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**The Built Environment:  
How Infrastructure Shapes City Design Today and Tomorrow**

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## **The Built Environment: How Infrastructure Shapes City Design Today and Tomorrow**

### *Abstract*

This essay explores the nexus between hard infrastructure and city design in order to highlight crucial lessons for planning the great cities of tomorrow. It begins by tracking different conceptions of urban physical infrastructure from a variety of disciplinary perspectives and positions while illustrating its role in enabling and sustaining modern city life. The paper then turns to explaining how prevalent ideas about planning and provisioning of hard infrastructure in built environments have changed over time, highlighting the role of broader influences such as intellectual debates and design movements in shaping these shifts. Summarizing the influence of recent concerns with larger issues like social justice and environmental degradation upon scholarly thinking, the essay concludes by offering key lessons for policy makers and professional practitioners.

### *Introduction*

Great cities like Chicago and *hard infrastructure*, or the investment in fixed assets designed to improve both the economic development opportunities and the physical design of cities, have a close, even if sometimes estranged, relationship. On the one hand, both give rise to each other especially when the built environment (places, buildings and open areas) and enabling infrastructure (facilities, utilities, public works and more) are conceived and built complementarily. On the other hand, urban places and supporting infrastructure can quickly turn out-of-sync leading to dysfunction and even disasters (Graham and Marvin 2001). Dystopian chronicles of disinvestment in city infrastructure for a variety of reasons such as official neglect, deep social differences and growing economic rifts in erstwhile productive places like Flint, Michigan document such disasters in horrifying detail (Apel 2015; Highsmith 2015).

Not surprisingly, real as well as perceived gaps between the features of built environment and elements of hard infrastructure generate dissonance and vigorous public debate while some of the biggest budget battles, irrespective of the geographical location

and political leaning of the legislature or city hall, routinely concern infrastructure. Such a preoccupation with the nature and status of hard infrastructure across urban America is equally evident in the broad litany of complaints sponsors, planners and builders of physical infrastructure face on an ongoing basis: Design mismatch, bureaucratic tardiness, turf wars, petty politicking, talking past each other, working at cross-purposes, cost overruns, inordinate delays and even boosterism, or unabashed promotion of a place in public perception for narrow economic gains often centered around showcase design projects and prestigious real-estate developments. So, how do we make sense of such a deeply intertwined relationship between hard infrastructure and city design? What is our experience and what have we learned?

It is plain to see that cities cannot exist without hard infrastructure. Cities and physical infrastructure have always coexisted with mutual interdependence and coevolution long characterizing their intimate relationship. In fact, an important strand of urban historiography views modern cities as completely manmade entities that emerged from the interaction of society and technology because neither economic development nor urbanization could have occurred without the creation of enabling infrastructure (Tarr 1980). In this line of thinking, infrastructure leads city development (especially in developed societies) by getting built first and then continues to shape urban growth for a long time because of its foundational and enduring nature—easily outliving many other urban elements like built and open spaces by decades and even centuries.<sup>1</sup>

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<sup>1</sup> Literature documents the paucity of infrastructure in many parts of the world, where its provision often trails human habitation with substantial time lag, if built at all. Recent scholarship has appropriately conceptualized this phenomenon as “cold spots/hot spots” in the worldwide web of infrastructural systems (Coward 2015). This essay, however, focuses principally on the relationship between hard infrastructure and city design in the American context.

It is equally clear that the roles and significance of physical infrastructure have increased dramatically since the advent of large modern metropolis in the late 19<sup>th</sup> century and as a postindustrial society today, we are more dependent on technology enabled infrastructures than at any time in the past.<sup>2</sup> Moreover, as cities compete at the global level, leaders recognize the critical role of infrastructure in creating high quality urban facilities and living environments that provide crucial competitive advantage (McKinsey Global Institute 2014). Contemporary trends presaging planet's increasingly urban future including the emergence of megacities, massive urban regions, and the networking of places and communities all rely on infrastructures (World Bank 2015). Moreover, governments routinely turn to infrastructure for a variety of reasons such as society's overall development, administrative control of populations, and countering economic downturns, often in opposition to the prevalent political climate.<sup>3</sup> For instance, President Obama's Recovery act of 2009, despite the ongoing neoliberal impulses in this country, aimed at using investment in hard infrastructure to boost economic activity.

Not surprisingly, literature tracks the development of various forms and elements of hard infrastructure in shaping modern cities from a variety of positions and perspectives (e.g., Armstrong et. al. 1976; Blake 1956; Schwieterman, and Mammoser, 2009). In this essay, I offer a brief overview summarizing key insights from this extensive literature toward illustrating the nexus between hard infrastructure and city design in order to highlight key lessons for designing the cities of tomorrow.

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<sup>2</sup> In his majestic survey, *The Urban Millennium: The City Building Processes from the Early Middle Ages to the Present*, Josef Konvitz notes that the sense in which we use the word Infrastructure today is fairly recent and "probably appeared for the first time in 1875, in French" referring to military works. For an updated view on the role of technology in the envisaged future of cities see PCAST (2016).

<sup>3</sup> Michael Mann (1984) has described the nation-state's intrinsic desire to exercise sovereign authority (notwithstanding the form and type of government in power) by using "infrastructural power," or the state's capacity to enforce policy through out its territory and populations via various forms of infrastructures.

The next section begins by reviewing various conceptions and definitions of hard infrastructure in order to flesh out the intellectual foundation and theoretical framework of this essay. I find that meanings and perceptions of hard infrastructure have continued to change mainly to reflect the expanding roles and growing importance of various kinds of existing and emergent elements of urban physical infrastructure in enabling and sustaining modern city life. The following section tracks how prevalent ideas about the planning and provisioning of hard infrastructure in built environment have changed over time illustrating the critical role of broader intellectual debates and social movements in shaping these shifts. The final section concludes by offering a set of prospective policies that cities and metropolitan regions ought to consider and analyze for possible implementation, exploring both the challenges and benefits of such actions.

### *Conceiving Hard Infrastructure*

Even though urban physical infrastructure seems to be a moving target resisting precise specification, many scholarly conceptions and definitions refer to fixed assets in the form of built facilities and networks, either below or over ground, which support human health, safety and welfare (Neuman 2006). More important, the term's meaning has continued to expand over time largely to include growing number of different systems. For instance, the focus has grown to include a range of publicly and privately owned providers of spatial systems enabling and supporting human life in modern urban environments such as utilities (gas and electricity, water supply and sewerage, waste collection and disposal); public works (roads and bridges, dams and canals, ports and airports, railways and multimodal transportation hubs); community facilities (schools, parks, hospitals, libraries

and prisons); and telecommunications (telephone, cable television and internet). Given their significance for modern urban life many of these systems are nowadays termed as critical infrastructure (Neuman 2014).

While networks are clearly a part of this complex arrangement undergirding contemporary city life, often the policy and implementation focus has been on a single project (e.g., widening of I-290), facility (e.g., building a new pumping station) or a public work (e.g., rebuilding Lower Wacker Drive). Moreover, within these efforts, emphasis has customarily focused on a specific aspect, such as the nut and bolts of physical configuration, compared to other ramifications like the larger meaning and value addition generated by different networks comprising hard infrastructure—explained a little later in this section.<sup>4</sup>

Neuman and Smith (2010) argue that such a narrow focus stems from the emergence of many professions (rather than one single profession) developing expertise in different domains of urban infrastructure like transportation, electric supply, telecommunications and municipal administration. With each profession focused on its own specialized domain, it is not surprising that a plethora of definitions explaining hard infrastructure exists that are largely in line with the specific expertise of that particular profession and frequently codified in relevant professional norms and statutory rules and instruments. Neuman (2006) identifies different professions (identified in parentheses) that have proffered categorical denominations suited to their disciplines, such as utilities (service providers), urban infrastructure (city planning), public works (civil engineering), capital facilities (business administration), capital investments (finance), community

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<sup>4</sup> The predominant focus on spatial aspects and physically fixed nature of infrastructure is perhaps best evident in Joel Tarr's conception of urban infrastructure as "the 'sinews' of the city" (1984, 4). For a more contemporary preoccupation with physical dimensions of infrastructure in different parts of the world see Kerlin and Palter (2017) and Rastogi (2006).

facilities (public administration), and civic improvements (architecture). Below I explain each of these categories in slight detail because digging deeper provides a good idea about how different professions and concerned authorities have conceived and organized the various components of hard infrastructure across space and time (Ibid).

*Utilities* refer to an important subcategory of infrastructure financed largely by user fees, mostly administered locally in specified geographies, and delivered directly to the user premises. Water supply, waste collection, electricity, and natural gas are common types of utilities. Historically also known as public utilities, many utility companies have either private or public owners, and little or no competition in their service areas. But the utility market landscape is increasingly changing characterized both by growing competition and concomitant regulatory supervision for consumer protection. In contrast, the term *Public Works* commonly refers to an individual, large-scale facility customarily imposing no direct charge on the users that is usually built by the public sector for the benefit of general public. Examples include dams, reservoirs, ports, bridges, roads, and also airports—almost all of which belong exclusively to the domain of public sector construction. Today, the term public works continues to connote large-scale engineering projects even as prevalent ideas about user charges and fees have begun to change.<sup>5</sup>

Associated with the City Beautiful movement, the term *city improvement* emerged around the turn of the 19<sup>th</sup> century for referring to public projects targeted at bettering the overall built environment for the benefit of city residents. In line with the tenets of the progressive era, examples include the building of useful and prominent public facilities

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<sup>5</sup> Important to note here that strict meaning of the term ‘public’ is nowadays changing with all types of infrastructure entailing varying degrees of private sector involvement even as governments continue to exercise regulatory oversight. Roads are a good example where we seem to have gone back to the turnpike model of the 19<sup>th</sup> century controlled almost entirely by private sector in different parts of the World.

such as libraries, city halls, parks, boulevards, public lighting and street furniture. Designed by well-known architects and landscape designers, these projects also aimed at instilling civic pride by improving the urban environment that had become filthy and crowded in the industrial era. Today the term civic improvement generally refers to the (re)design of urban spaces through built projects encompassing more functional infrastructures, than the city beautiful predecessors, such as marinas, ports and public transit (Ibid).

The term *community facility* includes buildings such as city halls, fire and police stations, libraries and schools, parks and community meant to serve a specific set of users (individual community) at a particular scale (municipal or neighborhood). Usually owned and operated by the public sector, there were called public facilities in recent past. In the wake of ongoing privatization and not-profitization, the relatively generic term community facilities privileging scale to ownership has gained currency. In the case of small communities and private subdivisions, some of these facilities are provided by citizen volunteers, such as fire fighters, and others may be provided privately, such as a swimming pool and community center, by a homeowners association.

The notion of investing financial capital into an individual facility lies at the heart of the term *capital facilities*. The focus on a particular facility is common with the term public works but capital facilities can be owned by private, public, non-profit or mixed ownership. Originally connoting initial investment into any large public facility or network that performs a service to its users and owners, the term capital facilities has gradually expanded to include one of the broadest classifications of infrastructure encompassing libraries, schools, community facilities and even utilities. Although closely related, the term *Capital investment* explicitly emphasizes the role of financial capital in infrastructure

development and the return on investment anticipated by the investors. Neuman (2006) argues that in practice, however, this is largely an accounting issue with local variations and is not injurious to the overall concept of infrastructure as a capital investment.

But even as different professions conceptualize infrastructure into various categories in line with their professional expertise, different conceptions and interpretations can easily impede mutual understanding and coordination because many elements of infrastructure frequently overlap and connect with each other. In the category of capital investments, for instance, policy makers, decision makers and investors think and operate in terms of loans, interest rates, debt ratios, and satisfying relevant constituencies with specific projects. In the realm of public works, engineers employ a set of tools and ideas substantially dissimilar to that of policy makers. In the domain of community facilities and transportation, the same can be said about urban planners, architects, and landscape architects who both design and site infrastructure into existing urban fabric as well as plan new development patterns. As a result, decisions are routinely made piecemeal, with the inevitable high costs and consequences of the attendant lack of coordination. This fairly ubiquitous phenomenon not only brings blame to the doors of planners and builders of infrastructure but also predicates a major critique of the manner in which we have customarily conceived and built various elements of hard infrastructure.<sup>6</sup>

The second (and in fact a much older) critique comes from scholars studying the social and environmental implications of hard infrastructure and its physical design. Critiquing the underlying spatially-centered perspective that assumes social problems can

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<sup>6</sup> Recent scholarship has, however, began to argue that the increasing interconnected nature of infrastructure networks has created opportunities for reshaping the decision-making process, enabling new sites of experimentation and stimulating inclusive urban infrastructure. See, for instance, Ersoy (2017).

be solved by manipulating the physical built environment, scholars like Herbert Gans (1968) described how spatial solutions are not a prerequisite to thriving social communities, at least not to the extent posited by the advocates of hard infrastructure.<sup>7</sup> Along similar lines, William Sherman has described how the modern predilection for large-scale spatial solutions that sought to insulate human communities from the vagaries of nature not only portended growing disengagement with the surrounding natural environment but also shaped the nature and meaning of design itself in fundamental ways:

For the past hundred years...the incessant search for new form has been supported by the evolving technological apparatus of modernity. The process of abstraction that characterizes modern thought finds a physical analog in the vast infrastructures created to parallel and stabilize dynamic ecological systems. These infrastructural systems replace the temporal processes and spatial limits of a tangible place, allowing discrete works of design to disengage from their local surround. As a result, these projects stand seemingly absolved from accounting for their cultural and ecological impacts. The essential processes that structure human engagements with the physical world have been reduced to a resource delivery system, reflecting a predilection rooted in modernity for the ravenous consumption of the present tense, with-out consequence beyond the moment. The long-term impact of our technologically driven, consumer culture necessitates a critical reconsideration of the failings of this modern apparatus as a precondition for design (Sherman 2005, 312).

Informed both by these critiques and the growing scope and significance of hard infrastructure in enabling and sustaining modern city life, recent scholarship has began paying attention to the larger meaning and value addition generated by different networks comprising hard infrastructure. Neuman (2006), for example, has shown how infrastructure does not simply lie underneath other structures, such as buildings or cities,

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<sup>7</sup> For a recent overview of this vein of literature, see Brand (2005). For a spirited defense, see Batty and Marshal (2009)

but brings life and connects them in meaningful ways. Infrastructure is deliberately designed to infuse vitality channelizing a range of critical utilities (water, energy, people, information, wastes, and commodities) across different components of each supported building. It then links these buildings intelligibly with nearby places and facilities, and at still larger spatial scales, physically creates both the individual parts and the overall network of human settlements. This new understanding, based on a reconception of the nature of infrastructures, reflects how infrastructures infiltrate human habitats rather than underlie obscurely (Ibid). In this sense, hard infrastructure is the “connective tissue that knits people, places, social institutions and natural environment into coherent urban relations” (Graham and Marvin 2001, 43).

Adding value to places and buildings then is the fundamental nature and purpose of contemporary infrastructure. These value-additions gain special significance in large cities and urban regions due to different kinds of densities and intensities at play among various infrastructure networks. The network of networks is more closely woven in cities due to the spatial proximity of various buildings and places (or nodes are closer together) generating efficiencies and more benefit to the users. But unanticipated interactions among spatially proximate infrastructures can also entail negative costs to both the users and non-users. Informed by such an expansive understanding based on infrastructure network theory, Neuman offers the following broad definition of infrastructure:

Infrastructure is the physical network that channels a flux (water, fluid, electricity, energy, material, people, digital signal, analog signal etc.) through conduits (tubes, pipes, canals, channels, roads, rails, wires, cables, fibers, lines etc.) or a medium (air, water) with the purpose of supporting a human population, usually located in a settlement, for the general or common good. It consists of a long-lasting network connecting producers and service providers with a large number of users through standardized (while

variable) technologies, pricing and controls that are planned and managed by coordinating organizations (6, 2006).

How did we reach such a capacious conception of hard infrastructure? The next section takes up this story explaining how changing ideas and conceptions have shaped our notions about hard infrastructure in pluralistic ways and what that says about planning the great cities of tomorrow.

### *Changing Ideas about Hard Infrastructure*

This is not the first study of the relationship between hard infrastructure and city design. I describe here some of the extensive literature mainly to frame the context for judging and distilling important insights and lessons for designing better cities than the past. Before doing so, however, the following two backstories help comprehend the overall nature and disposition of the American planning tradition that scaffolds the relationship between physical design of places and infiltrating infrastructures in important ways.

First, in a brilliant essay overviewing the American planning tradition over last couple centuries, leading urban historian Robert Fishman (2010) explains how national planning played a crucial role in the rapid creation of a continent-size urban order by focusing on large-scale infrastructural elements such as transcontinental railroads, great hydro-electric dams of the South and West and the interstate highway system. Arguing that the “federal government itself was created in large part to overcome the barriers to national planning that existed under the Articles of Confederation” he posits that “no other nation has been so profoundly *planned* as the United States” [emphasis in original] (1, 2010). Countering the widely-popular narrative in this country that national planning is an

un-American activity—an exercise in bureaucratic hubris best left to the French—the essay goes on to illustrate the unique nature and structure of the American planning system.

According to Fishman, the remarkable power of planning in the United States is proportional to the strengths of the impediments it must constantly overcome. These obstacles include powerful ideas and structural elements such as the centrality of private property and the influence of this notion over important domains like economic thought and material culture, and the federal system of government with its complex division of powers. Planning in this country has therefore always been innovative and opportunistic, exploiting the flexibility in the federal system to bypass opposition while constantly seeking new coalitions of stakeholders that can advance the goals.

For instance, depending upon the issue at hand, the stakeholder coalition can easily include diverse players from an impressive spectrum of planning actors such as the federal or state agencies, public sector organizations, private institutions, individual entrepreneurs, local politicians, members of the civil society, property developers and even real-estate speculators. This special characteristic of American planning, where despite the lack of top-down bureaucracies to conduct planning (such as those in France and other European countries), the relatively open American system not only encourages citizen activism but also fosters close cooperation between seemingly incompatible stakeholders such as progressive leaders, real-estate builders and staunch environmentalists. Important, the federal system, with its division of power between the national government and states, and constituent urban regions and settlements of varying size and function, provides unexpected strength and a diverse range of practical opportunities to conduct planning at different spatial and policy scales. Thus, any study of planning work (conceiving,

predicting, designing, composing, implementation) involving hard infrastructure and city design in this country must pay attention to cross-scalar interactions between relevant policy domains and spatial realms shaped by the political dynamic and (often unique) contexts and cultures of local places and specific settlements.

The second, and interrelated with the previous, backstory describes the long-term development of relationship between infrastructure provisioning and the field of urban planning in the United States. In a series of well-articulated essays, leading subject expert Michael Neuman (2006, 2009, 2010, 2011, 2014) has illustrated the relationship's non-linear nature while describing the major historic episodes that shaped the nexus. He describes how the connections between modern infrastructure planning and city design were intimately intertwined at the beginning of relationship during the last quarter of the 19th century and, although the links remain numerous and multifaceted, the relationship today is mostly non-strategic and non-comprehensive even as the bond between infrastructures and cities remain tight. Scholars tracking other domains of infrastructure planning confirm Neuman's thesis.

Take the example of road infrastructure, for instance, where Michael Fein (2008) identifies major policy regimes that shaped the history of road building in the New York state.<sup>8</sup> Beginning in the late 19<sup>th</sup> century, local communities organized the entire wherewithal to plan and build the few primitive roads that existed at the time but always paid close attention to road alignment and its integration with settlements' physical layout and foreseeable spatial future. The second policy regime emerged around the turn of the century when some, albeit largely urban, interests began to turn toward the state of New

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<sup>8</sup> Roads are perhaps the hardest form of infrastructure because once built they are very difficult to relocate or realign as evident in the continuing use of Roman thoroughfares and Indian trails even today.

York in an effort to build more and better roads. Local officials' volunteer cooperation with higher authorities helped access state funds for building better roads through adjacent locales—despite many and long-standing differences that often marked their relationship. Many of these roads, however, also opened city edges and peripheral areas for building new urban extensions and designing real-estate projects. Local interests, however, still shaped decision-making around road location and alignment, but now generated many more potential opportunities for political patronage and actual corruption as the size and scope of roadwork increased substantially.

Shortly afterwards, emergence of the new profession of highway engineers accompanied the employment of progressive language of efficiency and technical expertise. This shift helped professionals pursue administrative and procedural reforms and gradually gain control of the road-building process from local and often vested interests. Increasingly asserting the superiority of their supposedly non-political approach, engineers' efforts culminated in the creation of a State Highway Department that they headed. Seeing the value in deflecting criticism from the legislature, politicians then ceded authority to the Highway Department and its engineers while retaining oversight control.

New Deal ushered in the next policy regime that saw greater federal money and involvement. Fein argues that during this period federal and state governments negotiated a power-sharing arrangement even as the states further insulated the road-building process from voters and local interests with the creation of an independent public authority to plan, finance and build the New York state thruway. Important, he shows that the movement of power and control from the local to state to national level was a non-linear process highly contested almost at every stage. States did not simply cede control

with the advent of federal funding rather the road-building process became a cooperative venture with substantial state and mayoral influence over when and where roads and, particularly, the interstate system would be built—an arrangement that shaped the spatial design and physical layout of postwar American cities and settlements in profound ways. Keeping these backstories in mind, below I elaborate the shifting tale of relationship between hard infrastructure and city design through the critical lenses of centralization / decentralization debate and the influence of larger movements like social justice and environmentalism that help highlight useful insights.

### *Centralization/ Decentralization Debate*

Since planning and provisioning of hard infrastructure commonly entails thinking and working across multiple policy domains and different political jurisdictions, the question of relevant scale and the nature and scope of effort assumes considerable significance. Even as professionals tend to support large-scale centralized systems, for ostensibly important reasons such as supervisory coordination and control and efficiencies of various kinds, influential actors such as place-based voters and community leaders often espouse decentralized distribution of power preferring local control over elements of infrastructure within their jurisdictions. Attendant debates about the size and role of government and the scope of regulatory controls, especially in this country, shape this dynamic as well. Not surprisingly, this broader debate between the advocates of decentralized control and centralized power has long influenced the nature of planning shaping the relationship between city design and hard infrastructure in critical ways.

Historically, however, city design has been deeply rooted in infrastructure planning. Before the advent of modern planning era, usually attributed to the efforts of Georges Haussmann in Paris and Ildefons Cerdà in Barcelona around the middle of the nineteenth century, physical design of cities was often conceived at the scale of communities (which were spatially small since the dominant mode of transport was walking) and customarily articulated in terms of infrastructure planning that included layout of streets, public squares, and open spaces, and location of monuments, churches, and markets. Physical infrastructure was the primary object of city design as well as the main vehicle for pursuing its realization (Neuman and Smith 2010).

This paradigm changed with Hausmann, who was a skillful administrator tasked by the French royal court to improve mid-nineteenth century Paris that had deteriorated on account of various reasons such as industrialization, urbanization and a lack of organized planning. He introduced the model of comprehensive city improvement through physical design conceived and implemented via centralized planning. By focusing on the creation of a modern network of wide boulevards, many of which cut through existing urban fabric, and new roads connecting prominent civic monuments, his plan transformed large parts of Paris by creating sanitary infrastructure, street lighting, omnibuses and open spaces comprising two large parks and numerous community facilities such as schools and hospitals. Perhaps most important, he embraced a design-oriented spatial view derived through physical survey of the entire city that in turn helped integrate the impressive array of open spaces, civic amenities and well-provisioned residential areas into an operative whole through a modern circulatory system (Ibid).

Cerdà advanced this line of thinking by expanding the scope of survey (incorporating social, public health, housing and physical environment conditions as well), enhancing the focus of city planning and design to include outward oriented development, and comparatively better provision of infrastructure than Hausmann. For example, employing innovative studies exploring the spatial integration of public open areas and residential buildings into the design of housing blocks, his centrally conceived and executed plan envisaged Barcelona's first major extension beyond the city walls. A carefully designed civic infrastructure of public parks and plazas, roads and sidewalks, water supply, sewerage and storm drains and multilevel transportation interchanges, that foresaw urban mass transit, not only characterized his seminal plan but also established the importance of infrastructure-oriented design thinking in the emergent field of modern city planning.<sup>9</sup>

Many of these ideas quickly transferred to the United States exerting influence on the incipient field of urban planning that had begun to emerge on this side of the Atlantic as well.<sup>10</sup> None other than Fredrick Law Olmsted, a founding figure of Landscape architecture and city planning in the United States who also served as the director of the United States Sanitary Commission, transformed the retail practice of city planning—traditionally conducted through town layouts focusing primarily on streets, lots and squares—into a more carefully conceived spatial design oriented craft paying attention to parks, parkways, landscaped open areas as well as sanitary infrastructure. Olmsted's 1868 plan for

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<sup>9</sup> This line of approach, however, is by no means dead. Recent examples include many comprehensively conceptualized and purpose-built new towns and city-extensions in different parts of the World including those in China (e.g., Ordos Kangbashi, Inner Mongolia), India (e.g., Lavasa, Maharashtra) and also in the United States (e.g., Celebration, Florida).

<sup>10</sup> Literature describes American urban infrastructure as a blend of European ideas and adaptations and homegrown inventions and innovations. See, for instance, Meritt (1969).

Riverside, Illinois, for instance, not only showcased these ideas in practice but also established a prototypical model for similar efforts in other cities (Peterson 2003).

Landmark planning events like the Chicago's Columbian Exposition of 1893 and Daniel Burnham and Edward Bennett's Plan of Chicago published in 1909 further popularized the idea of comprehensive urban improvement through centrally planned spatial design interventions. Attracting new clientele such as downtown business owners, city boosters and emergent urban middle classes, growth-inducing and growth-shaping infrastructural elements like waterfronts, street improvements, transport, parks and public open spaces soon rose high on the political agenda as well. Among other things, such as fomenting the professionalization of planning discipline, the subsequent City Beautiful movement not only helped expand urban planning's focus from infrastructure and hygiene to political, administrative, and legal concerns but also enhanced the geographical focus from the municipal to regional scale (Neuman and Smith 2010). Both these developments had profound influence upon the relationship between hard infrastructure and city design.

On the one hand, as professional planning matured, it began to align with powerful economic institutions like the chambers of commerce and political-administrative organizations like the city halls. Not surprisingly, city planning's focus began to shift from city design-oriented infrastructure planning and urban aesthetic considerations to administration, control of land use and private property through zoning, and coping with the wide-spread use of motorcars. Urban historian Christine Boyer explains how "Out of the complex of infrastructural and service needs, [modern] city planning from its inception became a multi-faceted process" (1983, 67). In the void created due to the shift in city

planning, state-appointed Public Utilities or Public Services Commissions stepped in and began taking control of infrastructure from the city governments (Ibid).

On the other hand, practitioners in the field increasingly recognized the regional scope and structure of the emergent modern metropolis. The *Regional Plan of New York and its Environs* prepared during the 1920s first articulated the idea of regional planning. Documenting an increasingly urbanized population across 22 counties in three states, the plan posited a key tenet of the regional planning model: Urban growth is best anticipated and guided at the metropolitan scale because the futures of adjacent settlements are tied together through shared economic and infrastructural (especially transportation and environmental) systems. Arguing that partisan interests weaken civic solidarity and limit public attention within narrow political borders, the plan's authors advocated state support for employing regional infrastructure systems as the operating framework while calling on the local communities to cooperate rather than compete. Despite formidable opposition from conservative suburbanites and public sector skeptics, the regional plan's progressivism shaped the New York region in important ways—albeit in a piecemeal fashion over several decades—casting a formative influence on both the discipline and practice of planning that grew exponentially in the postwar period (Fishman 2000).

Using the benefit of hindsight, Fishman (2000) has identified *Regionalists* and *Metropolitanists* as two rival planning traditions that both consolidated in the 1920s and shaped the changing relationship between city design and infrastructure planning. True to their name, Regionalists advocated region-wide planning and thereby focused on issues like regional land uses, intergovernmental coordination and infrastructure policy. By extension, and even if implicitly, they did not accord high priority to the issues of city

design and urban aesthetics that arguably mattered less at the regional scale.<sup>11</sup> Metropolitanists, in contrast, represented the dominant establishment view and believed that the giant metropolis of the future would still be defined by its downtown, “the overwhelming economic and cultural focus of the metropolitan area” (2000, 109).

Not surprisingly, Metropolitanists accorded relatively higher priority to city design believing that the basic urban form of American cities established in the 19<sup>th</sup> century will persist. Most of the population will continue to cluster around a monumental downtown worthy of a great urban civilization in an improved and better designed ‘factory zone,’ or the productive heart of the metropolis. Beyond this zone would be the residential suburbs, housing a relatively small urban elite, and then the ‘outer zone’ containing farms, parks and forests. Important, they believed that each of these zones could be carefully planned in line with modern ideas and prevalent design concepts balancing the quality of city life and easy access to nature via transit lines and parkways (ibid).

Between the 1920s and 1960s, however, two shifts in the Metropolitanist tradition, symbolized by Robert Moses’s massive projects for New York, not only underscored the importance of, often unforeseen, planning challenges associated with building large-scale infrastructure projects in urban settings but also illustrated the significance of carefully choosing the appropriate scale of design intervention. First, in contrast with the pioneers of the Metropolitanist tradition, who had championed rail mass transit investments to knit the region together, Moses and his followers believed in the

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<sup>11</sup> Recent scholarship exploring the ongoing planetary urbanization supports this argument finding that while “previous iterations of infrastructure were oriented toward the unitary project of the city...contemporary infrastructure is characterized by global reach, extending beyond the city as both place and idea. As such, the political implications of global urbanization are best read not in terms of a city-centric framework, but in terms of an infrastructural urbanism on a global scale” (Coward 2015, 97). This insight, however paradoxically, raises the importance of better place-making strategies and careful design of local places.

total dominance of the automobile and set out to rebuild the city in line with this conviction. Second, they embraced urban renewal as a total solution to 'urban blight,' believing that only the complete leveling of whole neighborhoods followed by rebuilding using the design concept of 'tower-in-the-park' could create a viable modern city (Ibid).

Although recent literature acknowledges the salience of Moses's contributions toward transforming New York into the modern global city of today (e.g., Ballon and Jackson, 2007), but the severe backlash to his modernist schemes at the time not only discredited the recently established disciplines of city planning and urban design but also advanced the fields' growing distance from infrastructure planning that had come to rely increasingly on "mega projects, or "initiatives that are physical, very expensive and public" to revitalize cities and stimulate their economic growth (Altshuler and Luberoff, 2003, 2). The influence of growth-oriented metropolitan elite, however, had already begun to wane even as new constraints requiring major alterations in design and mitigation strategies were about to massively drive up the cost of mega projects swiftly changing the overall character of urban politics during the late 1960s and early 1970s (Ibid).

In line with these shifts, planning academe began to critique infrastructure planning and physical design from a social equity, community design, and place-based perspective while focusing on emergent factors such as the declining economic value of new highways (Paul Peterson), the growing minority share of the central-city electorate (Clarence Stone), and the increasing importance of civic amenities as a competitive asset (John R. Logan and Harvey Molotch). On the other hand, planning practice continued the gradual shift away from physical form that had been a critical constituent of city planning in the United

States.<sup>12</sup> Professional engineers, meanwhile, took over regional-scale infrastructure planning and provisioning using sizable federal funds and ideas about efficiencies as the guiding mantra (Graham 2010). Larger debates around the issues of social justice and environmental degradation that crystallized around the same time, however, gradually laid the foundation to rethink this arrangement through the last few decades of the previous century. This is the focus of next section.

### *Influence of Larger Debates and Movements*

Since design and planning work always takes place within the broader armature of socio-political climate and cultural disposition of the society, the influence of dominant social debates and intellectual movements is both wide and deep. Examples include progressive and urban reform movements and debates around centralization vis-à-vis decentralization of political power that critically shaped and transformed ideas and actions in the fields of city design and infrastructure planning as illustrated previously. In this section, I briefly explain the influence of movements around social justice and environmental issues over the relationship between city design and physical infrastructure. Gaining traction around the same time, when modernist plans and projects came under fire through the 1960s and early 1970s, these movements not only cast an ameliorating influence but have arguably

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<sup>12</sup> Urban design consequences of many mega projects, however, are not well documented. In a notable exception, Aseem Inam (2014) offers a sympathetic critique of Boston's "Big-Dig" explaining how, despite the complexity of implementation and major time and cost overruns, this transit-oriented mega project also transformed the downtown by stitching together the urban fabric (as it replaced the elevated highway), reconnected neighborhoods and the waterfront, created new opportunities for real-estate development and an impressive range of open spaces like parks, plazas and promenades raising the overall quality of city life. In this respect, Inam shows how careful conception and focus on design consequences can help create better urban places even while pursuing infrastructure-centered mega projects.

also helped planners reimagine the estranged relationship between city design and infrastructure planning over time.

Influential writer-activists like Jane Jacobs and planners such as Paul Davidoff brought the issues around social equity and justice to the fore in the aftermath of urban renewal and urban expressways during the 1960s. Their writings were important not only because they critiqued infrastructure planning, led by transportation specialists and aided by federal and market subsidies, particularly in relation to low-income communities but also because these ushered in a profound reconsideration of urban planning's meaning and purpose while casting a long-lasting influence on its literature and practice.

Davidoff's seminal article "Advocacy and Pluralism in Planning," for instance, illustrated the importance of giving voice to the underrepresented and advocate on their behalf in the planning arena. In a similar vein, Jane Jacobs (1961) highlighted the importance of local places and place-based communities for making lively cities and paying attention to fine-grained urbanism particularly at the neighborhood level. Although it took planners considerable time to translate these discursive ideas into mainstream practice, while recovering from the almost complete breakdown of comprehensive planning ideal, concepts like 'place-making,' 'public participation,' 'social equity' and fine-grained 'mixed land uses' slowly became accepted planning wisdom supported by popular design movements like the *Congress of New Urbanism* (CNU) and adopted in major public sector programs like *HOPE VI* (Cisneros et al 2009).

In the envisaged scheme, planners strive to engage local residents and relevant stakeholders in the process of designing local places and compatible projects (no noxious land uses and facilities in low-income communities, for instance) while paying attention to

supporting physical infrastructure at the appropriate spatial scale [usually blocks and neighborhoods]. Important, large-scale spatial interventions, often necessary for building major urban infrastructure projects [such as the recent redesigning of Chicago's Jane Byrne interchange], remain largely in purview of administrators and engineers of public works agencies, transport departments and budget or finance offices (Neuman 2009).

In sharp contrast with the community-level and place-based focus of social equity oriented planners, environmental advocates have arguably paid more attention to the larger spatial and policy scales of cities, states and the nation. Calling for state intervention and support from the beginning, the upper- and middle-class professionals led environmental movement which grew as a political action movement in the 1960s, has focused upon government sponsored policies and legislative actions aimed at reducing energy and material consumption, waste production and its impact on the physical environment. Gaining momentum with landmark federal legislations such as the clean air act (1963), national environmental protection act (1970), clean water act (1972), Superfund (1980) and Oil pollution act (1990), the environmental movement made steady progress in the last decades of the previous century (Scheberle 2004).

Not surprisingly, infrastructure lies at the core of many of environmentalists' concerns. In the USA, for example, according to DOE (Department of Energy) most energy is consumed by infrastructure use, or the infrastructure system itself. 28% of all energy was used by the transportation sector while residential, industrial and commercial structures accounted for more than 50% in 2007. Moreover, urban areas consume energy and produce CO<sub>2</sub> at a rate disproportionate to their population, with estimates ranging from 60 percent to 75 percent for energy use worldwide compared to just 50 percent of the global

population (UNEP 2014). Thus, in order to reduce emissions and carbon dioxide production, getting infrastructure right is critical.

From an environmental perspective, two insights shaping contemporary thinking about the relationship between hard infrastructure and city design stand out. First, professionals increasingly realize the folly of relying solely upon manmade infrastructural systems to service large urban areas. For example, Chicago's TARP (Tunnel and Reservoir Plan), one of the largest civil engineering projects ever undertaken in terms of scope, cost and timeframe, has clearly demonstrated our inability to safely dispose all the storm water and sewerage, especially during hard-to-predict extreme weather events (Schwieterman and Mammoser 2009). Turning to design with nature (rather than control or dominate), planners and policy-makers increasingly think around 'green infrastructure,' or the natural network of parks, rivers, open spaces, forests and wetlands, for conceiving future-oriented resilient solutions that could purposefully combine the new green and existing hard infrastructure for supporting city life in the social-ecological systems of large (and still growing) urban areas (Anderies 2014; Brown 2014).

Second, and in line with Fishman's nuanced reading of the American planning tradition, professionals and local leaders consistently, even if tacitly, use the relatively open American planning system to innovate and take lead in pursuing progressive planning ideas at the city and state level. Notwithstanding the prevalent climate of political opinion at the federal level and broader changes in economic thought about the appropriate roles of public and private sectors in infrastructure financing and building, states like California and New Jersey and cities like Portland and Gainesville, for instance, have steadily pursued environmental friendly policies and plans over time (Scheberle 2004).

Even in the conservative state of Georgia, the two-term mayor of Atlanta Shirley Franklin, who called herself the ‘sewer mayor,’ unabashedly aligned her political agenda with infrastructure by providing leadership and organizing finance. With a 50 percent increase in property taxes and one percent voter approved sales tax dedicated to infrastructure, she set out to clean water ways and city’s sewers, bolster biking and walking and, perhaps most importantly, linking infrastructure with city planning through the innovative ‘BeltLine’ project. An innovative economic development and sustainable urban redevelopment effort to link 45 intown neighborhoods via a 22 mile loop of multiuse trails, parks and green transit corridors, the BeltLine is being developed on an abandoned railroad’s right of way (Pomerance 2007, 57). Indeed, riding high on the back of increasingly popular terms such as *sustainability* and *resilience* in policy and social discourses, the importance of planning better infrastructure and smarter local places than the past efforts can (and should) rise higher on the agenda of intellectual classes and progressive leaders (Angelidou 2014; Comer and Forbes 2016). This brings up a suitable point to sum up the essay’s findings.

### *Conclusion*

This essay began by asking what is our experience with infrastructure planning and city design and what have we learned? As illustrated, the relationship between infrastructure planning and city design has always been close even if estranged at times. Not discounting the importance of changing regimes and larger social influences, this essay has suggested that the stronger the relationship between city design and infrastructure provision, the more the professional activity of city planning and indeed the cities themselves have

benefitted. In this section, I conclude by summarizing key insights and offering a set of prospective policies that cities and metropolitan regions ought to consider and analyze for possible implementation, exploring both the challenges and benefits of such actions.

- Infrastructure provides a solid platform for leadership because residents pay attention to their quality of life. Diligent infrastructure planning coupled with careful design for local places can aid in solving vexing problems such as equitable access to civic amenities and facilities, promote sustainable urban development and preservation of rural and natural areas. Challenges to such an approach may include opposition from vested interests, lack of political momentum, or simply the absence of suitable policy climate. Grass root initiatives by local voters supported by advocacy and equity oriented planners and spearheaded by progressive leaders can both help organize such efforts and tap diverse sources of support from federal and state agencies.
- Collaboration is the key to pursue progressive policies and projects in order to maximize the cumulative gains from the nexus between cleverly conceptualized city design solutions and complementing infrastructural systems. Planners, engineers, and other professionals all have acknowledged that infrastructural issues in the complex contemporary world cannot be addressed by any single profession acting alone. But professionals, however united collectively, must act in concert with society and its progressive leaders to secure sustainable and lasting improvements. Challenges to such an approach may include professional rivalry and bureaucratic turf wars. The overarching and binding nature of contemporary infrastructure, however, can help bridge divides and promote meaningful collaboration.

- Owing to its centrality in sustaining contemporary city life, Infrastructure can help herald a new kind of place- and people-centered city planning. Much of the planning's current toolbox (methods, techniques and procedures) is inherited from the approaches deployed to enhance economic productivity and ameliorate the poor quality of human life in the industrial cities of the nineteenth century. Today, there is increasing recognition that contemporary cities and metropolitan regions are complex entities with nothing them like in the natural world. Professionals can help shift the paradigm to address new understandings by aligning emergent tools and inventive techniques (e.g., Life Cycle planning, Combined risk and cost-benefit analysis, and Community-centered design charrette) with money and power—the domain of politics and finance and makers of infrastructure decisions—while paying attention to the values of sustainability, social equity and environmental integrity along with the field's original concerns around health, safety and welfare.

For instance, Life Cycle planning, or a responsive approach considering the consequences (both on demand and supply side) over the life time of various project components, while contextualizing technical and monetary considerations along with environmental, social and other criteria as part of the decision-making processes, can help ensure that planning is long-term, comprehensive and sustainable (Neuman 2011). Moreover, such an approach can help all the concerned disciplines, like city planning, public policy, urban design and environmental engineering, work together while co-conceiving solutions that meet cultural, spatial and temporal considerations specific to particular places and project clientele. Employing combined risk and cost-benefit analysis can similarly help professionals include a focus on different kinds of risk and

analyses of uncertainties, such as those associated with depleting resources and climate change, as they conceive and analyze new projects. Further along the policy and spatial analysis continuum, use of community-centered design charrette can facilitate the hands-on engagement of professionals with place-based communities at the much more intimate scale of specific locales than the traditional 'top down' interventions.

Although many people and positions routinely perceive different facets and consequences of infrastructure and city design in an isolated manner, owing to a variety of reasons such as divergent worldviews, jurisdictional fidelity and ideological commitments, scholarly literature has begun to acknowledge that their intimately intertwined relationship holds an important key to the future sustainability of city life on this planet. As illustrated in this essay, an increasing body of empirical and interdisciplinary knowledge can help professionals and progressive leaders move toward a new paradigm centered on co-designing and co-building sustainable, safe, secure, pleasing and inclusive human settlements—impossible to conceive, build or maintain without supporting infrastructure systems. Diverse challenges associated with any major shift in the normal-way-of-doing-business may pose challenges to such an approach but growing awareness about the centrality of infrastructure to modern city life can help move forward.

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