic. Thus, the book does not look for when a given practice or institution originated so much as the point at which it demonstrated incontestable significance. The *longue durée* is more important than the short term, and quotidian routines tell more than stories of innovation, diffusion, and change; what has escaped notice often proves to be more revealing than what is readily apparent.

SPHERES OF DEFINITION

Of course, innumerable definitions have been proposed. For Paul Edwards, mentioned earlier, *modernity* means living in and through infrastructures, which constitute its very essence.[24] Other scholars understand infrastructures as "a symbol of the collective *we*."[25] Infrastructures have been said to be the "matter" of the social sphere or to amount to its "condition of functioning."[26] By turns, such "infrastructuralism" has been described as an arrangement, dispositive, rhizome, or consolidation.[27] In concrete technical terms, this translates to more laconic observations—for instance, "Modern civilization is unthinkable . . . without working sewers."[28]

Even if many questions remain unresolved, this book confers order on how they are framed. Since the eighteenth century, thinkers and scholars have sought to shed light on the requirements for functioning markets, which cannot exist without state measures. Adam Smith and others who followed his lead are wrongly said to have demanded that governments refrain from economic intervention.[29] In fact, many liberal economists called for state action in emergencies, and they acknowledged that certain economic spheres defy the rules of supply and demand.

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Since the civil engineer and economist Jules Dupuit introduced them to France in 1844, *travaux publics* have represented an integral component of governmental policy.[30] The corresponding terms in English-speaking and German-speaking lands are *public works* and *öffentliche Arbeiten*. In the nineteenth century, ministries and departments were founded expressly to oversee the building of national roadways and communications networks. In a parallel development, the science of logistics attended to the distribution of wares, circulation of human beings, and diffusion of ideas. To this day, theories developed in this framework are the cornerstone of statewide and, more specifically, regional infrastructure policies. The goal is to activate social development and promote economic growth. Until the late twentieth century, the latter meant increased productivity, and commercial enterprises routinely called for suitable provisions to be put in place to fuel business in new areas.

As the nineteenth century drew to a close, a second field of infrastructural policy emerged. Policies assigned tasks to the state and municipalities that hitherto had been performed by extended families or by conscientious employers. To secure the loyalty of specialized workers, many companies in the mining industry—for instance, Krupp, Thyssen, and Cockerill—built accommodations and founded institutions to ensure the well-being of employees. Later, many of the same arrangements were taken over by insurance plans and the welfare state (*Vorsorgestaat*).[31] Modern nation-states created systems for traffic and transport, water supply, and waste disposal—that is, fixed assets on a massive scale.

In the period between the two world wars, an umbrella term for such institutions was coined: *public utilities*. Expanding infrastructures would catalyze overall economic vitality.[32] Later, in 1953, the Estonian economist Ragnar Nurske promoted the idea that the economies of "underdeveloped" regions would flourish once their stability had been secured by infrastructural "scaffolding."[33]

Since the early 1960s, a general agreement has prevailed that infrastructures provide the basic operations required for economic growth, integration into markets, and steady supply streams. In 1966, the economist Reimut Jochimsen elaborated a provisional "theory of infrastructure."[34] Even if, in the intervening decades, no consensus has emerged about everything it includes, infrastructure represents the main sector for public

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investment and planning, alongside military spending and measures for ensuring the social safety net.

The vast sums involved make infrastructure a political item of the first order. Projects both demonstrate power and serve common interests, however one defines them. Canals, roads, postal systems, and communications networks promote social interaction and unification.[35] Only through infrastructure did Breton peasants turn into Frenchmen or Catalan fishermen become Spanish.[36] In Europe, telegraph wires and power cables bound a patchwork of regions into nations.[37] Administrative and technological measures achieved legitimacy inasmuch as they created prosperity at home and averted danger from abroad.[38]

To this very day, as times and systems undergo further change, the political theater of groundbreaking ceremonies, cutting ribbons, or pushing a button for the first time has survived. Such demonstrations of confidence in the future, the sound organization of communal life, and good government blur the boundaries between the realms of politics, bureaucracy, and civil society.[39] "This is collective power," Michael Mann observes, "'power through' society, coordinating social life through state infrastructures."[40] But such power also depends on popular consent.[41] The sociologist Trutz von Trotha calls it *Organisationsmacht*, or "organizational power":

> [Its] productivity—the fact that it makes a difference and changes things—exerts persuasive forces. This [principle] holds for trees planted, buildings, roads, bridges, and railroad tracks, in which organizational power creates *accomplished facts* [*vollendete Tatsachen*]; their *finality* signifies its unconditional claim.[42]

Examples of organizational power include undertakings in societies where survival depends on collective effort—when the elements threaten settlements or must be controlled for agricultural purposes (to grow grain or rice, for example). Max Weber and Karl August Wittfogel used the terms "bureaucratic water-engineering state" (*wasserbaubürokratischer Beamtenstaat*) and "hydraulic society" some hundred years ago. Historians might debate whether such projects determined the shape of social systems and government to the extent that the authors implied, but it is clear that they conferred, stored, and distributed power in both real and symbolic terms.[43]

In complex modern societies, power over transport, communication, and supply simply cannot be exercised directly from the top down.

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Moreover, processes of control, integration, or exclusion can be turned against those who would wield them to others' disadvantage. The significance of this is evident after examining twentieth-century projects of state socialism. As the historians Jens Ivo Engels and Gerrit Jasper Schenk put it, infrastructures "capacitate" (*ermächtigen*). That said, they do so not only for politicians, planners, and operators but also for users.[44] The field they constitute abounds in indirect and technocratic modes of intervention, as well as spaces to reverse the flow of power.[45]

The urbanist Keller Easterling has observed that infrastructures are producing some of the most enduring changes in our globalizing world. Because the systems operating in cities emerge more rapidly than administrative structures for regulating them, they qualify as "extrastatecraft."[46] Consulting firms active across the globe, multinational corporations, and bodies such as the International Organization for Standardization are constantly working to create uniform conditions that hold universally.[47]

In non-Western societies, of course, infrastructure meets with fundamentally different ways of dealing with power—as the ups and downs of developmental policy have shown. For many decades, efforts have been made to transfer a concept shaped by the West to "underdeveloped" countries without considering cultural or historical factors. Planners of the unreconstructed sort still view putting basic infrastructures in place as a panacea for "backward" and "primitive" conditions.[48] When the formula fails to deliver, the set response is that the societies in question do not understand the specific "language of infrastructure."[49]

Far more often, however, the problem lies elsewhere. Infrastructures represent a kind of fetish, and in many cases they have been instituted because they radiate a certain kind of "enchantment."[50] Thus, following World War II, many roadways were built in Balkan countries even though the private ownership of automobiles was practically nonexistent.[51] It seemed that the mere symbolism of traffic and circulation would be enough to consolidate, spatially and socially, regions only loosely connected until this point.[52]

Accordingly, infrastructures have often been defined as social programming. As early as 1950, the business journalist Ferdinand Fried described the matter fairly precisely:

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> One enters into an immense network of mutual contractual entanglements and thereby . . . into a vast scheme of organization, without which modern existence would lapse into anarchy. . . . In this way, modern man finds himself in a magic circle from which he can no longer escape. All things influence and exaggerate each other into furious necessity, driving people together into ever-larger communities of shared purpose.[53]

For their part, sociologists have described such communities of purpose in terms of "structuration" (Anthony Giddens) and society as a "megamachine" (Lewis Mumford).[54] By encoding human action, habitus, and knowledge, infrastructures form the basis for cultural practices of arranging life, communicating, and exchanging information. Moreover, they enable these aspects of existence to be controlled.[55] Thus, when coin-operated water meters were introduced into homes, a certain civic and consumer morality came along with water, and users were trained to become "calculating subjects."[56]

Large-scale technological systems, the very heart and soul of infrastructures, have generated their own branches of research[57] that examine how political and social decisions are inscribed in them and their long-term effects. The question, Do artifacts have politics? demands a more nuanced response than the one offered in 1980 by the philosopher of technology Langdon Winner, who claimed that New York bridges had been built so low to ensure that only automobiles driven by whites could use roadways, and people of color traveling in buses could not. The allegation turned out to be a myth.[58]

The Spanish sociologist Manuel Castells's phrase for infrastructures, "spaces of flow," refers to the permeable boundaries that prevail between technology, nature, and urban culture. According to another contemporary sociologist, Elisabeth Heidenreich, the expectation that flexibility will be available at any given time represents "one of the most far-reaching aspects of modernity."[59] Under these conditions, the natural world turns into a raw material, or fuel; in a word, it is commodified. Infrastructures liquefy both social relations and interactions with the natural world. Because they are built to last and require complex organization, they set the course for society over the long term, establishing path dependencies.

Anthropologists, ethnologists, and cultural theorists have long noted that humankind enhances its comparatively limited physical strength

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by technical means. Along the lines described by the sociologist Arnold Gehlen, tools and instruments act as prostheses to supplement "deficient human being." Amplifying the scope and reach of bodily organs, they are ways to increase convenience, secure control, and broaden horizons. The philosopher Hans Blumenberg has argued that technological progress aims to gain more time—that is, to extend the feeling of life.[60] The sociologist Wolfgang Essbach, in contrast, stresses the increasing reliance on "second nature," or the "bioartificial symbiosis"[61] that modern humans live in with their surroundings.

In the early twentieth century, Georg Simmel analyzed the sensory overload that is part and parcel of metropolitan life. Urbanites must learn to filter out excess stimuli so as not to break down and fall victim to a fit of nerves—a fashionable disease of the day.[62] A perceived "annihilation of space and time," which the cultural historian Wolfgang Schivelbusch has discussed in relation to the railroad system, was a phenomenon remarked time and again by diagnosticians of the modern condition. More recently, the claim has been advanced that postmodern culture and life are characterized by constant acceleration, or even a "speed virus."[63] As a rule, blame attaches to innovations in the fields of communication and movement, which overload systems of traffic and flow.

How is it that millions of people meet the everyday challenges of roadways and get from one place to another? How do they deal with vast quantities of information pouring in from every side? According to the sociologist Susan Leigh Star, the planning behind large-scale networks does not need explaining so much as their practical operation does, which is constantly being modified. Paradoxically, she observes, people tend to prefer the familiar and routine to alternatives that are more functional or less expensive.[64] Her findings confirm the extent to which infrastructures and the habits they engender stabilize ordinary life.

The field of media studies has examined today's networked society with an eye to the environments and lifeworlds that infrastructures arrange, or "dispose."[65] Often, scholars remark, media are invented and developed in a military context. Cannons, artillery, radio technology, aviation, satellites, teletechnologies, and the Internet activate space by breaking down boundaries.[66] Even in a civilian setting, such dynamism fosters forms of behavior that depart from previous norms.[67]

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The ethnological perspective, which analyzes relationships between self and other, has shed light on industrialized societies and the infrastructures on which they depend. Thus, in 1996, the anthropologist Marc Augé was asked whether he could conduct his research without traveling halfway around the world; after all, different cultures exist side by side in London, Paris, and Los Angeles.[68]

If social relations are increasingly mediated by technology, then it is necessary to analyze infrastructural power, too: for instance, exclusion from networks or the inequitable distribution of services.[69] Especially in the booming megacities of the Global South, infrastructures vary in telling ways. According to the architectural historian Swati Chattopadhyay, places such as Lagos and metropolises in East Asia exist in a realm beyond urban planning. The concept of infrastructure, which comes from the West, needs to be rethought to account for conditions elsewhere; subaltern populations engage with systems along wholly different lines, displaying both creativity and stubborn resistance.[70] Day-to-day life in these places is not determined by reliable exchange and connections; instead, unpredictability sets the course.[71] For the uprooted and mobile inhabitants of "infracities" (for instance, the townships of Johannesburg or Cape Town, where development is piecemeal), the real infrastructure is made up of flexible chains of acquaintance and kinship.[72] In other words, everything comes full circle: in overpopulated areas in a state of semipermanent emergency, human beings, not large-scale technical systems, ensure survival.[73]

In sum, more and more disciplines have turned their attention to infrastructures in recent years because these systems link highly varied, and even opposing, sectors of society to one another. Infrastructures are the material expression of social and political negotiation; they structure communities and shape individual character and life. Drawing on the approaches outlined in the preceding, the following chapters seek to portray, as vividly as possible, the diverse and surprising forms of what otherwise remains impersonal and nameless. On the one hand, infrastructures stand for stability, continuity, and new possibilities and opportunities. On the other, they harbor the potential for rupture, danger, and new burdens. Infrastructures reflect social and cultural processes; whether they remain invisible or stand in plain view, they have become a defining feature of modern life.[74]

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