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Obduracy in the City: Three Conceptual Models

Unbuilding[1] Cities

Utrecht, December 1997: The City Council approves plans to demolish a quarter of Hoog Catharijne, a generally despised but commercially successful shopping mall right in the middle of the city's downtown area. It took 10 years of debate and controversy to reach this decision. The indoor mall was planned and built in the 1960s as a part of the Plan Hoog Catharijne, a large-scale redesign of Utrecht's city center. In addition to the mall, the Plan Hoog Catharijne comprised a new railway station, a bus station, new infrastructure, offices, cultural facilities, and apartment buildings, all integrated and interconnected. In the mid 1980s, the negative effects of the Plan Hoog Catharijne became more and more apparent. In 1987 the city initiated a new project aimed at upgrading the area: the Utrecht City Project (UCP). Despite Hoog Catharijne's commercial success, its overall concept began to be generally perceived as outdated and its architecture as ugly; the drug addicts and homeless people who populated the indoor mall in ever-larger numbers damaged its image further. For quite some time, though, it seemed highly unlikely that the mall would ever be touched in the slightest way; it had become accepted as a fact of life. In 1997 it seemed very likely that part of Hoog Catharijne would be demolished. But in 2000 the mall's

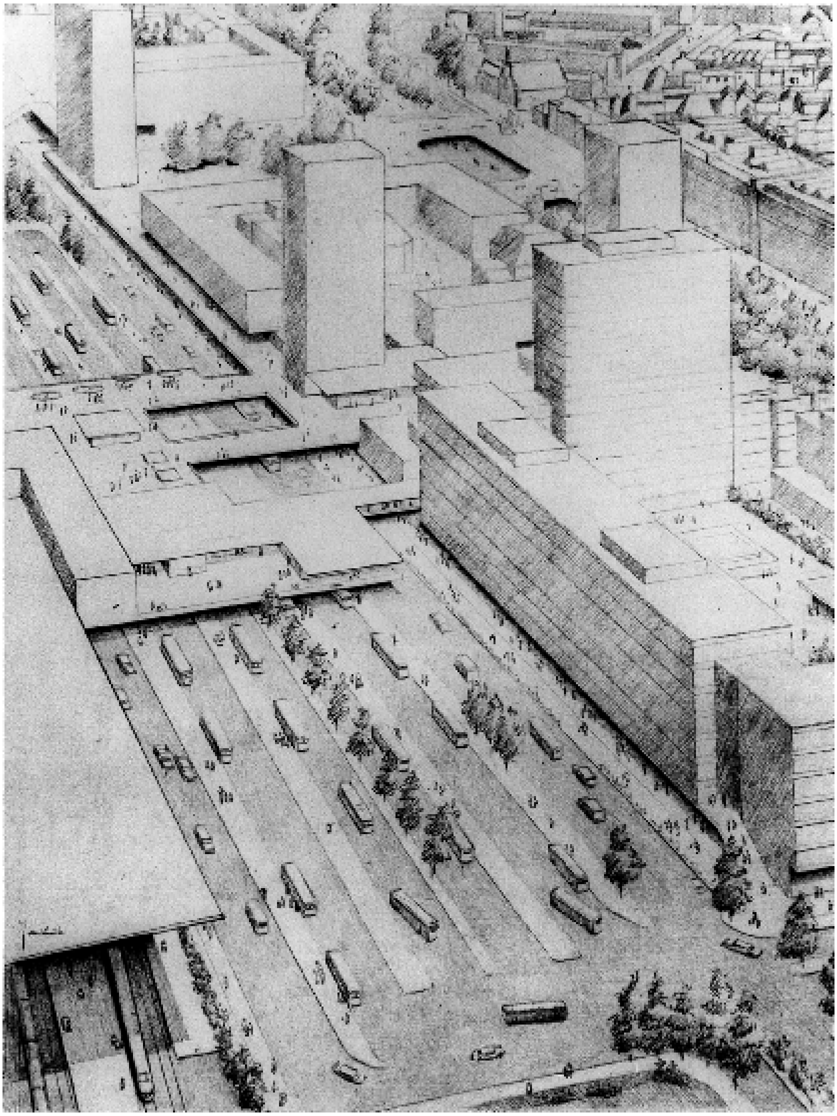

Figure 1.1
Drawing of original Plan Hoog Catharijne (1963). Source: Utrechts Archief.

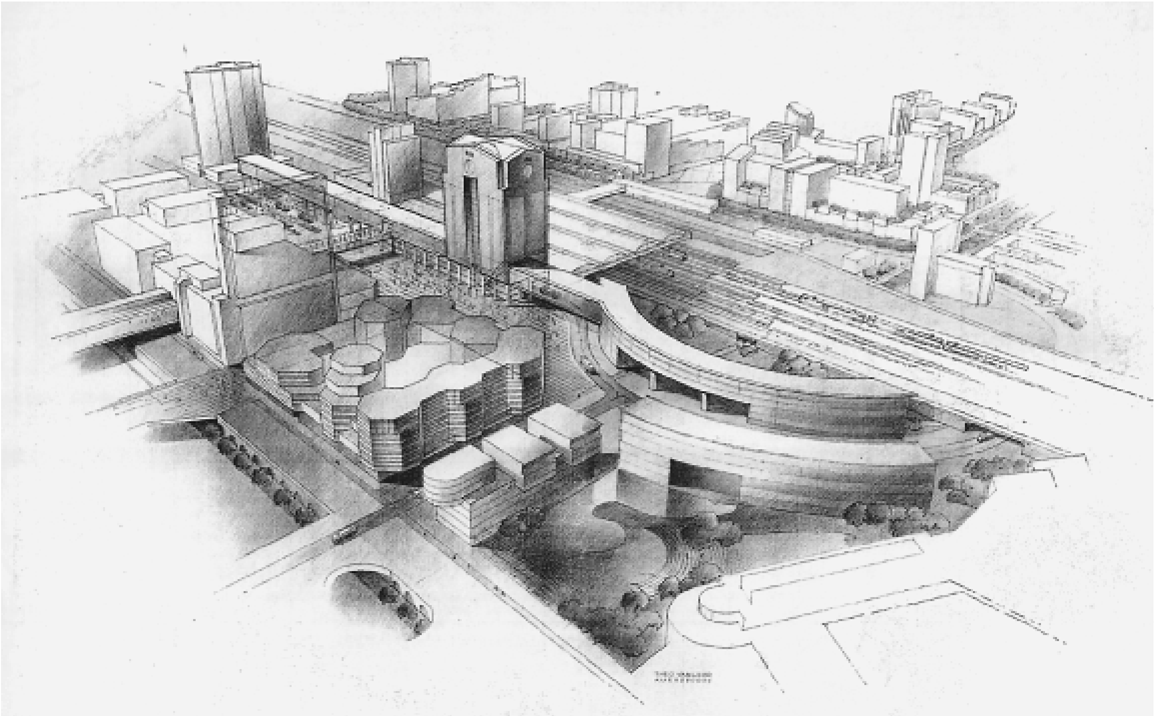

Figure 1.2
Artist's impression of plan for reconstruction of Hoog Catharijne (1995). Source: Projectbureau UCP.

fortunes turned again. The members of the partnership that had been formed to implement the UCP ended their cooperation, and Leefbaar Utrecht, a new local party whose main goal was to prevent execution of the renewal plans, won some seats on the City Board in local elections. In 2003 a completely new master plan was approved by the City Council, but it is still rather uncertain whether Hoog Catharijne will maintain its obduracy.

Maastricht, October 1998: The Minister of Transportation decides to postpone all planning activities for a major highway reconstruction project in Maastricht until after 2012. A two-kilometer stretch of highway that divides the city is the last part of a highway system that cuts through a densely populated urban area without overpasses.[2] As a result of an extraordinary increase in the number of automobiles since the 1960s, local congestion has increased substantially, especially during peak hours. At the same time, Maastricht's overall accessibility and livability and the safety of its traffic have deteriorated seriously. This stretch of highway is seen as the last bottleneck on the "autoroute du soleil" running from Amsterdam to Genova. Since the early 1960s, when the highway was built, engineers, politicians, and citizens have vied to change and adapt it. Building a tunnel has been considered from the very beginning, but so far neither that solution nor any other has been implemented. Despite all efforts at altering the highway's design to allow through traffic to avoid the city, the road has maintained its obduracy. After the national elections of 2002, the City Board put much effort into getting the commitment of the newly elected politicians. In 2003, the national government promised that a tunnel will be built after 2007.

Amsterdam, July 1999: During a visit to the Bijlmermeer, one of Amsterdam's suburban districts, I witness the demolition of a huge multi-level parking garage and a shopping center. Since 1992 a number of apartment buildings have been torn down in this part of the city. According to the present plans, only ten of the original thirty apartment complexes will survive. The Bijlmermeer (commonly abbreviated to "Bijlmer") was built in the 1960s and the 1970s according to a functionalist design. Its high-rise buildings and spacious apartments were

Figure 1.3
The highway that cuts through Maastricht (1968). Source: Gemeentearchief Maastricht. © Gemeentearchief Maastricht. Photograph by J. Naseman.

Figure 1.4
Congestion on the highway through Maastricht (ca. 1985). Source: Gemeentearchief Maastricht. © Fotopersbureau P. Mellaart.

originally intended for middle-class Dutch families. Quite soon, however, it became clear that such families were not attracted to the Bijlmermeer, and it became a refuge for minorities and immigrants, who had begun to enter the country in larger numbers. By the 1980s, the Bijlmermeer, plagued by unemployment and crime, had become one of the most criticized urban districts in the Netherlands. For a time, changes in its basic design were not seriously considered. But in 1992, after years of discussions involving the city government, the neighborhood council, housing corporations, community workers, and residents, it was decided that a rigorous redesign of the Bijlmermeer would have to be undertaken in order to solve its urgent social problems and the severe financial problems of the housing corporation. This meant a radical break with the original concept, as over the years many of the huge apartment buildings had been replaced by single-family homes. Because there appeared to be less crime and vandalism in the low-rise areas, it was decided in 1999 that an even more rigorous renewal of the Bijlmermeer would be needed: half of the remaining apartment buildings would be demolished and replaced with low-rise structures. Meanwhile, a small number of Bijlmermeer residents try to preserve part of their living environment by establishing a "Bijlmer Museum" to conserve and display the original designs.

These three vignettes illustrate the central theme of this book: the confrontation between ongoing attempts to change cities (sometimes even recent additions or innovations) and the obduracy of existing urban structures. The book deals with the clash between new ideas about urban development and the opinions and policies embedded in the urban structures that are already in place. It addresses the unexpected or unforeseen societal developments that gradually give rise to questioning of existing urban configurations. It is about urban design and attempts to renew it—a process in which the stakes often are so high that years of planning, debate, and controversy may result in no changes at all in some cases, whereas in other cases urban reconfiguration may eventually result.

The projects described in the vignettes above are indicative of the boom in planning activities and large-scale spatial redesign efforts that occurred in the 1990s in the Netherlands.[3] Remarkably, projects built in the 1960s have already

Figure 1.5
Characteristic spatial features of Bijlmermeer (April 1976). Source: Archive Dienst Wonen Amsterdam. © Dienst Wonen Amsterdam.

Figure 1.6
Demolition of Koningshoef apartment building (April 1999). Source: Archive Dienst Wonen Amsterdam. © Dienst Wonen Amsterdam.

been remodeled, "facelifted," and even demolished.[4] Because trends in architecture and ideas about the role of the automobile in cities and about the spatial planning of urban areas changed profoundly, many large-scale planning interventions of the 1960s were written off as failures in the 1990s.

In the Netherlands, a small country where building space is perceived to be scarce,[5] the tension between new developments and old structures is felt most dramatically in attempts to redesign established urban spaces. In many cases, of course, existing structures must be removed or destroyed to facilitate new development. Redesign plans play an important role in public debates because such plans may have far-reaching consequences for people's daily lives. As the journalist H. J. A. Hofland noted, in the Netherlands "national conflicts are about space."[6] As a result, many plans remain controversial for long periods before a compromise is reached, and even comparatively minor redesign projects may turn into money-gobbling and time-consuming affairs.

The wide range of planning initiatives and activities in the Netherlands confirms the image of city building as an ongoing process: cities are being built and rebuilt all the time; they are never finished but always under construction, always being realized. Many plans to redesign urban space assume that the existing urban configuration is almost infinitely malleable. The urban historian Josef Konvitz claimed that "nothing may look less likely to change in a radical way than the status quo in city building, but nothing else may be more likely."[7] It seems counterintuitive to change cities, but nevertheless they change continuously. But despite the fact that cities are considered dynamic and flexible spaces, numerous examples illustrate that it is very difficult to radically alter a city's design: once in place, urban structures become fixed, obdurate, securely anchored in their own history and in the histories of the surrounding structures. Objects and facilities that define urban space tend to coagulate into an amorphous whole. As a consequence, urban artifacts that are remnants of earlier planning decisions whose logic is no longer applicable may prove to be annoying obstacles to urban innovation.

It is not my intention to provide tools for judging the desirability of either changing urban structures or maintaining them, to argue for changing cities, or to plead for their preservation. My study is more theoretically inspired. It deals with the confrontation between "new" plans for urban development and "old" urban structures. How can cities be adapted to accommodate newly conceived ideas and policies? Why do urban structures maintain their obduracy despite efforts at urban innovation? How do special-interest groups and politicians deploy strategies to change what seemed solidly in place or to hold on to what has become contested? My study focuses on this tension between the dynamics and malleability of urban space, on the one hand, and its hardness and obduracy, on the other.

The most obvious examples of obduracy in urban contexts involve buildings, facilities, or structures that have never been contested; they have simply "been there," noticed by few or never in conflict with other potential uses of their locations. To me these sites are not the most interesting ones. More interesting are the urban sites and structures that have been subjected to "unbuilding activities"— locations or elements of cities that are disputed or contested, or that at some point were included in redesign plans. The obduracy of urban structures is "tested" in efforts to "unbuild" them. Debates about redesigning cities or parts of cities are infused with questions about the flexibility or obduracy of a city's elements. To be sure, not all the existing elements of a city are equally contestable, nor is the intensity of particular debates the same in every case or at every stage of the planning process. Yet by concentrating on attempts at city renewal we should be able to gain insight into the circumstances under which urban change eventually becomes possible.

I will concentrate on these tensions between obduracy and change in three Dutch urban redesign projects: the facelift of a city center as part of the Utrecht City Project, the reconstruction of a highway in Maastricht, and the spatial renewal of the Bijlmermeer. In choosing projects to study, I strove to find a balance between homogeneity and heterogeneity: the case studies should have enough in common to be comparable, but they should be different enough to allow for interesting generalizations. For the sake of heterogeneity, I chose a downtown area (Hoog Catharijne), an urban highway, and a suburban district. Moreover, the three empirical examples are unique in themselves. Hoog

Catharijne was the first large-scale reconstruction of a downtown space in the Netherlands in which a city cooperated with a private building company; later it became an example for many other similar projects in other Dutch cities. The highway through Maastricht is one of the last stretches of the Dutch highway system to run through a densely populated part of a city. The fact that the highway is fully encapsulated by the city, which itself is locked into the Maas River Valley, raises extremely challenging redesign problems. The Bijlmermeer is one of the few city districts in the Netherlands to have been built according to strictly applied modernist design principles; it has large, identical high-rise apartment buildings, a separation of traffic flows, and huge public car-free zones.[8]

Despite the uniqueness of each of the projects and the obvious differences between them, there are some similarities between them that make it interesting to consider them together. The first of these similarities is that all these projects were originally planned and built between the late 1950s and the early 1970s, and none of the redesign or reconstruction efforts have been completed. The second is that all three case studies are characterized by several comparable themes: the role of infrastructure in relation to urban planning, issues of social safety, criminality, and livability, housing and demolition issues, mobility, the role of the government and national policies, public-private partnerships, and so forth. In addition, all three projects are closely intertwined with Dutch middle-class life. The stretch of highway that cuts through Maastricht is regulated by a series of traffic signals, and this interrupts the fluid passage of the annual exodus of Dutch families, who in their cars and vans have to get past Maastricht to reach the south of France. Hoog Catharijne, for some the national symbol of drabness, certainly did not become more appealing with time; moreover, it began to be increasingly frequented by drunks, addicts, and homeless people. The Bijlmermeer, built for neat middle-class families, became socially degraded and rife with crime and drug activity. The fact that the projects I focus on are all Dutch makes it easier to compare them and allows me to be more precise and specific about the particular Dutch cultural and socio-political context within which these projects figure.

Foreigners visiting the Netherlands always think that the country is planned "from above" because its spatial structures look harmonious, neat, and orderly, but scholars have pointed out that planning in the Netherlands is somewhere between "chaotic planning and planned chaos."[9] Planning takes place "at several levels, without central command."[10] Scholars argue that the harmonious and ordered impression made by the spatial structures of the Netherlands is attributable to the strong role of the public sector in the development, exploitation, and maintenance of the physical environment. A crucial characteristic of Dutch spatial planning is that the local municipalities have forceful land-use policies.[11] This contrasts with the situation in many other European countries and in the United States. The anthropologist Constance Perin concludes that in the United States "the system of land use, its beliefs and practices is in important aspects a *national* one, due to federal government standards and regulations, to the freedom to invest anywhere with the same expectations of return and to the employment mobility of a group having a high level of skill in finance, development, architecture, planning and management."[12]

Urban historians have also observed cultural differences in urban planning between European and American cities. Germany and France have strong traditions of neatly planned infrastructure, leaving less room for technological innovations and resulting in a more "rigid" urban space. The design and evolution of American cities tends to be influenced more by outside factors, on account of which American cities are also more receptive to radical infrastructure innovation than European cities.[13] In general, market forces are having a more profound influence in American cities than in Dutch ones. Americans have a "deep-rooted ideological antipathy to government intervention in urban and regional development."[14]

Despite these international differences between planning cultures and political systems, I am convinced that the specific examples of unbuilding processes I have chosen for this book are relevant beyond the Netherlands. What is happening in the Netherlands is very much like what is happening in other parts of the world. Obduracy and change in urban environments are as problematic in Glasgow, Paris, and Boston as in Maastricht, Utrecht, and Amsterdam. Although Boston's Central Artery/Tunnel Project was much larger in scale than the Maastricht highway, the processes of negotiation and discussion about alternative designs were similar in the two cases. In the Netherlands we have the Bijlmermeer, but several countries have their own landmarks of failed modernism. The Pruitt-Igoe complex in St. Louis and Hutcheson Town "c" in Glasgow are similar projects where demolition was chosen as the ultimate solution to the problems. Furthermore, the developments around Hoog Catharijne's shopping mall and railway station should be considered in the context of the 1980s, when several European cities (including Lille, Stockholm, and Basel) started to make plans to adapt the areas around their railway stations to accommodate high-speed trains. Huge expansions of railways stations, including the introduction of new concepts of public transportation and increasing amounts of office space, were planned and implemented in several European cities.[15]

However, this study is not meant as an international comparison of urban renewal projects. The three Dutch case studies allow for a detailed empirical analysis of three unbuilding processes. What happened when the Utrecht City Project was confronted with the obduracy of Hoog Catharijne? How did it affect the UCP's ideas and priorities? To what extent did the actors succeed in changing the seemingly obdurate design of Hoog Catharijne? Why did the existing structures of the highway that cuts through Maastricht maintain their obduracy despite all efforts to construct a tunnel? Why was the demolition of the Bijlmermeer (or a portion of it) initially out of the question, and why have radical changes of its original plan nevertheless occurred since 1992? How and to what extent can the proponents of the Bijlmer Museum succeed in their struggle to conserving the original planning structures, at least in part?

Empirical analysis of the tension between obduracy and change in these urban redesign projects is the focus of my chapters 2–4. But my concerns are not solely empirical. My book also has two interrelated theoretical aims. First, I intend to apply STS (Science, Technology and Society) concepts to the study of cities. In this book I will view cities as large socio-technological artifacts. The city is the result of human interactions, constructions, and representations. It is an ensemble that includes the material (roads, buildings, bridges, tunnels, transportation facilities, communication systems) and the immaterial (legal regulations, institutions, communities). Thus, I aim to show that cities can be fruitfully analyzed with the conceptual tools of technology studies that were earlier applied to other technological artifacts. Second, I aim to contribute to the theoretical understanding of the role of obduracy in socio-technical change. The issue of obduracy and change informs one of the current theoretical debates in STS studies. On the basis of the case studies, I seek to refine various theoretical concerns about the role of obduracy in urban socio-technical change. In contrast to earlier STS studies that focused on the early stages of technological development, I will concentrate on the process that involves negotiations and attempts at undoing the socio-technical status quo in a city, changing the taken-for-grantedness of its reality, and making its obduracy flexible. It is clear that obduracy and urban change are major concerns both for urban scholars and for practitioners such as architects and urban planners. Therefore, it is interesting to use obduracy as a focal point in exploring the question how STS and urban studies might benefit from each other. In the final section of this chapter, I will propose three models of obduracy that emerge from STS. By applying these three models to cases of urban unbuilding, I aim to show their complementary analytic utility.

VIEWING CITIES AS TECHNOLOGICAL ARTIFACTS

In studying the tension between socio-technical change and urban renewal, I will take the city as a basic unit of analysis. A city, conceptualized as a technological artifact,[16] consists of a wide array of erratic and heterogeneous elements that we must take into account if we are to begin to understand its complexity more comprehensively. Of course, the city as a technological artifact is (like other technologies) never purely technical—it is a "seamless web"[17] of material and social elements. Furthermore, I view planning as a process of socio-technical change. In order to understand the development (and the redevelopment) of cities, it is necessary not only to understand technological processes but also to look at social processes and interactions taking place in the urban context. Therefore, in this book, the city is conceptualized as a socio-technical artifact—a perspective that will be developed, refined, and brought into sharper focus in the course of the book.

Surprisingly, STS studies have paid little attention to the city per se or to the city as a strategic research site for the study of other issues.[18] Moreover, the few studies that have been done mostly address technologies *in* the city, rather than the city *as* a technology. In a 1997 article in *Technology and Culture*, Julie Johnson-McGrath noted that "only a handful of book-length works have addressed the shape and shaping of urban technology."[19] In another article published the same year, Simon Guy, Stephen Graham, and Simon Marvin observe that "since Lewis Mumford's path-breaking books addressing the wider links between . . . technologies and urban history . . . only a few urban historians have attempted to understand how cities and technical networks co-evolve."[20]

Studies of large technical systems focus on specific technological networks, such as electricity, transport, and waste networks. The city as such is hardly mentioned. The authors appear mainly interested in how these networks were built and how the various actors took part in the development of new technologies. Technological systems and networks serve as the basic category of analysis in these studies. Rather than being the focus, the city functions as a mere locus.[21] Although the founding father of the systems approach in the history of technology, Thomas Hughes, situated his analysis of electric power systems in cities,[22] many of his followers have not elaborated on this theme.[23]

Recently, however, some studies have been published that are most appropriately situated at the intersection of STS and urban studies.[24] The urban scholars Stephen Graham and Simon Marvin (1996, 2001), for instance, made worthwhile efforts to explicitly integrate STS theories (Social Construction of Technology, Actor-Network Theory, Large Technological Systems) with urban perspectives such as urban political economy and "relational theories of contemporary cities."[25] A similar line of argumentation has been advanced recently by some American sociologists and philosophers, including Thomas Gieryn, Steven Moore, and David Brain, who point to the importance of space and place in the sociological research agenda and who argue convincingly that such STS concepts as interpretative flexibility, actor networks, and black boxing can be fruitfully applied in analyses of the built environment. Gieryn, Moore, and Brain argue that, because STS concepts pay attention to both the social shaping of technology (or, here, spatial artifacts) and the simultaneous technological shaping of society, they have more to offer than the traditional sociological concepts that can be found in the works of Giddens, Bourdieu, Harvey, and Foucault.[26] In a similar vein, the historians of technology Mikael Hård and Marcus Stippak (2003) ask how historians of technology could contribute to urban history. They argue for a "broad, cross-disciplinary approach" in which more attention is paid to the role of engineers in urban debates and to the relationship between city images (as reproduced in art and literature) and technological form.

Having noted that in STS attention for the city is almost absent, I add that it is also remarkable that the material aspects of the city seem to be neglected in the dominant theoretical perspectives of urban studies. Probably as a result of this, the specific issue of obduracy in urban change does not seem to belong to the subject matter of urban studies at all. For a long time, urban ecology was the dominant approach in research on the social dynamics of cities. Urban ecology was developed by Chicago School sociologists at the beginning of the twentieth century. In the field of human ecology, spatial relations are the analytical basis for understanding urban systems. The Chicago School ecologists Robert Park, Ernest Burgess, and Louis Wirth see the city as a kind of social organism. They explain urban development through a "biotic" determinism, a kind of Social Darwinism of space. This means that competition for the best strategic location (the one where profits can be most easily maximized) is the main underlying mechanism guiding urban development.[27] These ideas can be understood in the American context of the early twentieth century, when laissez-faire economics and privatization dominated the socio-political scene.[28]

Insofar as technology or material factors figure in their analyses, Chicago School ecologists focus on communication and transportation technologies.[29] Example: "Modern methods of transportation and communication—the electric railway, the automobile, the telephone, and the radio—have silently and rapidly changed in recent years the social and industrial organization of the modern city."[30] For urban ecologists, technology seems to be an exogenous force that has a strong influence on the city, and for this reason they have been accused of technological determinism.[31]

Neither the role of technology nor the role of resistance to change in cities has been thoroughly conceptualized by Chicago School ecologists, though Ernest Burgess points to some "complications" that may occur in the expansion of cities. In his influential "concentric zones" model, Burgess developed the idea that cities consisted of a number of circular regions, the central business district being the innermost zone, followed by a zone for industry, one for "working men," a residential zone, and a zone for commuters. Burgess admits that this ideal model for urban expansion might be hampered by existing physical, ecological, or social structures, such as railroad lines, rivers, factories, or "the resistance of communities to invasion."[32] But although it is recognized that urban expansion is not a trouble-free process, urban ecologists do not conceptualize the underlying mechanisms and causes.

In the mid 1970s, the scientific orientation of urban studies started to shift. Urban ecology was criticized for its market-driven economic determinism and for its exclusion of political and cultural factors. New approaches to the city originated from an interdisciplinary mix of neo-Marxism, urban geography, and political economy. In their analysis of the city as a growth machine,[33] the urban scholars John Logan and Harvey Molotch adapted urban ecological points of view to include political developments and cultural institutions.[34] In the neo-Marxist urban geography perspective represented by scholars such as David Harvey, cities are seen as mirrors of the contradictions and flaws of the capitalist system. Capitalism, according to Harvey, is inherently expansory—its goal is maximum mobility of goods, capital, water, energy, and information products. But in a world where infrastructure networks must be embedded in space this is impossible. Cities, the basic units of production and consumption, are fixed and embedded in space.[35] This means that capitalist expansion can be hampered by the fixity of urban structures. Again we see recognition among urban scholars that urban structures can be difficult to change. Nevertheless, Harvey's approach is arguably not very sophisticated in regard to the complexity of the relations between the material and the social and on the role of obduracy in urban change. One reason for this is that Harvey's theory is too monocausal: it relates everything to capitalism, thereby neglecting other relevant factors.

We may thus conclude that something important is missing from the perspectives that dominate the field of urban studies. Arguably, urban scholars do not have the proper conceptual tools to analyze the complexities of relationships between the social and cultural and the material in processes of urban change. In general, they fail to appreciate the significance of obduracy in urban development.

In this book I propose to focus explicitly on obduracy as a major stumbling block in processes of urban socio-technical change. Throughout the book, I aim to show how focusing on obduracy makes it possible to look at urban form and processes of change in a new and different way. I shall do so by elaborating and extending three different models of obduracy. In doing so, I will be refuting four "commonsense" explanations of urban obduracy.

The first "obvious" explanation for urban obduracy is that change is too expensive. Many people tend to think that urban obduracy is directly caused by a lack of money. Throughout the book, I will show that the situation is often more complex than that. Financial considerations can be a reason to keep things as they are, but they can also be a reason to start unbuilding processes. Moreover, financial stakes are not the single cause of obduracy, and they are often inextricably linked to other interests. And, as the sociologist Donald MacKenzie has argued, costs are socially constructed.[36] This implies that "costs" arise from interactive negotiation and calculation processes in which various (non-monetary) values also figure—that "costs" are not a factor in themselves.

The second "commonsense" view holds that there is no agreement on what should be done. As I will show, conflicts of interests are indeed crucial in many unbuilding processes. The process of seeking consensus on what should be done is often very time consuming. But even when consensus is reached, that is no guarantee that urban structures will become malleable immediately. There are other, more complex reasons for the obduracy of urban structures. I will analyze the complexity of the mechanisms involved in interaction processes around urban structures without reducing them to mere conflicts of interest.

Third, it is often claimed that stasis in urban development can be explained by the fact that powerful voices want things left as they are. This claim starts from a rather monolithic idea of power. A careful study of unbuilding processes shows that rarely is it the case that a single actor "has the power" to keep things as they are (or to change things). I favor a "relational" conception of power that emphasizes the "attribution" of power to certain actors, rather than actors' being "in possession" of power.[37] This implies that power balances may change frequently during unbuilding processes, and that hence opinions about what should be changed also vary.

The fourth "commonsense" notion of urban obduracy states that urban structures are difficult to change for material reasons. None of the "commonsense" notions mentioned so far takes the role of materiality into account. However, some approaches in urban history and architecture can be criticized for their *exclusive* focus on the material aspects of obduracy.[38] I dispute the notion of "material obduracy"—the idea that cities, buildings, or infrastructures have inherent technical properties that resist change. Although it may not be technically difficult to demolish an apartment building or to adapt a city highway, such structures may nevertheless prove very obdurate in some "immaterial" sense.[39] Obduracy, then, cannot be explained only by reference to the solidity of concrete and the physical properties of technologies; a wide range of cultural factors come into play.

In contrast to the four "commonsense" accounts of obduracy that focus on single-factor explanations, my study will reveal the complexity and heterogeneity of processes of urban socio-technical development. Urban innovation, conceived as a mode of socio-technical change, involves a laborious, time-consuming, and precarious process marked by a delicate interplay of various social, technical, cultural, and economic factors. By focusing on only one or two of these factors, urban change and redevelopment can be understood only poorly and incompletely. By concentrating on the actors' ideals, assumptions, and cultural values, it can be demonstrated how cities are shaped and how specific ideas are always built into urban design.

It is my contention that STS research has something to contribute to urban studies with respect to the conceptualization of the myriad relations between the social and the material in cities, and with respect to the specific issue of obduracy in urban change. Since one of the major goals of this book is to specifically contribute to the theoretical understanding of the role of obduracy in urban socio-technical change, I will now address how recent conceptualizations of obduracy can help to improve our understanding of this phenomenon. One of the theoretical implications of viewing the city as a technological artifact is that it becomes possible and productive to analyze it with the same conceptual STS tools that are applied to other technologies, such as bicycles, transport systems, or refrigerators. Focusing on obduracy enables a new and different way of looking at urban form and process.

Obduracy of Technology: Three Conceptual Models

The three conceptualizations and explanations of technology's obduracy presented here have roots in technology studies and in urban studies (urban history, history of architecture, geography). Each conceptual model emphasizes different aspects of obduracy, or foregrounds other explanatory mechanisms in the constitution of obduracy. My aim in this chapter is not to argue which view of obduracy is preferable, but to bring out the complexities of the three conceptions in terms of the issues and questions they address (or fail to address). This specifically means that I will focus on the set of concepts and metaphors used in the various views of obduracy, the explanatory mechanisms they rely on, their disciplinary backgrounds or intellectual traditions, and the types of explanations. I will present the three models as "ideal types," which means that I emphasize the distinctions between them instead of the similarities. It is important to keep in mind that the three models are meant as heuristics for the analysis of obduracy in socio-technical change, rather than as accurate empirical descriptions. In later chapters I will discuss the usefulness of these categories when applied to empirical studies of unbuilding processes. In this confrontation with empirical studies, it becomes possible to analyze their relevance, whether they require adjustment, and what we gain or lose by applying them.

Dominant Frames

The category of dominant frames consists of conceptions of technology's obduracy that focus on the roles and strategies of actors involved in the design of technological artifacts. The constraints posed by the socio-technical frameworks within which they operate will be addressed in particular. The concepts of this category apply to situations in which planners, architects, engineers, technology users, or other groups are constrained by fixed ways of thinking and interacting. As a result, it becomes difficult to bring about changes that fall outside the scope of this particular way of thinking. The concepts in this category are generally used to analyze the *design and use* of specific technological artifacts. As an *interactionist* conception of obduracy, this category highlights the struggle for dominance between groups of actors with diverging views and opinions. In relation to specific technological artifacts, examples of this conception of obduracy include Wiebe Bijker's "technological frame," Michael Gorman and W. Bernard Carlson's "mental models," and Cliff Ellis's notion of "professional worldviews." The concepts of "technological frame" and "professional worldviews" have also been applied to planning. Specifically, the concepts in this category highlight the significance of users (or "relevant social groups") and inventors when it comes to explaining technology's obduracy.

Bijker developed his concept of the "technological frame"[40] in the context of the SCOT (Social Construction of Technology) model.[41] This model defines the obduracy of a technological artifact as a stage in the artifact's development. In the early 1980s, Bijker and Trevor Pinch formulated the outlines of their sociological model of technological development. They distinguished three stages in the analysis of a technological artifact. In the first stage, the "interpretative flexibility" of an artifact has to be analyzed. Bijker and Pinch argue that an artifact's technological development should be described from the viewpoints of various "relevant social groups," because, typically, members of various social groups look differently at an artifact and attribute different meanings to it ("interpretative flexibility"). The second stage consists of analyzing the artifact's stabilization. During the interactions within and between these social groups, one meaning will eventually become dominant: the artifact's interpretative flexibility decreases, its meaning becomes more stable, and finally it will have a single dominant meaning. This "closure" of the artifact's interpretative flexibility implies that its meaning will be quite fixed for a period of time.[42] This fixity of meaning results in technology's obduracy. As Bijker puts it, "previous meaning attributions limit the flexibility of later ones, structures are built up, artifacts stabilize, and ensembles become more obdurate."[43] The third stage in the analysis of an artifact's social construction involves relating "the content of a technological artifact to the wider sociopolitical milieu."[44]

Bijker's concept of the "technological frame" is particularly relevant to the analysis of obduracy. A technological frame is built up during interactions among relevant social groups. It may consist of goals, problems, problem-solving strategies, standards, current theories, design methods, testing procedures, tacit knowledge, user practices, and so forth.[45] For the analysis of obduracy, it is important to consider the role of artifacts as "exemplars." After closure, an artifact becomes part of an technological frame as a "exemplary artifact":

> An artifact in the role of exemplar (that is, after closure, when it is part of a technological frame) has become obdurate. The relevant social groups have, in building up the technological frame, invested so much in the artifact that its meaning has become quite fixed—it cannot be changed easily, and it forms part of a hardened network of practices, theories and social institutions. From this time on it may indeed happen that, naively spoken, the artifact "determines" social development.[46]

Besides analyzing the role of artifacts as exemplars, it is also important to analyze for whom a technological artifact is obdurate and for whom it is not. An actor with high inclusion in a particular technological frame thinks and interacts very much in terms of that technological frame. It is difficult for such an actor to think of alternative technological designs. This may be referred to as "closed-in" obduracy. "Closed-out" obduracy is possible too. This occurs when actors have little involvement with a particular technological frame—when they have "low inclusion." For them, the technology presents a "take it or leave it" choice. Seeing no possibilities for variation within a technological frame, they are left with the choice of either accepting it or abandoning it. In this way, according to Bijker, an artifact can be obdurate in terms of having one fixed meaning or in terms of enabling and constraining interactions and ways of thinking.

Although cities are more complex than singular technological artifacts, Eduardo Aibar and Wiebe Bijker suggest that the SCOT approach is also applicable to more complex and heterogeneous socio-technical ensembles, such as planning projects. They analyze the controversies around the Cerdà Plan for the extension of Barcelona between 1854 and 1860.[47] They consider planning "as a form of technology, and the city as a kind of artifact."[48] Taking the SCOT model as their theoretical framework, they analyze the interactions between social groups and their negotiations concerning the extension issue, and they describe how technological frames were formed during these interactions. The technological frames consisted of the problems that were considered important by the relevant social groups, the various solutions to these problems, and the extension plans they proposed. In the course of the events, two rival technological frames came into being: the "engineers' frame" and the "architects' frame." Aibar and Bijker describe the controversy in terms of opposing technological frames that try to become dominant. They argue that where there is no single dominant technological frame an "amortization of vested interests"[49] generally occurs. This is what happened in Barcelona. Aibar and Bijker show how the final layout of the city "got the mobility and easy traffic attributes from the engineers' frame, while hierarchy and high density of buildings were achievements of the architects' frame."[50]

The "technological frame" concept bears a resemblance to the "technological paradigm" notion developed by the economist Giovanni Dosi. According to Dosi, technological development follows a certain "technological trajectory." A technological trajectory is the direction of change within a "technological paradigm"—that is, as an "'outlook,' a set of procedures, a definition of the 'relevant' problems and of the specific knowledge related to their solution" (Dosi 1982:

148). Dosi claims that trajectories are mainly selected on technological and economic criteria, and that, once established, they can acquire momentum. Whereas Dosi emphasizes economic and institutional factors in the construction of a technological paradigm, other concepts encompass more factors, such as cognitive factors, rules, and expectations. A crucial difference between Bijker's "technological frame" and Dosi's "technological paradigm" is that Bijker does not link frames or paradigms with certain technological trajectories.[51]

Although Gorman and Carlson's "mental model" resembles Bijker's "technological frame," they make a distinction between mental models, mechanical representations, and problem-solving strategies or heuristics. Mechanical representations are very precise images of technological artifacts, whereas mental models are often more diffuse, cognitive ideas. Mental models especially address the inventor or designer. Technological frames also apply to other social groups involved in the development of technological artifacts. Moreover, "technological frame" is a broader concept, since mental models mainly consist of inventors' ideas about the future working of artifacts. Gorman and Carlson emphasize that mental models "are shaped by the inventors in response to social and economic pressures as well as personal preferences."[52]

Scholars who have studied processes of urban change advance a similar view. The historian of planning Cliff Ellis, for instance, has looked at the role of "professional worldviews" in the process of American city planning, in particular the design of urban freeways between 1930 and 1970.[53] He argues that, on account of differences in professional training, members of the various professional groups involved in freeway planning (architects, engineers, urban planners, and landscape architects) held different worldviews, which in turn led to their proposal of different design solutions: "The involved professionals used different ideas and images to advance their goals: intellectual tools acquired through education, professional socialization, and daily practice. Professional worldviews shaped the styles of research, the generation of alternatives, and the presentation of proposals to the wider public."[54] Highway engineers, for example, tried to simplify the problem of highway design and make it calculable by developing engineering standards and using computer models. Land-use planners divided the city into urban zones that had to be defined in legal terms and in terms of the activities that could be performed in various parts of the city. Urban designers interpreted the city as a combination of three-dimensional structures imbued with symbolic meanings. According to Ellis, these worldviews, "as embodied in methodologies, recurring solutions, standards, habitual ways of framing a problem,"[55] are difficult to ignore, since they are closely related to the professional's urge for (intellectual) influence and a good reputation.

As my discussion suggests, the various approaches all emphasize the constraining role of frames—ways of thinking and interacting including values, professional conventions, views of the world, typical solutions, problem definitions, and so on—for specific groups of actors. When certain ways of thinking have been built up around an artifact, it becomes difficult to ignore them, let alone change them. Implicit in these approaches is the assumption that, because certain ways of thinking are narrow in focus or difficult to adapt, the technology involved will become obdurate or will have limited flexibility. This means that obduracy, instead of being caused by material factors alone, is the result of interactions between social groups—interactions that are constrained by specific ways of thinking.

Embeddedness

Within STS, technology is often conceptualized as part of a greater whole. Thus, technological artifacts are not analyzed in isolation, but as part of a larger system, network, or ensemble. STS scholars argue that society plays a crucial role in the shaping of technology and that, conversely, technological developments have an important effect on society; they observe, in other words, a "co-evolution" of technological and societal developments. Applied to the built environment, this idea of co-evolution highlights that building cities implies the shaping of society, or that "civil engineering is also social engineering."[56] At the same time, utopian ideals, cultural values, economic considerations, and power relations are built into the physical structure of cities; there is always a "social shaping of technology" at work.[57] Thus, cities are not purely technical constructs; rather, they are a "seamless web" of material and social elements. In the most radical interpretation, the metaphor of the seamless web suggests that the "social" and the "technical" are two sides of the same coin: the technical is socially constructed and the social is technically constructed.[58]

In this approach, the obduracy of technology is related to technology's embeddedness in socio-technical systems, actor networks, or socio-technical ensembles.[59] In this respect, Thomas Hughes argues that the building of a system is accompanied by fewer difficulties when it has not yet become linked to politics, economics, or other value systems.[60] This category involves a *relational* conception of obduracy: because the elements of a network are closely interrelated, the changing of one element requires the adaptation of other elements. The extent to which an artifact has become embedded determines its resistance to efforts aimed at changing it. Such efforts may be prompted by usage, societal change, economic demands, zoning schemes, legal regulations, newly developed policies, and so forth.

The actor-network theorists Michel Callon, Bruno Latour, Madeleine Akrich, John Law, and Annemarie Mol describe technological development as a process in which more and more social and material elements become linked in a network.[61] They investigate attempts by actors to stabilize that network. But the larger and more intricate a network becomes, the more difficult it will be to reverse its reality. In this way, a slowly evolving order becomes irreversible.[62]

Latour gives a clear example of how a network became more obdurate and less reversible. He describes the late-nineteenth-century controversy between the city of Paris and a number of major private railroad companies concerning subway construction.[63] The socialist city government was looking for a way to guarantee that the railroad companies could not take command of the subway system if a right-wing party were to win the city elections in the future. It found a solution in having subway tunnels built that were narrower than the railway companies' smallest coaches. As the subway network expanded, its design became less and less reversible. The obduracy of the subway network became obvious when after 70 years the railroad companies and the subway companies wanted to link their networks. The engineers who were hired to enlarge a number of tunnels were essentially asked to undo what had been decided earlier. "What could have been reversed by election seventy years ago," Latour concludes. "had to be reversed at higher cost. Each association made by the socialist municipality with earth, concrete, and stones had to be unmade, stone after stone, shovel of earth after shovel of earth."[64]

Implicit in these constructivist views of technological development is a movement from flexibility to inflexibility: technology gradually stabilizes and becomes obdurate. Constructivist work argues that, typically, a socio-technical ensemble or system becomes more rigid and less flexible. According to actor-network theorists, it is equally possible to distinguish elements with varying degrees of malleability *within* a single network.[65] Law stresses that the social should not be privileged: "Other factors—natural, economic, technical—may be more obdurate than the social and may resist the best efforts . . . to reshape them."[66] Callon argues that the possibility of changing a network depends on testing the capacity of the various entities that make up the actor network to resist transformation.[67]

With its emphasis on the networked character of socio-technology, the concept of embeddedness seems particularly suitable for the analysis of cities. As Graham and Marvin remark, "the fundamentally networked character of modern urbanism . . . is perhaps its single dominant characteristic."[68] That some elements of a socio-technical network remain obdurate while other elements change—an idea raised by actor-network theorists—has also been mentioned by urban geographers. David Harvey, for instance, argues that the tension between fixity and mobility in urban space is an important issue: "We know that the built environment is long-lived, difficult to alter, spatially immobile and often absorbent of large, lumpy investments."[69] Harvey argues that there are inherent tensions in capitalism between "fixity" and the need for "motion," mobility, and global circulation of information, money, capital, and so on. Infrastructure networks are so crucial for the reproduction and development of capitalism "because they link multiple spaces and times together."[70] Harvey makes a distinction between infrastructure networks that are "highly" embedded in space and networks that are less embedded. Transport networks are highly embedded because the capital these networks embody consists of pipes, cables, roads, and so on that form the physical structures of modern cities. This brings risks with it: "This inflexibility means that sunk infrastructures go on to present problems later in further rounds of restructuring. . . . Crises emerge when older infrastructure networks which are embedded in space, become barriers to later rounds of capitalist accumulation."[71] According to Graham and Marvin, water and waste networks are highly embedded infrastructures, energy networks are "medium embedded," and telecommunication networks are "high to low embedded."[72] The main explanation for embeddedness in this perspective—and here it differs from actor-network theory—is that these infrastructures embody heavy investments and capital that are literally sunk in specific locations.

Stewart Brand makes a similar point when analyzing the adaptability of buildings.[73] Brand makes a distinction between the various layers of buildings that have different life cycles and that change at different paces. His 6-S scheme (table 1.1) differentiates between the slowest rate of change, which applies to the "site" or geographical setting of a building and which may last forever, and faster changes that occur in other layers. Air conditioning systems, for instance, are usually replaced at intervals of 7–15 years. The "stuff" in a building, its furniture, changes most rapidly, on a monthly or even daily basis. Brand suggests that the main reasons for changing a building are related to new styles, especially with regard to the building's exterior, the need for technical maintenance or repair, technological developments, and the obsolescence of systems in the building.

Table 1.1 Life cycles of buildings, ranked by length (longest at top). Based on Brand 1994: 13.

Site	Geographical setting, urban location ("eternal")
Structure	Foundation and load-bearing elements (30–300 years)
Skin	Exterior surface (now 20 years)
Services	Air conditioning systems, elevators, communications wiring, electrical wiring, etc. (7–15 years)
Space plan	Interior layout (walls, ceilings, floors, doors) (3–30 years)
Stuff	Furniture (chairs, desks, phones, lamps, kitchen appliances, etc.)

In sum, "embeddedness" refers to the difficulty of changing elements of socio-technical ensembles that have become closely intertwined. Changing one element may have consequences for the whole ensemble. Obduracy is no intrinsic property of technologies but can only be understood in the context of its ties to other elements within a network. It is possible to differentiate between degrees of obduracy of different elements in a network or system without assuming a priori that social elements are more obdurate than technical ones. In this model, materiality has a different position than in the category of "frames." Because most of the concepts within this category stem from the actor-network tradition, human and non-human "actants" in a network are analyzed more symmetrically.

Persistent Traditions

The category of persistent traditions comprises conceptions of obduracy that address the idea that earlier choices and decisions keep influencing the development of a technology. Because of this focus on the longer-term persistence of traditions in socio-technical change, I call this category *enduring*. The notions of trajectories, path dependency, momentum, archetypes, and city-building regimes embody this conception of obduracy. The crucial difference with the concepts discussed earlier is that they are less focused on interactions in local contexts than the other two models of obduracy: long-term, structural developments that transcend local contexts and interactions get more attention in this approach than in the previous two. The concepts discussed here are less focused on interactions in local contexts than the previous two models of obduracy. One of the potential disadvantages of the frames approach, for instance, is that it is always focused on groups and always emphasizing the local level. This makes it difficult to point at wider "contextual" or structural factors in the construction of obduracy.[74] Generally, the notions within the category of persistent traditions put more emphasis on the wider cultural context in the explanation of obduracy in cities.

Hughes (1987) has argued that the socially constructed features that became embedded in technical systems in the early stages of their development can have lasting effects. His metaphor of momentum highlights the role of trajectories in patterned technological development and can be used to describe the problems of changing large technological systems during certain stages in its development: "The systematic interaction of men, ideas, and institutions, both technical and non-technical, led to the development of a supersystem—a socio-technical one—with mass, movement and direction. An apt metaphor for this movement is 'momentum.'" (Hughes 1983: 140)

When systems are expanding, they acquire momentum, or "dynamic inertia." Hughes (1994) positions his concept of momentum between the two extremes of technological determinism and social constructivism. When a system has acquired momentum, this means that in that phase the system tends to resist change. Young, developing technological systems are more receptive to social and cultural influences than older systems, which, in turn, affect their environment more. This does not imply that a system in a phase of momentum develops autonomously. As Staudenmaier (1985: 154) remarks, "the momentum model understands the very dynamics of technological change as the result of some technical design embodied within a culture."

It is the emphasis on a long-term cultural context that makes this form of obduracy different from the other categories of obduracy. Hughes emphasizes how the supportive cultural context of a specific electricity-supply system (the "polyphase" system) contributed to the system's momentum in the 1890s. At first, manufacturers reinforced the system's momentum by investing in resources, labor, and factories to produce the equipment necessary for its functioning. Later, educational institutions contributed to the system's development by teaching students the skills needed to operate it. These practices were further spread and consolidated by professional journals. After this, research institutes were established to solve the system's "critical problems" (Hughes 1983). All these factors added to the system's momentum.

With its emphasis on the role of trajectories in patterned technological development, the concept of momentum resembles that of "path dependency," an influential conceptual notion developed in evolutionary economics. Path dependency refers to the idea that past events keep influencing the developmental path or trajectory of a technology. Path dependency develops over a longer period of time and suggests that "local, short-term contingencies can exercise lasting effects" (MacKenzie and Wajcman 1999b: 20). The QWERTY keyboard is a well-known example of patterned technological development. Crude notions of path dependency and trajectories as developing according to an internal, "natural" logic have correctly been criticized by STS scholars, who emphasize the contingent and fluid character of technological development. (See e.g. Pinch 2001 and MacKenzie and Wajcman 1999.) An important difference between the notions of path dependency and trajectories and Hughes's concept of momentum is that the former do not pay any attention to cultural factors. For these two reasons (its neglect of contingency in technological development and its lack of attention to cultural factors), the concept of path dependency seems less relevant to my study. Recently, however, some more sophisticated approaches of path dependency have been developed that focus on processes of "path creation" and "path destruction."[75] These approaches fit better in the general constructivist line of thinking I propose here.

Combining elements of Hughes's systems approach and elements of urban regime analysis, the historians of technology Anders Gullberg and Arne Kaijser (1998) introduced the notion of city-building regimes to explain morphological change in urban contexts.[76] Gullberg and Kaijser consider it a disadvantage that the Large Technical Systems approach focuses on only one technical system, since they are interested in the interactions between different infrastructure systems in cities. A city-building regime consists of "a set of actors and the configuration of co-ordinating mechanisms among them which produce the major changes in the landscapes of buildings and networks in a specific city region at a given point of time."[77] Coordination is mediated by regulatory systems in the city (legal and organizational instruments) and the "political culture" (which includes "more subtle" historically grown behavioral rules and conventions). Using this approach, Gullberg and Kaijser try to explain patterns of urban morphological change. They rightly criticize "macro-studies" that describe the development of cities as evolving from "walking cities" to the "tramway city" to the "automotive city." They criticize such an approach for its technological determinism and for its oversimplification (local and national particularities are not considered relevant). Gullberg and Kaijser applied their approach to the postwar development of Stockholm, where they identified three subsequent regimes: the municipal multi-family housing regime (1945–1979), the private single-family housing regime (1970–1985), and the commercial building regime (1985–1995). For example, the first regime was characterized by a strong hierarchical coordination and network coordination in which the municipality and private partners played a crucial role. It mostly produced multi-family houses. Despite tensions and conflicts within this regime, it was stable and extremely dominant.

I have already mentioned the explicit importance attached to cultural factors in Hughes's explanation of a system's momentum. The historian of technology Rosalind Williams gives an interesting cultural interpretation of persistent traditions in *Notes on the Underground* (1990). By analyzing artificial underground worlds as an "enduring archetype," Williams shows how literary traditions from all over the world have always expressed a concern with the underground, which suggests the persistence of the opposition between surface and depth in our thought. Present-day developments in planning and architecture, particularly the trend to build under the ground, to construct tunnels and subways, and to hide less attractive urban functions, can be understood in relation to the work of the nineteenth-century novelist H. G. Wells. In *The Time Machine* (1895), Wells wrote about an underground world inhabited by the Morlocks, who operated machines and utilities, and an above-ground paradise of nature and leisure inhabited by the Eloi. Williams shows that this tradition of "putting the less glamorous aspects of civilization underground" reverberates in the work of twentieth-century architects.[78] In their urge to deal with overpopulation and with space-consuming distribution networks, roads, central heating infrastructure, and factories, they have turned their gaze to the underground world, so that the surface may still be available for the more pleasurable aspects of life (leisure, recreation, parks, housing, schools, and so forth). Such traditions can be enduring in the sense that they are likely to keep influencing choices and decisions of large groups of people.

Another example of the role of persistent traditions in planning is cited by Sally Kitt Chappell (1989). In her study of designs of railway stations in American cities between the 1890s and the 1930s, she notes the importance of four "archetypal designs" for large railway stations: New York's Pennsylvania Station (1902–1910) and Grand Central Terminal (1903–1913), the Terminal Station built for the 1893 World's Columbian Exposition in Chicago, and Washington's Union Station (1903–1907). These archetypes were based on existing railway stations, and according to Kitt Chappell their influence on American architects is clearly noticeable in the architectural design of large stations built thereafter. Kitt Chappell points out that these stations belonged to the French Beaux-Arts tradition, characterized by monumental features. She explains how "the larger concepts behind each station have in some measure persisted."[79] The shared visions of different social groups (architects, engineers, public officials, railroad managers) continued to influence the design of major railroad stations. The emphasis on "archetypes" and "shared visions" makes this analysis fit into the category of persistent traditions rather than the category of frames, since in the latter category there is more attention to the differences between groups[80] and less to the structural, cultural, and symbolic factors in the obduracy of urban structures.

In the analysis of obduracy, focusing on the persistence of decisions involving the design and building of urban technologies may be quite useful. This model stresses the long-term effect of such decisions on socio-technology. In contrast to the "interactionist" conceptions of obduracy that were discussed under "frames," however, the conceptions described in this section do not focus on specific social groups that interact in local contexts. Instead, the emphasis is on the role of collectively shared rules and values that transcend local contexts, on culturally rooted traditions that derive their strength from the fact that they are shared by many people. The "technological frame" concept, for instance, allows for actors who have different degrees of inclusion in different frames, but the conceptions of "irreversibility," "path dependency," and "archetype" suggest a more comprehensive or pervasive quality of technological artifacts. It will be evident that this broader cultural conception of obduracy that focuses on persistent traditions enables a further operationalization of the linkages between urban technology and the wider cultural context. The main contrast with the category of "relational" conceptions of obduracy discussed under "embeddedness" lies in this category's emphasis on longer-term continuities, whereas conceptions of embeddedness do not specifically focus on such patterns and long-term (cultural) traditions.

Comparison of the Three Approaches of Obduracy

The models highlight different yet equally relevant interpretations of the phenomenon of obduracy. The three categories are schematically represented in table 1.2. When it comes to our understanding of obduracy, then, the various disciplines—architecture, history of planning, geography, history, sociology of technology—offer similar or interconnected conceptual tools. The use of concepts related to "paradigms" is apparent in both STS and planning history; consider, for

Table 1.2 Three models of obduracy.

	Dominant frames	Embeddedness	Persistent traditions
Explanatory mechanisms	Obduracy explained by constrained ways of thinking and interacting	Obduracy explained by close interconnectedness of social and technical elements	Obduracy explained by long-term persistence of traditions
Concepts and metaphors	Technological frames; paradigms; mental models; professional worldviews	Actor networks; irreversibility; fixity and mobility of space	Momentum; trajectories; path dependence; city-building regimes; archetypes
Disciplinary background or intellectual tradition	Social Construction of Technology; history of planning	Actor-Network Theory; urban geography	Large technical systems approach; history of technology; urban history; evolutionary economics
Type of explanation	Interactionist conception of obduracy	Relational conception of obduracy	Enduring conception of obduracy

instance, the concepts of "technological frame" and "mental model" in STS and the concept of "professional worldviews" in the history of planning. Moreover, there have already been attempts to apply concepts originally developed for the analysis of other technical systems or artifacts to the analysis of cities, of city planning, or of urban artifacts. (Examples include Aibar and Bijker's analysis of Barcelona using SCOT and Latour's story about the subway tunnels in Paris.)

If obduracy is mainly associated with dominant frames, we deal with an *interactionist* conception according to which obduracy can be the result of interactions between various groups of actors. The interactions between the actors are structured and often constrained by the meanings and values they attribute to technologies. In contrast to interactionist conceptions, explanations of obduracy in terms of embeddedness and persistent traditions no longer take social groups as a starting point. Embeddedness involves a *relational* conception of obduracy: it can be explained by the interrelatedness of heterogeneous elements in a socio-technical ensemble. Obduracy may be the direct result of, for instance, tight relations between the various material and non-material elements. An explanation of obduracy in terms of persistent traditions, my third category, differs from the others because of its more enduring character—its focus on longer-term processes that are deeply rooted in culture at large and that, depending on the specific tradition or pattern, may vary only slightly. A clear difference with the category of frames is its focus on collectively shared rules and values that transcend specific groups and local contexts. Whereas concepts in the category of frames highlight the differences between social groups, a focus on persistent traditions reveals the similarities, what is shared among groups: no group or single actor can easily escape from influential and lasting traditions.

There are also substantial differences between the conceptual frameworks as such, even within STS.[81] The STS approaches discussed—Actor-Network Theory (ANT), Large Technical Systems (LTS), and Social Construction of Technology (SCOT)—originate in different theoretical traditions. ANT grew out of semiotics; LTS is an offshoot of the history of technology and business history; SCOT has roots in symbolic interactionism. Although all three approaches rely on the "seamless web" metaphor as a starting point for research, ANT differs from the others by not accepting a fundamental distinction between human and non-human actors. ANT theorists embrace the "principle of generalized symmetry," which means that the same theoretical framework should be applied to the analysis of human and non-human actors. SCOT emphasizes interactions between "relevant social groups" and the meanings they give to a certain technological artifact. The concept of "technological frame" was introduced to avoid social reductionism.[82] At the same time, it is clear that "materiality" assumes different guises depending on which of the three models one chooses. ANT gives greater weight to material things; SCOT gives greater explanatory weight to social groups. The persistent-traditions model pays less attention to technology and does not emphasize the role of social groups but focuses more on long-term structural developments.

Furthermore, the wide range of "units of analysis" and "research sites" in the various approaches deserves mention. Technological frames and mental models are related to artifacts or technical objects; irreversibility is related to actor networks. How, then, are the three broad categories of conceptions of obduracy that I identified to be "translated" into a useful apparatus for approaching the issue of obduracy in processes of urban socio-technical change?

As I noted earlier, my interest in obduracy is motivated mainly by my concern for efforts that are aimed at reshaping urban technology. None of the concepts discussed above is entirely appropriate for analyzing such efforts. There are two reasons for this: (1) Some of the concepts are related to technological objects and are thus not specifically focused on the analysis of processes of socio-technical change in the city. (2) Most of the concepts discussed address the initial shaping of technology rather than its redesign in the context of urban renewal. Nevertheless, it would of course be a great mistake to reject these conceptions of obduracy altogether. At least some of the concepts discussed have already proven their usefulness in analyzing processes of urban redesign. That other concepts have not yet been applied to the city does not mean that it is impossible or unproductive to do so. By integrating elements of the three conceptions that have been shown to be fruitful in previous analyses, I focus my argument on those elements that I find particularly useful for the analysis of obduracy in cities:

- The frames model emphasizes obduracy in design processes. Studying obduracy in urban redesign involves identifying the actors involved in local planning processes and "unbuilding" activities and analyzing their potentially conflicting ways of thinking.
- Embeddedness emphasizes the interrelatedness of human and non-human elements in an urban socio-technical ensemble. This notion nicely captures the heterogeneity of cities: streets, buildings, distribution networks, development plans, politicians, and pressure groups together constitute the large, complex socio-technical ensemble that the city is. In cities, infrastructure, laws and regulations, traffic schemes, usage, urban policies, and planning structures are closely interconnected. In specific circumstances, this can result in the obduracy of individual elements or of the ensemble as a whole.
- A focus on persistent traditions highlights how cultural and collective traditions that persist over a longer period of time and transcend local contexts and group interactions contribute to the obduracy of urban structures. For example, long-term, long-standing traditions of architecture or of planning play a major role in the constitution of the obduracy or malleability of a city's parts.

Apart from this theoretical exploration of conceptions of obduracy in urban socio-technical change, a confrontation between these theoretical conceptions and my empirical case studies is needed in order to refine the conceptions and gain insight into the tensions between obduracy and change in urban redesign projects, and to elaborate on how STS can contribute to studying cities. In the following chapters, I will analyze case studies of the tensions between obduracy and change in three ongoing urban redesign projects in the Netherlands: the redesign of Hoog Catharijne as part of the Utrecht City Project, the highway reconstruction in Maastricht, and the spatial renewal of the Bijlmermeer. I rely on the three models of obduracy discussed above as ways of exploring the explanatory power and specificity of these conceptions in these case studies.

Attempting to apply the three models makes their relevance clear and shows the extent to which they need to be adjusted.

The first goal of this book is to analyze the tension between obduracy and change in three major urban redesign projects in the Netherlands, covering the period between the 1960s and the 1990s. The second goal is to make a specific contribution to the theoretical understanding of the role of obduracy in urban socio-technical change. The first goal has strong historical overtones; the second has a decidedly theoretical orientation. The third goal is to bring the city into the limelight of Science, Technology, and Society studies and to introduce STS to urban scholars. Conceptualizing the city as a socio-technical artifact, I will try to find out to what extent STS concepts can be useful to investigate processes of urban change. The final aim of this book is to contribute to a productive fusion between STS and studies of the city.